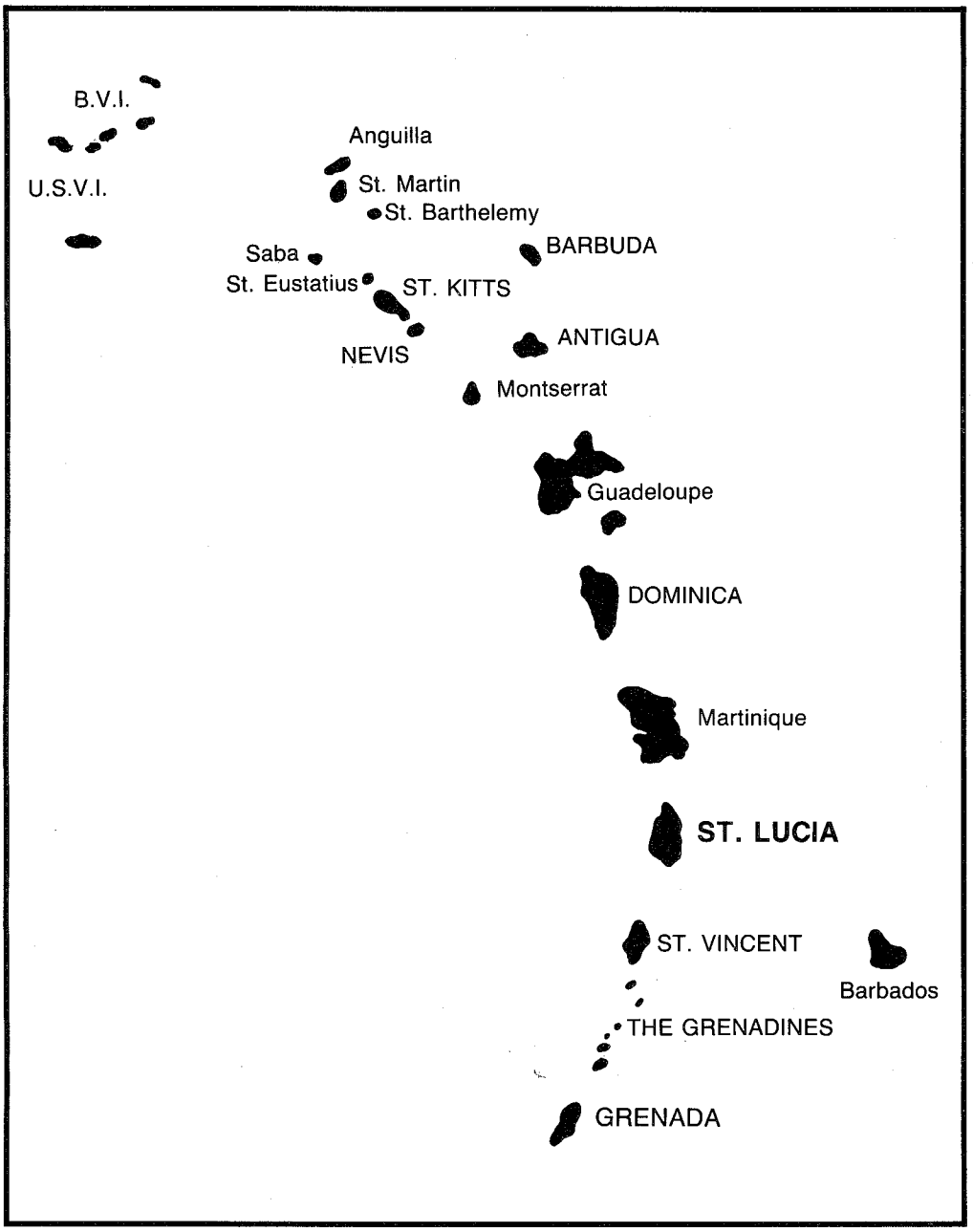
ST. LUCIA



Environmental Profile

S T. L U C I A

COUNTRY ENVIRONMENTAL PROFILE

Prepared Under the Aegis Of:

THE CARIBBEAN CONSERVATION ASSOCIATION
St. Michael, Barbados

On Behalf Of:

THE GOVERNMENT OF ST. LUCIA
Ministry of Planning, Personnel, Establishment and Training

With the Technical Support Of:

THE ISLAND RESOURCES FOUNDATION
St. Thomas, U.S. Virgin Islands

And

THE NATIONAL RESEARCH AND DEVELOPMENT FOUNDATION OF ST. LUCIA
Castries, St. Lucia

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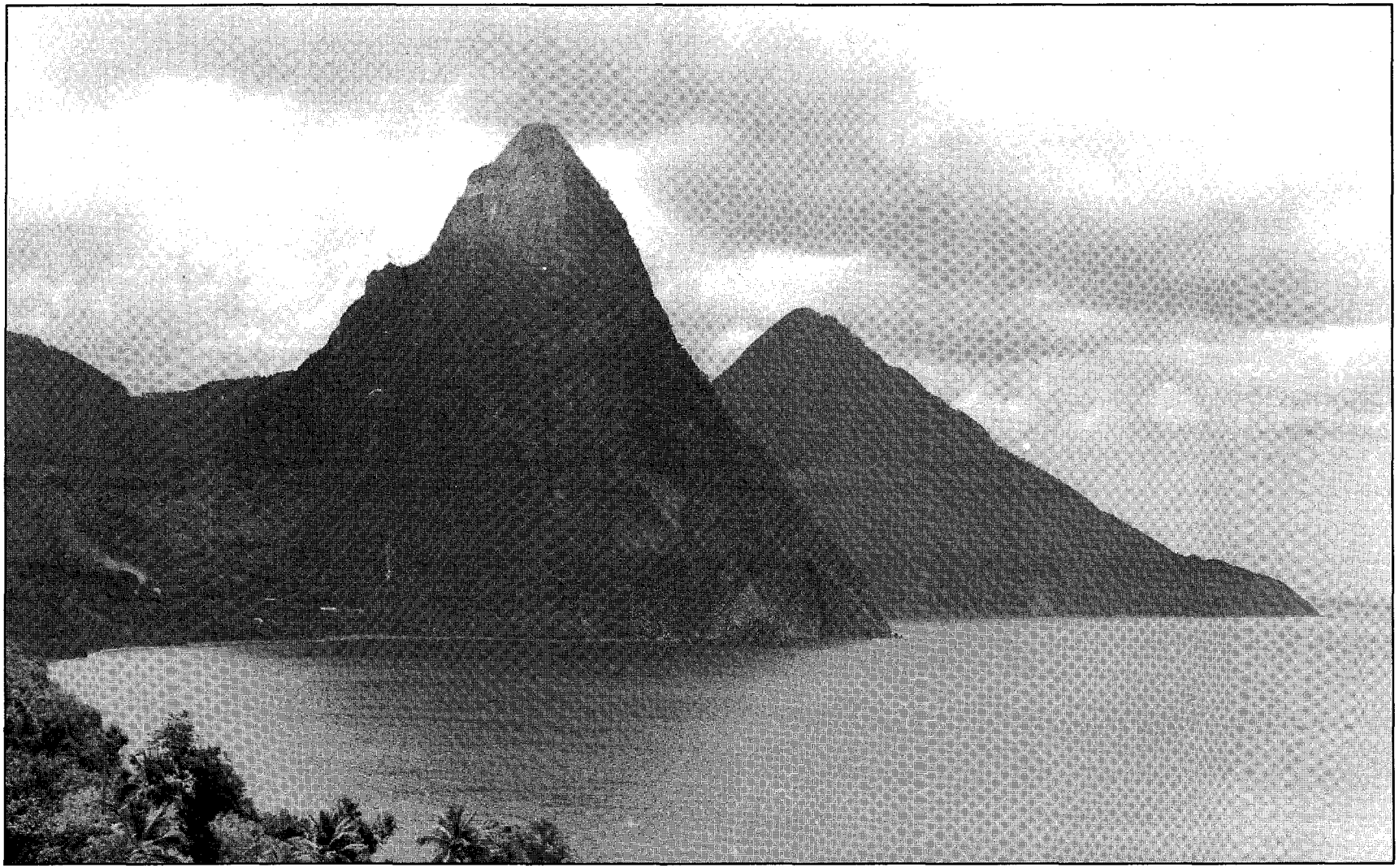

The Pitons, St. Lucia, on a cloudy day.

FOREWORD

One of the most serious threats to sustainable economic growth in the Caribbean is the increasing degradation of the region's natural ecosystems and a concurrent deterioration in the quality of life for Caribbean people. The task of reversing this unfortunate trend requires better knowledge and understanding of the region's unique environmental problems and the development of appropriate technologies and public policies to lessen and even prevent negative impacts on our fragile resource base.

In an attempt to provide such a framework, the Caribbean Conservation Association, with funding provided by the United States Agency for International Development and with the technical assistance of the Island Resources Foundation, has produced a series of Country Environmental Profiles for six Eastern Caribbean countries -- Antigua and Barbuda, Dominica, Grenada, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines.

Even though these documents do not claim to be encyclopedic in their treatment of individual sectors and issues, each Profile represents the most current and comprehensive information base assembled to date on environmental and conservation issues that affect, and are affected by, the development process in the Profile countries.

Each document addresses key environmental problems, constraints, and policy directions as these were identified and fleshed out by a team of researchers and writers, in collaboration with a local coordinating committee. Each Profile also identifies and examines a variety of opportunities and planning tools which may prove useful in meeting environment/development goals in the future. All of this information should play a significant role in informing and influencing ecologically-sound development planning in the region, and should provide a basis for improved decision-making -- both immediate as well as long-term. This may best be accomplished by using the data to define priorities (in view of related benefits and costs), to pursue in-depth analysis of issues, and to undertake necessary follow-on activities in such a way that they are mutually reinforcing. In short, action emanating from the recommendations contained in the Profile might best be undertaken within a comprehensive environmental management framework, rather than from a piecemeal, project-oriented perspective.

The Caribbean Conservation Association is very pleased to be able to make this contribution to development planning in the region.

Calvin A. Howell
Executive Director
Caribbean Conservation Association

(April 1991)

ACKNOWLEDGEMENTS

Overall project management for the St. Lucia Country Environmental Profile Project was provided by the Caribbean Conservation Association under the direction of Mr. Michael I. King, assisted by Projects Officer, David Simmons. Mr. Yves Renard, president of the Caribbean Conservation Association and a resident of St. Lucia, was extremely helpful to staff in executing the project.

Technical guidance in preparation of the Profile was the responsibility of Island Resources Foundation, with Edward L. Towle serving as team leader and Judith A. Towle as senior report editor. Mr. Paul Hippolyte served as IRF's in-country staff person for the Profile.

St. Lucia Government liaison for the CEP effort was the Central Planning Unit under the leadership of Mr. Ausbert D'Auvergne. Project coordination in St. Lucia was handled by the National Research and Development Foundation, whose director, Mrs. Patricia Charles, and her ever diligent staff, including Senior Project Officer, Mr. Felix Finisterre, provided assistance and support to in-country and visiting investigators.

Staff of the U.S. Agency for International Development have facilitated implementation of this project, in particular James Talbot, former Caribbean Regional Environmental Specialist and his successor, Andre de Georges; James Hester and Gregory Miller of AID's Environment, Energy and Science Staff in Washington, D.C.; and Michael Huffman, former Environmental Officer at USAID's Regional Development Office in Barbados and his successor, Rebecca Niec.

Many other organisations and individuals gave valuable and much appreciated assistance during the course of the project. Particular recognition is due to those whose names are cited on the following two pages.

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(June 1988)

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SECTION 6: SYNTHESIS OF ENVIRONMENTAL ISSUES AND RECOMMENDATIONS

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ACRONYMS USED IN THE ST. LUCIA COUNTRY ENVIRONMENTAL PROFILE

BDD	British Development Division
CARDI	Caribbean Agricultural Research and Development Institute
CARICOM	Caribbean Community
CCA	Caribbean Conservation Association
CDB	Caribbean Development Bank
CEHI	Caribbean Environmental Health Institute
CEP	Country Environmental Profile
CERMES	Centre for Resource Management and Environmental Studies
CFTC	Commonwealth Fund for Technical Co-operation
CIDA	Canadian International Development Agency
CPU	Central Planning Unit
CSC	Commonwealth Science Council
CTRC	Caribbean Tourism Research and Development Centre (renamed Caribbean Tourism Organisation, CTO)
CZM	Coastal Zone Management
DCA	Development Control Authority
ECNAMP	Eastern Caribbean Natural Area Management Programme (renamed Caribbean Natural Resources Institute, CANARI)
EDF	European Development Fund
EEC	European Economic Community
EEZ	Exclusive Economic Zone
EHO	Environmental Health Officers
EIA	Environmental Impact Assessment
ERP	Environmental Research Projects
FAO	Food and Agriculture Organisation of the United Nations
FMU	Fisheries Management Unit
GDP	Gross Domestic Product
GIS	Geographic Information System
GOSL	Government of St. Lucia
GTZ	German Agency for Technical Co-operation (Deutsches Gessellschaft fur Technische Zusammenarbeit)
HIAMP	High Impact Agricultural Marketing and Production (USAID)
HOSLL	Hess Oil St. Lucia Ltd.
HOVIC	Hess Oil Virgin Islands Corporation
ICBP	International Council on Bird Preservation
ICOD	International Centre for Ocean Development (Canada)
IDRC	International Development Research Centre
IICA	Inter-American Institute for Co-operation on Agriculture
IRF	Island Resources Foundation
IUCN	International Union for the Conservation of Nature and Natural Resources
LRTP	Land Registration and Titling Project
LUCELEC	St. Lucia Electricity Services

MOA	Ministry of Agriculture, Lands, Fisheries and Co-operatives
MOH	Ministry of Health, Housing, Labour, Information, and Broadcasting
NCS	National Conservation Strategy
NDC	National Development Corporation
NGO	Non-Government Organisation
NRDF	National Research and Development Foundation of St. Lucia
OAS	Organisation of American States
OECS	Organisation of Eastern Caribbean States
OECS-NRMP	Organisation of Eastern Caribbean States-Natural Resources Management Project
PAHO	Pan American Health Organisation
PPU	Physical Planning Unit (of the Central Planning Unit)
PRB	Population Reference Bureau
SLBGA	St. Lucia Banana Growers Association
SLNT	St. Lucia National Trust
STAFCO-OP	St. Lucia Association of Farmers Co-operatives
TFR	Total Fertility Rate
UNDP	United Nations Development Programme
UNDTCD	United Nations Department of Technical Co-operation for Development
UNEP	United Nations Environment Programme
USAID	U.S. Agency for International Development
UWI	University of the West Indies
WASA	Water and Sewerage Authority
WHO	World Health Organisation
WINBAN	Windward Islands Banana Growers Association
WRIU	Water Resources and Irrigation Unit
WWF	World Wildlife Fund

ABBREVIATIONS USED IN THE ST. LUCIA COUNTRY ENVIRONMENTAL PROFILE

ac	acre
BOD	biochemical oxygen demand
cm	centimetre
EC$	Eastern Caribbean Dollar
ft	foot
g	gram
gpd	gallons per day
ha	hectare
in	inch
kg	kilogram
km	kilometre
kn	knot
kV	kilovolt
l/s	litre per second
lb	pound
m	metre
MGD	million gallons per day
mi	mile
ML	millions of litres
mm	milimetre
MW	megawatt
US$	American Dollar (US$1.00 = EC$2.70)

CONVERSION CO-EFFICIENTS BETWEEN IMPERIAL MEASURES AND WEIGHTS AND THE METRIC SYSTEM

	IMPERIAL	METRIC SYSTEM
LENGTH	1 inch	2.540 centimetres
	0.39370 inch	1 centimetre
	1 yard	0.91440 metre
	1.094 yards	1 metre
	1 mile	1.609 kilometres
	0.6214 mile	1 kilometre
	1 fathom (6 feet)	1.829 metres
AREA	1 square foot	0.093 square metre
	10.6 square feet	1 square metre
	1 acre	0.405 hectare
	2.471 acres	1 hectare
	1 square mile	2.59 square kilometres
	0.386 square mile	1 square kilometre
VOLUME	1 pint	0.568 litre
	1.76 pints	1 litre
	1 gallon	4.546 litres
	0.220 gallon	1 litre
	1 cubic foot	0.028 cubic metre
	35.31 cubic feet	1 cubic metre
WEIGHT	1 pound	0.4536 kilogram
	2.205 pounds	1 kilogram
	1 long ton	1016 kilograms
	1 short ton	907.185 kilograms
	0.9842 long ton	1 tonne (1,000 kilograms)
	1.102322 short ton	1 tonne (1,000 kilograms)
TEMPERATURE	Conversion F to C: subtract 32 and divide by 1.8	Conversion C to F: multiply by 1.8 and add 32

Bananas on level land suitable for irrigation.

Bananas on unsuitable, very steep land showing significant landslide effects. Note five human figures on edge of landslide, upper left, for scale.

INTRODUCTION

Preparation of Country Environmental Profiles (CEP) has proven to be an effective means to help ensure that environmental issues are addressed in the development process. Since 1979, the U.S. Agency for International Development (USAID) has supported Environmental Profiles in USAID-assisted countries, principally in Latin America and the Caribbean. CEPs completed to date have provided:

(1) a description of each country's natural resource base, including a review of the extent and economic importance of natural resources and changes in the quality or productivity of those resources;

(2) a review of the institutions, legislation, policies and programmes for environmental planning, economic development and natural resource management;

(3) identification of the major issues, conflicts or problems in natural resource management and opportunities for effective responses.

Profiles have highlighted gaps in the existing information base, influenced the design and funding of development programmes, pinpointed weaknesses in regulatory or planning mechanisms, and illustrated the need for changes in policies. Most importantly, the process of carrying out a profile project has in many cases served to strengthen local institutions and improve their capacity for incorporating environmental information into development planning.

PROFILES FOR THE EASTERN CARIBBEAN

Country Environmental Profiles have been prepared for several countries in the Wider Caribbean Region, including Panama, Belize, the Dominican Republic, Haiti, and Jamaica. The potential utility of CEPs in the Eastern Caribbean sub-region (essentially the OECS countries) has been a subject of discussion since the early 1980's. The need for the profiling process to begin in those countries was reaffirmed during a seminar on Industry, Environment and Development sponsored by the Caribbean Conservation Association (CCA) and the University of the West Indies in August 1986.

Shortly thereafter, USAID entered into a Cooperative Agreement with CCA for preparation of a series of CEPs for the Eastern Caribbean. It was decided to begin the profile process in the country of St. Lucia as a pilot project, to be immediately followed by profiles for Grenada, Dominica, and St. Kitts-Nevis. The phasing-in of profiles in other Eastern Caribbean countries, as well as production of a regional, synthesis profile for the sub-region, is a possibility for a later date.

Early in 1987, CCA and the Island Resources Foundation (IRF), of St. Thomas, U.S. Virgin Islands, entered into an agreement whereby it was determined that IRF would provided technical assistance and support to CCA in the execution of the profile project in the Eastern Caribbean. The Executive Director of the Caribbean Conservation Association is the CEP Project Director, while the President of the Island Resources Foundation serves as CEP Project Manager/Team Leader.

THE ST. LUCIA COUNTRY ENVIRONMENTAL PROFILE

In May of 1987 a Memorandum of Understanding was signed by CCA and the Government of St. Lucia (GOSL) for the purpose of executing a Country Environment Profile, with the Ministry of Planning, Personnel, Establishment and Training the designated counterpart agency for the Government of St. Lucia. Shortly thereafter, CCA signed a second Memorandum of Understanding with the National Research and Development Foundation of St. Lucia (NRDF), wherein NRDF was

designated as the local implementing and co-ordinating organisation in St. Lucia for the CEP project.

A CEP National Committee was formed as an advisory and review body for the CEP project in St. Lucia. The committee is comprised of representatives from GOSL agencies and private sector organisations with responsibilities for or expertise about environmental issues in the country. The first meeting of the committee was convened in June of 1987, and the group has met consistently throughout the project.

The first task of the National Committee was to assist the technical team from IRF in drafting the CEP report outline and, once it was finalised and approved, to identify local experts to assist in compiling information and data for sector reports. After local consultants were selected and their services had been contracted for by NRDF, each was given an appropriate assignment to produce draft issue papers, which were subsequently reviewed by the full Committee and the IRF technical team. From within Government, local contributors represented the Ministries of Agriculture, Health, and Education, the Central Planning Unit, the National Trust and the Water and Sewerage Authority. Additionally four persons from the private sector and representatives from the St. Lucia-based Caribbean Environmental Health Institute were selected to participate in the CEP project.

While the draft issue papers were being prepared, IRF began an extensive literature review of extant reports, documents, and other information and data available on St. Lucia's environment. The literature search was carried out in St. Lucia, Barbados, U.S. Virgin Islands and Washington, D.C. A key-word bibliography of St. Lucia environmental references was eventually prepared using a computerized data management software programme, REFMENU (based on dBase III Plus). Total entries exceed 400 and are coded not only by key words but also to identify the location(s) where the document may be found. This information has been entered on a computer maintained by NRDF and will serve as a reference source for future investigators in St. Lucia.

The sector and sub-sector papers received from local consultants formed a reference point for further in-depth research and writing by investigators from the IRF project team, who completed the final draft of the St. Lucia Country Environment Profile in June of 1988. The draft was widely circulated in the country, to both public and private sector reviewers. Additional meetings of the National Committee were held to consider specific sections of the Profile document, with particular attention given to the chapter on institutional development.

ORGANISATION OF THE ST. LUCIA CEP REPORT

As determined by the St. Lucia CEP National Committee, this Profile has been organised in six major sections, as follows:

Chapter 1 provides a very detailed description of the country, focusing on the natural and physical environments in sufficient depth to allow the reader to approach the sector chapters with an increased understanding of how the natural and physical parameters of the place influence and determine the environmental issues. Section 1 also includes a discussion of land capability and land use, demographic information, and historical and economic background.

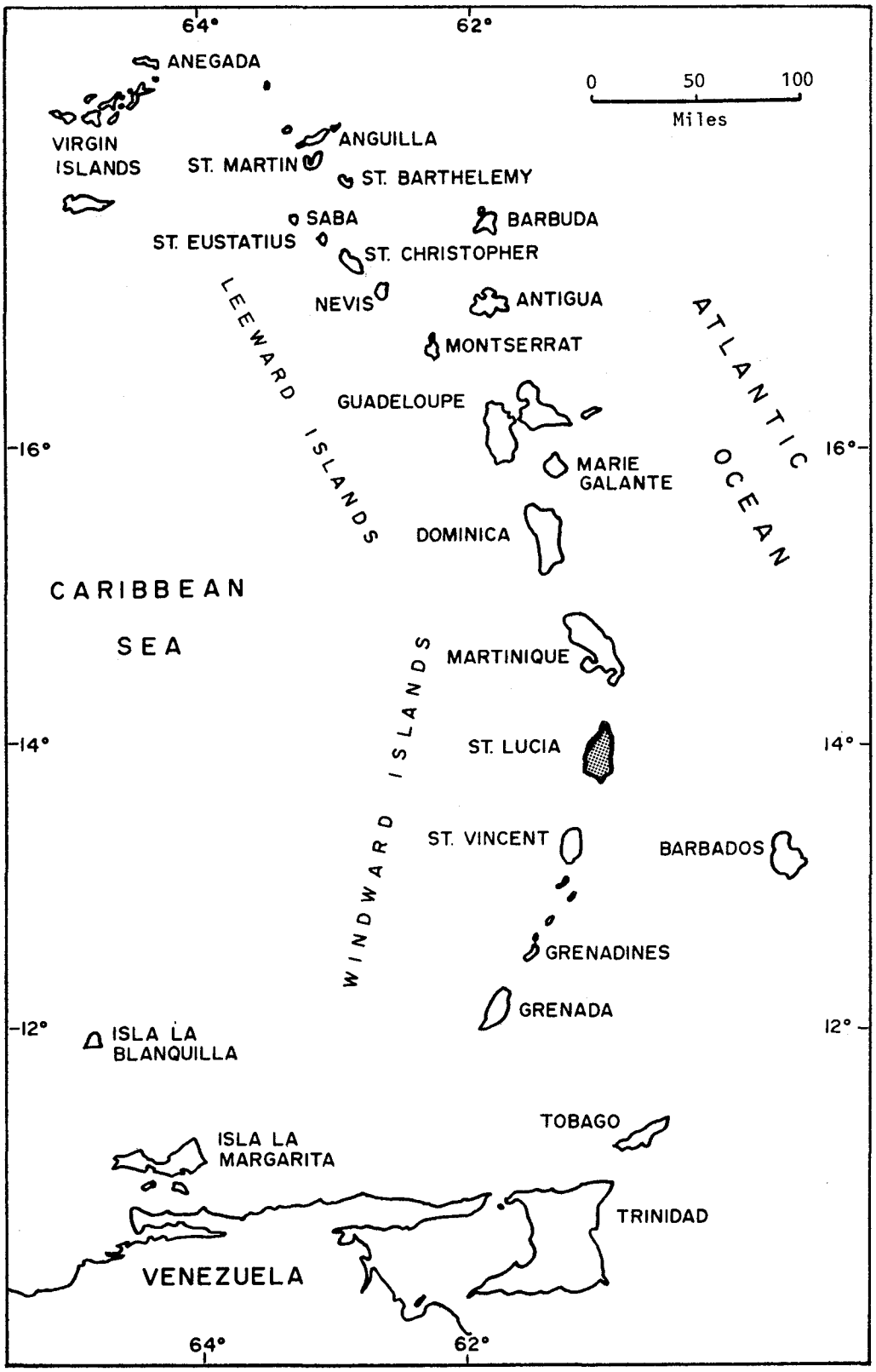
Chapter 2 has been organised around the theme of "common property resources" and identifies those elements of the resource base which exhibit common property characteristics, specifically: forestry, wildlife, water, and marine and coastal resources. The section also examines the role of conservation and preservation programmes in St. Lucia (e.g., parks, reserves, sanctuaries, archives, and museums) and concludes with a discussion of natural hazards which affect all elements of the common property resource base.

Chapter 3 concerns the rural environment and focuses on agriculture and its key place in the St. Lucian social and economic framework. The roles of both large estate agriculture and the small farm system are examined, as are current trends in land use patterns.

Chapter 4, as a counterpoint to Chapter 3, concerns the urban environment and focuses on the industrial activities of St. Lucia and their impact on the environment. The chapter opens with a discussion of the country's leading growth industry, tourism, and follows with a look at other sectors of the economy: mining, wholesale and retail business, utilities, transportation, infrastructure, manufacturing, construction, and financial institutions. The chapter closes with a review of energy resources and requirements.

Chapter 5 focuses on the institutional framework for environmental management in St. Lucia. Although each of the sector chapters in Chapters 2-4 includes an institutional/legislation component, Chapter 5 of the Profile brings all this information together for analysis. The chapter includes an overview of the historical development of environmental management in St. Lucia and reviews GOSL agencies with environmental responsibilities (i.e., agencies with resource planning and control, management, regulation, conservation, coordination, and development responsibilities). The non-government sector is also discussed, as is the role of research and development assistance agencies. The chapter concludes with policy recommendations for Government and for local institutional development.

Chapter 6 summarises the key environmental issues and problems facing St. Lucia and makes policy and programme-specific recommendations to enhance the achievement of a sustainable balance between resource development on the one hand and resource conservation and resource management on the other.



EASTERN CARIBBEAN ISLANDS

1. THE GENIUS OF THE PLACE

". . . in everything, respect the genius of the place."

(Alexander Pope, Essays on Man, 1733)

1.1 PHYSICAL AND NATURAL ENVIRONMENTS

1.1.1 The Place: A Descriptive Overview

Within the so-called Antillean Archipelago or garland of Eastern Caribbean islands that sweeps in such a graceful curve from Puerto Rico in the north to Trinidad near the old Spanish Main, one finds, just south of the arc's midpoint at Latitude 14 degrees North, the fortunate island of St. Lucia (Figure 1.1(1)), perched somewhat precariously on the submerged (and therefore hidden) ancient volcanic ridge secretly connecting Martinique to the north with St. Vincent to the south. This underwater ridge, or St. Lucian "sill" (see Figure 1.1(2)), serves two purposes. First, it provides a pediment or base for St Lucia, in effect, keeping the island above sea level. Secondly, as part of the easterly edge of the Caribbean basin, the ridge effectively separates the wide and deep Atlantic abyss from its smaller Caribbean counterpart, the dark, 12,000 foot-deep (4.1 km) Grenada trough which lurks beneath the ocean surface immediately west of St. Lucia.

What kind of island is St. Lucia? Where does it fit in the global scheme of insular taxonomy? To begin, St. Lucia is volcanic and monolithic, comprising one main island with only a few miniscule nearshore satellite islets. As part of the Lesser Antilles cluster, in effect an "archipelagic" island, St. Lucia enjoys the best of both insular worlds (oceanic and coastal), displaying on the one hand oceanic features: discrete smallness, psychological independence, an unambiguous national identity and a generally pristine environment distant from more polluted continental areas. But it is, on the other hand, situated near well-serviced sea and air transport routes, conveniently located in the trade wind belt, and is surrounded at a near distance by non-threatening small island neighbours.

Wholly apart from its locational advantages, St. Lucia enjoys the luxury of voluptuously green mountain landscapes, rich and exotic flora, ample fresh water, a salubrious maritime climate and a superior natural harbour. As far as natural endowments go in the normally resource-poor, constrained world of islands, St. Lucia is rather more fortunate than most.

This fact caught the attention of the first European explorers of the New World, although Columbus, who missed St. Lucia on his first three visits, somehow managed to avoid it again on his fourth and final voyage by turning right instead of left when he made his landfall at Martinique in June of 1502. Some scholars insist that Columbus did, in fact, "see" the island now called St. Lucia in the distance to the southwest as he approached Martinique, but the significance of this hypothetical circumstance does not seem to matter to present day St. Lucians. In retrospect, Columbus simply missed his chance. The real "discoverer" of St. Lucia was undoubtedly some unknown fearless and perhaps foolish seafaring Amerindian taking his dugout canoe out for an island-hopping adventure as the area's first trend setting tourist.

After Columbus took the wrong turn, however, his immediate successors did better, and St. Lucia became the object of a series of Spanish landfalls and subsequently French and English exploratory settlements, of disputed title claims, and of private and imperial military invasions extending over the seventeenth and eighteenth centuries. Some were more successful than others, and the island changed hands (as well as flags and languages) on at least fourteen occasions, the last being in 1814. Testimony to the tenacity and

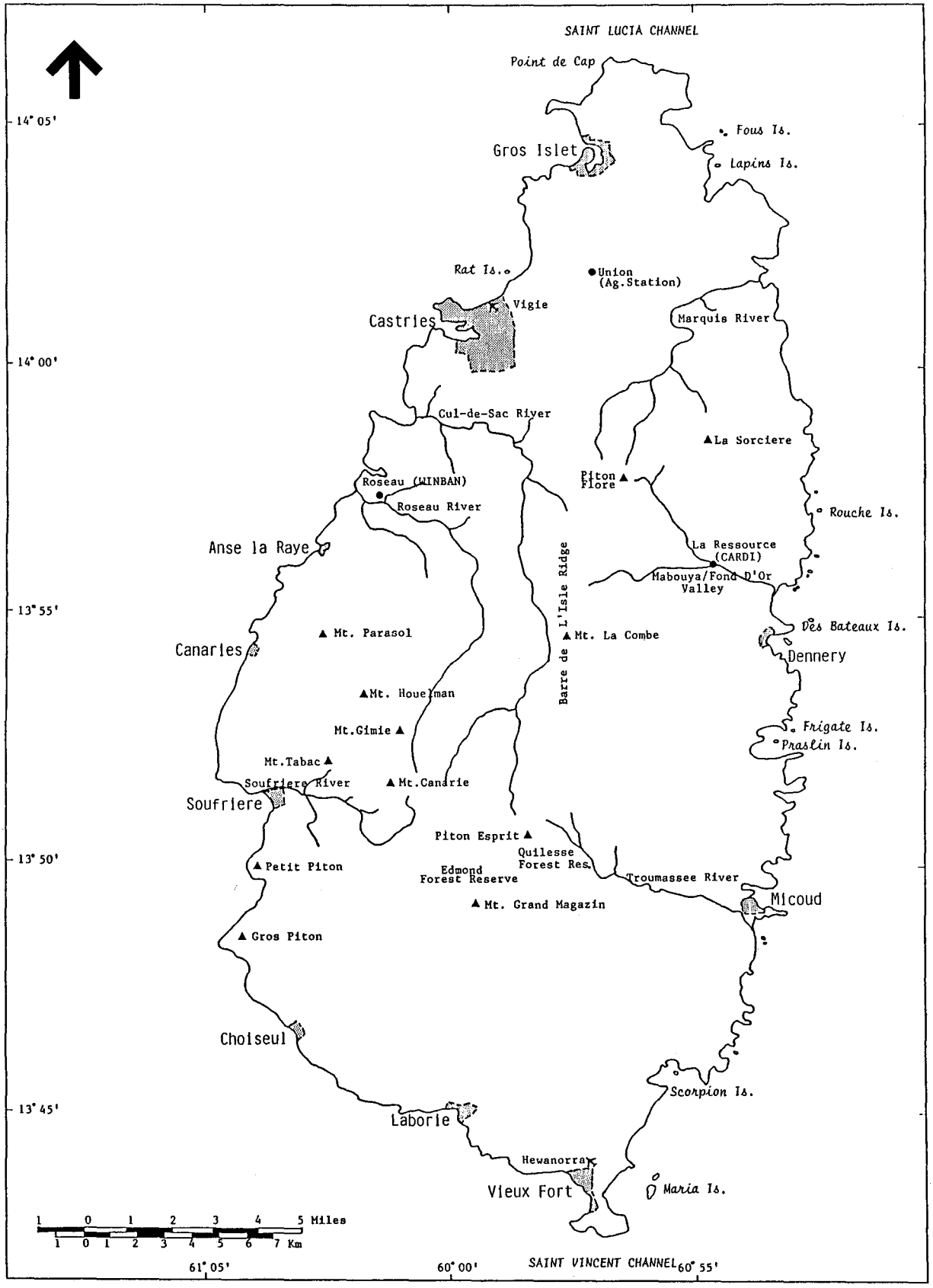


Figure 1.1(1). Location map, St. Lucia.

scope of French colonisation activities in St. Lucia is found in the fact that virtually all geographic places and geophysical features retain their original French names, while French patois remains the language of the vernacular.

COASTAL APPROACHES

Northward of St. Lucia, looking toward the island of Martinique, lies the famous, broad and blustery "St. Lucia Channel" which leads from the Atlantic Ocean into the Caribbean Sea. This often choppy, heavily used channel is about eighteen miles wide and a little more than 800 metres (450 fathoms) deep at the "sill," except on the southernmost end where the top of the submerged ridge rises to the 100 fathom (175 metre) mark nearly four and a half miles offshore north of Point de Cap.

For the rest of the island, however, including the 25 mile (40 km) wide St. Vincent passage to the south, St. Lucia exhibits relatively bold bluff shorelines, a fairly narrow submerged coastal shelf and is generally clear of off-lying dangers to navigation. In fact all coastal hazards that might endanger approaching vessels are contained "close in," within the 18 metre (ten fathom) curve which generally lies a mile or so from shore (except in the extreme north and south). This navigational advantage, however, also means that the narrower, shallow shelf presents a rather limited target area for fishermen, yachtsmen, and divers and a more restricted substrate for energy absorbing coral reef and seagrass ecosystems (both of which are highly efficient, productive marine habitats requiring specific ranges of water depth and clarity).

On the windward (or upwind) side, St. Lucia is like most Eastern Caribbean islands -- exposed to the full impact of the Atlantic Ocean and its easterly and northeasterly trade winds, waves, swells and storm systems. There are no secure, accessible anchorages on this Atlantic shore, and its few natural harbours of refuge lack marked channels and require local knowledge for use.

By way of contrast, the leeward (downwind side) anchorages and harbours on the southwestern and western coasts have good holding ground, easy access, and generally secure protection against heavy swells, abnormal tidal currents and contrary winds. The main harbour, Port Castries, is an excellent, though small, well-protected facility with containership, reefer and breakbulk cargo handling capability plus a new cruise ship terminal, tug service, fisheries complex and the beginning of a waterfront renewal programme.

All things considered, the island of St. Lucia is, at once, both compact and complex, full of juxtaposed dissimilarities and contrasts with closely interlocked ecosystems. And it is small, with a land area of 616.4 sq km (238 square miles) and maximum dimensions of 42 km (27 miles) long and 22 km (14 miles) wide. By way of comparison with its immediate neighbours, Dominica and Martinique to the north are half again larger and more mountainous, while St. Vincent and Grenada to the south and Barbados a hundred miles to the southeast are all slightly smaller and less rugged with the last, Barbados, having a completely different geologic history as an uplifted limestone platform capping an ancient volcanic base.

1.1.2 Climate

REGIONAL SETTING: THE ARCHIPELAGIC ENVIRONMENT

The normal climate of the oceanic region at Latitude 14 degrees North in the western reaches of the Atlantic is characterised by a pleasant average temperature of about 78 degrees F (27 degrees C) and a relative humidity of about 75 percent with little seasonal or diurnal variation and a fairly constant, strong wind out of the east. Rain tends to be showery and is distributed roughly into a drier season from January to May and a wetter season from June to December, with a risk of hurricanes from late June to early October and the threat of severe tropical storms with high winds and very heavy rains often through November.

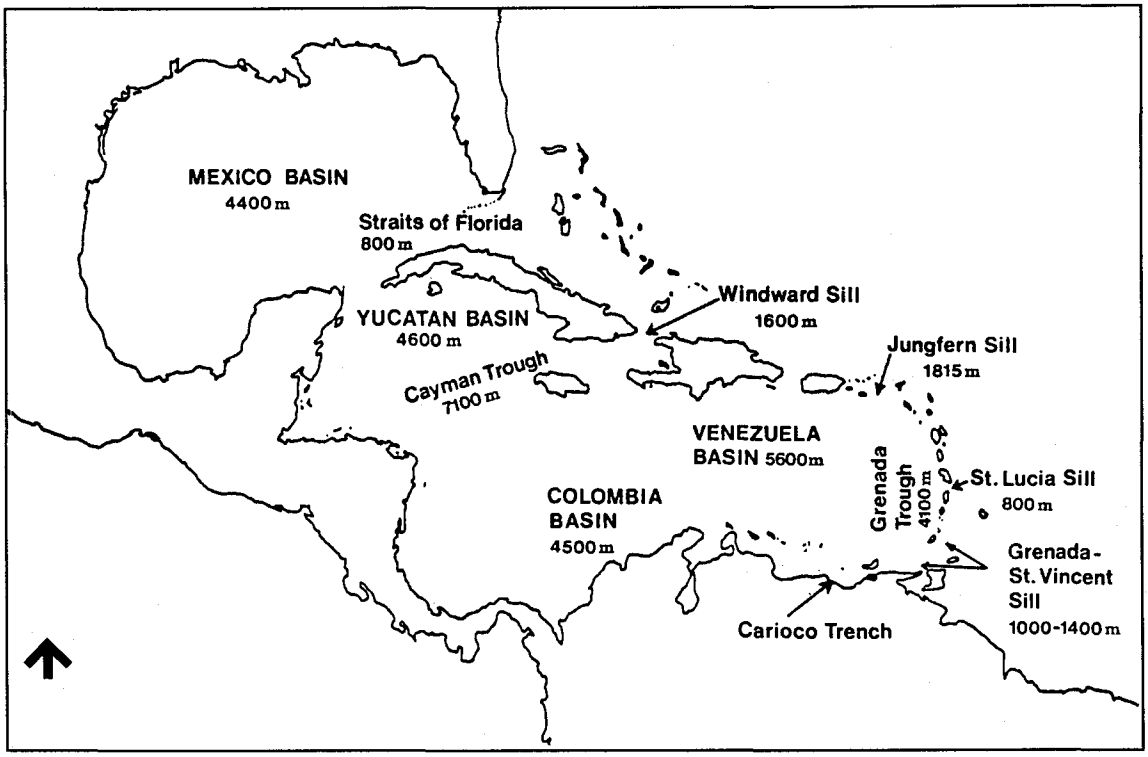


Figure 1.1(2). Caribbean basin bathymetry and entrance sill depths. Note the shallow 800m St. Lucia Sill east of the Grenada Trough (source: Rodriguez, 1981).

WINDS: THE OCEANIC ENVIRONMENT

The Windward Island group of which St. Lucia is a part is located within the belt of "trade winds" famous among seamen for their directional reliability and generally predictable schedule. These winds move westerly along the southern edge of the Atlantic-Azores sub-tropical high pressure zone and approach St. Lucia from directions between east-north-east to east-south-east. Changes in this wind regime are mostly caused by the annual seasonal (vernal and autumnal) shift in the declination of the sun from the equator, with stronger, more northerly winds being common from December to May. Disturbances to this system can be induced by the passage of so-called "easterly waves" in the upper atmosphere and other low pressure systems during the "wet season."

Statistical data on wind speed and direction at sea in the environs of St. Lucia are presented in Table 1.1(1). It is obvious that for 95 percent of the time the trade winds are true to form and blow out of the northeast, east and southeast. However, for the leeward coast ports which face west, the four percent frequency of occurrence of wind from south, west and north should not be ignored (especially given wave refraction behaviour on an island like St. Lucia which has steep-to approaches and no barrier reefs to speak of).

WINDS: THE LAND ENVIRONMENT

These odd periods of westerly, northerly and southerly winds average nearly 18 days per year of potentially destructive, abnormal, high risk conditions with wind-driven waves and swells assaulting west-facing roadsteads and coastlines. Generally speaking, the isolated day or two day period with a mild westerly wind is no cause for alarm.

But an extended period of three or four consecutive days with a stronger westerly wind

(or, of course, the occasional hurricane which also reverses wind direction) can generate damaging waves and swells which lay siege to the normally protected leeward coast, severely eroding otherwise stable beaches and knocking about boats, barges, docks and other shoreline facilities. This can happen even inside customarily safe leeward coast harbours when entering waves and swells are reflected off vertical surfaces like piers, jetties, seawalls and buildings, refracted by shorelines, and amplified by harbour and channel geometry -- offering the prospect of extensive damage in unlikely places (Deane, 1987). Modifications to harbour shoreline configurations, therefore, need to be done with great care to avoid unintended, potentially damaging wave building in precisely the places where calm, still waters are needed and, in fact, are required.

Table 1.1(1). Annual average wind speed and direction on the seas around St. Lucia.

WIND DIRECTION	WIND SPEED (m/sec) 0-3.0	3.5-8.0	8.5-14.0	14.5-20.5	PERCENT FREQUENCY
N	0.5%	1.0%	0.1%	*	1.6%
NE	3.1%	18.7%	6.2%	0.2%	28.2%
E	6.1%	38.1%	12.4%	0.3%	56.9%
SE	2.4%	6.6%	1.2%	*	10.2%
S	0.6%	0.8%	0.1%	0.0	1.5%
SW	0.2%	0.2%	*	0.0	0.4%
W	0.1%	0.1%	*	0.0	0.2%
NW	0.1%	0.0	0.0	0.0	0.1%
VAR	0.0	-	0.0	0.0	0.0
CALM	0.7%	-	-	-	0.7%
TOTAL %	13.8%	65.5%	20.0%	0.5%	100.0%

Notes: 1. Frequencies are based on 17,650 observations taken between 1858 and 1973.
2. * represents percentage frequency between 0.0 and 0.09.
3. To convert m/sec to km/hr multiply speed by 3.6 = km/hr.

Source: Deane, 1987. Presented as Table 2.1, adapted from U.S. Naval Weather Command, 1974.

For most of the year, however, and for most of the island, the oceanic regime of trade winds provides a cooling effect and also enables high islands like St. Lucia to manufacture their own local weather, shaping a kind of home-grown microclimate which varies greatly with height, location and orientation on any given island. St. Lucia has more than a dozen peaks or ridges over 2,000 feet (600 m) high. Accordingly, these island land-masses force a marked upward deflection of westerly moving moisture-laden air currents. This rising sea air is cooled by expansion and the moisture is condensed so that "orogenic" cloud formations and often heavy precipitation result. In fact, a typical feature of all the central mountain peaks in the Eastern Caribbean is a great billowy mass or cap-like "trade wind cloud" which masks their summits day after day and is only dissipated in very still or very dry weather (see Figure 1.1(3)).

TEMPERATURE

Typical of a small tropical island, the temperature of St. Lucia at sea level is generally rather high with little seasonal, diurnal or locational variation due to the damping effect of the ocean mass and its near constant temperature between 23-28 degrees C. Diurnal variation is almost entirely within the range of 23 degrees C (73 degrees F) to 31 degrees C (87 degrees F). Monthly averages for four stations, all less than 20 metres (65 ft) above sea level, are displayed in Table 1.1(2). Differences are hardly significant.

Annual mean temperatures for all four stations are displayed in Table 1.1(3), but to display the effects of altitude, a final entry in the calculated average annual temperature at the top of Mt. Gimie peak, 3,117 feet (950 metres) above sea level, has been added.

Temperature falls with altitude above sea level at a rate of one degree C drop per 100 metres in elevation. Thus, the temperature at the peak of Mount Gimie (with its cloud forest habitat and ecological conditions profoundly different from those at lower altitudes only a few miles distant) is normally around 18 degrees C (57 degrees F). While this method of estimating upland temperature at a given altitude is very simple and does not, therefore, take into account other elements that may affect temperature in a given place, it

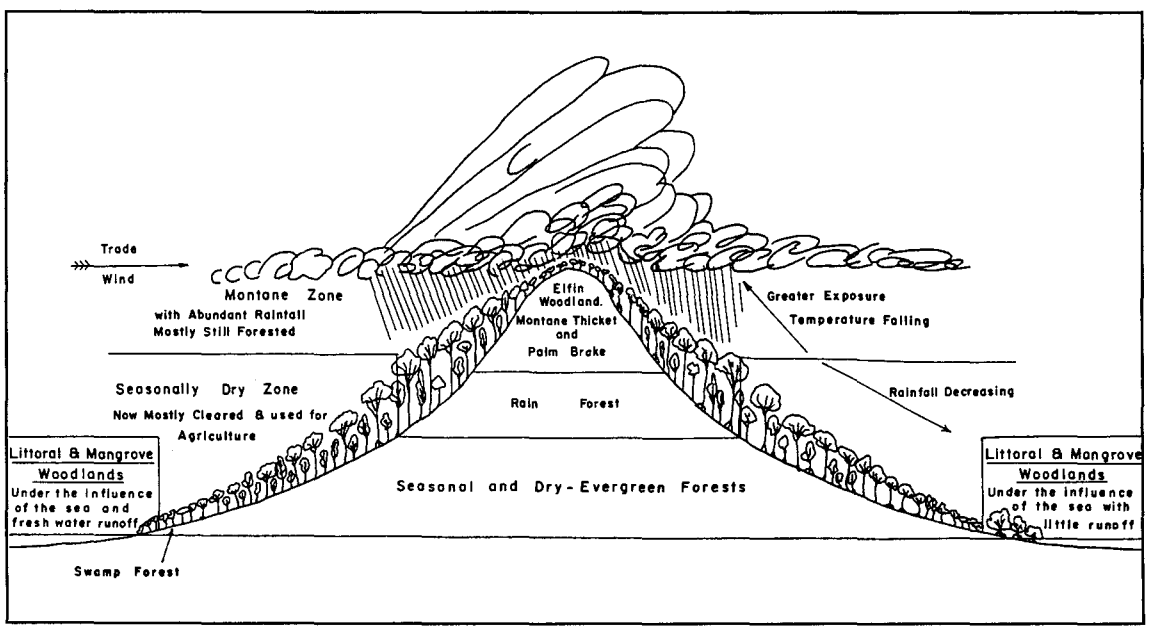


Figure 1.1(3). Cross-section of a high oceanic island, showing typical arrangement of vegetation zones (source: Beard, 1949).

Table 1.1(2). St. Lucia average monthly temperatures (degrees C).

	Jan	Feb	Mar	Apr	May	Jun
Botanical Station	23.4	23.3	23.4	24.5	25.7	25.5
Hewanorra Station	25.6	25.8	25.8	26.5	27.6	27.7
Roseau Station	24.7	24.7	25.1	25.7	26.7	27.2
Union Station	25.7	26.2	26.2	26.0	26.8	27.6

	Jul	Aug	Sep	Oct	Nov	Dec
Botanical Station	25.0	25.3	25.4	25.1	24.2	23.3
Hewanorra Station	27.8	27.7	27.7	27.4	26.9	26.0
Roseau Station	23.1	26.9	26.8	26.4	26.0	24.8
Union Station	27.7	27.6	27.5	27.7	27.4	26.8

Source: GOSL, Min. of Ag., Land and Water Use Unit.

Table 1.1(3). St. Lucia average annual temperatures (rounded).

	Fahrenheit	Centigrade
Castries (Botanical garden)	76.2	24.5
Hewanorra Airport	77.4	27.0
Roseau (WINBAN)	77.4	26.0
Union (Agricultural Station)	80.0	27.0
Mt. Gimie*	57.0	18.5 (estimated mean)

* Peak altitude is 3,117 feet on DOS (1:50,000) 1982 topo map, but 3,145 feet in GOSL, *1986 Annual Statistical Digest* (Table 1), which presumably includes steel antenna tower for air traffic clearance height.

Source: OAS, l986a.

is especially useful in classifying environmental units and in working out evapo-transpiration rates for which approximate ambient temperature data is needed (see also Section 2.4).

RAINFALL: THE PROBLEM

It is often remarked that St. Lucia does not have a water supply problem, only a water distribution problem, and in a simplistic way this is true. St. Lucia does receive a lot of rain. Unfortunately, the temporal and spatial pat-

tern and the extremes of the island's wet and dry season rainfall regime are ill-matched to its agricultural, residential, and industrial needs, considered both seasonally and locationally. At certain times and locations, it is just too dry. At other times, billions of gallons of excess rainwater descend in drenching rains on the high central mountain region only to then run off downstream into the sea (via relatively short watersheds with limited infiltration capacity), often causing flood conditions and damage to soils, crops, roads, bridges and houses en route.

The main problem is that catching, impounding, pumping, and distributing water, especially in large volumes, requires an odd combination of skilled engineering, costly infrastructure, and exquisite foresight and accuracy in predicting rainfall and stormwater/river runoff flows within projected time frame variables -- for both demand and supply side requirements. It is risky business. When estimates are wrong, by even a small margin, disaster can strike with little notice, despite a seemingly adequate commitment of public monies for reservoirs, pumps, gauge stations, and the like.

One thing is certain: there is great variability and a high degree of unpredictability to the quantities of rainfall from year to year. For example, the annual average rainfall over only a seven year period varied over 20 percent (see Table 1.1(4)). Many are the farmers who have faced financial ruin in a local drought waiting for the so-called "average rainfall" that never came to their small patches of ground (irrigation needs, opportunities and impacts are discussed in Section 2.4).

RAINFALL PATTERNS

For St. Lucia, the period of lowest rainfall occurs generally in mid-to-late December (always by the beginning of the year), when the so-called Bermuda high pressure cell extends its sphere of influence southward, bringing attention to its arrival by forcing a pronounced shift of the ubiquitous trade winds from the southeast to out of the northeast. These so-called "Christmas winds," as they are known to seamen, also bring clear, relatively dry conditions to St. Lucia from mid-December to early May.

Furthermore, at this time of year, the trade winds have such a low moisture content that they are insufficient by themselves to give "rise" to either convective or orographic rain. Under these conditions, the rain comes infrequently and then only in short showers. Localised droughts and the sunny weather loved by tourists are both common during these "winter season" months. For the other months of the year (May through mid-December), rainfall increases with varied intensity according to the degree of windward exposure and height above sea level.

Table 1.1(4). Island-wide average annual rainfall, St. Lucia (1980-86).

	1980	1981	1982	1983	1984	1985	1986
in	72.83	88.30	71.67	71.21	74.50	74.70	82.20
mm	1849.90	2242.80	1820.40	1810.30	1892.20	1897.30	2088.00

Source: GOSL, *1986 Annual Statistical Digest.*

Island-wide rainfall data are presented graphically in Figure 1.1(4) as a small scale "Isohyets" Map (displaying levels of equal rainfall). St. Lucia's rainfall is highest in the hilly or mountainous south-central part of the country which normally receives more than 120 inches (3,048 mm) of rain a year. The heaviest rainfalls are experienced at Quilesse (3,682 mm) and Edmond (3,697 mm) slightly southeast of Mount Gimie, the highest peak in the country.

By way of contrast, most of the valleys and coastal plains are relatively dry, with annual precipitation of less than 80 inches (2,032 mm). An exception is the valley of the Lower Soufriere River which receives over 100 inches (2,540 mm) per year. Cap Estate to the north and Vieux Fort to the south, which are quasi-peninsulas with mostly low relief, both average less than 60 inches (1,524 mm) of rain a year and are, therefore, the driest parts of the country with the most sun, the fewest clouds and both Atlantic and Caribbean sea frontage and exposure.

RAINFALL DATA BASE

While ambient air temperature on a high island like St. Lucia is more or less inversely proportional to altitude and while rainfall levels are the opposite (that is, directly proportional to height above sea level), the relationship between these two and various other agro-meteorological parameters is generally less linear and more complex. In order to illustrate this point, Table 1.1(5) displays, for three sample stations, mean monthly and annual summary data on rainfall and temperature, plus relative humidity, evaporation, solar radiation, sunshine hours/cloud cover, and average wind speed. Figure 1.1(5) displays, in histogram form, the same kind of information presented in the table and is included to demonstrate how changing the mode of presentation from tabular to graphic can make trends, reversals, comparability and dissimilarity more readily discernible. In the same fashion, monthly variation is more readily perceived when the data are transformed into a bar graph as in Figure 1.1(6).

Rainfall data collection is an ongoing effort in St. Lucia, with several dozen active rainfall measuring (and also stream gauge) stations and, at the present time, five full-fledged agro-meteorological stations. These are:

Station Name	Number
Union Ag. Station	(35-M-1)
Roseau (WINBAN)	(31-M-1)
Hewanorra Airport	(15-M-1)
Saltibus School	(21-M-1)
CARDI (La Ressource)	(06-M-1).

These stations collect a full range of climate data as displayed in Table 1.1(5). Some monitor additional parameters like evapotranspiration, atmospheric pressure, and dew point and also log daily maximum and minimum temperature readings. In addition to the five, the Vigie Airport station collects rainfall, temperature, and wind data, and there is an automated station operated by the U.S. Weather Bureau at Marisule (36-M-1), which collects cloud cover, rainfall, temperature, and wind (speed and direction) data. The range and specifications of instrumentation installed at these meteorological stations and that of the related, more elaborate rain gauge and stream/river gauging network are discussed in Section 2.4.

Over the past decade, interest in expanded irrigation services, water storage and flood control has led to a vastly expanded agro-meteorological data assembly and analysis programme in St. Lucia, involving not only GOSL/Ministry of Agriculture (MOA), but also OAS, UNDTCD, EDF, CIDA, and USAID. Much of the assembled data has been organised and published, and some is computerized (using an IBM-PC) at the MOA's Water Resources and Irrigation Unit (formerly called Land and Water Use Unit). It is possible to obtain climate summaries on both a monthly and an annual basis, and the system has been used for rainfall and runoff catchment modeling as well as water quality/sediment transport analysis. Despite lacunae in some data strings (some of which run back as far as 1900), it constitutes a remarkably comprehensive "high, wet" island

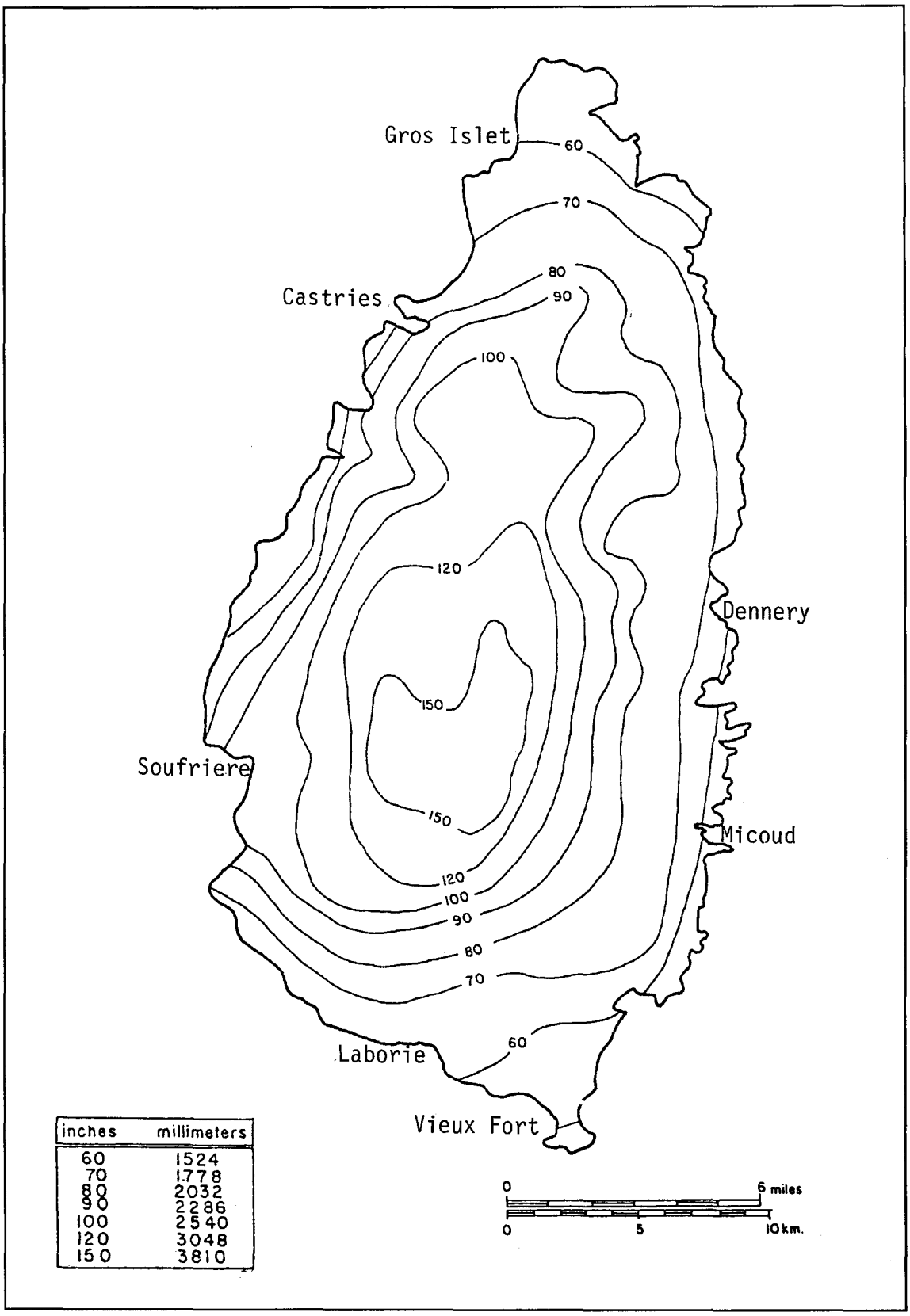


Figure 1.1(4). Average annual rainfall for the island of St. Lucia (source: Leonce, 1978).

Table 1.1(5). Average monthly agro-meteorological data from selected stations in St. Lucia.

UNION AGRICULTURAL STATION MEAN MONTHLY AGRO-METEOROLOGICAL DATA

MONTH	RAINFALL mm	EVAPORATION mm	TEMPERATURE oC	SUNSHINE HOURS	RELATIVE HUMIDITY %	WIND RUN m/s	RADIATION at 9h00 MJ/m2	POTENTIAL EVAPOTRANSPIRATION mm
JAN	122.1	126.0	24.8	7.2	77	0.37	21.93	107.1
FEB	75.7	129.0	25.3	7.4	76	0.56	22.88	109.7
MAR	66.0	158.0	25.4	8.0	74	0.61	25.46	134.3
APR	86.3	152.4	26.0	8.3	73	0.72	24.08	129.5
MAY	132.0	155.8	26.9	7.8	74	0.66	23.57	132.4
JUN	194.1	142.6	27.3	6.5	74	0.69	22.76	121.2
JUL	229.7	144.9	26.9	6.2	76	0.63	22.92	123.2
AUG	226.9	149.1	27.0	6.5	77	0.45	23.30	126.7
SEP	229.5	132.0	26.8	5.6	76	0.34	22.45	112.2
OCT	262.9	133.3	26.5	6.8	77	0.32	23.13	113.3
NOV	266.6	112.6	26.4	6.4	77	0.27	21.77	95.7
DEC	151.6	121.1	25.8	6.6	76	0.40	20.52	102.9
TOTAL	2040.0	1656.8	----	---	--	----	--	1408.2
MEAN	170.0	138.1	26.3	6.9	76	0.50	22.90	117.4
PERIOD	1923/85	1979/85	1976/85	1980/85	1979/85	1981/85	1979/85	1979/85

ROSEAU WINBAN MEAN MONTHLY AGRO-METEOROLOGICAL DATA

MONTH	RAINFALL mm	EVAPORATION mm	TEMPERATURE oC	SUNSHINE HOURS	RELATIVE HUMIDITY %	WIND RUN m/s	RADIATION at 9h00	POTENTIAL EVAPOTRANSPIRATION mm
JAN	152.0	95.0	24.7	7.5	76	0.95	--	80.7
FEB	97.0	115.0	24.8	8.2	73	1.12	--	97.8
MAR	84.8	140.8	25.2	8.1	72	1.18	--	119.7
APR	95.9	156.2	25.9	8.1	70	1.21	--	132.8
MAY	113.0	163.9	26.8	8.1	72	1.29	--	139.3
JUN	175.1	146.2	27.3	7.3	72	1.37	--	124.3
JUL	245.8	135.8	27.1	7.4	74	1.12	--	115.4
AUG	251.9	134.5	26.9	7.4	75	0.96	--	114.3
SEP	251.5	129.1	26.8	7.1	76	0.72	--	109.7
OCT	266.5	125.4	26.6	7.2	78	0.73	--	106.6
NOV	237.2	96.5	26.1	7.4	78	0.71	--	82.0
DEC	176.4	100.4	25.3	7.2	76	0.89	--	85.3
TOTAL	2147.0	1538.8	----	---	--	----	--	1307.6
MEAN	178.9	128.2	26.1	7.6	74	1.02	--	109.0
PERIOD	1966/85	1978/85	1968/85	1968/85	1978/85	1978/85		1978/85

HEWANORRA AIRPORT MEAN MONTHLY AGRO-METEOROLOGICAL DATA

MONTH	RAINFALL mm	EVAPORATION mm	TEMPERATURE oC	SUNSHINE HOURS	RELATIVE HUMIDITY %	WIND RUN m/s	RADIATION at 9h00	POTENTIAL EVAPOTRANSPIRATION mm
JAN	69.6	197.3	25.7	7.7	74	3.18	--	157.8
FEB	48.3	191.0	25.8	8.4	73	2.82	--	152.8
MAR	49.2	231.8	26.1	9.2	73	2.82	--	185.4
APR	68.8	261.5	26.8	9.6	72	2.71	--	209.2
MAY	77.8	246.6	27.6	7.4	74	2.96	--	197.3
JUN	82.8	202.8	27.5	8.0	76	3.05	--	162.2
JUL	152.3	191.8	27.6	7.7	77	3.09	--	153.4
AUG	158.6	208.4	27.5	8.4	78	2.67	--	166.7
SEP	139.1	181.6	27.6	7.4	77	2.38	--	145.3
OCT	230.6	192.6	27.5	8.8	77	2.25	--	154.1
NOV	180.3	144.6	26.8	8.6	75	1.96	--	115.7
DEC	128.5	207.9	26.2	8.4	74	2.30	--	166.3
TOTAL	1385.8	2457.9	----	---	--	----	--	1966.2
MEAN	115.5	204.8	26.9	8.3	75	2.68	--	163.9
PERIOD	1974/84	1982/84	1974/84	1974/84	1982/84	1982/84		1982/84

Source: Migeot and Hadwen, 1986.

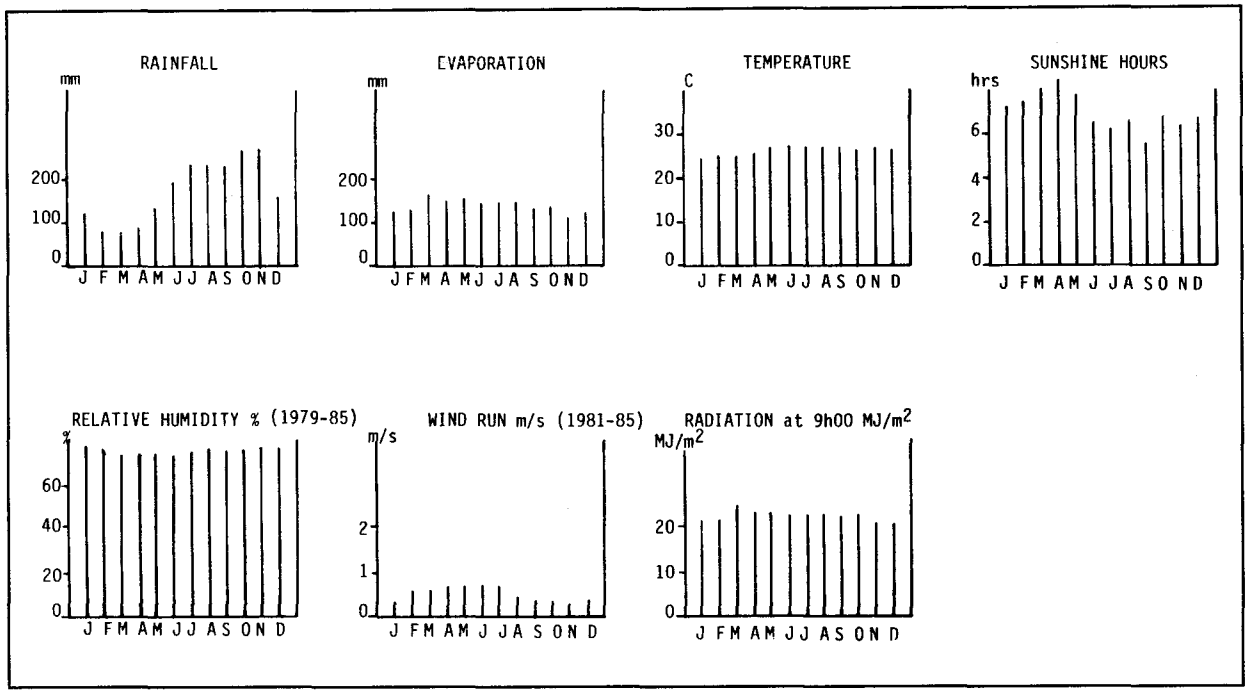


Figure 1.1(5). Union Agriculture Station average monthly agro-meteorological data (source: Migeot and Hadwen, 1986).

data base on rainfall and runoff phenomena, perhaps the best in the Eastern Caribbean.

As for country-wide base figures, the most accessible source for the average reader is the meteorological section of GOSL's *Annual Statistical Digest* (see tables 2 and 2A, 3 and 3A, 1987). This handy summary section also presents equivalent multi-year coverage of annual rainfall totals at fifty stations and monthly rainfall data from Union Agricultural Station. This is a good first source for a general picture although there is no discussion of methodology, reliability or sources, and the data provided, almost as a sample, constitute a very small portion of a very large data base, a subject discussed in more detail below.

HURRICANES AND TROPICAL STORMS

St. Lucia lies in the path of tropical storms, including hurricanes, situated as it is between the subtropical high pressure belt of the Atlantic Ocean and the equatorial low pressure belt to the south. It is, however, far enough south so that passing tropical cyclones normally do not reach their maximum intensity. Nevertheless, there is a high frequency of micro-disturbances that generate squalls and winds with potentially damaging, short burst, high velocities.

On land, the risk of wind and rainstorm damage can be serious, especially during the August-November period as is illustrated by Table 1.1(6). Lesser storms, even though not of hurricane or even gale force and of only short duration, are common, and St. Lucia averages about 25 such windstorms per year. However, by way of contrast, the country has experienced only one serious hurricane since the turn of the century -- hurricane Allen which hit the island in 1980 (see Figure 1.1(7)) and left in its wake a devastated banana, citrus, cocoa and coconut crop, a severely damaged rain forest (estimates ran to 40 percent loss) and millions of dollars worth of wind and flood damage to property and infrastructural facilities. Recovery has been a painful, costly affair.

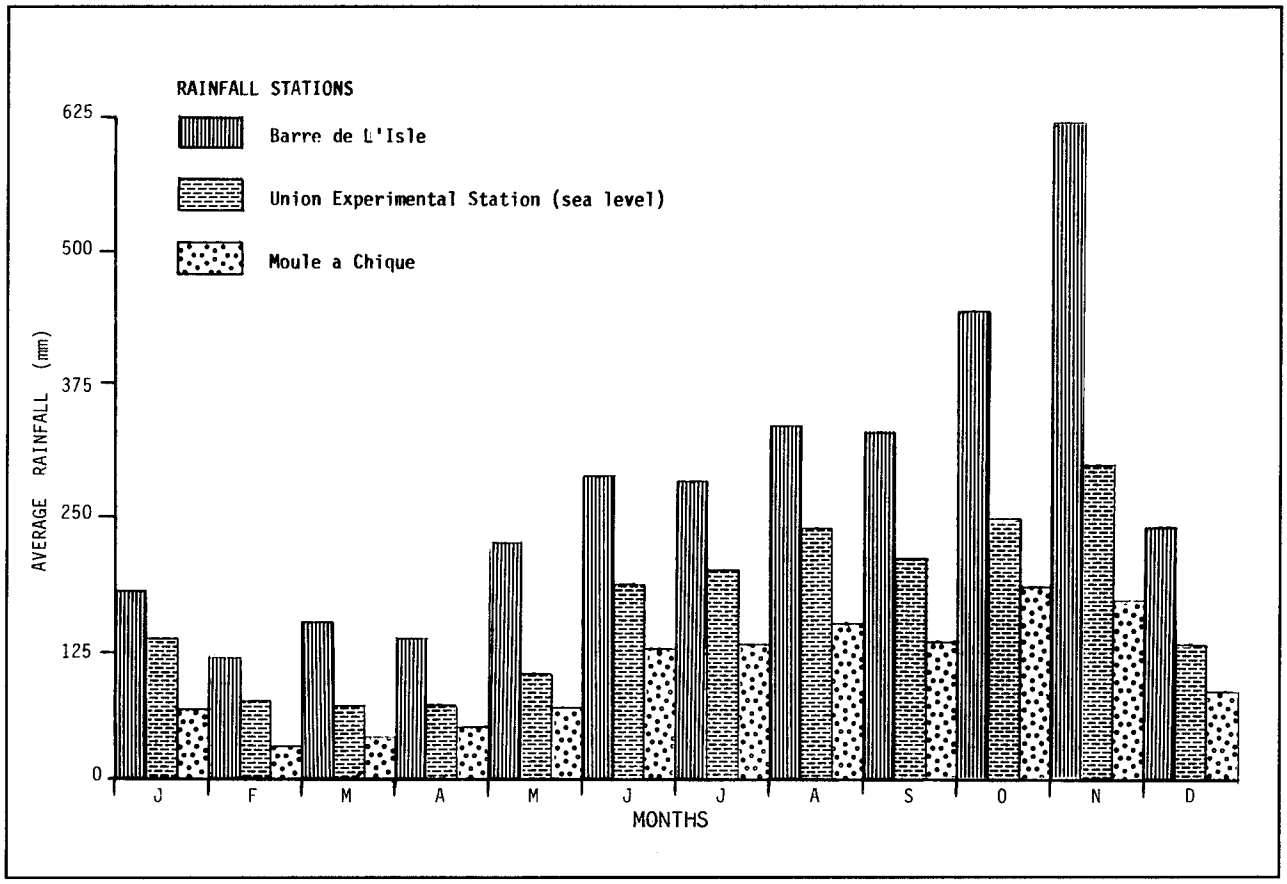


Figure 1.1(6). Typical St. Lucia annual rainfall pattern (source: Talbot and Bottrell, 1983).

1.1.3 Topography

The island of St. Lucia is mountainous, having an exceedingly disordered interior topography with a south-central mountain cluster rising at Mount Gimie to its highest elevation of 3,117 feet (950 m) above sea level and extending to the northeast and southwest in an irregular but pronounced axial ridge about 24 km (15 miles) long. The main highway from Castries to Dennery is the only one to cross this Barre de L'Isle ridge. In so doing, it climbs to 850 feet (260 m) above sea level, above Ravine Poisson.

On both the eastern and western sides of the ridge, sharp, heavily wooded offset spurs descend to the coast, some interrupted by spectacular isolated pitons (cone shaped pinnacles of solid lava from residual volcanic plugs) and others extending outward in steep-sided, buttress-like ridges with deep, serpentine valleys. In a few cases the ridges gradually separate, opening up enough to make room for a narrow but increasingly expansive valley, perennial streams and a river, and finally, just before reaching the sea, a flat, fertile, alluvial plain.

Needless to say, this irregular steep terrain makes communications difficult, transport costly and erosion likely. But it also makes for dramatic landscapes with unexpected streaks of sunlight, green shadows, giant ferns, ledges, perched boulders, dark canyons, hanging valleys, waterfalls and ever-changing skylines. Beneath the surface, always lacy green, there lurks in a slightly menacing but not depressing way the ever present risk of flash floods, land slips, rock falls and the lesser nuisances of isolation, dampness, mold, mud, and the long walk back up the steep and slippery track. From outside, there is, at least for part of each

Table 1.1(6). Hurricanes and tropical storms affecting St. Lucia.

1780/06/13	(H)	1931/08/16	(TS)
1780/10/11-12	(H)	1941/09/23	(TS)
1817/10/23	(H)	1942/08/21	(TS)
1818/10/21	(H)	1948/08/31	(TS)
1819/09/21	(H)	1951/09/02	(TS)
1819/10/13	(H)	1955/09/22	(H)
1837/07/09	(H)	1956/11/05	(H)
1841/10/06	(H)	1960/07/10	(H)
1886/09/15	(H)	1963/09/25	(H)
1888/11/21	(TS)	1966/08/01	(TS)
1894/10/11	(H)	1967/09/07	(H)
1898/09/22	(H)	1979/08/29	(H. David)
1901/07/05	(TS)	1979/09/12	(H. Frederick)
1905/09/06	(TS)	1980/08/3-4	(H. Allen)
1911/09/03	(TS)	1984/11/7-9	(H. Klaus)
1916/10/06	(TS)	1985/10/21-22	(H. Gloria)

[Key: H - hurricane; TS - tropical storm.]

Source: Adapted from Deane, 1987 (adapted from Stevenson, 1969); DuBois, 1985.

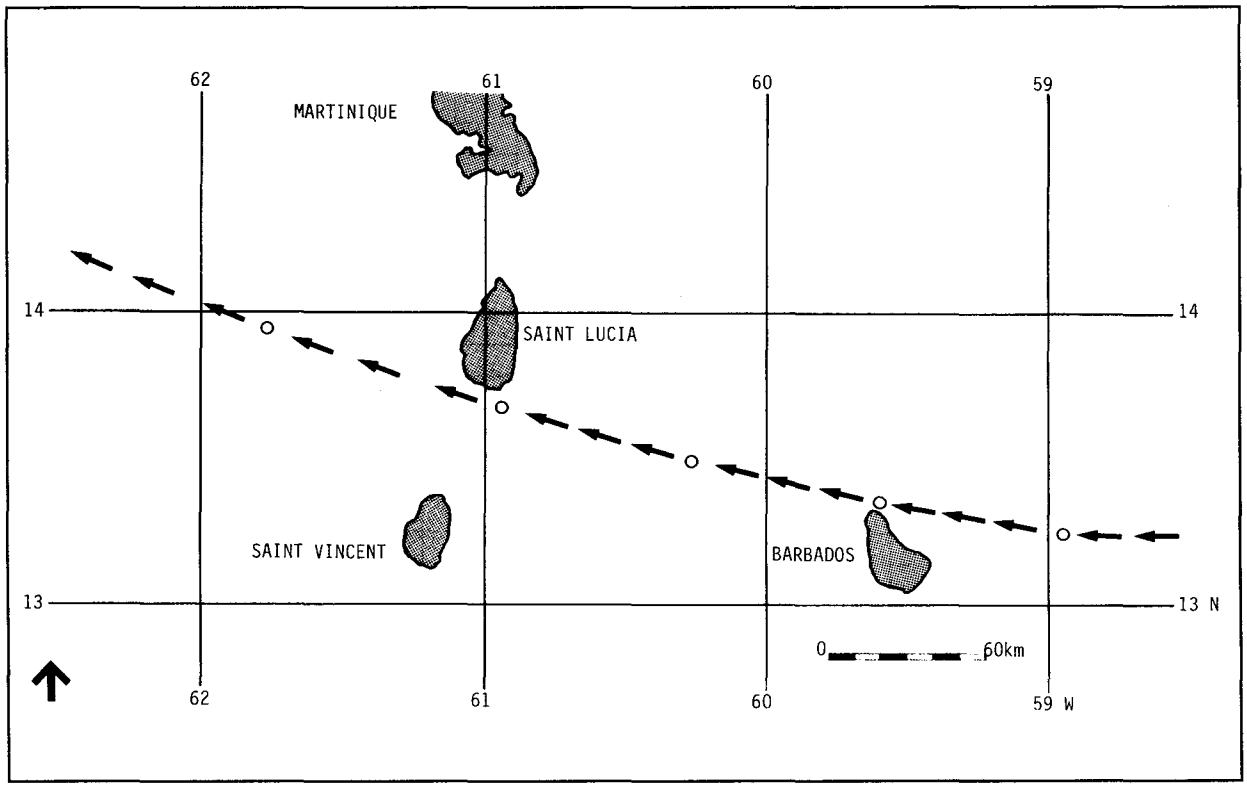


Figure 1.1(7). Passage of the central area of Hurricane Allen, 3-4 August, 1980 (source: Deane, 1987).

year, the vaguely looming risk of a knock-down, mash-up, no-warning hurricane.

Taking the country as a whole, three separate and distinct physiographic regions can be identified, although exact boundaries are sometimes difficult to trace and fortunately not terribly important. In simplified terms, there is an "old part" (to the north and east), a "new part" in the midwest "pitons" coastal area, and, in the far southwestern corner, an old part modified by an overlay of new material spilled over from the nearby "new part." In sum, there is an old and a new section and one that is a little bit of both. In geomorphological terms, the regions are identified as follows.

(1) The topography of the northern, central and eastern parts of St. Lucia has a softened, rounded quality to it that reflects its age and the long history of geological erosion and weathering that has worn down the original stark landscape generated by flowing lava, pyroclastic muds and other volcanic ejecta which formed the island when it first emerged from the sea. Clear traces of individual volcanic centres are difficult to identify, and peaks in the north barely exceed 60 metres.

Throughout this older sector can be found numerous valleys -- expansive, flat, and mature, now filled with alluvium and highly suitable for intensive agricultural pursuits (for example, Roseau, Cul-de-Sac, Mabouya/Fond D'Or, Marquis, and Troumassee Valleys). The Roseau Valley, in particular, is notable for having the largest watershed (49 sq km) and the longest river (19 km), with an average flow of 3.62 mgd. It also has the largest cluster of readily irrigable acres (1,300) in the entire country and is the site of both the WINBAN (Windward Islands Banana Growers Association) Research Station and the St. Lucia Model Farms Project (see Section 3).

At the upper reaches of this and other similarly mature watersheds in the central portion of the "older" part of the country, the elevation of rounded ridge tops reaches to about 900 feet (274 m), but these are thoroughly overwhelmed by surviving pitons such as:

- La Sorciere (2,221 ft., 677 m)
- Piton Flore (1,850 ft., 564 m)
- Mount Lacombe (1,485 ft., 453 m)
- Piton St. Esprit (1,919 ft., 585 m).

(2) On the west and southwestern edge of the country, the newer, more dramatic, more geologically active section of St. Lucia is shaped like a four-sided schooner mainsail. Starting just south of Roseau Valley, the boundary line extends inland and east along the line of the Anse La Raye River to the ridge, then south passing about a mile east of Mount Gimie and along the ridge to Mount Magazin and then turning west towards the Gros Piton and the sea. The topography of this mid-western, younger part of the island is more mountainous with some of the highest and most precipitous mountains in the island. Among these are:

- Mount Gimie, (3,117 ft., 950 m)
- Piton Canarie (3,012 ft, 918 m)
- Mount Paix Bouche (2,445 ft., 745 m)
- Mount Tabac (2,224 ft, 678 m)
- Mount Parasol (2,010 ft., 613 m)
- Mount Houelmon (2,094 ft., 638 m)
- Mount Grand Magazin (2,117 ft., 645 m)
- The Petit Piton and Gros Piton (at more than 2,000 feet, 750 m).

These "pitons" at Soufriere Bay are especially dramatic because they are situated directly on the coastline and their steep, almost sheer, western slopes rise directly out of the sea. The region also contains the remnants of the island's last massive caldera and the only active "Soufriere" or sulfurous steam and water vent, located just south of the village by the same name.

(3) The extreme southwestern area is the smallest and is wedge-shaped with its boundary extending from Gros Piton inland and east to Mount Grand Magazin and then south down the Vieux Fort River to the sea. The most notable topographic feature is a huge fan-shaped glacis sloping gently seaward, spreading around and almost inundating several older isolated hills. It stands as mute testimony to an earlier era and belongs to the larger, more easterly, older region discussed in (1) above. The glacis slopes have been deeply cut over geologic time by the erosive

force of heavy rains, creating a complex system of very narrow and deep, steep-sided gorges which make road building in the area very costly. The River Doree canyon is an outstanding example. To the east in the neighbourhood of Vieux Fort, the land levels out to form a sandy plain of about ten square kilometers.

1.1.4 Geology and Soils

INTRODUCTION AND REGIONAL SETTING

The Antillean arc of islands is geologically young, probably not exceeding 50 million years, and is predominantly volcanic in origin. Some islands were formed primarily by subaqueous and subaerial lava flows and pyroclastics followed by seabed uplift. Some of these acquired thick coral reef caps while still submerged and, thus disguised, emerged from the sea looking like a limestone island.

At the present time the active tectonic or mountain forming process has all but ceased in the region except for St. Vincent's Soufriere, which last erupted in 1979, and the rambunctious underwater volcano north of Grenada known as Kick 'em Jenny. But within the arc, there are still eight active volcanic sites on as many islands -- some with gas vents, some fumaroles, some sulfurous steam vents, one real boiling lake, and a few, like St. Lucia, with near-surface hydrothermal hot spots that have promising geothermal energy potential (see also Table 1.1(7)).

Table 1.1(7). Eastern Caribbean volcanic phenomena.

St. Lucia Soufriere	caldera with domes and solfataric activity, most recent eruption about 50,000 years ago
Kick'em Jenny	submarine basaltic volcano north of Grenada, more or less continuous activity
St. Vincent Soufriere	andesite-basaltic volcano (1,325 m), four historic eruptions (1812, 1902, 1971, 1979), all with emission of lavas
Montagne Pelee	four historic eruptions (1792, 1851, 1902, Martinique 1929); the first two were phreatic (hot water discharge) the last two magmatics
Dominica "Valley of Desolation"	near the recent Micotin volcano; solfataric activity (boiling lake 80 m in diameter), one historic eruption in 1880
Guadeloupe Soufriere	numerous recent phreatic eruptions preceded by one magmatic eruption in 1600 +/-50 years
Montserrat Soufriere Hills	solfataric activity, most recent eruption 20,000 - 40,000 years ago
St. Kitts Mt. Liamuiga (now Mt. Liamuiga)	solfataric activity; one phreatic eruption in 1843

Source: Migeot and Hadwen, 1986.

St Lucia and the associated undersea ridge upon which it is perched are located on the edge of what is known as the Caribbean Plate, which behaves like a raft of crust floating on the less dense underlying mantle (see Figure 1.1(8)). Its movements are apparently related to the convection "currents" in the mantle.

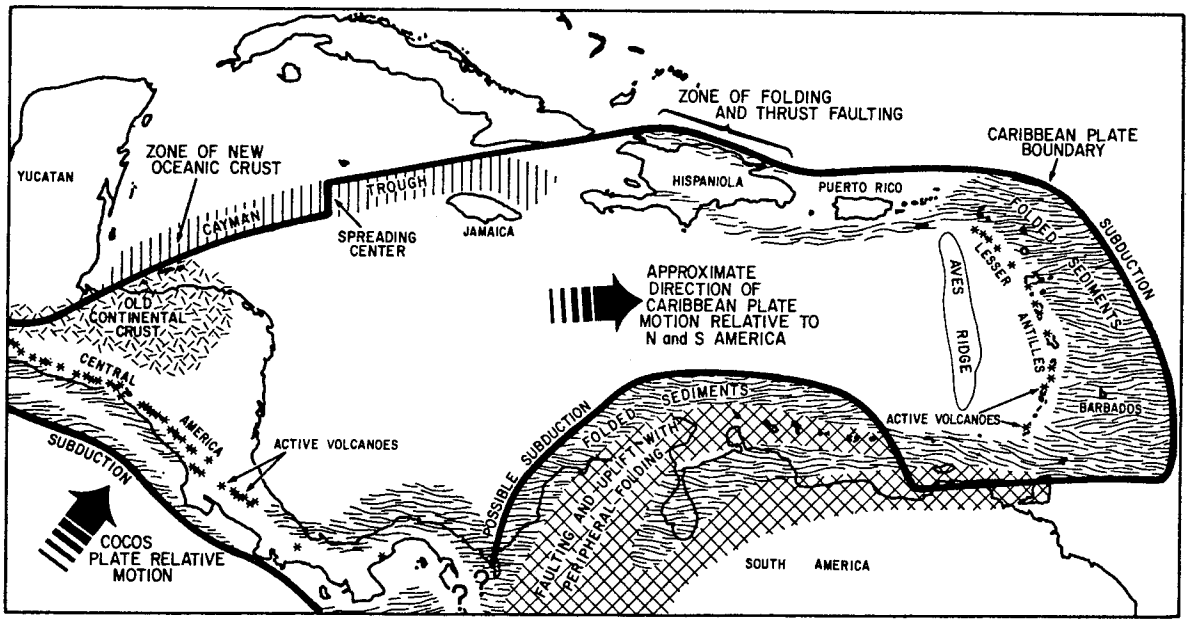


Figure 1.1(8a). Geological features of the active boundary zone of the Caribbean plan (source: Dillon, *et al.*, 1987).

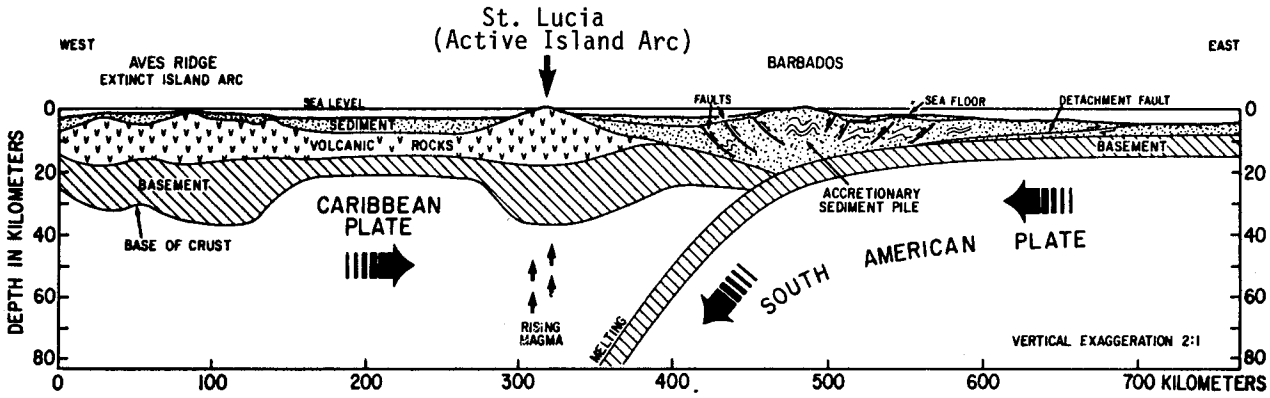


Figure 1.1(8b). The eastern margin of the Caribbean plate at the location of Barbados and St. Lucia. Cross section showing the Caribbean plate being underthrust by the South American plate. Figure adapted from Dillon, *et al.*, 1987.

The Caribbean Plate is bounded by the North American Plate to the north and east, the South American Plate to the south and the Cocos Plate to the west and southwest. The North American Plate moves to the west relative to the Caribbean Plate, while the Cocos Plate subducts towards the northeast. There is little relative displacement between the Caribbean and South American Plates at this time in geologic history.

Closer to home, the eastern boundary of the Caribbean Plate is a subduction zone in which the North American Plate is subducted, i.e., passes under the Caribbean Plate and into the mantle where melting occurs. This resulted in the formation of the magmas which, when extruded as lava by volcanoes, have resulted in the formation of the islands of the Antillean Arc (see Figure 1.1(8)).

ST. LUCIA'S GEOLOGICAL HISTORY

St. Lucia is almost entirely volcanic with its oldest rocks, largely rhyolite, andesite and various basalts, dating from the Early Tertiary period or about fifty million years ago (see Table 1.1(8)). These older rocks are found at the surface, principally in the extreme northern and southern parts of the island, and probably underlie most of the more recent rocks found elsewhere.

During the Lower Miocene (25 million years later) St. Lucia experienced an extended oceanic "baptism" as part of a wider general submergence of the entire Lesser Antilles. As one might expect during this immersion period some islands acquired a veneer of reefal limestone, which in St. Lucia's case resulted in some lenticular (lens-like) deposits of limestone in amongst the volcanics which were under water at the time and later uplifted above the sea surface. Therefore, a few small sedimentary beds of granular limestone occur intrusively, but these are of negligible extent. Along the coast can also be found beds of mixed sedimentary volcanic materials with good bedding and stratification (tuffs, agglomeratic tuffs and conglomerates). Since corals grow in most coastal waters, most beach "sands" are a mixture of terrigenous sediments and rock fragments, intermixed with calcareous coral and shell particles.

The geology of the island has been studied and mapped by William R. Newman, under the aegis of the United Nations Department of Economic and Social Affairs (1965). His work was supplemented by J.M. Tomblin's study of the Soufriere area, also in 1965. More recently the larger geological picture was further improved upon by the Organisation of American States within the framework of its Natural Resources and Agricultural Development Project which issued (1984) an enlarged (1:50,000 scale) redrawn version of Newman's map as part of a six map set distributed as a St. Lucia Development Atlas.

Newman and his successors have found it convenient to group the rock formations of the island into a northern (Early Tertiary-Eocene) series, a central (Middle Tertiary-Miocene/Pliocene) assemblage, and a southwestern (mid- to late-Pleistocene) series.

(1) **St. Lucia Rock Formations: Northern Series.** These older rocks are predominantly basaltic in composition, often highly folded and quite probably of Eocene age (see Table 1.1(8)). Some andesite porphyry (with large well-developed feldspar crystals) in blocks up to two metres in diameter can be seen at the old quarry site on the southwestern side of the Vigie Airport. In general, there are few surprises and fewer anomalies, although no one has yet explained the odd single patch of ryolite exposed in the Choc River Valley near Union. A few examples of the underlying basaltic rock plus andesites, mud flows, and lava agglomerates can be found on the extreme southern tip of the island at Moule a Chique Peninsula. Additionally, the nearby quarry northeast of the Hewanorra Airport also exposes to view a combination of basalt, interbedded andesite, agglomerate and tuff.

(2) **Rock Formations: The Central Series.** Thirty to forty million years ago, during the Miocene Epoch, the entire central massif and ridge, or Barre de L'Isle, and the rocks underlying the eastern coast from Grand Anse as far as upper Savannes Bay (in other words the central part of the island

Table 1.1(8). Geology of St. Lucia: geologic column.

PERIOD	EPOCH		FORMATIONS: Sedimentary	FORMATIONS: Volcanics
Quaternary	Recent	HOLOCENE	Alluvium, beach and terrace sands	Last eruption at Soufriere
Tertiary	Late Tertiary (Southern Series) [started in late Pliocene]	PLIOCENE	Pumiceous Tuffs Dacite Tuffs	<u>Dacites</u> Belfond pumice flow, tuffs Belfond pumice fall Belfond dome lava Terre Blanche dome lava Piton agglomerate Piton dome lava St. Phillips agglomerate St. Phillips lava flow <u>Andesites</u> Pale andesite dome lavas Andesite pumice flows, tuffs Andesite agglomerate caldera, tuffs Dark andesite cones <u>Basalts</u> Porphyritic basalt Aphyric basalt
	Middle Tertiary (Central Series) [Miocene to Pliocene]	MIOCENE	Limestone granular Thin-bedded tuffs Agglomerate tuffs, tuffs	<u>Andesite</u> Altered andesite, andesite Porphyry, breccia Hornblende andesite Andesite porphyry Andesite breccia Columnar andesite Andesite ash, altered andesite Mud flow Andesite agglomerate, mud flow
	Early Tertiary (Northern Series) [58,000,000 before the present]	EOCENE	Agglomerate tuffs, tuffs	Rhyolite Andesite Basalt, some andesite Basalt agglomerate

except the southwestern wedge) were formed by an extended sequence of volcanic activity which generated vast, repeated extrusions of younger andesites, basalts, agglomerates and tuffs, and, as a by-product, some sedimentary conglomerates. Near L'Anse La Raye can be seen a high cliff of andesite pillars, but shapes, colours and hardness vary widely. While most of the andesite porphyry, as in the Millet area, is a greyish colour, west of Ravine Poisson it is green to purple as a hard, dense breccia but, up on the central ridge where it has been and continues to be exposed to high levels of rainfall, it appears as highly coloured red to orange cliffs visible in the steeper valleys.

(3) **Rock Formations: The Southern Series.** A line drawn from Canaries on the sea coast due east to the Roseau River, then south-southeast by Mount Gimie to Mount Grand Magazin and then due south to Black Bay just east of Laborie more or less defines the land boundaries of the newest (geologically speaking) dacite segment of St. Lucia. This highly irregular area contains four pitons, seven craters, hot sulfur springs, the town of Soufriere, the island's highest peak (Mt. Gimie) and has been a focal point for years of speculation about the prospect of tapping the geothermal potential of its subterranean, super-heated steam supply. It now appears that the geological dreamers and optimists may carry the day, and the naysayers and pessimists have been proven wrong (see Section 4.3).

The main structure in the Soufriere area is the massive circular depression about 6 kilometres in diameter known as the Qualibou Caldera. It is actually an enormous defunct volcanic crater produced on a grand scale in mid-Pleistocene times by either a major volcanic explosion or more likely the collapse of a very large volcanic cone, leaving behind a bowl-shaped depression.

The caldera itself and especially its walls resulted from an extremely active period of vulcanism when enormous volumes of dacite and pyroclastics were the products of thirty-three consecutive eruptions which triggered glowing avalanches of andesite pumice on the receiving slopes. These were interspersed with long cycles of torrential rains and floods that periodically redistributed a large portion of the recently deposited, unconsolidated sediment. One pumice flow cycle resulted in a deposit near the foot of the southern glacis that is over 40 metres thick. As much as a thousand years went by between eruptions since deposits of ash were exposed to weathering long enough to develop a thin layer of soil.

At some point in this cycle of cataclysms, the caldera abruptly collapsed, dropping the floor about 250 metres. This literally and figuratively set the stage for the gradual emergence of a half dozen lava domes and seven volcanic craters which built up, one by one, on the jagged caldera floor in the Belfond area where they can be seen today. We do know that these were violent times because the vertical eruptions from these newer smaller craters carried pumice blocks, ash and other pyroclastic ejecta up to 13 kilometres *beyond* the caldera rim. There was no place to hide!

During this same period, the dacite domes were extruded that formed the four notable Pitons of Gros, Petit, Plaisance and Rabot. These Pitons represent domes from which the surrounding marginal talus (or skirt) of sediments has been almost completely removed by erosion leaving exposed the striking, well known shape of the dacite rock core which has come to symbolise St. Lucia, even in its national flag.

SOIL-FORMING PARENT MATERIAL

With the waning of active vulcanism in St. Lucia during the mid- to late-Pleistocene period, the raw exposed surface area of basaltic, andesitic and dacitic rock gradually underwent a "weathering" process and, under the impact of sun and rain, heating and cooling, algae and bacteria, leaching and abrasion, was transformed into a primitive kind of soil. The process was sometimes accelerated by the chemical action of wind-driven salty sea spray or interrupted by occasional earthquakes, landslides, storm tides and floods. The various types of soil-forming base material and their areal extent are listed in Table 1.1(9).

No one knows how many years passed before the physical and chemical breakdown process

Table 1.1(9). Principal soil-forming parent material.

PARENT MATERIAL	EXTENT Acres	Hectares
Andesitic agglomerate	62,190	25,106
Dacitic ash	26,520	10,737
Andesitic ash	12,100	4,899
Tuff	4,700	1,903
Agglomeratic ash	3,300	1,336
Dacitic agglomerate ash	3,010	1,219
Basalt	1,500	607
Andesite agglomeratic ash	540	219
Calcareous tuff	350	142
Colluvium	10,700	4,332
Alluvium	7,800	3,158

Source: Taken from W.R. Newman (1965), "A Report on General and Economic Geological Studies - St. Lucia, West Indies," UN Department of Economic and Social Affairs. Reprinted in OAS, 1987.

reached the momentous day when a small damp patch of half-formed soil material at some unknown location received and nourished to life the island's first seed which had drifted ashore or arrived in the digestive tract of a migratory bird. That seed became St. Lucia's first green growing plant. The rest was painstakingly slow as other species arrived, one by one -- plants, birds, insects, and animals, one by one, species by species, year by year, century by century, millennia after millennia, until St. Lucia had a living environment more or less as we know it today.

As this living vegetative cover grew more complex, so did the soil-building process. For example, with an expanding surface cover of vegetation the new, primitive soils could catch and hold more rainwater, capturing even dew at night, with the added moisture accelerating both the physical breakdown and chemical transformation of volcanic rock and ash particles into proto-soils. Over time these would mix with increasing quantities of organic plant materials and nutrients and eventually become host to an interstitial resident mychorizal fungi which, in a classic example of symbiosis, would help plants in the uptake of needed trace element chemicals from the soil.

A wide variety of soils have developed in St. Lucia from a relatively narrow range of original parent materials. There are five major variables in soil formation: (1) type or mix of parent material, (2) climate, (3) topography, (4) vegetation and (5) time. In St. Lucia's case, temperatures are relatively constant throughout the year, but the rainfall regime varies widely and increases greatly with elevation in the high central mountains where the length of the dry season is greatly diminished. Thus, throughout the island, the parent materials are subject to differing amounts of weathering, with thick soils prevailing in higher, wetter areas and thin soils in lower, drier areas.

Most of St. Lucia's soils formed very slowly beneath a thick forest cover where the transformation took place under conditions of sustained high temperature and humidity. In the heavier rainfall areas, latosols or latosolic soils

Table 1.1(10). Soil classification table, St. Lucia.

Soil Type	*Dominant Slope Range*	*Drainage Through Soil*	*Dominant Mean Annual Rainfall Range*	*Moisture Supplying Capacity*	*Factors, if any, Limiting Root Penetration*	*Erosion Hazard*	*Natural Fertility*	*Any Special Soil Management Problems*
Annus Clay	5–25°	Slow	60″–120″	Good	Mottled clay subsoil below from 6″–12″	Moderate. Tendency to slip	Medium. Acidic	Drainage. Erosion control.
Anse Clay	10–30°	Slow	70″–150″	Good	Mottled clay subsoil below from 6″–12″	Moderate	Low. Very acidic	Drainage. Erosion control. Low fertility.
Assor Clay	10–20°	Slow	70″–100″	Good	Mottled clay subsoil below from 6″–12″	Moderate	Medium. Very acidic	Drainage. Erosion control. Often stoniness.
Balembouche Gritty Clay Loam	2–8°	Slow in subsoil	60″–90″	Fair	Compact clay subsoil at 16″–28″. Silica pans tending to form	Slight to moderate	Medium to low. Acidic	Difficult of cultivation. In arid area. Drainage in wet periods.
Balembouche Gritty Clay Loam (Shallow variant)	2–8°	Slow in subsoil	60″–90″	Poor	As above, but much nearer surface	Moderate to high	Low. Neutral to slightly acidic	Erosion control. Moisture supply. Shallowness.
Belfond Clay Loam	10–30°	Moderate to rapid	95″–120″	Good	—	Moderate	High. Acidic	Erosion control. Shallowness.
Becune Loam	15–30°	Rapid	50″–60″	Fair to poor	—	Very high	Medium to low. Neutral	Erosion control. Moisture supply, in arid area. Shallowness.
Bocage Stony Clay	25–35°	Rapid	70″–120″	Good	—	High. Subject to slumping	Medium. Acidic	Erosion control. Stoniness.
Calfourc Silt Loam	10–20°	Rapid	100″–160″	Fair to poor	—	High	Medium. Acidic	Erosion control.
Canelles Clay	5–25°	Moderate	70″–120″	Good	—	Moderate	Medium to low. Acidic	Erosion control. Stoniness in places.
Casteau Gravelly Bouldery Silt Loam	5–25°	Rapid	95″–105″	Good	—	Slight to moderate	Medium to high. Acidic	Erosion control. Stoniness. Steepness.
Cochon Silty Clay Loam	10–35°	Rapid	80″–150″	Fair to poor	—	High	Very low. Very acidic	Erosion control. Steepness.
Deglos Silty Clay	0–1°	Extremely slow	70″–85″	Good	Highly mottled clay at 8″–10″ and water table at 20″–30″	Nil	High. Acidic	Great drainage problem.
Delomel Clay	5–25°	Slow to very slow	60″–75″	Fair	Compact mottled clay 8″–15″	Moderate	Medium. Acidic	Erosion control. Difficult soil to work. Moisture supply. Drainage in wet periods.
Dennery Clay	10–20°	Slow to very slow	50″–80″	Fair	Agglomeratic ash or agglomerate at less than 2 ft.	Slight to moderate	Medium to low. Acidic	Erosion control. Moisture supply. Drainage in wet periods.
Dugard Clay	5–15°	Moderate to slow	50″–65″	Fair	Weathered agglomerate at 2′–4′	Slight to very slight	Medium. Acidic	Moisture supply. Difficult soil to work. Saline subsoil.
Esperance Clay	10–30°	Slow to very slow	80″–100″	Good	—	Moderate. Subject to slumping on steeper slopes	Low. Slightly acidic	Erosion control. Drainage.
Falaise Stony Loam	15–35°	Rapid	50″–110″	Poor to fair	Agglomerate at 15″–20″	High to very high	Low. Slightly acidic	Erosion control. Should not be cultivated.
Franciou Stony Clay	5–25°	Rapid	50″–70″	Poor	Agglomerate at 12″–24″	High to very high	Low. Neutral to slightly acidic	Erosion control. Stoniness. Little agricultural use.
Garrand Clay Loam	5–25°	Rapid	75″–100″	Good to fair	Agglomerate at 24″–40″	High	Medium to low. Slightly acidic	Erosion control. Stoniness.
Gommier Stony Loam	5–25°	Extremely rapid	50″–80″	Poor to very poor	Basalt bedrock at 6″–12″	High	Low. Neutral	Erosion control. Shallowness. In arid area. Little agricultural value.
Hardy Clay	5–25°	Moderate to slow	50″–70″	Good	—	Slight	Medium. Slightly acidic	Difficult soil to work. Moisture supply in arid area. Drainage in wet periods. Saline subsoil.
Haut Clay Loam	10–25°	Rapid	80″–100″	Fair	—	High	Medium to high. Slightly acidic	Erosion control. Moisture supply in dry periods.
Ivrogne Stony Clay	20–35°	Rapid	70″–120″	Good	—	High	Medium to high. Slightly acidic	Erosion control. Stoniness.

Source: Stark, et al., 1966.

Table 1.1(10) (continued). Soil classification table, St. Lucia.

Soil Type	*Dominant Slope Range*	*Drainage Through Soil*	*Dominant Mean Annual Rainfall Range*	*Moisture Supplying Capacity*	*Factors, if any, Limiting Root Penetration*	*Erosion Hazard*	*Natural Fertility*	*Any Special Soil Management Problems*
Jalousie Clay	2–6°	Slow to very slow	90″–100″	Good to fair	Mottled clay subsoil at 12″–20″	Very slight	Medium. Slightly acidic	Drainage.
Jambette Stony Silty Clay Loam	5–25°	Rapid	60″–90″	Poor to fair	Agglomerate at 20″–30″	Moderate to high	Medium to Low. Acidic	Erosion control. Stoniness. Shallowness. Moisture supply.
Jean Baptiste Silty Clay Loam	15–35°	Rapid to moderate	80″–150″	Fair to good	—	High to very high. Subject to sliding	Low. Very acidic	Erosion control. Low natural fertility.
Latille Clay Loam	0–2°	Moderate	60″–80″	Good	—	Almost nil	High Acidic	Almost none.
Mabouya Silty Clay	18–25°	Slow to very slow	90″–120″	Good	Mottled clay subsoil at from 15″–25″	High. Subject to sliding	Medium. Acidic	Erosion control. Drainage.
Mahaut Silty Clay Loam	5–25°	Rapid to moderate	90″–150″	Fair	—	Slight on gentle slopes	Medium. Acidic	Erosion control on steep slopes.
Marquis Clay	15–25°	Rapid to moderate	75″–100″	Fair to good	—	Moderate	Low to medium low. Highly acidic	Erosion control. Stoniness in places. Low fertility.
Michel Gritty Clay	1–5°	Slow to very slow	60″–80″	Fair to good	Mottled clay subsoil at 12″–20″	Slight	Medium. Acidic	Drainage in wet periods. Moisture supply in dry periods. Very difficult soil to work.
Micoud Gritty Clay	5–25°	Slow	60″–90″	Poor to very poor	Often silica pans; at 12″–35″	Extremely high	Medium. Acidic	Extreme measures for erosion control.
Moreau Clay	15–25°	Rapid to moderate	80″–120″	Fair to good	—	Moderate	Medium to low. Acidic	Erosion control. Low fertility.
Parasol Clay	30–40°	Rapid to moderate	80″–100″	Good	—	High to moderate	Medium. Acidic	Erosion control. Stoniness. Only suited to forestry.
Panache Silty Clay Loam	25–40°	Moderate to rapid	80″–160″	Good	—	High. Subject to slipping	Very acidic	Erosion control. Steepness. Suited to forestry.
Piaye Silty Clay	0–2°	Very slow	60″–70″	Fair	Water table at 18″–30″ (often saline)	Nil	High. Acidic, neutral with depth where saline	Drainage. Often salinity. Only really adapted to pasture and rice.
Quilesse Silty Clay	5–15°	Slow to very slow	120″–160″	Good	—	Slight to moderate	Very acidic	Diversion of seepage. Drainage. Extreme acidity.
Rabot Clay	15–25°	Rapid	90″–120″	Good	Dacite at 20″–30″	High to moderate	Medium. Acidic	Erosion control. Stoniness.
Raveneau Clay	0–1°	Slow to very slow	50″–80″	Good to Fair	Mottled clay subsoil at 15″–24″	Nil except stream bank	High. Acidic	Drainage. Moisture supply in dry season. Heavy intractable soil.
Regnier Stony Clay	20–35°	Rapid	80″–90″	Good	—	High	Acidic	Erosion control. Steepness. Stoniness. Only suited to forestry.
Richefond Fine Sandy Clay Loam	0–1°	Moderate to rapid	70″–90″	Good	—	Nil except stream bank	Medium to high. Very acidic	Almost none.
Rozette Gritty Clay	2–15°	Slow to moderate	55″–80″	Fair	Clay subsoil, often with silica pans at 12″–35″	Moderate to high	Medium. Acidic	Erosion control. Moisture supply in dry season. Heavy soil to work.
Soucis Silty Clay Cloam	0–2°	Slow to very slow	70″–120″	Good	Water table at 3′–4′	Nil except stream bank	Medium. Acidic	Drainage.
Troumasse Loam	0–2°	Rapid	60″–90″	Good to fair	—	Nil except stream bank	High. Acidic	Almost none.
Vanard Peat	0–2°	Water-logged	80″–90″	Very good	Water table almost at the surface	Nil	Neutral to slightly acidic	Drainage. A high organic content.
Venus Loam	20–35°	Rapid	80″–120″	Fair to poor	—	High to moderate	Medium. Acidic	Erosion control. Shallowness.
Warwick Clay	20–35°	Moderate	90″–150″	Good	—	High	Low. Very acidic	Erosion control. Steepness. Acidity.
Zenon Gravelly Bouldery Loamy Sand	2–8°	Rapid	90″–100″	Fair	—	Slight	Medium. Acidic	Stoniness.

Source: Stark, et al., 1966.

have developed; the clay of these soils is generally kaolinitic, but allophane and illite may also occur.

Soils in the interior tend to be acid, heavily leached and deficient in minerals, especially those on the central ridge and on the pitons which are continuously wet. In fact, from a resource management perspective it is important to understand that little of the fertility that sustains forest growth in St. Lucia is in the soil itself; rather it is bound up and stored for recycling in the living biomass, the forest itself -- the trees (from canopy to ground) and organic leaf litter and deadfall material on top of the ground. If this storehouse of nutrients is removed in any way, it is certain that it will *not* be a forest that grows back right away -- only scrub bush which can survive the nutrient-poor conditions. Furthermore, as is typical of most tropical soils, the top soil layer tends to be shallow and vulnerable to erosion. Consequently, the removal of vegetation from steep slopes tends to be followed by mudslides or landslips which expose a subsoil that is a very sterile mixture of clay, iron compounds and quartz.

In the drier areas of St. Lucia, lattice clays of the montmorillonitic type are common, and soils along the coast except near the river mouths and around Hewanorra Airport tend to be stony, shallow and infertile. By way of contrast, the best and thickest soils are the alluvial deposits in the lower reaches of the main river valleys, especially Roseau, Cul de Sac, and Mabouya, plus the plain around Vieux Fort.

Regardless of the location, however, the high quality productive soils of St. Lucia tend to be taken for granted and undervalued. Concern about soil loss by erosion centers on the fact that reformation of replacement soils is an extremely slow process. Best estimates are that it takes from 200 to 700 years to form just 2.5 cm (about 1 inch) of top soil weighing about 360 tons/hectare (Pimentel, *et al.*, 1986). Under certain rainfall conditions, some St. Lucian rivers carry that much sediment in one day! And some of this unfortunately is top soil; all of it is lost into the sea. Such loss is unnecessary if common soil conservation practices are followed (see also Section 3 of this Profile).

J. Stark, *et al.* (1966) prepared a useful classification and pedologic matrix of St. Lucian soils, a useful component of which is the erosion susceptibility classifications. This matrix is presented as Table 1.1(10).

1.1.5 Vegetation

THE LESSER ANTILLEAN BIOGEOGRAPHIC SETTING

Few areas of comparable size anywhere in the world are endowed with a botanical heritage as diverse and as interesting as the flora found on the Caribbean assemblage of islands. For botanists and naturalists, however, the region is a tough taxonomic, ecologic and biogeographic nut to crack because of its checkered geologic past, the intermixture of high and low, wet and dry, volcanic and limestone islands and because of the proximity of and floral species input from the islands of the Greater Antilles to the north and the South American mainland to the south. One of the region's notable forester-ecologists, J. S. Beard, in a very utilitarian book published nearly 40 years ago (Beard, 1949) reported that the Lesser Antilles alone had nearly 2,000 species of flowering plants. As for trees, Beard's list stood at 243, of which 68 were regionally endemic, that is, peculiar or native to the area under discussion. St. Lucia's share, at the time of Beard's study, was 151 tree species or 62 percent of the regional total (Table 1.1(11)).

Isolated from larger land masses, true oceanic islands are expected to show a highly endemic flora with a few waif origin types. St. Lucia, as an archipelagic or quasi-oceanic island, exhibits these phenomena but not in a very marked degree. Endemism only reaches an appreciable proportion in the mountainous interior of the island. Thus, there is a striking difference between the coastal, dry zone, lowland flora, with endemism at about 12 percent, and the rain forest and montane floras with endemism at 40-50 percent.

Table 1.1(11). Distribution among Lesser Antillean islands of 243 tree species, 68 regionally endemic.

	TOTAL NO. TREE SPECIES	PERCENT OF TREE FLORA	NO. OF ENDEMICS
St. Kitts-Nevis	121	50	13
Montserrat	132	54	17
Guadeloupe	193	78	43
Dominica	167	68	42
Martinique	181	74	47
St. Lucia	151	62	35
St. Vincent	151	62	29
Grenada	120	49	15

Source: Beard, 1949.

Part of the reason for this difference is geological. When the four central islands of the Lesser Antilles (Guadeloupe, Dominica, Martinique and St. Lucia), which also form the oldest group, began to form in Miocene time (see geologic time line, Table 1.1(8)), there was only open sea to the north of St. Lucia all the way to Puerto Rico. Subsequently, during the Pliocene period, there was widespread regional uplift. In the south, Grenada made its appearance above the ocean surface, but north of St. Lucia the temporary uplift process appears to have produced a fairly large, low emergent land mass or cluster of islets more or less linking Puerto Rico and the Virgin Islands group to Antigua, which was very close to Guadeloupe, the northernmost of the "big four". This made it possible for Greater Antillean dry zone flora (but *not* the montane flora) to migrate across the low, dry "land bridge" to Guadeloupe and beyond.

Slightly later in Pleistocene time, submergence caused the fragmentation of the prototypic "Leeward Island" land bridge or platform and an outburst of vulcanism, finally resulting in the appearance of Montserrat, St. Kitts, Nevis and St. Vincent.

These much more recent island systems were then rapidly colonised by flora and fauna originating mostly from the four older islands at the centre of the group. It is interesting to note that nearly all of St. Lucia's rain forest trees, even though they are large, tend to be species with relatively small seeds, easily consumed by birds at one island, carried intestinally, and subsequently deposited in faecal matter on another island. Birds were the primary vehicle for seed transport and floral colonisation of upland areas. Furthermore, since inland areas with more fresh water provided a less hostile environment, the upland areas were vegetated first and got a head start in the adaptive process leading to endemism.

Coastal tree types, on the other hand, tended to have larger seeds or nuts (propagules) which arrived by sea as floating waifs and which were cast ashore into a fairly hostile environment, only occasionally taking root and surviving. Even when the colonisation process was successful, coastal vegetation was always at risk from inundation caused by secular

changes in sea level and periodic, short-term but destructive storm flooding and tidal waves.

VEGETATIONAL ZONES

There are nine significant and distinct vegetational associations customarily used for classification purposes in Lesser Antillean islands like St. Lucia. They are:

Zone 1	Rain Forest
Zone 2	Lower Montane Rain Forest
Zone 3	Montane Thicket
Zone 4	Elfin Woodland
Zone 5	Littoral Woodland
Zone 6	Swamp Formations (mangroves, etc.)
Zone 7	Secondary Rain Forest
Zone 8	Dry Scrub Woodlands
Zone 9	Fumerole Flora.

The normal distribution of natural vegetation in St. Lucia is, at first glance, quite simple (Figure 1.1(3)). The great majority of the climax formations, in St. Lucia's case the first six in the above list, are climatically, and therefore topographically, induced. While edaphic (soil) factors are important, they lack the controlling force of climate, except in the case of the swamp/mangrove formations and the fumarole sites at Soufriere. In effect, the forest zones or vegetational belts mirror the climatic belts described in Section 1.1.2, and this results in a nearly concentric zonation of vegetational types related to the increase of rainfall with altitude above sea level (see Figure 2.2(2) in Chapter 2 of the Profile).

Zone 1 (Primary Rain Forest). Includes the axial mountain ridge, Barre de L'Isle and its elongate spurs, pitons, steep slopes and upper valleys. This central, heavily forested core of St. Lucia encompasses perhaps eighteen thousand acres, containing four closely related but different formations.

(1) RAIN FOREST: (*Dacryodes-Sloanea* Association). The dominant trees are Gommier, Chataignier, and Mahoe. (See Figure 2.2(3) and Table 2.2(3) in Chapter 2.)

(2) LOWER MONTANE RAIN FOREST: (*Licania-Oxythece* Association). The dominant trees are Balata, Balata Chien, Laurier Puant, Corosol Marron, Dacryodes and Paletuvier. Despite its name, this assemblage is located upslope from the rain forest but is "lower" than the mountain peak and ridge top area as described below. (See Figure 2.2(4) and Table 2.2(4) in Chapter 2.)

(3) MONTANE THICKET: (*Micropholis-Podocarpus* Association). This formation is found on the numerous peaks, pitons and higher ridges, the principal localities being La Sociere, Piton Flore, Morne Locombe, Piton St. Esprit, and Grand Magazin. (See Figure 2.2(5) in Chapter 2.)

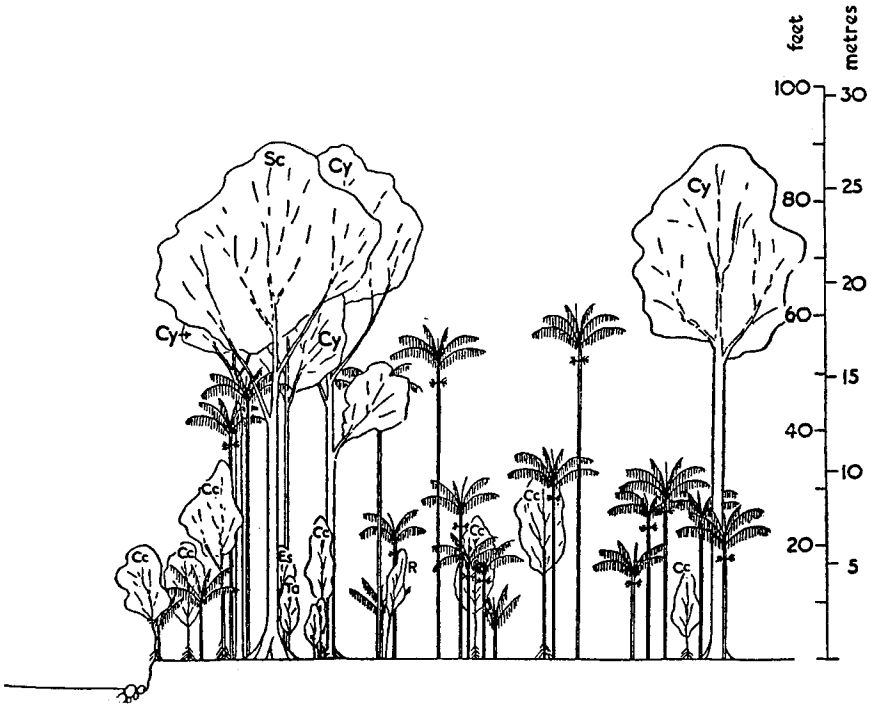
(4) ELFIN WOODLAND: (*Didymopinax-Charianthus* Association). Restricted in St. Lucia to the top of Mt. Gimie. Trees are small in stature, mossy, knarled, wind-deformed, and festooned with epiphytes.

These four forest types basically cover everything above the altitude line where an annual drought has no effect and there is abundant moisture all year round. This is the zone of the most luxurious, least disturbed forest. As used here, however, "undisturbed" does not necessarily mean pristine. As far back as 1949 Beard noted that the area was "...not a defined forest reserve and has not been well protected, so that, while there is a large central core of inaccessible virgin forest, the shifting cultivator has been very active all round the flanks."

This nibbling away process continues to this day. It is seldom difficult to find after the fact, marked as it is by an unnatural break or gap in the forest canopy signaling exploitation by some unknown and uninvited itinerant banana

Cg. Casearia guianensis
Cp. Coccolobis pubescens
Fo. Faramea occidentalis
Hc. Hymenaea courbaril
L. Lauraceae
M. Myrtaceae
Mb. Manilkara bidentata
Me. Maytenus elliptica
Pf. Pisonia fragrans
Pr. Pimenta racemosa
Tb. Tabebuia pallida

Figure 1.1(9). Profile diagram of evergreen forest site near Praslin, St. Lucia, as it existed four decades ago (source: Beard, 1949).



Cc. Chrysochlamys caribaea
Cy. Chimarrhis cymosa
Es. Exostema sanctae-luciae
R. Rubiaceae
Sc. Sterculia caribaea
Ta. Tapura antillana

Figure 1.1(10). Profile diagram of riverine forest along the Roseau River, St. Lucia, as it existed four decades ago (source: Beard, 1949).

farmer, parrot poacher or charcoal burner who escaped detection long enough to make and leave an ugly, grafitti-like mark on the face of the forest.

Zone 2 (Secondary Rain Forest). Surrounding the central, mostly primary rain forest there is an irregular band of secondary forest that has been devastated by the shifting cultivator who has moved to a new plot, leaving behind abandoned gardens which often generate groves of tree ferns. Breadfruit trees are frequently seen, having been planted by the former cultivator-tenant. Pioneer specimens of most rain forest species are common.

Zone 3 (Dry Scrub Woodland). Downslope of the secondary forest, with which it shares an irregular boundary, the formerly forested, dry scrub woodland is now the primary agricultural zone. This wide band of land -- now farms, rural villages, roads, pastures and banana stands -- was once an area of dry evergreen or semi-evergreen seasonal forest. According to Beard, only a few, probably non-representative, examples of this type of forest remain. Figure 1.1(9) displays a profile diagram and key species list for a dry evergreen forest site near Praslin on the east coast as it existed four decades ago.

Zone 4 (Littoral Woodland - Dry Scrub). A discontinuous band of dry scrub woodland occurs around the coastlands, interrupted by an occasional embayment, by a half dozen or so significant rivers making their way to the sea, and by numerous protruding rocky headlands.

These physical discontinuities have vegetational counterparts in the form of a fresh water swamp (Bois d'Orange), sand beach areas, salt flats, a swamp forest (Marigot), some herbaceous savannah, and, most importantly, fourteen mangrove wetlands which are listed in Table 2.5(1) and displayed in Figure 2.5(6) in Chapter Two of the Profile. The vegetational formations and relative abundance of plant species in each of these specialised coastal habitats is presented in Table 1.1(12), and avian (bird) species common to mangrove areas are shown separately in Table 2.3(2) found in Chapter Two of the Profile.

Another specialised forest formation, not covered in the preceding summary, is the low altitude, valley floor, "riverine rain forest" which mimics the higher altitude rain forest associations (see Roseau Valley example shown in Figure 1.1(10)). This type of valley floor, micro-forest site was common in the 1940's at the time of Beard's survey but has, in the intervening decades, been cleared and displaced. What is illustrated is the climax stage and represents the kind of formation that would grow back if the sites were left alone, all other things being equal.

Other specialised vegetational sub-climax formations are found in the extreme north and south near Cap Estate and Vieux Fort, respectively, which are St. Lucia's driest areas. Here the "dry scrub woodlands" merge into thorn scrub, logwood thicket, cactus bush and thorn savannah. (For more information, the reader is referred to OAS, 1984, "Land Use and Vegetation" map.)

VEGETATION ZONES: BEARD's "LIFE FORM" CLASSIFICATION SYSTEM

In 1942 the British Treasury in London provided funds under a Colonial Development and Welfare plan for a forester from Trinidad and Tobago to undertake some exploratory investigations into the state of forestry matters in the Windward and Leeward island group. At that time, only Trinidad had a Forestry Department, established in 1901, and no forestry research efforts had been previously undertaken in the Lesser Antillean region. Since the intention was to start an insular forest service and execute a forestry programme in each of the islands, and since the venture was, in the absence of any prior research, starting from first principles, it necessitated mounting a series of field surveys and ecological investigations we would today call a forest resource assessment.

At the time J.S. Beard, then of the Colonial Forest Service, started his decade of work in the Lesser Antilles (which led to publication of his classic monograph, *The Natural Vegetation of the Windward and Leeward Islands*, in 1949), he found the existing classification

Table 1.1(12). Relative abundance of plant species in different coastal habitats.

Habitat and species	Marquis Bay	La Sorciere	Dennery	Cas en Bas	Bois d'Orange	Esperance	Anse Louvet	Choc Bay	Man Koté	Fond d'Or	Marigot	Praslin	Micoud	Savannes Bay
Sand beach														
Ipomoea pes-capreae		+	+	3	2					+				
Wedelia trilobata	3	+	+	+										
Stachytarpheta jamaicensis				+										
Paspalum vaginatum				+										
Euphorbia mesembryanthemifolia				+										
Ipomoea cairica							+							
Salt flats														
Sesuvium portulacastrum									2					
Fimbristylis spathacea									1					
Spartina patens									2					
Strand woodland														
Morinda citrifolia	+	+	+	+	4									
Terminalia catappa	4			3							+			
Coccoloba uvifera		+		+										
Erithalis fruticosa		+		+										
Hippomane mancinella			+	+										
Jaquinia arborea		+												
Cytharexylum fruticosum					+									
Randia aculeata					+									
Haematoxylon campechianum					4									
Lonchocarpus benthamianus					2									
Acacia farnesis					+									
Fimbristylis ferruginea					+						+			
Clerodendron aculeatum					+									
Melia azedarach					+									
Cocos nucifera	+	+	+	+	+		+	+			+	+	+	
Mangrove swamp														
Rhizophora mangle	2	2	4	4		3	3	+	2	2	4	4	4	4
Laguncularia racemosa	4	+	2	2	+	4	1		2	+	+	3	+	2
Avicennia schaueriana											2	+	3	
Avicennia germinans		+	+				+		+	+		+		
Conocarpus erecta	+	+		+					+	+		+	+	+
Acrosticum aureum			+								+	+		+
Thespesia populnea			+				+				+	+	+	
Dalbergia ecastaphyllum	2		1	1	2	1				+	+			
Hibiscus tiliaceus	4						+				+	+		
Pluchea odorata					+	+								
Anona glabra					+	2						+		
Brachypteris ovata	3		+	+		3	2					+		
Sporobolus virginicus	1	+	+	3	2		+		+	+		3	+	
Sporobolus indicus	+			+	+							+	+	
Mangrove type	Riverine								Basin		Fringe			

Mangrove swamp (contd.)	Marquis Bay	La Sorciere	Dennery	Cas en Bas	Bois d'Orange	Esperance	Anse Louvet	Choc Bay	Man Koté	Fond d'Or	Marigot	Praslin	Micoud	Savannes Bay
Mariscus planifrons	+				+	+	+						+	
Fimbristylis dichotoma				+									+	
Rhabdenis biflora						+								
Cydista aequinoctialis											+		+	
Eichhornia crassipes	+		+								+		+	
Swamp forest														
Pterocarpus officinalis										3	3			
Lonchocarpus domingensis	+		+	+							+			
Calophyllum calaba											+			
Montrichardia arborescens										+				
Pimenta racemosa											+			
Mangifera indica											+			
Ceiba pentandra											+			
Leonotis nepetaefolia											+			
Nephrolepis rivularis											+			
Gynetium sagittatum											+			
Herbaceous savanna														
Eleocharis mutata						+					+			
Ludwigia octovalvis						+					+			
Hyptis verticillata						+						+		
Eleocharis interstincta												+		
Mariscus mutisii												+		
Schrankia leptocarpa												+		
Capraria biflora													+	
Enicostema verticillatum													+	
Mangrove type	Riverine								Basin		Fringe			

Key:- Index of abundance= frequency of occurrence in sample areas within each site;

+ = occasional,<10%
1 = 10%
2 = 25%
3 = 50%
4 = 75%
5 = 100%

Source: Portecop and Benito-Espinal, 1985.

system, one developed by French agriculturalist, M. Henri Stehle, quite unsuitable, lacking a sufficiently broad and comprehensive *ecological* perspective. In Stehle's book, *Forest Types of the Caribbean Islands* (1945-6), as in two previous studies (in French), he followed the nomenclature used by Gleason and Cook in their study of the vegetation of Puerto Rico (1927), where the principal names -- Mesophytic, Xerophytic, Hygrophytic and Altitudinal -- were cryptic to all but the author.

Beard preferred simpler terms that would apply to more specific kinds of communities which "...are united by common structure and life-form." Beard was convinced that the "...natural vegetation itself gives a much better index of the local environment." His system not only informs the structure of this St. Lucia Environmental Profile but also now serves as the working foil and forerunner of one component of an Organisation of American States' strategy to develop an improved information base for St. Lucia on 1:50,000 scale maps. In fact, the fifth map in the new OAS series is entitled "Land Use and Vegetation" and retains Beard's vegetational classification framework almost in its entirety.

HOLDRIDGE'S NATURAL LIFE ZONES: AN ALTERNATIVE FRAMEWORK

In the same map series referred to above, OAS also introduced a more precise nomenclature for the vegetation. It produced a new "Natural Life Zone" map based on the so-called Holdridge system of classifying bio-geoclimatic zones by using an elaborate nomogram which identifies all first order ecosystems. Favoured by the agriculturalists, the Holdridge classification technique gives the appearance of being a more finely tuned, more quantitative version of Beard's classification methodology. The Holdridge vegetation classes for St. Lucia, displayed in Table 1.1(13), can be useful indicators of the kinds of plants best adapted to each "life zone" ecosystem (see Annex A of OAS, 1986a, for species composition data). Conversely, observation of the natural vegetation can be used to predict broad environmental conditions where such site-specific data are not available. This is of some utility in scheduling the introduction of either annual or tree crops in areas newly opened up to farming.

Table 1.1(13). St. Lucia life zones (Holdridge's terminology).

LIFE ZONE	AREA Acres	AREA Hectares	% OF TOTAL AREA
Tropical dry forest	48,207.0	19,517.0	31.7
Tropical dry forest transition to tropical very dry forest	3,046.3	1,233.3	2.0
Tropical moist forest	20,448.6	8,278.8	13.4
Subtropical moist forest	11,186.1	4,528.8	7.3
Subtropical wet forest	47,835.5	19,366.6	31.4
Subtropical wet forest transition to subtropical rain forest	18,661.6	7,555.3	12.3
Subtropical rain forest	2,870.6	1,162.2	1.9

Source: OAS, Life Zones Map (1984).

But on islands as small and as rugged and hilly as St. Lucia, ritual concern for micro-detail and for establishing "boundaries" for irregular, ill-defined "transition zones" leads to zonal patchiness and a very confused picture. Under these circumstances, the value of devising individual "management plans" for each discrete life zone, as has been recently suggested (Lugo, *et al.*, 1981), appears quite doubtful, even impractical -- at least for a country as small as St. Lucia.

1.1.6 Water

Rainfall is the primary source of fresh water in St. Lucia. Average annual total precipitation is about 150 gigalitres or 1.5 cubic kilometres of water (35 billion gallons). Due to the rugged topography and the absence of lakes and ponds to serve as storage reservoirs, most of this water flows quickly to the sea. Worse yet, a rather low proportion is stored naturally as ground water because of the generally impervious nature of the volcanic bedrock. Consequently, the timely interception of some portion of this rainfall run-off is the only means of making water available for human use, while the remainder performs its essential role in maintaining natural vegetation and rain-fed agriculture.

The forested areas of St.Lucia (see Figure 2.2(2)) provide a reliable, cost-free rainwater storage service for the country that works in the following way. Nearly all rain that falls in the protected upland forest and watershed reserve areas (approximately 19,000 acres (7,600 hectares), see Table 2.2(2)) is first intercepted and atomized (broken up) by the forest canopy (which minimises the soil erosion effects) and then is absorbed by the humus, soils, root systems, subsoils and fractured rock layers which form the forest floor (see Figure 1.1(11)). This *infiltration* process gradually evolves into a down hill subsurface flow called *percolation*, with the *groundwater* sometimes finding its way into and through rock fissures or pores, sometimes surfacing in the form of seepage or natural springs, with nearly all of it ending up in the streams and rivers of the watershed surface drainage system which eventually discharges into the sea.

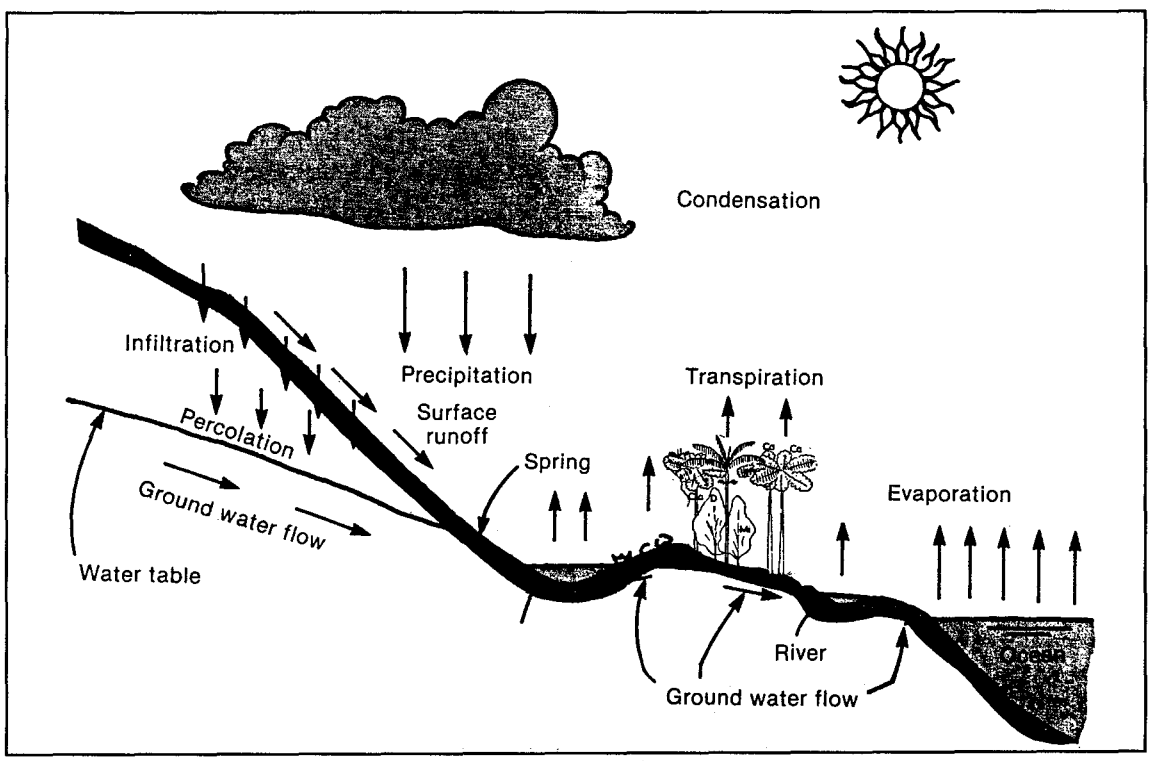


Figure 1.1(11). The water cycle.

When there is a heavy rainfall which exceeds the infiltration capacity of the watershed, the surplus water moves downslope on the surface as sheet run-off, often eroding valuable topsoil from disturbed areas en route and flowing, with its newly acquired sediment load, directly into the nearest tributary stream. Sometimes it also picks up floatable trash, which often ends up blocking cul-verts, filling and clogging catch basins and causing localized flooding. Hence, the infiltration capacity of the forest (largely a function of canopy integrity) is an important factor in optimizing water storage and reducing down-slope flooding and water loss.

While only covering a little more than a tenth of the island, government forest and watershed reserve areas and adjoining protected forests receive about 30 gigalitres (7 billion gallons) of water per year, perhaps 20 percent of the total rainfall for St. Lucia. Currently, about one-third of this total is intercepted at various springs and river sites by WASA dams, weirs and intakes and channeled to about three dozen publicly maintained water supply reticulation systems. Some are village-sized at about 100,000 gallons per day (gpd), with others ranging upward in size to a 1.0 million gpd (4.5 Ml/day) treatment and distribution system at Vieux Fort and a 3 million gpd (13.6 Ml/day) integrated facility serving the Castries area. The existing network of production and distribution facilities is depicted in Figure 1.1(12).

PRODUCTION, CONSUMPTION AND DEMAND

Present consumption by users of piped water systems, based on 1987 WASA data, is approximately 6.5 million gallons per day or 29 megalitres per day. This calculates out, assuming a population of 140,000, to about 200 litres or 45 gallons per person day. Figure 1.1(13) displays historical trends of water production/consumption since 1977. Perhaps the most striking thing about the data is the growing steepness of the curve and fact that it confirms a 200 percent increase since 1977, a figure considerably higher than most previous estimates. Of additional note is the 1.5 million gallon (6.8 Ml/day) per day shortfall between water demand and delivered production.

The entire coastal development zone from Cap Estate in the north to Vigie is served by water piped from the Grande Riviere and the Choc River. This system is interconnected with the municipal network serving Castries and the extensions as far south as Roseau (WINBAN) and Marigot Bay. Most of the water comes from intakes within the Castries Waterworks Reserve, part of which was established in 1916. It has been recommended that the Castries Waterworks Reserve be expanded by at least 300 hectares (750 acres) to ensure a continuing source of water for the urban area. Other, less elaborate water supply networks serving non-metropolitan areas are listed in Table 1.1(14).

At the present time, 50 percent of the population is directly connected to the water supply system, 38 percent is served by community standpipes, and 12 percent has no access. As the service network is extended, bringing water to more and more users, total consumption and per capita consumption will both increase. Population growth, improved living standards, industrialization, urbanization, tourism development, and irrigation schemes are all actively forcing an escalation of water demand with no counterpart expansion of productive capacity.

The St. Lucian Government's 1977 National Plan somewhat boldly estimated that the "... total water demand will be 10.00 mgd [45 Ml/day] by 1990." Even that figure, which is the equivalent of 45 Ml/day (70 gallons per person-day), will in all likelihood be exceeded, given recent government and private sector announcements regarding scheduled and intended new hotel construction by 1990. Unfortunately, no data are available on projected water demand by industry, but an analysis of the 1987 annual reports from NDC, SLBGA, CDB and the SLDB suggests that any figure below an additional 2.0 mgd would be unrealistic.

As for agriculture and its projected seasonal need for irrigation water, the most recent estimate is 25 mgd (112 Ml/day) to serve irrigable lands of major interest, mostly

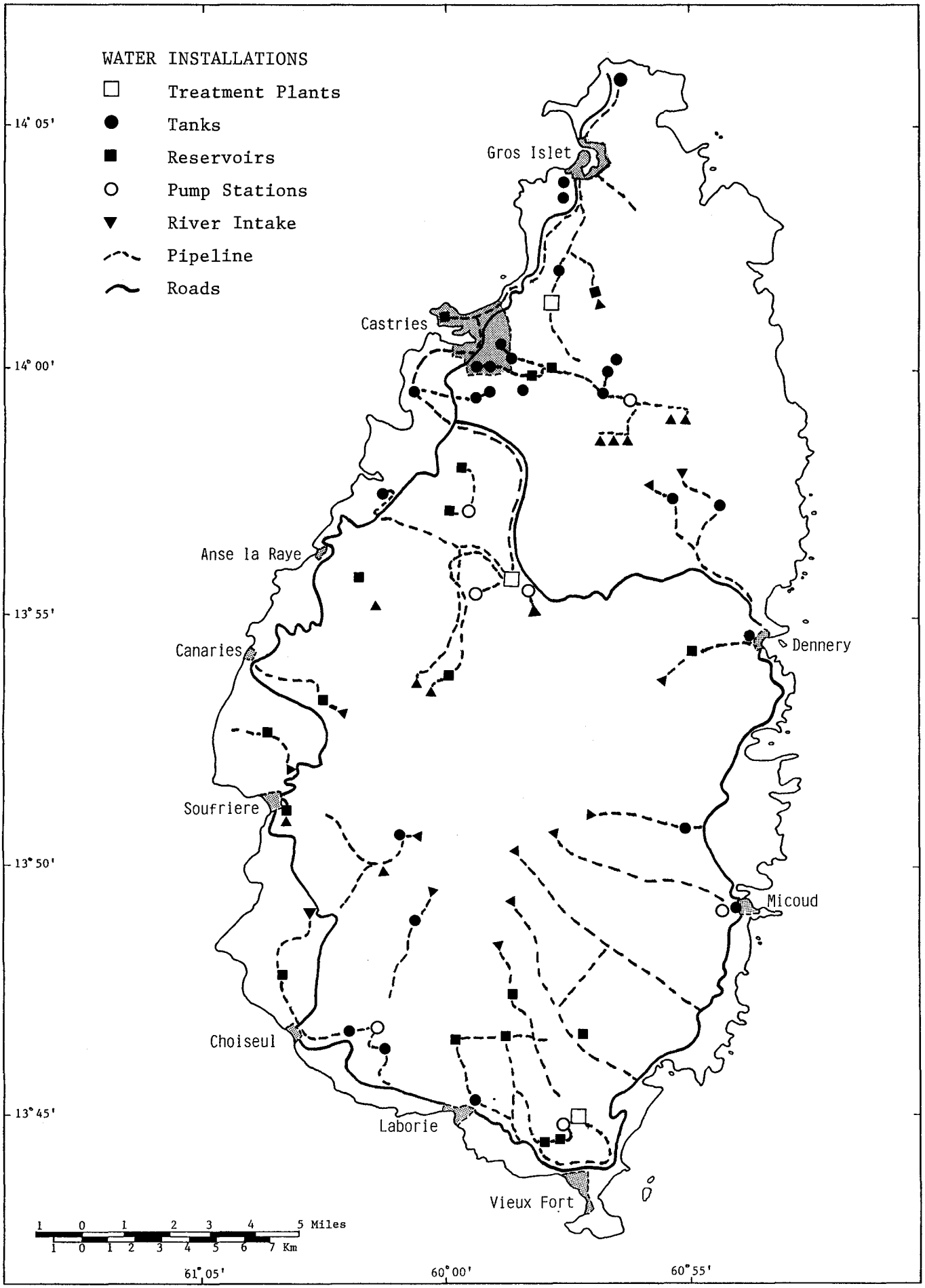


Figure 1.1(12). Water production and distribution network.

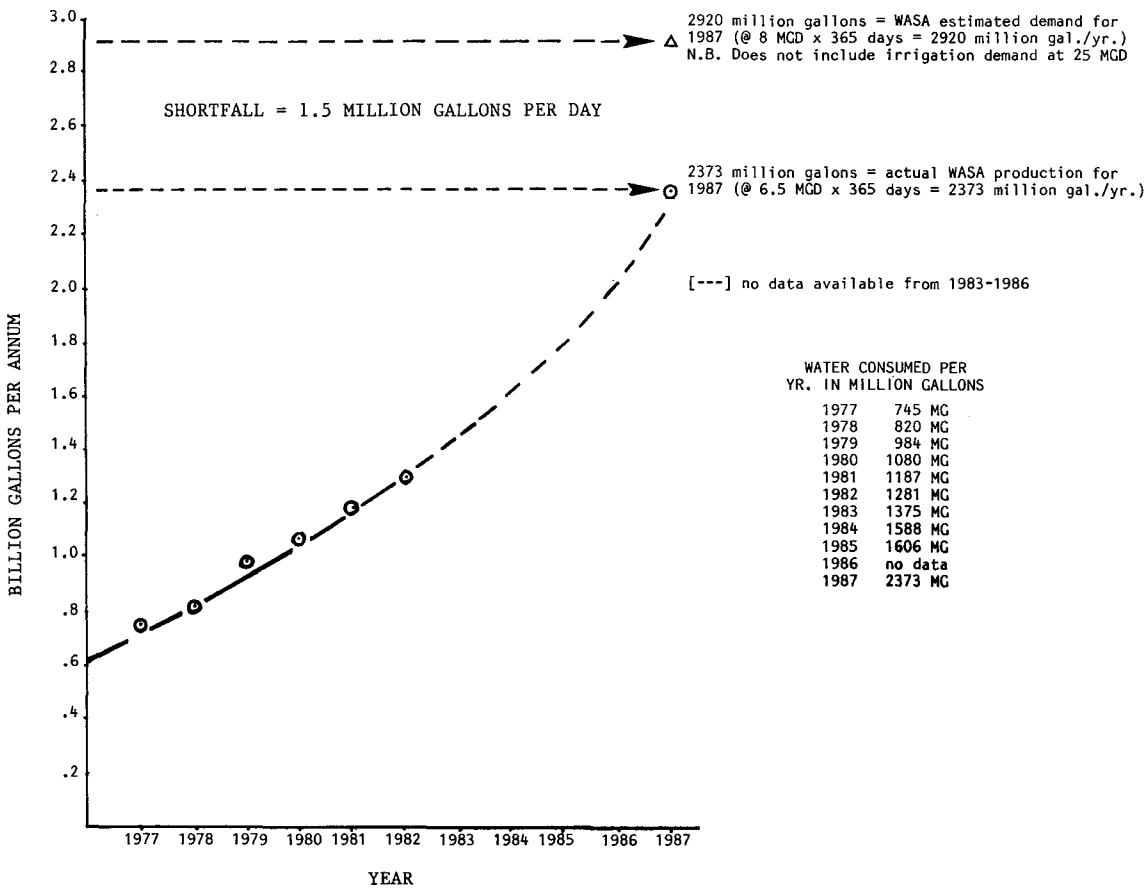


Figure 1.1(13). Historic trends in water production and consumption, 1977-1987 (source: 1977-1985 data from GOSL, *Annual Statistical Digest*; 1987 data from WASA).

alluvial soils which exceed 5,000 acres (2,000 hectares) in seven principal river valleys (see Table 1.1(15)). This is ten times the area now irrigated and forecasts a heavy need for water should these lands be brought under irrigation. This subject is also discussed in the agriculture section of the Profile (Chapter 3) and in Section 2.4 on hydrology.

SUPPLY AND THE DATA BASE

There is a growing volume of both historical and contemporary information on quantitative, qualitative, spatial and temporal aspects of St. Lucia's rainfall and its associated infiltration, runoff, stream and river flow volumes and rates, evapotranspiration, floods and droughts, and water uses -- rural, urban, industrial and agricultural. Consulting reports and data books on water fill a small bookshelf; some measuring instruments are now automated and some rainfall and stream flow data can be retrieved from and manipulated on an IBM computer.

But there is some confusion because there is so much data, not all of it consistent. The problem has arisen largely since 1980 as a consequence of different outside consultants

Table 1.1(14). Water intakes serving non-metropolitan water supplies.

	INTAKES	SERVING	PROTECTED "LAND" EXPANSION REQUIREMENTS
1	Forest Reserve (3 intakes)	Mabouya Valley	
2	Ravine Bassin Noir (2 intakes)	Mabouya Valley	250 ha
3	Ravine Saut	Dennery	400 ha
4	Fond River	Patience, Mon Repos	50 ha
5	Forest Reserve	Micoud	
6	Grand Riviere du Vieux Fort	Pierrot, St. Urbain]	
7	Grand Riviere du Vieux Fort	Vieux Fort]	
8	Grand Riviere de L'Anse Noir	Vieux Fort, Laborie]	675 ha
9	Grand Riviere du Vieux Fort	Choiseul Villages]	
10	Doree + L'Ivrogne Rivers	Choiseul Villages]	
11	Local springs	Soufriere	
12	Canaries River	Canaries	400 ha
13	Grand Riviere de L'Anse La Raye	Anse La Raye	50 ha
			1,825 ha

Source: Stevenson, 1985, 1986, based on data from CPU Issue Paper No. One (1985).

Table 1.1(15). Irrigable lands and water demand by major watersheds.

RIVER BASIN	AREA Acres	AREA Hectares	WATER DEMAND (mgd)
Marquis	378	153	1.89
Roseau	1,332	539	6.66
Troumassee	299	121	1.50
Fond D'Or	1,169	473	5.84
Camelles	250	101	1.25
Cul de Sac	1,443	584	7.22
Vieux Fort	163	66	0.81
TOTALS	5,034	2,037	25.17

Source: Oelsner, 1981; cited in OAS, 1987.

and contractors each, in the absence of local standards or guidelines, "inventing" *de novo* his or her own way of organising and mapping primary watershed-related or focused information. Subsequent users, analysts, local planners and resource managers have not helped matters by compounding old errors, by ignoring inconsistencies, and by not developing proper reference standards and then holding consultants to the mark. This matter needs some sorting out as part of any upgraded strategic planning initiative.

In Oelsner's OAS technical report on St. Lucia's water resources done in 1981, he identified 28 river basins to which he assigned identification numbers linked to maps and various tables of data such as area, slope, rainfall, river flow, etc. This base list of 28 is reproduced as Table 1.2(5) below. In October of the same year, a different OAS/GOSL research team, Pretell and Polius, came up with yet another watershed list. Although the new list superficially looks like an expansion of the first list (i.e., it has the same 28 key entries with only new sub-heads added), there are actually 47 catchment areas, with new watershed identification numbers and with new (different) acreage figures cited for each watershed! This change (not explained) then throws off all associated, previously done calculations such as total rainfall volume per watershed and land usage percentages.

To confuse matters even further, a later OAS summary document on its St. Lucia natural resource project published in 1986 (OAS, 1986a) reprints *both* watershed lists with no accompanying errata sheet or footnote explanation, and with incorrect column acreage totals on the adapted Pretell and Polius list (OAS Table 7, Map B-1 and A-1). Furthermore, in the accom-panying text, it states that there are 31 watersheds, a statement that leaves the reader understandably confused. But this was not end of the matter.

In that same year, 1986, after the completion of two related hydrological study efforts by two different consulting teams, one UN and one EDF-sponsored, the official reports presented St. Lucia with yet another watershed inventory list using 37 catchment units (see Figure 2.4(1)), a brand new numbering system, a new map key and, once again, different acreages shown for each catchment area.

Within a seven year period, a half dozen fairly significant studies were done for St. Lucia focusing on its rainfall and river flow data base, on water supply and hydrology. But the findings are structured by four different, unintegrated, incompatible, numerically different tabular systems -- 28 watersheds, 31 watersheds, 37 watersheds and 47 watersheds, with mostly inaccurate acreage figures as far as the reader can discern.

Despite these annoying data problems, there is more than enough information available to undertake a comprehensive water resource management planning effort in the country. These matters are dis-cussed in some detail in Section 2.4 on Hydrology and Water Resource Management.

Until recently, the only limiting factor in the supply of water to populated communities has been the ability and willingness of Government to make funds available for the operation and maintenance of water intake, purification, pumping and the pipeline network. Even now, there remains some untapped potential in a few river basins with high rainfall and relatively low population such as the Troumassee and the Canelles. There has been some discussion about transferring "surplus" water from these rivers to the water-short Roseau and Vieux Fort rivers.

However, the cost of water supply increases dramatically when water has to be shifted by costly gravity feed tunnels or pumping from one basin to another. Costs escalate even further when the demand exceeds the base flow, necessitating the construction of elevated impoundment facilities in the form of tanks, ponds or reservoirs. Evaporation losses at an average of 4 inches of water per month from open empondments exacerbate the problem. The alternative of more effective watershed protection and management, aimed at capturing more rainfall through improved infiltration, is, by far, the preferred strategy.

Matters of money and technology notwithstanding, there remains a limit to the amount of rainfall run-off that can be "harvested" from

a given watershed acreage with a given assemblage of vegetation. River flows during drought periods are dropping. St. Lucia is fast approaching that maximum water withdrawal limit. In a somewhat slower mode, it is approaching the stark reality that although it has an impressive collection of hydrological studies and consulting reports addressing pieces of the problem, there is no water supply and watershed development plan, no water system management plan, no water conservation plan, no water quality monitoring plan and no water resource policy.

1.2 LANDSCAPE AND LAND USE

1.2.1 Overview

The existing pattern of land use and settlement in St. Lucia, as in the case of most rugged volcanic islands, reflects a general historical preference for living on or near the coastline due to the difficulty of road building and transport in the upland interiors. Communications between places like Vieux Fort and Soufriere and Vigie were customarily by ferry boats and cutters which used the inshore waters as a "highway" or seaway. In more recent times, coastal settlements have been artificially linked together by a sinuous, narrow, sometimes dangerous and often dramatic coastal road. Like St. Vincent and Montserrat, St. Lucia does not have a truly circumferential highway; in the northeast the coastal area from Dennery Knob all the way to Cap Estate is more or less inaccessible. It has only one significant cross island road.

St. Lucia is basically a village society with farm families living in quasi-urban (St. Lucian-style) centres and walking to their land daily. Rural women market their food crops in the the urban or town centres, and many urban households have family land in the "country" which provides them with a link to the land and access to a part of their food requirements. Even Castries is, in many ways, more like a large waterfront village than a small city.

It is no accident that all ten "urban" areas are located at river mouths on the generally flatter coastal plain and have had a long dialogue with both the sea and shipping (as a local entrepot) on the one hand and with agriculture and inland farming areas on the other. At one time, before the interior network of paved roads was developed, the standard communication link between Castries and the outlying towns along the sea coast was by boat. It is notable that transportation for official dignitaries from Castries to Soufriere for the recent ceremonial events marking the discovery of a five megawatt geothermal steam source at Soufriere was by sea using the coast guard vessel, as in days long past.

In addition to Castries, which has always been the metropole (although its predecessor, the Vieille Ville, was originally situated where the Vigie Airport now is), there are nine "old" primary coastal villages that are now undergoing an urbanization process. These include (see Figure 1.1(1)):

- Anse la Raye
- Vieux Fort
- Canaries
- Micoud
- Soufriere
- Dennery
- Choiseul
- Gros Islet
- Laborie.

There are, additionally, over 120 small towns that are mostly but not entirely agricultural. Table 1.2(1) organises them by type and function into six categories which reflect and suggest the complex, three-way interaction among historical, social, and environmental forces as they affect the landscape, the style, and the structure of human settlements in rural St. Lucia.

Choices about nearly all land use in St. Lucia, whether public or private sector driven, are in general constrained by the rugged nature of the terrain. Whether the task is siting a new town standpipe or dump or laying out the route of a new feeder road or selecting new sites for small farm plots, all these tasks are affected by one common denominator -- namely, the degree of flatness of the location *and its approaches*, or the obverse, which provides an index of its slope or steepness. This is generally measured in angular degrees of arc from the horizontal and called the gradient, or it is sometimes referred to as a ratio of rise to run and called slope (as in 1:28, which is the same as a two degree gradient).

Even a cursory review of Table 1.2(2), which displays land distribution by slope in St. Lucia, brings home the inescapable fact, confirmed by looking at any topographic map, that St.

Table 1.2(1). Types of human settlements in St. Lucia.

Type	Characteristicts	Settlements
A-1: Urban, or urban function related, as defined by functional and economic relationships.	Less than 50% of population engaged in agriculture, forestry and fishing, and/or concentration of tourism, industry, commerce, and construction, and/or served with greatest frequency by independently owned transport vehicles allowing residents to commute to work in urban areas.	Castries, Vieux Fort, Marisule, Augier, Reduit, Black Bay, Bois D'Orange, Gros Islet, Dennery (village), Soufriere (town), Choiseul (village), Laborie (village). Settlements which show signs of increasing dependency on urban jobs, e.g., Bexon area, Babonneau area,[1] Ti Rocher (Castries).[1]
A-2: Related to urban area by location but have no urban functions.	Heavy reliance on non-agricultural sources of income (e.g.: craftwork in the Choiseul Quarter,remittances in Anse La Raye and Canaries Quarters).	Reunion, Cafetere, Monchy, Desrameaux, La Borne, Theordorine, Anse La Verdure.
B: Rural, agricultural functions supported by good natural resource base.	Concentration of small farmers producing crops that enjoy the most reliable market system (bananas, coconuts, fresh vegetables) and/or good rainfall, soils not seriously eroded and/or high percentages of 1-5 and 5-10 acre holdings.	Babonneau,[1] La Gare, Balata, Marquis, Paix Bouche, Marc, Fond Cannie, Chassin, Forestiere, Trois Piton, Fond Petit, Ravine Poisson, Guesneau, Odsan, Boguis, Deglos, Becage, Barre de L'Isle, Ti Rocher (Castries),[1] La Ressource, Mon Repos, Woodlands, Au Leon, Belle Vue, Morne Panache, Banse, Canelles, Grande Ravine, Vige, Desruisseau, La Rue, La Caye, Annus, Micoud, Giraud, Saint Joseph, Ti Rocher, Saltibus, Blanchard, Millet, La Croix, Maingot, Grace, De Mally, Latille, Ti Riviere, L'Eau Mineur, Moreaux, Degard, Durocher, Mahaut, La Cour Ville, Galba, Lumbard, Seleau,[2] Raillon, Choco Mel,[2] Londonderry, Praslin, Patience, Mamiku, Derniere Riviere.
C-1: Predominantly small holdings (under 1 acre).	Holdings generally smaller than type B with a greater percentage under 1 acre and/or greater land constraint than type B because of mountainous terrain which restricts settlement expansion or because nearby lands are controlled by well-cultivated medium and large estates.	Roseau, Soucis, Saint Philip, Crown Lands, Migni, Garrand, Colombette, Debbarrah, Sarot, Fond Assau, Durandeau, Dupui, Hill 20,[2] Pois Dous,[2] La Haut, Talvern, Eating, Dauphin, Belle Fond, La Pointe, Malgretoute, Jac Mel, Grand Riviere, Fond Saint Jacques.
C-2: Predominantly small holdings (under 1 acre)	Lower rainfall, than in type C-1 or poorer soils and/ or heavier rate of emigration (especially the 15-44 age group) than occurs in areas characterized in type C-1.	Morne Sion, Delcer, Ravenau, Fiette, Victoria, La Fargue, Industry, Debreul, Esperance, La Pointe (Choiseul), La Riche.
D: Former sugarcane growing areas.	Areas that did not go into intensive cultivation of replacement cash staples.	Morne Jacques, Mal Mason, Masacre, Sarot, Au Tabor, Robot, Belvedere, Gertrine, Ravine Duval, Savanne, Bouton Chateau Belair, Esperance (Canaries).

1. Settlements that have characteristics of more than one type.
2. Not traceable on the 1: 25 000 scale. Directorate of Overseas Survey Map.

Source: OAS, 1986a, based on Carnegie (1981); Directorate of Overseas Survey 1: 25,000 scale map and GOSL, Ministry of Agriculture, 1980 Farmer Survey.

Lucia has precious little flat land. Eighty percent of the country has slopes greater than 10 degrees, and almost half of the entire country has to live with slopes in excess of 20 percent. Nearly 20,000 acres (a little under 8,000 hectares) are over 30 percent and suitable mostly as forested water catchment and wildlife habitat -- both of which leave the vegetation and canopy undisturbed.

The reader is alerted to the fact that there are several different slope tables circulating in St. Lucia among both local professionals and visiting consultants. Over the years various modifications have been made by persons unknown, with little consistency and less concern about the effects of arbitrary exclusions (for example, the forest reserve acreage *which is not a constant*) which skew the base figure downward and the percentage value upward and almost always guarantee false conclusions.

1.2.2 Classifying Patterns of Land Use

Amongst the various land development and resource planning consultants who have sought to help St. Lucia develop new ways to observe, measure, map and project land usage patterns, there has been an occasional lapse of consistency, a common tendency to invent ever new land classification systems or use categories, and an unfortunate lack of consistency regarding area or acreage figures for the various classes of slope, usage or vegetation type. This has led to some confusion, best illustrated by several examples.

Example #1. Recent land utilisation surveys and studies are in general agreement that St. Lucia has about 15,000 acres (9.8% of total land area) dedicated to urban and rural settlement use. According to OAS's land use survey by river basin (see example #3 below), about one-third of this (or 5,000 acres) is literally urban, and a little more than 9,000 acres is made up of rural villages and towns and linear settled areas characteristic of residential development alongside roads and highways in hilly terrain. It is perplexing, however, to find no change in the urban classification total after 14 years (see Table 1.2(3)).

Between the shoreline and the upland forest, a broad band of 50,000 acres (33% of total land) is devoted to mixed agricultural uses (1988 figures). This contains the majority of small and medium-sized farms and represents the most highly productive agricultural land use zone according to the Government's 1986 *Agricultural Census*.

Approximately 13,600 acres are described as "pure banana stands." These alluvial, river valley lands are in the main occupied by medium to large farms and are generally located on lands of Agricultural Capability Classes I to IV (see Section 3.1 of the Agriculture Chapter). Finally, GOSL designates 31,320 acres as scrub and pasture lands and an elongated central zone of primary and secondary forest and woodlands covering 44,960 acres.

The reader's attention is drawn to column three in the comparison table (Table 1.2(3)) with its built-in dilemma for any prospective user. It is obvious that one or more entries must be incorrect because the table has 2,380 more acres than the country had in the 1973 Agricultural Census and the 1977 National Plan and 2,986 more acres than Piitz shows (Table 1.2(4)).

Example #2. What happens when a professional forester approaches the task of developing a profile of land use in St. Lucia, addressing the very same 152,500 acres? Inspect Table 1.2(4) and notice how different it looks compared to the GOSL information cited in Table 1.2(3). How could nearly 10,000 acres of urban area simply disappear? Why would the forester (Piitz) find more farmland and the planners more forest? ... and the forester find grassland (1,500 acres) where the planners found none, but the planners found 13,600 acres of bananas which the forester never mentions except indirectly as "mixed agriculture".

It is, of course, obvious that the problem arises out of the matter of structuring and defining appropriate classes or categories. There is always the difficult choice to be made between simplicity and complexity, between generalities and explicit detail. In the above tables, GOSL errs on the side of simplicity;

Table 1.2(2). Land distribution by slope in St. Lucia.

GRADIENT (degrees)	SLOPE (ratio)	ACRES	HECTARES	% OF AREA IN SURVEY (133,180 ac)*	% TOTAL AREA IN ST. LUCIA (152,180 ac)**
0 - 2	Under 1:28	10,900	4,400	8%	7.2%
2 - 5	1:28 - 1:11.5	3,900	1,500	3%	2.6%
5 - 10	1:11.5 - 1:6	15,000	6,070	11%	9.9%
10 - 20	1:6 - 1:3	37,580	15,215	28%	24.7%
20 - 30	1:3 - 1:1.7	46,000	18,620	35%	30.3%
over 30	Over 1:1.7	19,800	8,000	15%	13.0%
SUB-TOTAL		133,180	53,805	100%	
Misc./Mixed*		19,068.6	7,719		12.5%
TOTAL		152,248.6	61,524 ***		100.0%

* Miscellaneous surface types: barerock, salinas, urban areas, beaches, swamps, and other excluded areas. N.B. Several documents leave out this line/category and calculate percentage on a base acreage of 133,180 + (see column #5).

** A few documents (for example, see Talbot, 1984), as well as information provided by the GOSL/CPU for the CEP study, calculate percentages using a base of about 152,200 acres, with minor variations. Caution is suggested in using all of the various slope tables available for St. Lucia as they vary widely.

*** This hectare column varies as a function of the acres to hectares conversion factor used by different researchers. Some use 2.4, while some use 2.5 as a divisor. This column uses 2.47, a more accurate figure, but it changes the total. At least four standard sources have an apparent error in the acreage figure shown for gradient over 30 degrees -- often showing 19,000 acres, not 19,800 acres.

Piitz, the forester, errs on the side of detail as the descriptive guide for his classification system is larger than his table -- and too lengthy to reprint here but very useful to future investigators for the following reason. The advantage to the data user is that once he or she has access to the criteria by which the classification was accomplished, it is possible to subsequently disaggregate, i.e., take apart, the components of individual classes (which are com-

posites anyway of different subgroups) and, without distorting the numbers, put them back together again in whatever way will be most useful.

Secondly, one can more easily replicate the survey methodology at a later date in order to measure changes to specific areas and classes and over given time frames and establish rates of change -- an important input to good forecasting and planning. In Piitz's favour is the fact that he elected to borrow and use a standard FAO set of land use categorical labels and definitions. His work and his allocations can therefore be checked for accuracy by other researchers.

Table 1.2(3). Comparison of three land use tabulations (acreage by class).

	1973/74	1977	1988
Urban Areas	15,000 ac	15,000 ac	15,000 ac
Banana Land	13,300 ac	13,500 ac	13,600 ac
Scrub and Pasture	23,000 ac	23,000 ac	31,320 ac
Mixed Agriculture	55,200 ac	55,000 ac	50,000 ac
Forest and Woodland	46,000 ac	46,000 ac	44,960 ac
TOTALS	152,500 ac	152,500	154,880 ac

Source: 1973/74 data from the 1973/74 Agricultural Census; 1977 from the 1977 National Plan; 1988 data from CPU background information submitted for the CEP based on the 1986 Agricultural Census.

Table 1.2(4). Area of land by land class as classified by Piitz.

CLASS	AREA/ACRES	PROPORTION
PRIMARY FOREST		
Rain Forest	16,752	11.0%
Montane Thicket	1,501	1.0%
Mangrove	135	0.1%
Elfin Woodland	329	0.2%
Plantations	608	0.4%
SCRUB FORESTS	30,911	20.4%
OPEN WOODLAND	4,624	3.0%
MIXED AGRICULTURE-SECONDARY FOREST	73,816	48.6%
DEVELOPED AGRICULTURE	17,547	11.6%
URBAN INFLUENCES	4,141	2.7%
GRASSLAND	1,530	1.0%
	151,894	100.0%

Source: Piitz, 1983.

Example #3. Since 1981 the Organization of American States has carried out a lengthy series of investigations in St. Lucia focusing on natural resource and agricultural development issues, all within the framework of a technical co-operation agreement with the Government of St. Lucia. A major group of basic planning and resource assessment studies, undertaken in the early 1980's, sought to employ an integrated strategy, combining work on land tenure, watershed assessment and management, rainfall data assembly and evaluation, and an impressive sequence of incremental "building block" projects classifying land capability, land uses, water storage, water supply, and water demand.

It was decided early on in the OAS natural resources project that the Holdridge life zone vegetation classification system (see Section 1.1.5) would be supplemented by a watershed framework for recording land and water use systems and for applying environmental data to the task of basin planning and management. This was a thoroughly defensible strategy for watersheds are excellent analytical units or "building blocks" in both resource assessment and planning. (They are often difficult "management units," however, as their boundaries, which are natural, seldom coincide with political and administrative boundaries.) OAS also sought to assemble in a tabular or graphic format as much basic data about the resource base as could be located, collated, massaged and published within the project framework. It employed a small army of research consultants to undertake various tasks producing, between 1981 and 1988, a series of over 65 reports covering nine broad thematic areas of focus. They are very helpful documents -- if used carefully.

The first OAS water study (Oelsner, 1981) introduced a simple 28 unit clockwise numbering system for watersheds (see Table 1.2(5) and Figure 1.2(1)). It was, with some adaptation, to become the basis for the OAS data base on watersheds. It seemed harmless and innocuous at the time, but its roots were planted and, with OAS's nurturing, it grew.

To begin with, several years later two other project teams working in St. Lucia with WASA, apparently finding the OAS 28 watershed code too small, proceeded to develop a 37 unit system which provides slightly more detail (Migeot and Hadwen, 1986; HTS, 1986). (The reader is re-ferred to Section 2.4 for further information on the 37 watershed system.) In the meanwhile, at some point before 1986, OAS expanded its own 28 unit numbering system to a heirarchical file system with sub-files, suitably designed for computer "file" use. This may explain the peculiar numerical coding used to identify each watershed in Table 1.2(6), i.e., there are 47 in 28 *primary* river basins.

This "Land Use by River Basin" table is an extremely useful assemblage of information, but a comparison of the basin acreage column in Tables 1.2(5) and 1.2(6) immediately suggests a problem: they do not agree. Now compare these basin/acreage figures with the similar column in the table entitled "Land Capability by River Basins" (Table 1.2(7)). Alas, there one discovers yet a third, completely different, set of basin acreage figures. They need to be used with caution and at the very least the issuing agency, OAS, should disseminate an appropriate errata sheet with notes on the methodologies used in the various classifications and labelling exercises.

It is important that such contradictions and classification errors be clarified. Until they are, land use planning efforts by various branches of Government, which need and use baseline information such as is presented in these various tables and the documents from which they have been extracted, will be at risk and, at best, calculations by the user are rendered more complex than they need to be.

1.2.3 Spatial Patterns of Development

Population distribution shows a marked spatial concentration in what is referred to, in planning terms, as the northwest urbanised zone, i.e., the Castries/Gros Islet coastal corridor. Just under half the total population lives in this administrative zone (see below, Section 1.3.3). Economic activity is dominated by three main productive sectors -- agriculture, tourism, and manufacturing -- with the construction industry performing a critical

Table 1.2(5). OAS initial 1981 numbering code for St. Lucia river basins.

NO.	BASIN NAME	DRAINAGE AREA Acres	Sq. Km.
1.	Sallee	890	3.6
2.	Esperance	2273	9.2
3.	Dauphine	1409	5.7
4.	Marquis	7512	30.4
5.	Fond D'Or	9711	39.3
6.	Dennery	4645	18.8
7.	Praslin	1977	8.0
8.	Fond	4472	18.1
9.	Volet	1779	7.2
10.	Troumassee	7586	30.7
11.	Micoud	2298	9.3
12.	Canelles	4028	16.3
13.	Vieux Fort	7240	29.3
14.	Black Bay	3583	14.5
15.	Piaye	2768	11.2
16.	Balembouche	1334	5.4
17.	Doree	2743	11.1
18.	Choiseul	2273	9.2
19.	L'Ivrogne	1433	5.8
20.	Soufriere	3954	16.0
21.	Canaries	3410	13.8
22.	Grand Riviere de L'Anse La Raye	2174	8.8
23.	Petite Riviere de L'Anse La Raye	1661	4.7
24.	Roseau	11861	48.0
25.	Cul de Sac	9563	38.7
26.	Castries	1137	4.6
27.	Choc	3410	13.8
28.	La Brelotte	2397	9.7

Source: Oelsner, 1981.

and supporting role to all three. See Section 1.5 for a full economic profile of the country.

This concentration of population, services, and economic activity has serious implications for the future. For example, despite the presence of an international airport at Vieux Fort, the smaller Vigie Airport at Castries handled 14,158 aircraft movements, or 83 percent of the total in 1982. In addition, Castries is the centre for banking and insurance, health and education, electricity, water and telecommunications. Official planning policies call for decentralisation away from the northwest urban region. However, this earlier settlement pattern, dominant since colonial times, has not been reversed or even significantly slowed.

Urban Areas. Urban growth rates have varied over the period 1970 to 1980. Only five of the ten settlements defined as "urban" (see above, Section 1.2.1) showed positive growth rates, but the 1986 Agricultural Census data suggest that during the first part of this decade several of these have reversed the negative trend and by the time of

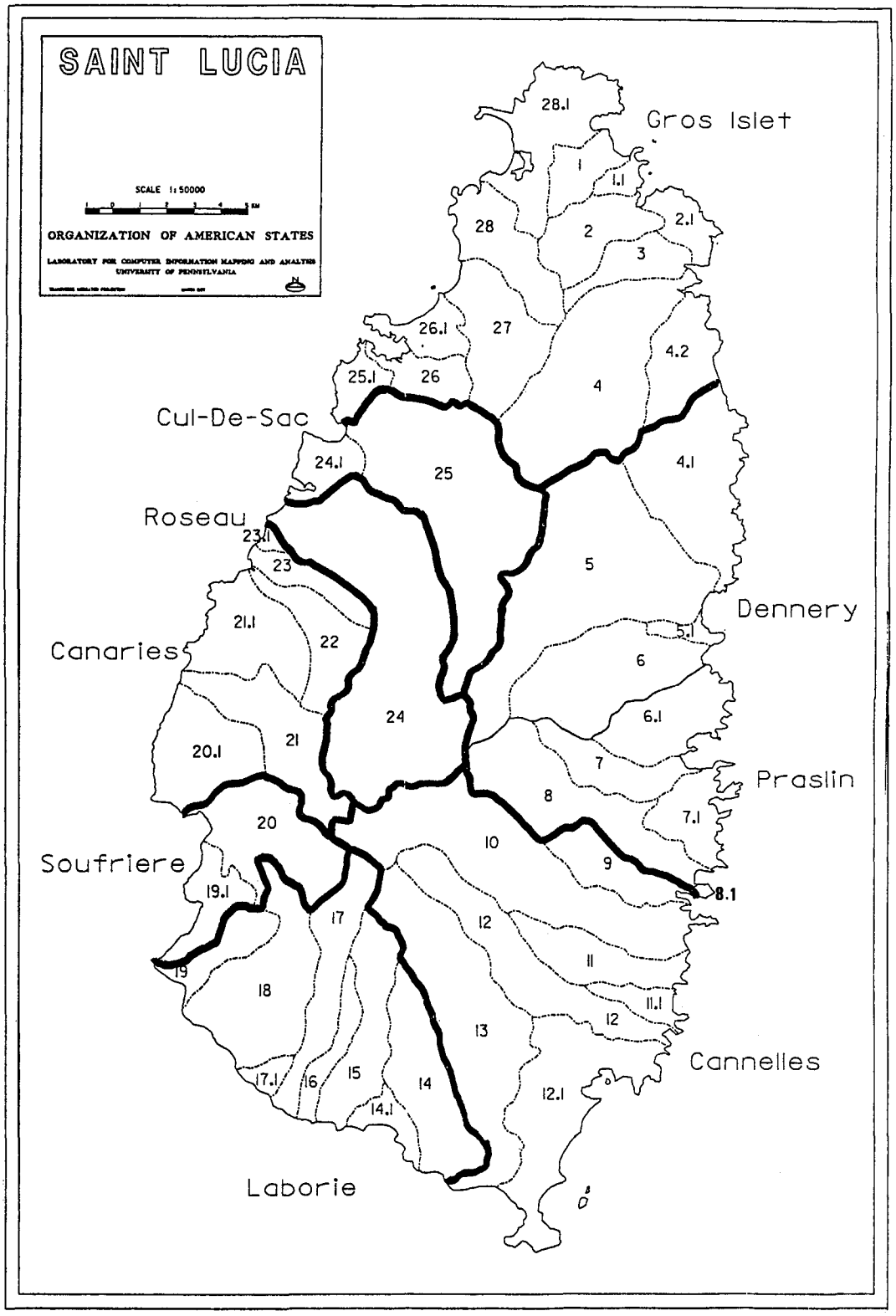


Figure 1.2(1). OAS drainage basin numbering system; see also Table 1.2(5) (source: OAS, 1987).

Table 1.2(6). St. Lucia land use by river basin.

N° RIVER BASIN or AREA	BASIN AREA (acres)	PRIMARY FOREST	SECONDARY FOREST	SCRUB FOREST	GRASS LANDS	OPEN WOODLANDS	LARGE SCALE AGRICULTURE	INTENSIVE SMALL FARMING	MIXED SMALL FARMING	RURAL SETTLEMENT	URBAN SETTLEMENT
1.0 SALLEE	1245.2	53.5	74.5	722.5	234.2	101.5	0.0	0.0	0.1	58.8	0.0
1.1 LAPINS AREA	458.2	0.0	0.0	402.5	0.0	55.5	0.0	0.0	0.0	0.0	0.0
2.0 ESPERANCE	2221.6	24.6	568.8	992.9	40.4	12.7	65.0	10.8	139.2	367.1	0.0
2.1 TROU GRAUVAL AREA	1048.4	0.0	0.0	1048.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.0 DAUPHIN	1432.5	0.0	343.0	646.3	0.0	0.0	29.8	168.6	171.5	73.4	0.0
4.0 MARQUIS	7483.2	1777.5	804.7	324.0	65.5	0.1	1420.6	1203.6	955.2	816.9	0.0
4.1 LOUVET - GRAND ANSE AREA	5027.3	345.3	1371.0	2484.6	0.0	0.0	51.2	215.9	539.7	18.1	0.0
5.0 FOND D'OR	9898.5	1848.6	1462.9	846.0	30.7	0.0	1901.4	1963.8	1166.4	678.0	0.0
5.1 RAVINE TROU A L'EAU AREA	406.5	0.0	0.0	220.9	50.4	30.6	0.6	32.4	0.0	43.0	19.2
6.0 DENNERY	4662.0	586.4	1490.4	436.8	172.6	0.0	449.3	258.8	1140.5	15.7	75.7
6.1 RIVIERE DES TROIS ISLETS AREA	2656.3	83.8	131.3	1798.8	0.0	0.0	395.4	0.0	228.3	18.4	0.0
7.0 PRASLIN	1890.9	310.1	97.1	172.8	0.0	0.0	1179.9	0.0	80.6	50.3	0.0
7.1 PATIENCE AREA	1756.2	0.0	10.4	1451.5	0.0	0.0	0.5	0.0	108.6	185.0	0.0
8.0 FOND	4681.5	2438.6	138.2	97.1	0.0	0.0	1548.0	0.0	277.6	181.9	0.0
8.1 LUC POINT AREA	69.3	0.0	0.0	69.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.0 VOLET	1918.5	166.8	92.0	354.7	0.9	0.0	619.2	245.1	439.1	0.0	0.7
10.0 TROUMASSE	8013.2	2660.7	738.3	401.1	164.8	186.3	880.3	2183.2	420.1	226.4	151.0
11.0 MICOUD	2200.9	16.6	78.4	716.6	127.7	1.3	55.6	716.1	252.6	236.0	0.0
11.1 RAVINE BETHEL AREA	748.3	3.2	0.0	448.0	22.5	85.9	1.7	11.0	89.4	86.7	0.0
12.0 CANELLES	4142.8	856.7	549.3	770.8	112.6	27.1	196.9	1102.0	183.0	343.8	0.0
12.1 SAVANNES BAY - VIEUX FORT	5149.6	154.0	0.0	2434.7	220.4	467.3	327.1	192.6	438.8	311.9	532.9
13.0 VIEUX FORT	7129.0	954.3	967.6	730.4	672.1	323.5	355.4	1606.6	928.8	525.0	63.8
14.0 BLACK BAY	3652.6	0.0	40.7	966.3	595.4	13.0	130.0	87.4	726.8	338.3	204.7
14.1 LABORIE BAY AREA	799.6	0.0	0.0	491.8	51.8	0.0	49.2	46.4	10.4	0.0	109.3
15.0 PIAYE	2904.8	0.0	730.1	762.5	30.4	59.6	241.6	425.7	360.4	294.6	0.0
16.0 BALEMBOUCHE	1042.9	0.0	12.1	6.5	0.0	42.7	650.3	156.5	89.4	85.4	0.0
17.0 DOREE	2826.8	38.1	1032.6	276.6	56.3	4.5	966.2	213.3	108.6	130.5	0.0
17.1 LA FARGUE AREA	414.1	0.0	0.0	17.3	0.0	0.9	241.6	11.0	58.2	84.9	0.0
18.0 CHOISEUL	4754.2	0.0	358.9	614.1	48.5	872.8	223.3	530.6	1087.1	1011.8	6.8
19.0 L'IVROGNE	1405.3	0.0	87.5	364.6	0.0	61.1	467.1	154.6	192.5	77.8	0.0
19.1 ANSE DES PITONS AREA	1455.9	0.0	1.0	380.9	222.9	0.0	499.2	261.5	31.4	58.0	0.0
20.0 SOUFRIERE	3874.3	76.1	1337.2	141.2	0.0	144.6	775.6	793.5	262.8	261.5	66.1
20.1 MAHAUT	3143.2	0.0	745.9	1716.1	0.0	0.0	353.0	118.5	109.0	85.8	14.5
21.0 CANARIES	3452.1	764.0	1946.5	248.1	0.0	0.0	120.4	284.7	61.8	0.0	10.0
21.1 ANSE COCHON - ANSE GALET	3121.7	162.9	997.7	1520.3	0.0	0.0	297.5	111.3	0.0	22.5	5.0
22.0 GRAND RIVIERE DE L'ANSE LA RAYE	2198.0	447.6	1011.5	253.0	0.0	0.0	225.4	45.7	196.5	0.0	3.9
23.0 PETITE RIVIERE DE L'ANSE LA RAYE	1183.8	0.0	72.7	958.5	0.0	0.0	68.2	0.1	57.5	20.3	1.9
23.1 ANSE PILORI AREA	188.4	0.0	0.0	187.9	0.0	0.0	0.5	0.0	0.0	0.0	0.0
24.0 ROSEAU	11838.0	4295.2	1706.1	429.0	0.0	0.0	1504.9	517.1	1492.2	853.9	1.1
24.1 MARIGOT AREA	1165.2	9.7	37.8	242.5	0.0	0.0	17.8	51.8	57.1	50.6	697.3
25.0 CUL DE SAC	9508.1	894.5	1896.3	0.0	0.0	0.0	1579.8	2359.9	1230.7	732.0	162.6
25.1 COUBARIL ESTATE AREA	851.8	0.0	183.4	98.1	0.0	52.5	0.7	0.0	142.9	112.0	261.7
26.0 CASTRIES	1231.1	0.0	113.8	0.0	0.0	0.0	0.0	51.7	219.4	124.7	416.3
26.1 VIGIE AREA	1147.0	0.0	75.2	0.0	0.0	0.0	0.0	0.0	140.5	30.3	704.6
27.0 CHOC	3294.2	0.0	415.9	364.7	41.5	0.0	326.9	495.3	977.6	367.8	87.3
28.0 BOIS D'ORANGE	2603.6	0.0	80.4	976.2	266.8	57.6	130.2	381.5	81.1	233.5	395.3
28.1 REDUIT - CAP AREA	3546.9	0.0	20.8	1893.6	457.3	140.5	111.8	0.0	0.0	143.2	751.7
Total	148089.9	18995.8	22344.7	31311.9	3804.7	2778.8	18801.7	17008.6	15575.0	9399.4	4743.4

Source: OAS, 1987. N.B. Because of rounding, figures may not add up to totals cited.

Table 1.2(7). Land capability classes by river basin.

N° RIVER BASIN or AREA	DRAINAGE AREA km	DRAINAGE AREA acres	RAINFALL in	RAINFALL mm	VOLUME hm	LAND CAPABILITY CLASS (ACRES) I	II	III	IV	V	VI	VII	VIII
1.0 SALLEE	5.03	1242.90	60.23	1530	7.69	-	-	32.42	208.44	208.44	157.48	603.72	32.40
1.1 LAPINS AREA	1.53	378.28	60.00	1520	2.27	-	-	-	-	-	-	378.28	-
2.0 ESPERANCE	9.40	2323.71	70.00	1775	16.70	-	-	89.55	29.34	140.50	335.04	1729.28	-
2.1 TROU GRAUVAL AREA	4.00	988.16	60.00	1520	5.90	-	-	-	-	-	154.40	833.76	-
3.0 DAUPHIN	5.65	1395.77	69.68	1770	10.00	-	-	-	-	84.92	101.90	1208.95	-
4.0 MARQUIS	30.96	7650.12	88.18	2240	69.35	256.30	49.41	72.57	-	24.70	2178.58	4784.46	284.10
4.1 LOUVET - GRAND ANSE AREA	28.37	7008.22	75.00	1905	53.00	-	38.60	-	-	284.10	211.53	6270.18	203.81
5.0 FOND D'OR	40.45	9992.76	97.24	2470	100.00	646.94	231.60	245.50	78.74	81.83	2336.07	6069.46	302.62
5.1 RAVINE TROU A L'EAU AREA	1.62	401.44	72.00	1830	2.93	-	-	-	-	-	18.53	382.91	-
6.0 DENNERY	19.35	4760.54	90.55	2300	44.53	165.21	-	77.20	-	32.42	800.95	3484.04	200.72
6.1 RIVIERE DES TROIS ISLETS AREA	10.19	2518.26	72.00	1830	18.50	44.78	-	-	-	40.14	545.03	1755.53	132.78
7.0 PRASLIN	7.91	1954.70	85.43	2170	17.16	12.35	-	-	-	13.90	180.65	1514.66	233.14
7.1 PATIENCE AREA	7.62	1883.67	70.00	1650	12.57	12.35	-	-	-	163.66	611.42	1094.70	1.54
8.0 FOND	17.78	4392.68	106.69	2710	51.33	186.82	-	-	-	131.24	515.70	3060.21	498.71
8.1 LUC POINT AREA	0.19	46.32	60.00	1520	0.28	-	-	-	-	-	-	46.32	-
9.0 VOLET	7.64	1886.77	79.13	2010	15.35	-	-	46.32	-	49.41	903.24	860.01	27.79
10.0 TROUMASSE	30.45	7525.66	119.68	3040	118.00	400.00	-	55.50	84.60	277.90	1901.20	4152.20	654.26
11.0 MICOUD	9.06	2238.60	76.77	1950	23.29	46.32	-	-	-	69.48	648.48	1440.35	33.97
11.1 RAVINE BETHEL AREA	2.88	711.78	65.48	1663	4.79	-	-	-	-	12.35	58.67	640.76	-
12.0 CANELLES	16.95	4188.87	101.18	2570	43.57	240.86	-	-	-	15.44	631.50	3301.07	-
12.1 SAVANNES BAY - VIEUX FORT	21.25	5249.60	7.72	1553	33.00	7.72	-	-	-	656.20	378.28	2640.24	1567.16
13.0 VIEUX FORT	29.17	7205.85	91.33	2320	67.67	208.44	-	-	29.34	805.97	1347.91	4781.77	32.42
14.0 BLACK BAY	14.92	3685.23	74.01	1880	28.05	67.94	-	58.67	-	656.20	208.14	2658.77	35.51
14.1 LABORIE BAY AREA	3.01	744.21	66.44	1688	5.08	-	-	4.63	-	38.60	38.60	660.84	1.54
15.0 PIAYE	14.53	2847.14	82.91	2360	27.21	-	-	6.17	30.88	335.05	154.40	2291.30	29.34
16.0 BALEMBOUCHE	4.46	1100.88	83.46	2120	9.46	-	-	-	46.32	271.75	532.68	250.13	-
17.0 DOREE	10.31	2547.60	111.85	2840	29.25	-	-	177.56	88.00	259.39	220.79	1588.79	213.07
17.1 LA FARGUE AREA	1.46	362.84	69.30	1760	2.57	-	-	-	-	223.88	-	138.96	-
18.0 CHOISEUL	19.30	4767.87	89.36	2270	43.81	-	-	125.06	33.97	120.43	1455.99	3030.88	1.54
19.0 L'IVROGNE	5.45	1347.55	87.00	2210	12.08	-	-	123.52	152.86	-	177.56	553.93	339.68
19.1 ANSE DES PITONS AREA	6.41	1582.60	96.18	2440	15.64	-	-	58.67	15.44	10.81	460.11	579.00	458.57
20.0 SOUFRIERE	15.70	3878.54	109.84	2790	43.80	-	-	121.98	154.40	-	543.49	2342.25	716.42
20.1 MAHAUT	13.21	3264.03	81.89	2080	27.50	-	-	-	67.94	-	307.27	2703.54	185.28
21.0 CANARIES	14.49	3558.14	108.26	2750	39.85	40.14	-	-	-	-	-	2018.78	1499.22
21.1 ANSE COCHON - ANSE GALET	12.48	3134.32	80.44	2040	25.50	23.16	-	-	-	-	186.82	2669.58	254.76
22.0 GRAND RIVIERE DE L'ANSE LA RAYE	9.03	2231.08	106.69	2710	24.47	98.82	-	-	-	-	248.58	1482.24	401.44
23.0 PETITE REVIERE DE L'ANSE LA RAYE	4.85	1198.15	88.18	2240	10.86	13.90	-	13.90	-	20.07	393.72	756.56	-
23.1 ANSE PILORI AREA	0.71	174.47	65.75	1670	1.19	-	-	-	-	-	7.72	166.75	-
24.0 ROSEAU	48.53	11989.17	120.47	3060	148.50	753.47	404.53	121.99	27.79	3.09	1440.55	7923.81	1313.94
24.1 MARIGOT AREA	4.59	1134.84	74.62	1895	8.70	-	7.72	30.88	-	23.16	123.52	949.56	-
25.0 CUL DE SAC	45.34	11200.14	111.02	2820	127.86	776.63	594.44	-	98.82	75.16	1232.11	8376.66	46.32
25.1 COUBARIL ESTATE AREA	3.25	720.00	71.23	1800	5.88	-	-	-	-	-	225.00	466.00	29.00
26.0 CASTRIES	5.19	780.68	90.94	2310	11.82	-	-	-	-	13.90	200.13	566.65	-
26.1 VIGIE AREA	3.81	942.00	80.94	2055	9.37	-	-	39.50	-	87.50	79.00	701.50	34.50
27.0 CHOC	13.59	3358.20	87.79	2230	30.30	114.26	-	94.18	33.97	140.50	1006.69	1858.98	109.62
28.0 BOIS D'ORANGE	11.03	2730.16	72.04	1830	24.60	-	49.41	169.84	-	172.93	599.07	1738.91	-
28.1 REDUIT - CAP AREA	15.15	3742.65	60.00	1520	22.70	-	46.32	69.48	-	265.57	634.58	2428.71	297.99
Total	602.87	148967.15				4116.41	1422.03	1835.09	1180.85	5810.59	24493.08	99935.94	10173.16
Percentage of total area	100					2.76%	0.94%	1.23%	0.79%	3.90%	16.44%	67.08%	6.83%

Source: OAS, 1986a. Based on Pretell and Polius, 1981, and Oelsner, 1981.

the 1990 Census will show a modest gain. The most rapidly growing urban area was Gros Islet, although in absolute terms Castries added the most people, over 5,000 persons.

The most striking feature of urban growth has been urban sprawl, the uncontrolled and haphazard spread of development in the vicinity of urban areas. This pattern has resulted in the loss of a yet undetermined amount of prime agricultural land (see also Section 3.4) and the loss of lands more suited to recreation, commercial or industrial use. This urban sprawl has further resulted in spiraling costs for infrastructure provision and maintenance. Land subdivision has therefore in less than two decades literally "leapfrogged" all the way from Castries to Point de Cap leaving intervening blocks of only partially serviced lands, generally held for speculative reasons.

Another result of urbanisation has been the growth of slums and squatter ("spontaneous") settlement areas within and on the periphery of the larger urban areas. These areas are the physical manifestations of rural-urban migration, of a critical shortage of urban housing and land, and of the failure of land use management schemes to adapt to new problems. Such areas are concentrated in: (1) the inner neighbourhoods of Castries from La Clery/Vide Bouteille in a broad area to Faux a Chaux; (2) the peripheral neighbourhoods of Castries and Vieux Fort, and (3) other small pockets of other rural and urban settlements.

Other serious problems associated with rapid urban growth include:

(1) Transportation, traffic and roads:

- Severe traffic congestion and critical shortage of parking space in Castries and Vieux Fort;
- The absence of an organised public transportation system;
- The failure to provide for pedestrian usage of urban streets and roads and, in particular, the absence of policies aimed at child safety on school streets;
- The effects of the by-pass roads on the growth and development of Micoud, Dennery and to a lesser extent Laborie.

(2) Utilities:

- The lack of functioning systems for sewerage disposal in all residential centres outside of Castries. In Castries the problem is more complex with underuse of the existing system by the urban poor and failure of the system to serve the rapidly growing communities to the south and north of the city centre (see also Section 4.2.2);
- The failure to integrate utility expansion plans and programmes for all urban areas.

(3) Recreation and open space:

- A continuing shortfall in the provision of recreational facilities and open space for active and passive recreation in all urban centres.

Rural settlements patterns. The southeastern districts of Micoud and Vieux Fort have experienced rapid rates of growth since 1970, with the total population of the region increasing from 18,253 in 1970 to an estimated 27,055 in 1984. This rapid increase was most pronounced in the rural parts of these districts. The west coast districts of Anse La Raye, Canaries, Soufriere and Choiseul continue to be areas of net out-migration to other areas of the island, while the districts of Laborie and Dennery are comparatively more stable (CPU, "Population" Issue Paper, 1985).

Overall, rural areas grew by 17.0 percent, or 9,918 persons (compared to 22.5 percent or 9,504 persons in urban areas), during the ten year period 1970-1980. Thus, rural settlements have experienced relatively rapid growth marked by horizontal sprawl similar to that of urban areas. Most rural settlements are unplanned and lack a distinct settlement centre. The costs of infrastructural provisions

and maintenance are therefore proportionally high.

The following issues continue to affect the development of rural communities:

- An archaic land tenure system and the continuing high rate of unplanned land fragmentation (see also Section 3.1);

- The need to diversify agricultural production and increase rural incomes (see Section 3.4);

- The need for non-agricultural employment opportunities in a growing number of rural communities;

- Required expansion of utility and social services to rural areas;

- The need to better integrate the service delivery strategies of the Ministries of Education, Health and Community Development in rural settlements (a problem which the new decentralisation scheme was designed to alleviate; see also Section 5.6).

1.2.4 Land Management

The "land question" in St. Lucia has been a topic of study and debate for decades. It is a complicated issue, but in recent years attention has tended to focus on: the need for a more effective definition of land ownership and tenure, Government land distribution programmes for landless farmers and/or squatters, implementation of a land registration and titling system, and establishment of a new GOSL policy for management of Government or Crown Lands. All of these issues are linked directly to natural resource management questions and are discussed in more detail in several chapters of the Profile, most specifically in Chapter 3 (Agriculture) and sections of Chapter 2 (Section 2.2 on Forests and Section 2.6 on Protected Area Management).

The problem of an equitable distribution of land in St. Lucia has deep historical roots dating from the original French land system. The first and only national land survey in the country prior to this decade was conducted by the French Government in the eighteenth century and was used as a reference point for land surveying until just recently. The lack of a nationwide cadastral land survey, with compulsory registration, created only confusion and mismanagement, with land deeds frequently omitting precise information on size and geographical boundaries, a large number of farmers having no documentation whatsoever for land they worked, and perpetration of an archaic form of deed registration which resulted in more disputes over legal ownership rights and difficulty in establishing clear title to property (OAS, 1986a).

All of this was further complicated by a tradition of "family land" (inherited land held in common by multiple heirs, with increasing fragmentation of the commonly shared property over time) and the concept of "landlessness" which characterises a variety of people/land relationships in the rural sector ranging from the rental of land to squatting on privately owned or publicly held Crown Lands. During the 1970's, debate on the need for Government to do something about the "land problem" intensified and led to increasing calls for land reforms and ultimately to creation of a Land Reform Commission (LRC) in 1979 and subsequent establishment of a new section in the Ministry of Agriculture, the Land Reform Management Unit, to implement recommendations from the LRC.

Out of this spirit of reform, specific land resettlement, land redistribution, and land management projects were initiated in the 1980's. St. Lucia Model Farms Limited was set up as a GOSL experiment in land distribution for the landless small farmer and is discussed in more detail in Chapter 3, as is the integrated rural development scheme for the Fond D'Or Valley, at the site of the Government-owned Dennery Farmco Estate. Equally important has been implementation of the first national land survey carried out in St. Lucia in over 200 years, the USAID-funded Land Registration and Titling Project (LRTP).

Government-owned land is another facet of the land management issue in St. Lucia. Such lands are widely dispersed throughout the island and include land held in the official forest reserves (see Section 2.2); properties held by Government-owned corporations like the National Development Corporation (NDC); Crown Land estates (most of which have been subdivided and leased for agricultural or mixed residential/agricultural purposes); land vested in the St. Lucia National Trust for the protection and management of unique natural and historical resources; land required for Government services; and coastal land constituting the so-called "Queen's Chain," land from the mean high water mark extending 186 feet (60 m) inland which belongs to the State. Management of Crown Lands, including registration, distribution, and leasing, is the responsibility of the Department of Forest and Lands in the Ministry of Agriculture.

Long-standing problems associated with illegal squatting in the forest reserves and lack of definitive boundaries for management of Crown Lands both within and external to the forest reserves should be somewhat alleviated by completion of the recent LRTP and by implementation of a CIDA-funded forest management and conservation project which has surveyed and demarcated the entire Forest Reserve and is now in the process of compiling information on protected forests on Crown Lands outside of the forest reserves (see Section 2.2). An unresolved issue is that of the use and ownership of land in the coastal zone, the so-called "Queen's Chain."

A recent Cabinet-approved Crown Land Policy (1988) establishes revamped procedures for the management of Government-owned lands, including establishment of a Crown Land Committee whose duty it will be to review and make recommendations on the allocation and use of these lands (see also Chapter 5).

1.2.5 Current National Land Use Policies

The 1977 National Plan and Development Strategy, although never officially approved by Government, did outline broad land use policies to guide government actions and development activities (see Section 5.2 for a more complete discussion of Government planning efforts since 1977). These broad policy guidelines call for Government to:

(1) contain the drift of population toward the Castries region through integrated rural development programmes;

(2) consolidate facilities in selected villages;

(3) establish a new pole of development in Vieux Fort;

(4) establish strict limits on urban expansion in order to protect agricultural land from deleterious urban sprawl;

(5) identify and zone for environmental protection certain selected areas;

(6) consolidate industrial activities in the Castries/Gros Islet urban region, reserve land for port-related industry in Castries and Vieux Fort, and provide for the zoning of sites in selected villages for industrial activities; and

(7) consolidate tourism development in Castries/Gros Islet, Soufriere, and Vieux Fort.

ST. LUCIA LAND USE FACTS

Did You Know . . . ?

. . . Less than 10% of the total land area occurs on slopes less than five degrees, which indicates for the remaining 90% the need to apply soil conservation measures of one type or another (regardless of use) proportional to the degree of steepness.

. . . Prime agricultural lands (U.S. Department of Agriculture Classes I, II, III) account for about 6% of land available for all uses.

. . . About 30% of the total land area is forest with 70% of this under legal protection and 30% in private hands.

. . . About 92% of land holdings are 4 ha (10 acres) or less in size and produce about 60% of St. Lucia's agricultural products. Some of this intensive farming is conducted on very steep slopes which should either be under forest cover or properly terraced and managed according to strict soil conservation practices in order to prevent erosion, to enhance water infiltration and to maintain water quality downstream.

. . . Drainage ditches at Cul de Sac which fill up with sediments were cleaned once a year four years ago but, because of increased upland soil erosion from expanded banana patches on steeper slopes, now have to be cleaned out four times a year. This quadrupled labour costs, and the value of the soil lost constitutes externalized banana production costs not borne by the grower but by his neighbours.

. . . Between 1973 and 1986 the number of farms grew about 6%, from 10,938 in 1973 to 11,551 in 1986, while the total amount of land under cultivation diminished from 72,000 to 58,000 acres (29,000 to 24,000 ha), which clearly illustrates a shift towards smaller farms.

. . . Farms over 50 acres (20 ha) represented nearly half (46%) of the land in holdings in 1986 but only 0.8% of the total number of farms.

. . . Over 60% of St. Lucia's best agricultural lands are located in four watershed areas: Dennery, Canelles, Roseau, and Cul de Sac.

. . . Steep slopes account for the largest proportion of St. Lucia's forest area, accounting for 66.4% or 4,500 ha (11,122 acres).

1.3 THE HUMAN RESOURCE BASE: DEMOGRAPHICS

1.3.1 Population Characteristics

As one of the larger islands in the Lesser Antilles with an area of 232 square miles (616 sq km) and a modest but steady out-migration, St. Lucia has never been considered overpopulated. In 1850, population density was a mere 100 persons per square mile; even in 1950, that density was only about 500 persons per square mile, and today it still is under 700 (if the population estimate 140,000 is used). It is a manageable figure, and more difficult questions concerning system "carrying capacity" have not yet become an issue (except perhaps at the Vigie Airport terminal and for anyone looking for a parking space near the market in Castries).

In 1843 a total of 20,694 persons lived in St. Lucia and by the time of the 1901 British Commonwealth census, the population had more than doubled to 49,883 giving an average annual growth rate of 1.5 percent. (The size of any population is determined by natural increase [births minus deaths] and by net migration [net movements into or out of the country]). Decennial censuses were mounted from 1851 to 1921 and again in 1946 at which time the population stood at 70,113 (Figure 1.3(1)). At that time the crude birth rate was 37.8 per 1,000 and the crude death rate was 15.1, yielding an annual rate of natural increase of 2.3 percent, less, of course, an average annual out-migration of 600 persons (net) which resulted in a 1.2 percent annual rate of growth observed between 1921 and 1946 (Bouvier, 1984).

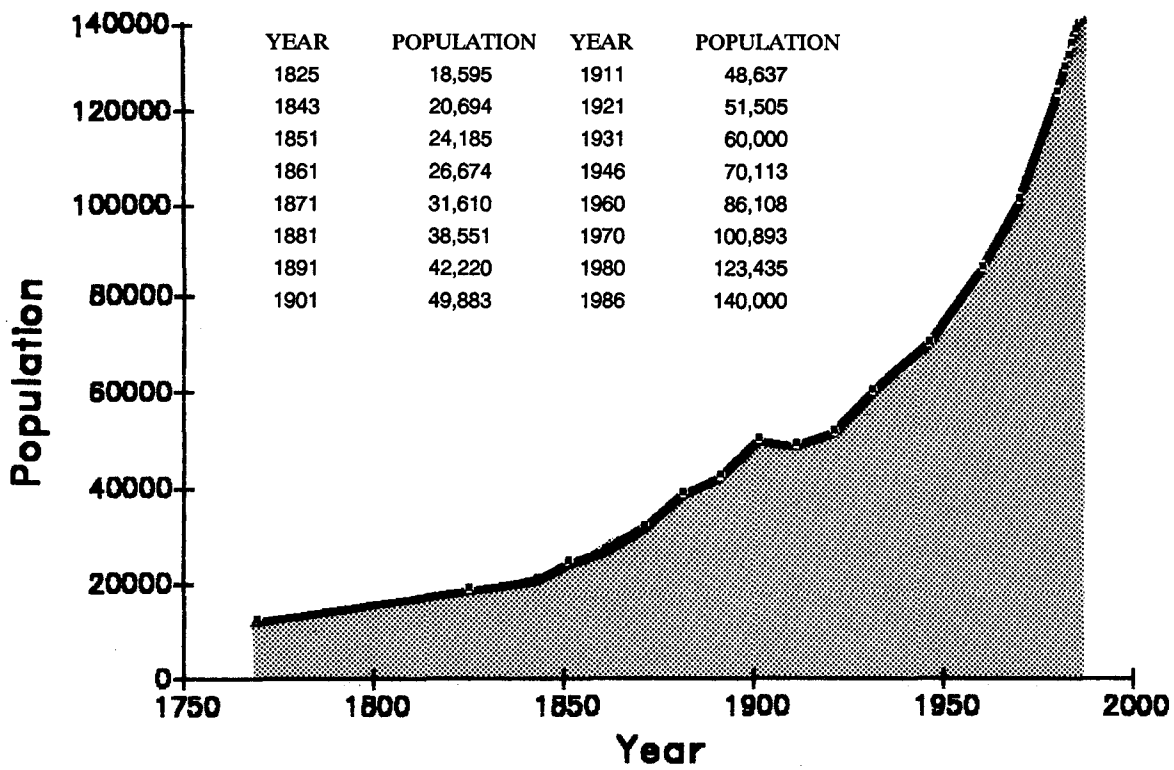
Over the 14 years between 1946 and 1960 the average annual rate of growth in St. Lucia rose slightly to 1.4 percent, but a significant new stream of migration to the United Kingdom developed to the point where net emigration equaled 42 percent of St. Lucia's natural increase. Were it not for this large movement away from the island, St.Lucia's population would have soared to over 100,000 by 1960 and would be over 200,000 today.

During the decade of the 1960's the annual rate of population growth moved downward slightly to 1.3 percent despite the negative effects of the Caribbean Immigration Act of 1962, which severely limited movement from the West Indies to the United Kingdom and induced a fairly significant shift of migration to new destinations. Fortuitously for St. Lucia, immigration requirements for entry into both the United States and Canada were eased between 1965 and 1979, and immigration flows to those countries began to increase, making up for the loss of the U.K. outlet (see Table 1.3(1) for U.S. data).

Reduced net emigration notwithstanding, the major contributor to St. Lucia's increased population growth in the 1960's was the rapid decline in mortality. The crude death rate, estimated at 14.6 in 1960, fell to about 8.4 by 1970 (it now hovers around 6 per 1000; see Table 1.3(2)). This stands as a remarkable improvement within a relatively short time frame, an improvement facilitated by technical assistance programmes in the public health sector, an upgraded cleaner water supply system, and the demonstration effect on public health practices generated by the Rockefeller Foundation-funded schistosomiasis research and control project, which was based in St. Lucia.

As a result of these factors and variations in demographic behaviour, the population of St. Lucia passed the 100,000 mark, for the first time in its history, in 1970. The succeeding decade was a growth period, with an average annual population increase moving upward to 1.8 percent according to the Population Reference Bureau (PRB) (Bouvier, 1984) and a 2.1 percent increment if a Central Planning Unit (CPU) figure is preferred (see CPU "Issue Papers," unpublished report, 1985). Why the difference in the two figures, i.e., PRB vs. CPU? It relates to the fact that different population figures were used for 1980, which closes one decade and becomes the base figure for the next.

As noted in Sections 1.1 and 1.2, there is a certain elusive quality to many statistics



YEAR	POPULATION	YEAR	POPULATION
1825	18,595	1911	48,637
1843	20,694	1921	51,505
1851	24,185	1931	60,000
1861	26,674	1946	70,113
1871	31,610	1960	86,108
1881	38,551	1970	100,893
1891	42,220	1980	123,435
1901	49,883	1986	140,000

Figure 1.3(1). St. Lucia population curve, 1843-1986. N.B. 1851 to 1921 census held in the first year of the decade. The 1986 population figure is estimated.

bearing upon the natural, physical and human environments of St. Lucia. Population and census data are no exception. By way of illustration, the variations for the 1980 population figure include:

- 113,409, 1980 Census (later adjusted for low count)
- 118,900, from OAS, 1986a
- 122,264, from CPU, Issue Paper #3 "Population", 1985
- 120,300, from PRB (Bouvier, 1984)
- 120,300, from CPU, background information provided for the CEP project (1988), Table 7
- 123,435 from GOSL, *Annual Statistical Digest*, 1986
- 123,773 from World Bank, 1986; CDB, 1987.

With this kind of discrepancy regarding a fairly important base figure (the last census was in 1980), various estimates of recent or current growth rates can only be used with some caution, remembering that the population base figure is used for growth projections, as well as for other important calculations such as gross per capita income.

In St. Lucia, despite a long history of net out-migration, population growth rates have been surprisingly high, and its fertility levels are among the highest in the region. Over the ten year period from 1977 to 1986, the birth rate fell from 35.7 to 29.3 per 1,000. At the same time, total fertility rate (TFR) (the average number of live births per woman of child-bearing age) dropped from 7 to 4.3. Similarly, its counterpart aggregate indicator, "fertility rate" (the number of women per thousand of child-bearing age, 15-44, who give birth in a given year), decreased from 238 in 1970 to 154 in 1984. However, these trends towards a less dynamic growth pattern have to some extent been nullified by the opposing effects of declining death rates, reduced levels of out-migration, and some return migration.

Table 1.3(1). St. Lucian-born immigrants admitted to the United States, 1960-1986.

YEAR	NUMBER
1960-64	457
1965-69	773
1970-74	1,243
1975-79	2,727
1980-84	3,898
1985	499
1986	502
Total, 1960-1986:	10,099

Source: Bouvier, 1984; GOSL, Annual Migration and Tourism Statistics for 1986.

Table. 1.3(2). Crude birth and death rates in St. Lucia, 1977-1986.

YEAR	CRUDE BIRTH RATE	CRUDE DEATH RATE
	[per 1,000 population]	
1977	35.7	7.1
1978	33.5	6.7
1979	31.5	7.2
1980	29.3	6.7
1981	31.2	6.9
1982	32.6	6.6
1983	31.0	6.0
1984	31.0	5.5
1985	30.8	6.0
1986	29.4	6.0

Source: Bouvier, 1984; GOSL, Annual Statistical Digest for 1986.

Population trends since 1976 are summarised in Table 1.3(3) for thirteen different parameters. An age/sex distribution pyramid, based on the 1980 census, is presented as Figure 1.3(2). Fifty-two percent are female and forty-eight percent are male, but the out-migration process which favours males visibly skews the distribution pattern beginning at age group 20 to 24. Infant mortality has dropped, but annual fluctuations suggest marginally effective responses to outbreaks of infectious diseases, especially of the water-borne type.

The population of St. Lucia is, as in the case of most West Indian islands, very young with

Table 1.3(3). St. Lucia population trends.

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Total Population (mid-year)	114270	116575	118927	121326	123773	126270	128817	131415	134066	136771	139529
Density (population/sq mi)		549	553	557	566	570	584	618	631	656	668
Crude Birth Rate (per 1000)	34.3	35.4	33.9	30.8	30.6	30.6	31.4	31.0	30.0	29.2	29.4
Crude Death Rate (per 1000)	7.7	7.0	6.6	7.0	6.8	6.7	6.3	6.0	5.4	5.8	6.0
Rate of Natural Increase (per 1000)	26.6	28.4	27.3	23.8	23.8	23.9	25.1	25.0	24.5	23.4	
Total Births	3920	4127	4029	3732	3789	3860	4045	4069	4159	4223	3907
Total Deaths	883	816	781	850	843	843	817	782	728	799	843
Natural Population Increase	3037	3311	3248	2882	2946	3017	3228	3287	3289	3201	
Net Migration	839	1006	896	483	499	520	681	689	638	496	
Migration to U.S.	379	545	572	953	1093	773	586	662	684	499	502
Net Population Increase	2198	2305	2352	2399	2447	2497	2547	2598	2651	2705	
Annual percentage growth rate	1.6	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Infant Mortality					25.3	23.8	22.7	26.1	17.1	22.6	21.5

Source: World Bank, 1986; GOSL, Annual Statistical Digest for 1986.

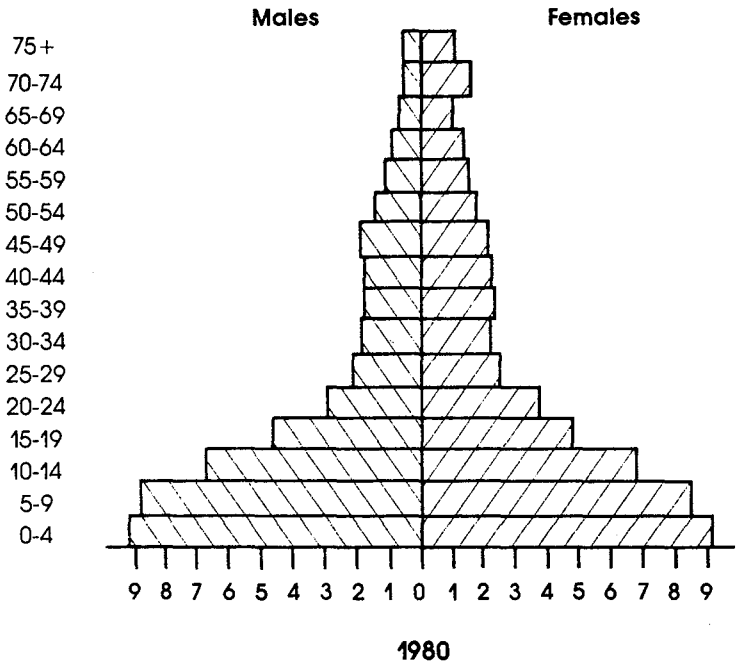


Figure 1.3(2). Age-sex distribution of St. Lucia's population based on the 1980 census (source: Bouvier, 1984).

over 50 percent under the age of 15. Life expectancy in 1980 for males was 67.4 at birth and for females it was 71.8, and by 1982 it had risen to 68.7 for males and 72.4 for females, levels more typical of a continentally developed nation than a developing island state.

Of the approximately 4,000 annual live births, four-fifths are illegitimate, and one-quarter of the total or about 1,000 per year are born to teen age mothers, ages 15 to 19 (GOSL, *Annual Statistical Digest*, 1986). Unlike some of her neighbours, St. Lucia has not vigorously pursued strategies to restrain population growth as an environmental policy matter appropriate to an insular system with limited resources.

1.3.2 Population Futures: 1980-2030

It is not possible to predict the future population of St. Lucia, and therefore the demographic future of the country is uncertain. This makes it hard to project the number of schools or teachers that will be needed and makes it even harder to anticipate levels of demand for scarce local resources, including land for various purposes. There seems to be a widespread consensus that the population cannot increase much more, given growing density patterns and the social and economic costs to St. Lucia of a high level of emigration, if that alternative remains open. For some, the prospect of a population of 200,000 seems less than desirable, in part because it could spread the resources of St. Lucia too thin.

It is fairly certain that if the fertility rate stays as high as it is, the population will double in less than forty years, since the safety-valve of out-migration is not functioning as well as it did in the past -- there seems little prospect for changes in immigration policy on the world scene, especially in popular destination countries.

But it is, unfortunately, very easy to overlook the fact that the slope of St. Lucia's population growth curve has been quietly growing steeper by the decade. This problem will not just go away. It is likely to become worse, densities will rise, as will difficulties with youth alienation, crime, crowding and social unrest. Two key factors in any policy choice, TFR and net migration, are presented in Figure 1.3(3), which displays three population growth scenarios for St. Lucia.

- Scenario A assumes no action on the part of Government regarding the continuation of the current, relatively high fertility rate of 4.5 and also assumes a continuation of out-migration of 1,500 persons per year.

- Scenario B assumes a replacement level fertility rate of 2.1 and half the current level of emigration (750) per year.

- Scenario C assumes a policy-driven adjustment of the fertility rate to 2.9 and a net emigration of 1,500 per year.

In another set of projections -- a GOSL forward planning exercise -- the following assumptions were offered regarding future population trends for the period 1980-2010:

(1) Birth rates will continue to decline, then fluctuate at around 21 - 26 per 1,000 by 1990.

(2) Death rates will also decline to stabilise at 5.6 per 1,000 from 1990 onwards.

(3) The rate of out-migration will continue to fall to reach a low as 0.5% over the 1990 to 2000 decade.

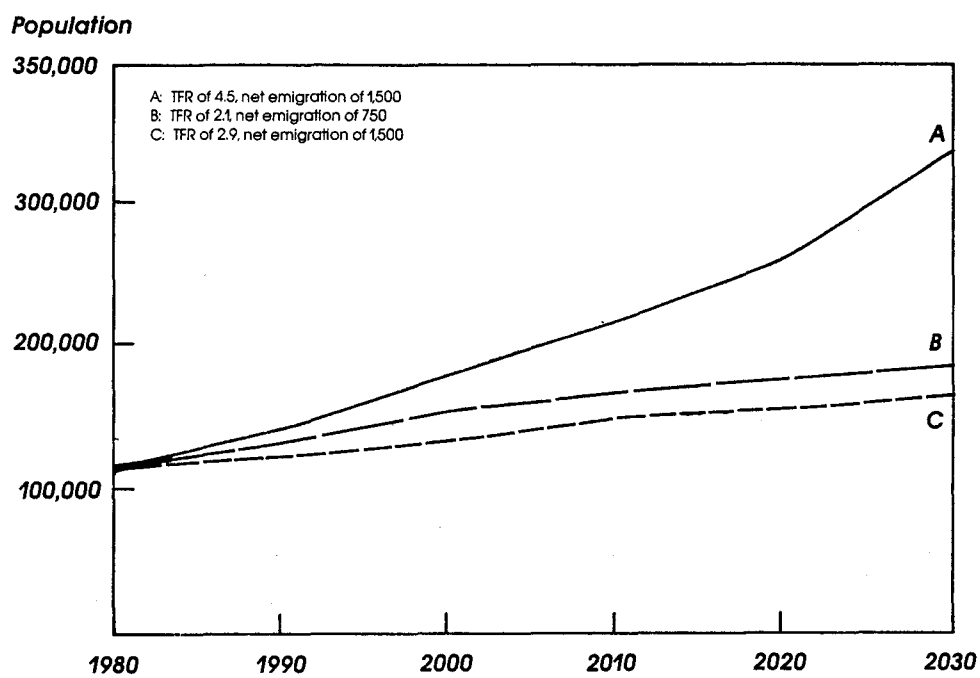


Figure 1.3(3). Three hypothetical growth scenarios for St. Lucia, 1980 - 2030 (source: Bouvier, 1984). N.B. TFR = Total Fertility Rate (average no. of live births per female, ages 15-45). In 1988, it appears St. Lucia is on line for scenario C, but this will not be known for certain until the 1990 census since population totals and TFR are all estimates and less reliable at the end than at the beginning of a census decade.

(4) Annual growth rates will fluctuate between 1.1% to 1.6% over the period but are assumed to average 1.32% between 1980 and 2000 and fall to 1.20 between 2000 and 2010.

The unrestrained optimism displayed in these assumptions, especially in the face of evidence of continuing past practices and the limiting ranges of change in various demographic parameters shown in Table 1.3(3), should be cause for concern. The miracle/parable of the loaves and fishes will not easily be duplicated in St. Lucia. There will come a day when there are no more fish, and the fuelwood to bake the bread will have long since been used up.

Finally, it should be noted that the allocation of scarce natural resources to more and more people is the kind of problem that becomes more and more difficult, the margin of error thinner, and the margin of response capability less resilient when confronting unanticipated natural disasters or unpredictable, externally-caused economic crises.

1.3.3 Population Distribution

The population of St. Lucia is concentrated in the northeastern portion of the country, with the distributional pattern continuing to show a marked preference for the Castries/Gros Islet administrative area where over 65,000 persons or 46 percent of the total population live. Furthermore, when the population of Anse La Raye and Dennery are included within the Castries/Gros Islet "commuter catchment" area, it merely confirms the reality of twentieth century transport capability within a metropolitan sphere of influence. This larger commuter watershed constitutes, informally at present, a substantial population/market/resource user group of at least 82,500 persons, or 58 percent of the total population.

Within the Castries to Gros Islet nexus, or corridor as some have called it, the city's proportionate share of total population has been marginally declining since the mid-1970's, while Gros Islet's share rose (as did Vieux Fort's over the same period). The Gros Islet administrative area manifested the most rapid rate of population growth over the 1970-1982 period, growing at an average annual rate of seven percent, although this has since tapered off. Gros Islet has become a virtual extension of the Castries urban area, and the entire coastline from La Toc to Mount Pimart and beyond to the base of the Pigeon Island causeway is rapidly filling up, in many cases with non-water dependent uses.

1.3.4 The Labour Force

The labour force of St. Lucia is estimated to be 33 percent of the total population, this rate being midway between the relatively low figure used in the 1980 census and the high estimate (35%) provided by the World Bank (1985). A 33 percent rate yields a 1986 labour force of 46,045 persons (139,529 x 0.33). The reader is cautioned, however, that this calculation may be off the mark because the World Bank's 1986 population estimate of 139,529 persons is based on (1) a probably incorrect 1980 "corrected" census base figure, and (2) an arbitrary two percent per annum growth increment which is probably too low.

The level of unemployment represents the difference between this labour force figure (46,045) and an estimated total employment for 1986 of 38,510 (extrapolated from World Bank, 1985, figures), that is 7,535 persons. As a result, the 1986 unemployment rate is estimated at approximately 16.5 percent (7,553/46,045). This figure is somewhat higher than levels reported in the late 1970's, but considerably below some estimated published rates for the mid 1980's. The frequently observed higher unemployment rates between 20-25 percent may reflect an increasing incidence of uncounted, part-time work.

Despite the vicissitudes to which agriculture is subject, it continues to absorb a high percentage of the labour force, about 40 percent according to the World Bank (1985) and almost 34 percent for 1985 in the latest GOSL *Statistical Digest*. At the height of the tourism season about 11 - 12 percent of the employed labour force find jobs in this sector (World Bank, 1985); tourism may indirectly generate a similar number of opportunities in other

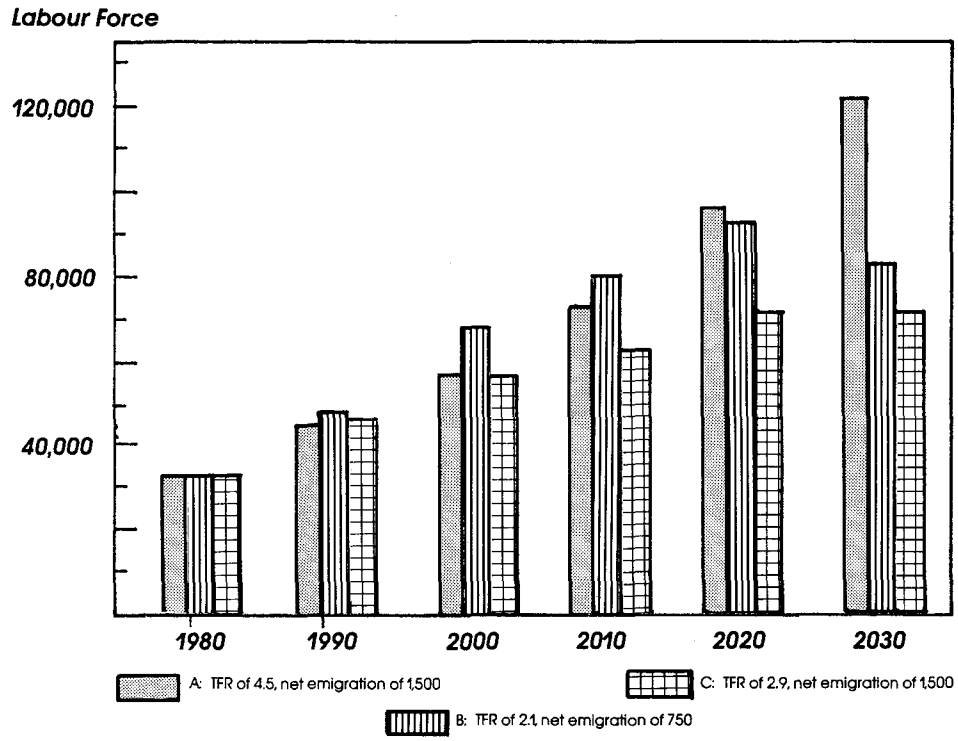


Figure 1.3(4). Projected expansion of the labour force for the decades 1980-2030 (source: Bouvier, 1984).

sectors (see further discussion on this topic in Section 4.1 of the Profile). The Government sector is also a large employer, with a permanent civil service staff of approximately 4,300 (World Bank, 1985).

Projected expansion of the labour force is presented decade by decade in Figure 1.3(4) which postures three alternative high, medium and low growth tracks -- each achievable with a prescribed set of government policies relating to fertility rates and net emigration levels. Obviously, the first is socially difficult and the second more subject to external than internal factors.

1.4 HISTORICAL BACKGROUND *

The history of St. Lucia is not only one of the most turbulent of any island in the Caribbean but also one subject to debate according to historians who have tried to pinpoint the exact date and circumstances of its first sighting by Europeans. Indeed, even its National (Discovery) Day -- celebrated on December 13 -- remains open to question and is almost certainly based on an unproven historical premise.

St. Lucia was first occupied by the Ciboneys -- an Amerindian, pre-ceramic culture -- about two thousand years before Columbus. The civilization of the Arawak Indians who followed became firmly established about 200 A.D. An industrious people who live largely by agriculture, fishing and hunting, the Arawaks enjoyed about 800 years of peaceful occupancy before being invaded and eventually crushed by the more warlike and cannibalistic Carib Indians, who killed and sometimes devoured the Arawak men and enslaved and interbred with their women. By the early thirteenth century the Carib takeover was complete, and the pure-blood St. Lucian Arawak had become extinct.

The first European discoverer of St. Lucia may have been Juan de la Cosa, Columbus' map-maker, who undertook a voyage to the southeastern Caribbean in 1499. A year later, St. Lucia appeared on his maps as "The Falcon." Columbus' lookout may have sighted the island in June of 1502 during the Admiral's fourth voyage to the West Indies, when he put his fleet into nearby Martinique for wood and water. Just which Spaniard gave the island its haunting name of Santa Lucia in honor of the virgin saint is not known; later the French were to change it to Ste. Lucie. The Indian name for the island had been Iouanalao (thought to mean "there where the iguana is found"); the pronunciation was later changed and eventually evolved into Hewanorra, which is also the present day name of St. Lucia's international airport.

What is beyond dispute is that the first attempt at settlement by Europeans occurred in 1605 when a band of 67 Englishmen from the ill-fated ship *Olive Branch*, bound for Guiana, an English colony on the South American mainland, put into what is now thought to be the Vieux Fort area rather than risk a voyage home with scant rations. Although the awaiting Carib Indians were at first friendly, most of the party was eventually ambushed and killed, with only a small group making it back to South America. Sometime later in 1639, an English planter from the island of St. Kitts, a Captain Judlee, sponsored a colonising scheme for St. Lucia, but this venture too was wiped out by hostile Caribs within a year and a half. The Caribs were ultimately expelled from the island in 1663.

In the meantime, the French had also laid claim to St. Lucia through a grant of territories sought and secured in 1627 by a Sieur d'Esnambus, from the island of St. Kitts, for the newly formed French Company of the Isles of the Americas. Thus began an almost 200 year, often bloody tug-of-war over St. Lucia between the English, who claimed the island by virtue of the two early settlements, and the French whose claims were in the form of a grant. St. Lucia was to change hands fourteen times before finally being ceded to Britain by the 1814 Treaty of Paris.

During this period, the island was primarily occupied by the French -- for over 150 years except for five short interludes of occupation by the English which totaled less than twelve years. Thus, while the English were eventually to earn the island by rights of capture and treaty, French claims of history and culture remain apparent even to this day. For example, while the French language was officially abolished in 1838, remnants survive in place names and geographical locations, in family names, and in the unique Creole patois which is still widely spoken.

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* Historical background for this section of the Profile is largely taken from Devaux, 1987b; Jesse, 1953; Durham and Lewisohn, 1971; and Koester, 1986.

The period of Anglo-Franco warfare took place during the height of the infamous slave trade which saw the island's population multiplied many times over with the importation of thousands of captive West Africans. In the nineteenth century, Great Britain moved to abolish slavery, and emancipation for all slaves was secured in St. Lucia in 1838. Approximately 13,300 former slaves were freed on August 1, Emancipation Day. Also at this time, St. Lucia was joined for administrative purposes with several other British Windward Islands under a governor-general residing in Barbados, while still retaining its own local legislative and executive councils.

Early cash crops in St. Lucia included indigo, coffee, tobacco, and cassava, followed by the introduction of sugar cane which, largely due to continuing warfare, did not emerge as the primary cash crop here as early as it had in other Caribbean islands. By the nineteenth century, however, sugar had gradually become the dominant crop, foretelling St. Lucia's future as basically a one-crop economy. Some attempts were made to find new cash crops; the first coconut plantations, for example, were established in the 1870's.

In its pursuit of agriculture, St. Lucia was rarely beset by the droughts and near-famine conditions of neighbouring islands which were less endowed with fertile soil and dependable rainfall. The island was not free of all natural disasters, however; a hurricane caused considerable damage and some deaths in 1831, and the country was devastated by an earthquake in 1839, followed by a yellow fever epidemic. The town of Castries was partly destroyed by fire in 1813, only 17 years after its total destruction by the same cause.

It is interesting to note that during this period there was an early attempt at sulphur mining at Soufriere, beginning in 1836. The infant industry was quickly killed, however, with imposition of an export tax.

Before the nineteenth century was ended, an Agricultural Society had been formed (in 1882); a Botanical Station established in 1886; a newspaper, *The Voice*, launched in 1885, which continues to publish today; and new shipping wharves constructed at Castries. The latter was important to the island's prominence as a major coaling station for the region; for approximately fifty years between 1880 and 1930 more than 1,000 steamships per year called at the coalbunkering station in the superb natural harbour of Castries. In 1885, Grenada replaced more removed Barbados as headquarters of a new British Windward Islands Government, which joined St. Lucia with St. Vincent, Grenada, and Tobago.

The early years of the twentieth century were marked by labour unrest, triggered by a strike of coal carriers in 1907 which subsequently set off uprisings elsewhere on the island. Sea-island cotton emerged as a new cash crop, banana plantations were established in the 1920's and efforts were made to expand the coconut and lime industries -- although sugar continued to dominate until the 1950's when banana cultivation, later joined by tourism, emerged as the leading economic activities. In 1901, an Agricultural School had been opened at Union; in 1916 the Castries Waterworks Reserve was established to protect upland watersheds, the source of the urban area's water supply; and in 1917 the U.S. Weather Service opened the first meteorological station.

Following World War I, most of the island's public services were improved and modernized, including new roads, bus services, coastal shipping, and radio and telephone communications, along with a new legal and taxation system. In 1927, Castries was again destroyed by fire, but, on a more promising note, only two years later St. Lucia became linked to the rest of the world via sea plane service. The coal trade had entered a period of decline, and increasingly the economy of the island was linked to agriculture, but at a time when the worldwide sugar beet industry, which had been depressed during the War, would prove to be stiff competition for St. Lucian sugar cane.

The Depression years were a time of extreme hardship particularly for St. Lucia's agricultural workers. Unemployment was widespread, and -- with the decline of sugar -- the country was without a reliable cash-generating export crop. Resulting deprivation led to a strike of sugar workers in 1937 and reformist

labour legislation. As if economic conditions were not severe enough, mother nature also took her toll, with devastating floods and landslides in 1938 which destroyed roads, bridges, and homes with a great loss of life. World War II was to bring a temporary respite from these difficult times.

The advent of the War produced dramatic changes in St. Lucia, at one point even bringing the European conflict to the island's front door with German torpedoing of two ships at Castries wharf in 1942. The signing of a wartime Anglo-American agreement -- outmoded U.S. warships were swapped for airbases in the British Caribbean -- resulted in construction of a U.S. naval station at Gros Islet Bay near Pigeon Island and an airfield near Vieux Fort. The new Vigie runway and airport was also built in 1942. With the end of the war, disaster befell Castries again, with yet another fire destroying four-fifths of the entire town, including most of the commercial area, in 1948.

With the end of the War, the demise of the sugar cane industry had to be confronted, with the British government encouraging a revival and expansion of the island's banana industry. Unlike cane, bananas could be grown by small farmers, an important consideration in St. Lucia with an increasing number of small holders. Throughout the history of sugar cultivation in St. Lucia, particularly during periods of downturn in the export market, agricultural labourers had traditionally turned to the cultivation of subsistence crops on small plots of land -- some on plots purchased from private owners, some on Crown Land, some on rented land, and others as squatters on Crown or other land to which they did not have title. With the introduction of bananas, a profitable cash crop could now be grown on these small holdings, as well as on large estate-style plantations.

The post-war period has been marked by a steady transfer of political control from Great Britain to St. Lucians. Full adult franchise was granted in 1951, followed in 1960 by abolition of the Windward Islands Government and establishment of a new Constitution with ministerial government. On March 1, 1967, St. Lucia became an Associated State of Great Britain with full control over its internal affairs, and just twelve years later, on February 22, 1979, the island became an independent member of the Commonwealth.

Perhaps the symbolism and colours of the nation's flag best explain how St. Lucia had come to see itself at the dawn of independence. On a field of blue, representing the Caribbean Sea, rises an island of yellow sunshine, surmounted by two triangles of black and white, representing the dominant black culture in association with the European. In their shape, the two triangles also represent the island's best known geographical feature -- the twin Pitons, symbols of the ascending expectations and hopes of the young country.

HISTORIC LAND USE PATTERNS

History Repeats Itself in St. Lucia

Following emancipation, displaced slaves lacking access to estate land moved from coastal villages in droves to Crown Lands in the interior of St. Lucia to cultivate provision lands as squatters. This practice of shifting cultivation gradually devastated more and more of the forest land. Government apparently took the path of least resistance, tacitly acquiescing in this practice and legalising the procedure by the offer of Crown Lands for sale in parcels of any size at a nominal figure -- 10 shillings per acre -- which was less than the value of the timber on the land.

As the effects of deforestation began to have serious impacts on stream flow and water control and as public concern mounted, an officer of the Indian Forest Service, Mr. E.M.D. Hooper, visited the British West Indian Islands in 1886 and recommended a series of reservation forests. Hooper's warnings, however, passed unheeded until 1916 when St. Lucia adopted a Crown Lands Ordinance similar to that enacted a decade earlier in St. Vincent. The St. Lucia Ordinance was followed by a Timber Protection Ordinance in 1918 which was designed to prevent the unlawful felling of timber on Crown and vacant land. In practice, however, there seems to have been no slowdown in the deforestation process.

Writing in the *Caribbean Forester* in 1939 (Vol. 1, No. 1), Mr. E.Y. Wald, then Agricultural Superintendent in St. Lucia, repeated earlier warnings about the continued exploitation of the forests. He also noted at this early date that the primary importance of the country's forests lay not in their timber value. Rather, he wrote, "... the importance [of forests] in soil and moisture conservation, particularly in the vicinity of the headwaters of the principal rivers, cannot be overstated, and it is unfortunate that these points have been appreciated insufficiently in the past." One might add that almost 50 years later, this same point could be made.

In the early 1940's, Mr. J.S. Beard, a forester from Trinidad, began his now famous forest assessment work in the Lesser Antilles, including St. Lucia. The 1945 *Caribbean Forester* (Vol. 6, No. 3) summarised Beard's report for the island as follows: the total forest area was estimated at 68,444 acres, of which 15,400 acres were rain forest, generally in good condition. The Crown was found to hold only 4,913 acres of forest but another 10,131 acres were noted as "vacant" land for which no clear title existed.

Surveys to clarify all of this were needed, said Beard, as well as land acquisition of sensitive areas, timber surveys, protective legislation, a management working plan, a cutting budget and a regeneration plan for 60 acres per annum to equal estimated cutting area. Other requirements identified by Beard were research, education, encouragement of private forestry, and land use surveys for the preparation of a "land allocation" policy. Does any of this sound familiar to the present day St. Lucian resource planner? See the forest section of Chapter Two, for example, for a replay forty years later.

1.5 THE ECONOMIC CONTEXT

1.5.1 Overview

The development of the St. Lucian economy has been largely constrained by its small population and limited natural resource base. No mineral assets of economic importance have been identified, but the country's fertile volcanic soils provide the resource base for agricultural development, long the dominant economic sector. Other natural resources are now being exploited in support of tourism, which today rivals agriculture as the country's lead economic growth sector.

The period of the 1960's and early 1970's was characterised by relatively high rates of overall economic growth, but the economy experienced a slowdown beginning in the late seventies and continuing through the 1980-82 period (Figure 1.5(1)). This decline can be attributed to a combination of factors, including the international recession, a series of destructive natural disasters, and political uncertainty. However, since 1983, St. Lucia has experienced real growth rates averaging nearly five percent, largely as a result of increases in banana production and tourist arrivals and high levels of construction activity (CDB, 1987).

St. Lucia's economy exhibits two fundamental characteristics which are also common to the microstate economies of other Eastern Caribbean states: (1) the promulgation of public policy initiatives which promote rapid restructuring of the economy, and (2) excessive "openness" to trade and foreign dependency, a tendency endemic to small island economies.

(1) **Restructuring**. The most dynamic aspect of St. Lucia's economy has been the post-war restructuring of the colonial economy away from traditional monoculture of banana and copra towards:

- fruit, vegetable, and meat production for the domestic market,
- petroleum storage and light manufacturing for export, and
- international tourism services.

Table 1.5(1) traces economic restructuring over the past quarter century. Using broad-brush data to maintain comparability across the sectorial distribution of Gross Domestic Product (GDP), the figures show a decline in the GDP contribution of agriculture, the traditional export mainstay, which was halved -- from 34 percent of the GDP in 1962 to less than 17 percent in 1986. The decrease in agriculture was matched by the doubling of tourism (up to 17.1 percent from 6.7 percent) which is clearly the leading growth sector.

Less dramatic during the 26 year period are the increases in export manufacturing (textiles, clothing, beverages, paper and wood products, fabricated metals, electronics), government, and local services. These smaller growth components are still significant, however, for the balance which they contribute to St. Lucia's overall economy.

In less than a generation St. Lucia has been transformed from a predominantly rural society to a modern economy founded on a diversified export base. This restructuring has been accomplished largely by a combination of relatively low regional wages, the far-sighted provision of investment incentives and supportive infrastructure, and a favourable location and abundance of natural recreational and scenic assets (USAID, 1985a). As a result, St. Lucia today is considered the most balanced economy among the smaller islands of the Lesser Antilles, with the most sophisticated manufacturing structure and, with the exception of Antigua, the most developed tourism sector (Burley, 1985).

Despite past success, the pace of restructuring slowed during the 1980's. A contributing factor has been the substantial increase in banana demand and output since 1985 (see Figure 1.5(2)), which has produced an understandable ambivalence in GOSL economic policy and support for restructuring. On the one hand, local producers are encouraged and supported in every possible way to take advantage of extraordinarily strong market

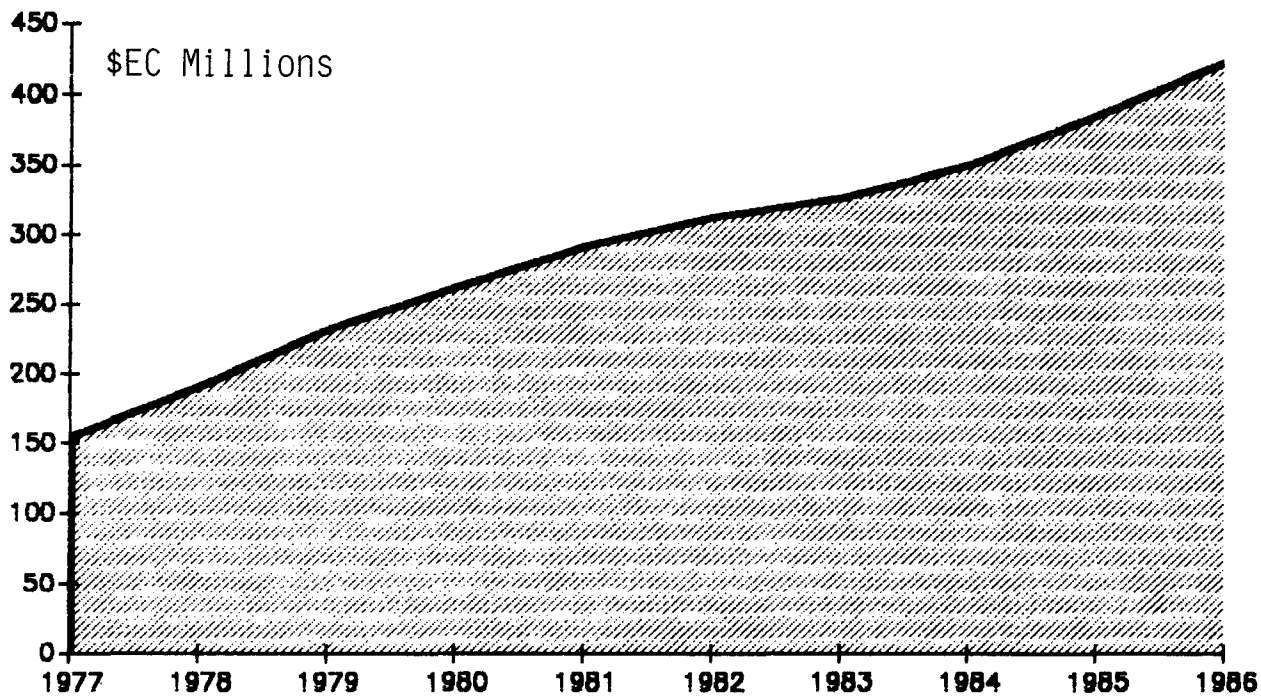


Figure 1.5(1). Gross domestic product, 1977-1986 (source: CDB, 1987).

conditions for bananas (for example, banana growers earning up to EC$75,000 per year are exempt from payment of income taxes). On the other hand, Government clearly recognises that the current situation is a boom of limited duration and is receptive to all efforts designed to prepare St. Lucia for the day when banana prices drop (see also "Banana Boom").

Over the longer term, agronomists and economists are united in predicting a return to sluggish or negative growth in foreign demand for St. Lucia's agricultural staples. This will contribute to a decline in the country's terms of trade (i.e., the change in prices of goods exported divided by the change in the prices of goods imported). In fact, the World Bank (1985) estimates the terms of trade will decline nearly 20 percent over the next decade. In addition, St. Lucia will face mounting problems from population pressures at home.

As a result of persistent balance of trade deficits, rapid increases in the costs of imported fuels and foreign exchange shortages, the cost of St. Lucia's economic restructuring has been financed increasingly by foreign aid and borrowing. The ratio of external debt to GDP doubled from 10 percent in 1975 to above 20 percent by the mid-1980's (World Bank, 1985).

In addition, population and labour force growth over the past decade of reduced emigration outlets has outstripped the economy's capacity to create jobs. Demographic data in Table 1.3(3) indicate a rate of natural population increase of 2.5 percent per year, composed of a birth rate of 3 percent and a death rate of 0.5 percent. Subtracting the rate of emigration of 0.5 percent yields a net rate of population growth of 2 percent, one of the highest in the Eastern Caribbean. This growth exceeds the 1.5 percent annual increase in employment between 1975 and 1983 (World Bank, 1985). As a consequence, island unemployment has risen from 14 percent in 1975 to an alarming figure of around 20 percent in the mid-1980's.

Table 1.5(1). Estimated distribution of gross domestic product by sector, 1962 and 1986.

SECTOR	1962 (EC$ Thousands)	%	1986 (EC$ Millions)	%
Agriculture	9,560	34.0	81.5	16.5
Manufacturing and Mining	1,514	5.4	42.0	8.5
Construction	2,168	7.8	36.6	7.4
Total Tourism Sector	1,987	6.7	84.3 **	17.1
Government	5,161	18.3	105.7	21.5
Other Local Services*	7,734	27.5	144.0	29.0
TOTAL GDP	28,124	100.0	494.1	100.0

* Includes distribution, finance, real estate, utilities, transportation, and other services.

** This is estimated to be hotel/restaurant expenditures times a multiplier of 2.48, following Bryden's methodology for 1962 data.

Sources: Bryden, 1973 (for 1962 data); GOSL, Annual Statistical Digest for 1986 data, with total GDP quoted AT MARKET PRICES. Note that preliminary GOSL GDP estimates have subsequently been increased by $28 million over the $494.1 million estimated for 1986.

(2) **Openness and Dependence.** The second structural feature St. Lucia shares with other island economies is excessive openness to trade and foreign dependence, a legacy of colonial monoculture and small size.

In contrast to larger, more self-sufficient and diversified continental economies, insular production systems are usually specialised along a few lines. To achieve the rising standards of living associated with economies of scale, it is necessary to penetrate large foreign markets. The foreign exchange earnings from the sale of narrowly specialised exports enable islanders to satisfy their diverse consumption requirements and overcome limited resource endowments. This intensive specialization, however, engenders instability since minor changes in foreign demand or costs can produce widespread local positive (booms) and negative (recessions) impacts.

Such highly open economies are most generally characterised as "export-propelled" (see also page 70). This term emphasises that sales to the large foreign market represent the primary engines of economic growth because they fuel the secondary respending that filters through the smaller local markets.

Export income multipliers of 2.0 or above have been calculated for large continental

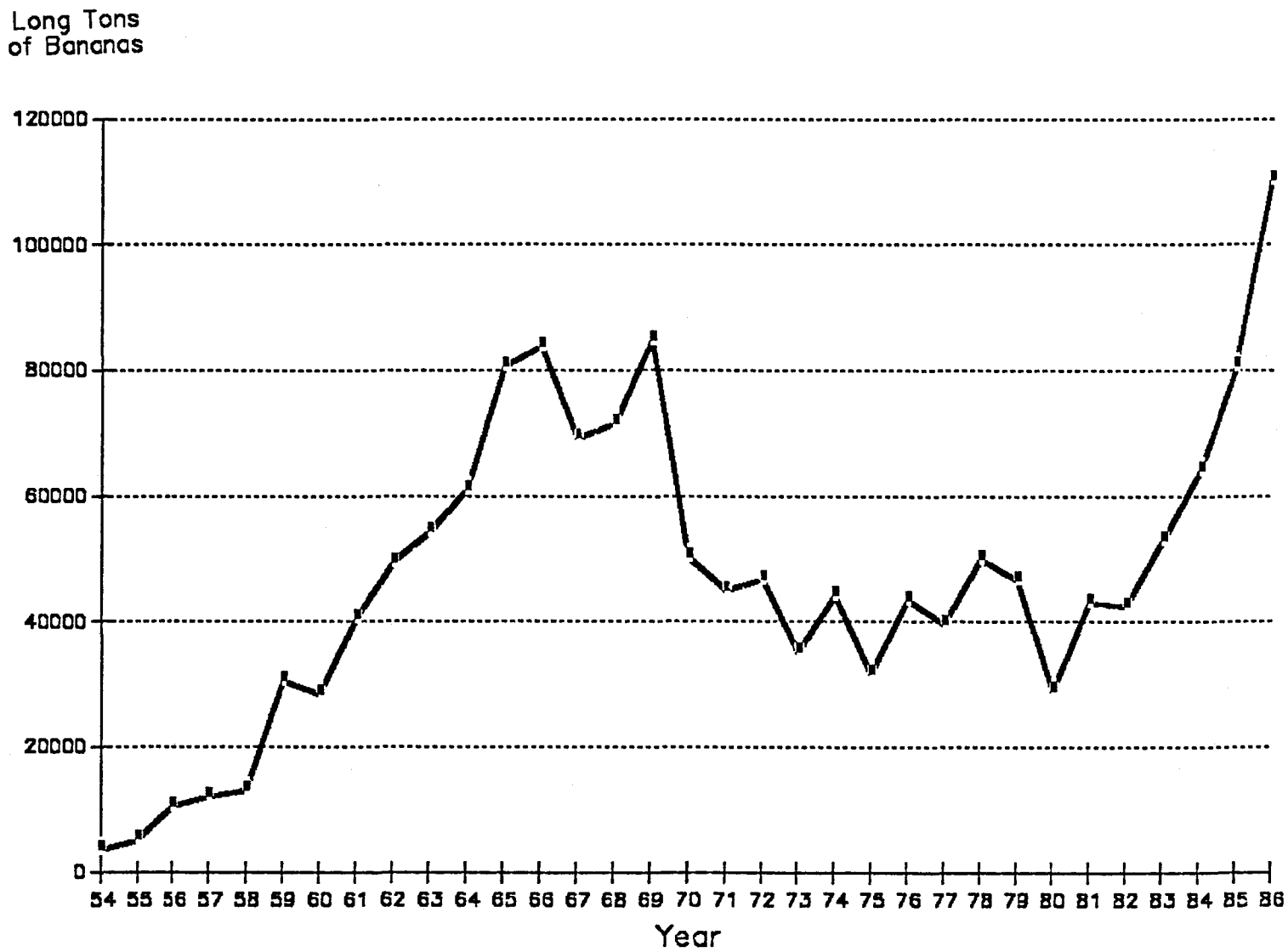


Figure 1.5(2). St. Lucia banana production, 1954-1986 (source: WINBAN, 1987).

THE BANANA BOOM

Banana production and exports from St. Lucia in 1988 will be double the level of just three years ago. Furthermore, prices are expected to remain near historic highs for at least the remainder of the year.

What are the reasons for this upward swing in price and production? Access to a protected market, improved agro-production efficiency, and favourable currency conditions are cited as primary causes for the recent "green gold" windfall. Yet the final chapter of this boom period remains to be written -- and it may well prove to be a cliffhanger.

The mid-1980's prosperity of the St. Lucian banana industry is directly related to the policies of the European Common Market, where the highly protectionist agricultural policies of participating governments -- including Great Britain -- have long been an issue of debate. Under current discussion are policies which would gradually eliminate the special price and market access granted the former colonies of member countries, viewed as an especially vexing subset of the larger protectionist problem.

Like many of the ACP countries (the former colonies of the European powers in Africa, the Caribbean and the Pacific), Jamaica and the Windward Islands have enjoyed special access to the UK banana market where they are regarded as the traditional supplier of that commodity. This commitment has been reaffirmed by successive British Governments, most recently in 1987 and is reflected in Protocol 4 of the current Lome Convention. In St. Lucia, the arrangement has had the effect of increasing access to markets in the UK at subsidised prices.

This achievement on the diplomatic front coincided with efforts of USAID, WINBAN (Windward Islands Banana Growers Association), and others to substantially upgrade the efficiency of banana production in St. Lucia and other Caribbean areas. The increase in production efficiency was accompanied by an increase in local multipliers for banana exports as a result, for example, of the introduction of ancillary producing activities like the box making plant.

As a final factor, over the past three years the U.S. dollar has declined against the British pound. This is especially fortunate for Caribbean producers who sell to European markets, while most of their inputs come from dollar-based economies. Based on recent data (World Bank, 1985), nearly 60 percent of St. Lucia's merchandise exports are sold to the United Kingdom -- the rising currency area -- while over half of essential imports (primarily food, manufactured goods, and machinery) are purchased in the dollar-denominated markets of the U.S. (37%) and CARICOM (17%). For the short term, St. Lucia has the best of both worlds because the cost of its inputs remains constant while the value of its exports increases with the value of the pound.

There is no doubt that the current market will eventually reverse. The major questions, therefore, are:

- whether that reversal will occur before 1992, when the special subsidised prices and UK market access are scheduled to end (unless renegotiated);
- how abrupt or gradual such a reversal may be; and
- the eventual ability of St. Lucian banana producers to compete in open, world market conditions.

This last question is complicated by the possibility of other diplomatic interventions in the markets as the 1992 EEC deadlines approach and by the rather precarious nature of banana production, which suffers from cycles of severe plagues which have variously devastated and benefited whole quarters of the banana-producing world.

economies like the United States and European countries (Gordon, 1987). In small islands, however, values between 0.5 and 1.20 are common (Bryden, 1973; Cleverdon, 1979). Usually, the more abundant the resource endowment and the more diversified the productive base, the larger the size of the multiplier. For example, a value of 1.0 means that one dollar in spending injected through the export sector creates, after all imports are subtracted, one dollar of island GDP. This income or product is composed of the sum of the direct on-island value-added production in the export sector, plus the indirect value-added output stemming from the secondary respending on local goods/services generated by the original export injection.

The export income multiplier for St. Lucia is calculated below. Despite some weakness in the local national income estimates (World Bank, 1985), and despite the hazards of excessive numerical aggregation of separate economic activities, this exercise provides an introduction to the functioning of the economy in broad macroeconomic detail and also provides a context for the tourism impact analysis in Section 4.1.

Table 1.5(2) converts GDP data for St. Lucia for the period 1981-1984 into U.S. dollars and displays World Bank estimates of the island's four major export activities. These include:

(1) merchandise (primarily agricultural) exports and tourism expenditures which account for 40-45 percent of the total;

(2) net transfers consisting primarily of wages and income remitted from St. Lucians working abroad;

(3) public grants and foreign borrowing primarily for infrastructure construction; and

(4) private foreign investment to construct factories, hotels, and the like.

The individual export spending streams are aggregated and divided into island GDP to determine the estimated export income multipliers for each year. Then an average value is calculated over the 1981-84 period to prevent possible distortions arising from single-year fluctuations.

[N.B. Despite dramatic increases in banana production and export earnings since 1985, they are omitted from this analysis because of a lack of consistent data across all sectors. Furthermore, it is an assumption of this analysis that the recent boom is an exception to a 30-year pattern of a diminishing share of export earnings from agriculture.]

The average multiplier is 1.0, suggesting that the average export dollar generates one dollar in island GDP. Note, however, that export multipliers from individual sub-sectors such as agriculture or tourism may vary considerably from this mean value depending upon their respective import intensities and local linkages. Detailed analysis may show, for example, that the multiplier for export agriculture -- produced primarily by local-spending smallholders -- may be considerably higher than the figure for tourism.

The data in Table 1.5(2) also highlight the increasing dominance of merchandise exports and tourism in the traditional economy and the related declining importance of emigrant remittances, external aid and foreign investment.

From a policy perspective, the model yields several useful pieces of information:

(1) It provides a straight-forward and intuitively appealing understanding of the structure and operation of the economy.

(2) Because of the one-to-one correspondence between St. Lucia's export revenues and local GDP, the multiplier provides planners and policy makers with a rough rule of thumb for gauging the impact of expected annual changes in export performance -- trade, tourism, foreign investment -- on local GDP.

(3) In addition, by reworking the export income multiplier (Kx) equation as:

$$GDP = X * Kx$$

the model lays open the two broad options for stimulating island growth, namely:

(i) promoting exports and/or foreign capital inflow, or

(ii) raising the value of the multiplier.

(4) The latter direction is achieved by replacing existing imports with domestic substitutes, and to a lesser extent by increasing local ownership of productive enterprises and thereby reducing the repatriation of profits off-island. (Note that both these factors have operated to increase the local multiplier for banana production in recent years.)

(5) Finally, the model underlines the need to continue restructuring St. Lucia's economy toward a diversified export base to avoid the economic vulnerability associated with highly specialised external markets.

1.5.2 Summary and Environmental Implications of Economic Policy

St. Lucia's economy is typical of the Eastern Caribbean in its openness and its restructuring away from traditional export crops. The St. Lucian economy is special in the success of Government's programme to diversify the economy, both in terms of increasing total exports and in increasing the local multiplier through import substitution.

THE EXPORT-PROPELLED MODEL

A Caribbean Economic Development Paradigm

At its simplest, the export-propelled model assumes the economy can be divided into two distinct macroeconomic sectors:

(1) export production and other off-island activity such as tourism that injects income into the system; and

(2) local transactions including government.

The model predicts that GDP varies according to export sector fluctuations which cause simultaneous repercussions in island spending on domestic goods/services in the local sector. The strength of this transmission from export-to-local activity is measured by the size of the export income multiplier (Kx). The formula is:

$$Kx = \frac{GDP}{X}$$

where GDP accounts for all export and local production combined, and X represents all revenue attributed to export sales, foreign investment on-island, and wages remitted to island residents.

Exports have increased through the development of tourism, light manufacturing and oil transshipment. The local multiplier has increased as a result of land reform (more exports being produced by smallholders), increased production of import substituting food stuffs, and the movement of more local personnel into higher levels of management formerly occupied by expatriates.

In the short run, Government's major challenge is to find politically acceptable ways to channel the windfall earnings from the "banana boom" into public or private investments which will support further diversification of the economy. This general strategy has specific implications for resource management policy objectives because of the environmentally high risk cultivation practices which the current boom has generated (see further discussion in Chapter 3). Short-term, marginal profits in bananas at the expense of ecologically sound agro-production will diminish the sustainability of the natural resource base over time, with negative impacts not only for the long-term profitability of agriculture but for the country's most important growth industry -- tourism.

Over the longer run, Government will need to pursue further diversification of the export economy and identify ways to increase the export income multiplier. St. Lucia has been notably successful in this process over the past generation, and there is every reason to expect this pragmatic approach to continue.

Table 1.5(2). Estimation of the export income multiplier for St. Lucia, 1981-84 (US$ millions).

Variable	Year 1981	1982	1983	1984	Average 1981-84
GDP AT CURRENT MARKET PRICES* (US$)	126	134	141	151	138
EXPORT SECTORS: **					
1. MERCHANDISE AND TOURISM EXPORTS	71	74	89	97	83
2. NET TRANSFERS	15	13	12	14	14
3. PUBLIC GRANTS/EXTERNAL BORROWING	9	9	9	7	9
4. PRIVATE FOREIGN INVESTMENT	45	36	12	15	27
TOTAL EXPORT REVENUE	140	132	122	133	133
EXPORT INCOME MULTIPLIER***	0.90	1.02	1.16	1.14	1.04

* Source: World Bank, 1985, converted to US$ (US$1.00 = EC$2.70).

** Source: World Bank, 1985.

*** Calculated by dividing GDP by total export revenue.

St. Lucia Parrot, *Amazona versicolor*.

2. COMMON PROPERTY RESOURCES

2.1 INTRODUCTION

Certain natural resources, for instance pasture lands, forests, fisheries, wildlife, coral reefs, beaches, and irrigation waters, are considered to be common property (or communal) resources, that is, ownership of the resource is held in common so that the resource can be shared and jointly used. Common property resources, by definition, are resources from which exclusion is difficult. Sustainable use of common property resources requires an understanding of the historical and cultural context in which the resource is exploited and of the ecological and physical nature of the resource.

This chapter focuses on the common property resource base in St. Lucia and discusses the contribution of these resources to national development. In general, these resources share similar characteristics, including:

- relative diversity;
- fragility which subjects them to rapid alteration from human intervention;
- significant natural productivity;
- capacity for important economic productivity;
- subjection to exploitation which in some cases exceeds the natural rate of renewal.

According to a recent publication on this issue (Bromley, 1986), there are four types of management regimes for natural resources:

(1) **Private property**, in which resource use rights are exclusive and transferable, as in the case of agricultural lands;

(2) **Open-access**, which may be characterised as a "free-for-all" regime;

(3) **State property**; and

(4) **Communal property**, which includes situations wherein resource use rights are held by an identifiable group which, through formal and informal procedures, manages (i.e., prevents degradation but allows use of) the resource.

The last three represent forms of common property management, and much of St. Lucia's resource base falls under one of these categories, in complex combinations of property (resources) and management regimes.

Historically, some of St. Lucia's natural resources have been, de facto, under an open-access regime, as in the case of Crown property, where lack of enforcement and public management has facilitated access and unregulated use. This also applies to most of St. Lucia's marine resources as well as to some of the marginal lands which, although in private ownership, have historically been left open for use by estate workers and landless peasants. This open-access regime is considered largely responsible for excessive exploitation of many natural resources, including traditional encroachment on forested lands.

On the other hand, the open-access regime presents a number of opportunities for communal forms of management which have also been explored in St. Lucia, for example: harvesting of the edible sea urchin (or sea egg) which has traditionally, in certain areas of the island, been regulated by the user community or the communal production of fuelwood on public or privately-held marginal lands. In effect, when open access does protect the livelihood of the resource user, some communities establish user group management regimes.

In the last four decades, the Government of St. Lucia (GOSL) has assumed an increasingly active role in developing and imposing state property management regimes for natural resources, for example, establishment of forest reserves or the exclusive economic zone. Present public management systems for natural as well as historical/archaeological resources

are discussed in the various sub-sections of this chapter.

In addition to state property management regimes, many communal management systems have a valuable role to play in resource management but are often overlooked or underutilised in the development process. But community-based or communal management regimes for common property resources can, in partnership with government, help to ensure the social acceptability of whatever collective action is necessary for management of the resource.

To paraphrase Bromley (1986), a common property regime is really a people management regime, the presumption being that the interests of the group transcend the interests of the individual. The goal of common property management is sustainable development as an explicit human choice that selects to pass on to the future what has been inherited from the past. The management goal says, in effect, that common property resources will not be exhausted by accident or by default -- or without a plan for what the options are if and when the resource is depleted or gone.

Governments and others preparing strategies for the sustainable development of natural resources should:

1. Systematically analyse such resources and any existing or potential institutions to determine which resources might best be managed as common property, assuming user group involvement.

2. Strengthen existing institutions involved in planning and implementing development goals affecting common property resources.

3. Support decision-making by communities of common property resource users and promote and support interdisciplinary common property resource organisations, as well as public and private institutional initiatives, that would increase their effectiveness.

2.2 FOREST RESOURCES

2.2.1 Overview of the Resource Base

The forests of St. Lucia have been steadily exploited since the time of the first settlements -- as wood for construction, as a source of food, fuel, and folk medicines, and as an expendable resource in the clearing of land for roads, housing and agricultural development. Gradually, the natural forest has disappeared from the coastal areas, and today the forest is largely confined to more inaccessible mountainous areas in the interior. Even in this region, shifting cultivation practices have had a marked effect, and gardens of bananas, coconuts, citrus and dasheen are not uncommon throughout the forest.

A reclassification of current forest land use has recently been undertaken by CIDA as a part of its Forest Management and Conservation Project for St. Lucia. March 1988 estimates from CIDA indicate that approximately 13 percent of the total land area of the island, or 7,707 hectares (19,044 acres), is occupied by primary forest, including plantations (see Table 2.2(1). This estimation varies slightly from the result of an earlier CIDA study (Piitz, 1983) which indicated the total area of primary forest was 7,820 hectares (19,323 acres).

Both estimates agree the rain forest represents 11 percent of the total land area in St. Lucia, 6,781 hectares (16,756 acres), of which one-fourth is under private ownership (Piitz, 1983). The remaining forest land (see Table 2.2(1)) represents plantations and several unique climax forest communities of limited distributions in St. Lucia, including Montane Thicket and Elfin Woodlands (Piitz, 1983).

There are seven climax and two secondary forest associations recognised on the island (see also Section 1.1.5)):

Climax:
- Rain Forest
- Lower Montane Rain Forest
- Montane Thicket
- Elfin Woodland
- Littoral Woodland
- Swamp Formations
- Fumarole Vegetation

Secondary:
- Secondary Rain Forest
- Dry Scrub Woodland.

Rain Forest and Lower Montane Rain Forest account for nearly all the commercial timber land. These forests are rich in flora with 104 species enumerated during a 1982 inventory (Piitz, 1983). Six of these species account for half of the merchantable timber volume: gommier (*Dacryodes excelsa*), chataignier (*Sloanea caribea*), balata chien (*Oxythece pallida*), bois de masse (*Licania ternatensis*), bois pain marron (*Talauma dodecapeela*), and mahaut cochon (*Sterculia caribea*).

Steep slopes (between 20 and 30 degrees) account for the largest proportion of the island's forest area (nearly 60 percent according to Piitz, 1983), while approximately nine percent of forest land occurs on excessively steep slopes of over 30 degrees. Together, these extremely mountainous lands represent about two-thirds of St. Lucia's forested area (Piitz, 1983).

Only 12 percent (7,496 hectares) of the total land area of St. Lucia has been designated as proclaimed Forest Reserves (see Table 2.2(2)). It has been estimated that approximately 1,000 hectares (2,470 acres) of Crown Lands lie outside the forest reserves (CIDA, 1987), although total areas of protected forest on private lands and Crown Lands outside of the forest reserves have not yet been officially compiled . Establishment of clear title to Crown Lands has been an historic problem in the country, although implementation of the recent GOSL-USAID Land Registration and Titling Project should begin to provide clarification. In March of 1988, the CIDA forestry project team began to compile such information, and this data should be available by mid-year. Up to March 1987, 170 hectares (422 acres) of private and Crown Lands were designated as Protected Forests (Table 2.2(2)).

Table. 2.2(1) Initial forest land use classification, with forest land in the reserve and outside the reserve classified by management option in hectares (preliminary classifications by CIDA Forest Management and Conservation Project, March 1988).

FOREST TYPE	ENVIRONMENTALLY SENSITIVE AREAS								TENTATIVE TIMBER MANAGEMENT AREAS			
	WATERSHED		PARROT SANCTUARY		EXTREME AND HIGH EROSION RISK		TOTAL		MODERATE/LOW EROSION HAZARD		TOTAL	
	ForRes	Other	ForRes	Other	ForRes	Other	ForRes	Other	ForRes	Other	ForRes	Other
RAIN FOREST	1319	442	1286	16	1652	491	4257	949	1022	553	5279	1502
MONTANE THICKET ELFIN WOODLAND	220		108		175	87	503	87	6	41	509	128
FOREST PLANTATION		66			134		200		89		289	
Sub-Total/ Primary Forest	1605	442	1394	16	1961	578	4960	1036	1117	594	6077	1630
	2047		1410		2539		5996		1711		7707	
SECONDARY FOREST OPEN WOODLAND	105		84		923		1112		414		1526	
TOTALS	1710	442*	1478	16	2884	578	6072	1036	1531	594	7603**	1630
	2152		1494		3462		7108		2125		9233	

* This figure does not include all watersheds.

** Includes Crown Estate of Polouze.

Source: CIDA Forest Management and Conservation Project.

FOREST RESERVES

The first step for establishment of a management and protection framework for forest resources occurred early in this century when, in recognition of the need to safeguard water catchment areas, the Castries Waterworks Reserve was established in 1916.

Between 1942 and 1946, Dr. J.S. Beard, Assistant Conservator of Forests in Trinidad and Tobago, carried out a now fairly well-known reconnaissance of forests in the Windward and Leeward islands. His report and recommendations ultimately established the legal basis for forest management policies in St. Lucia (and elsewhere in the region). By the time of Beard's inventory, the Government held title to a little over two thousand hectares (5,000 acres) of forested lands in the interior of the island, including the Castries Waterworks Reserve (1,047 ha), Warrick Reserve (16 ha), Barre de L'Isle Forest Reserve (40 ha), and the Quilesse Forest (925 ha).

Beginning in 1982, under a CIDA-sponsored Forest Management Project, the entire Forest Reserve, which had increased substantially since Beard's inventory, was surveyed and demarcated. This task was completed in 1987, and most surveys and maps have now been officially gazetted concurrently with the USAID Land Registration and Titling Project register. Table 2.2(2) shows a total GOSL Forest Reserve area of 7,496 hectares (18,526 acres). See also Figure 2.2(1).

Table 2.2(2). St. Lucia Forest Reserves and Protected Forests.

NAME	FOREST RESERVE		PROTECTED FOREST	
	(ha)	(ac)	(ha)	(ac)
Castries Waterworks Forest Reserve	1392	3442		
Barre de L'Isle Forest Reserve - North	231	570		
Barre de L'Isle Forest Reserve - South	724	1790		
Central Forest Reserve "A"	1631	4031	42	103
Central Forest Reserve "B"	1474	3642		
Quilesse Forest	1400	3460		
Saltibus Grand Magazin Forest Reserve	107	264		
Addition to Central Forest Reserve "B"	121	300	14	36
Dennery Waterworks Forest Reserve	145	359		
Dennery Ridge Forest Reserve	71	175		
Crown Estate of Pelouze			107	262
Marquis Estate Parcel M-1	134	330	1	2
Marquis Estate Parcel M-2	35	87		
Marquis Estate Parcel M-3-6	19	46	6	19
Forestiere Forest	12	30		
	---	---	---	---
	7496	18526	170	422

Source: CIDA, 1987; Harris, 1987. N.B. Some figures above have been rounded.

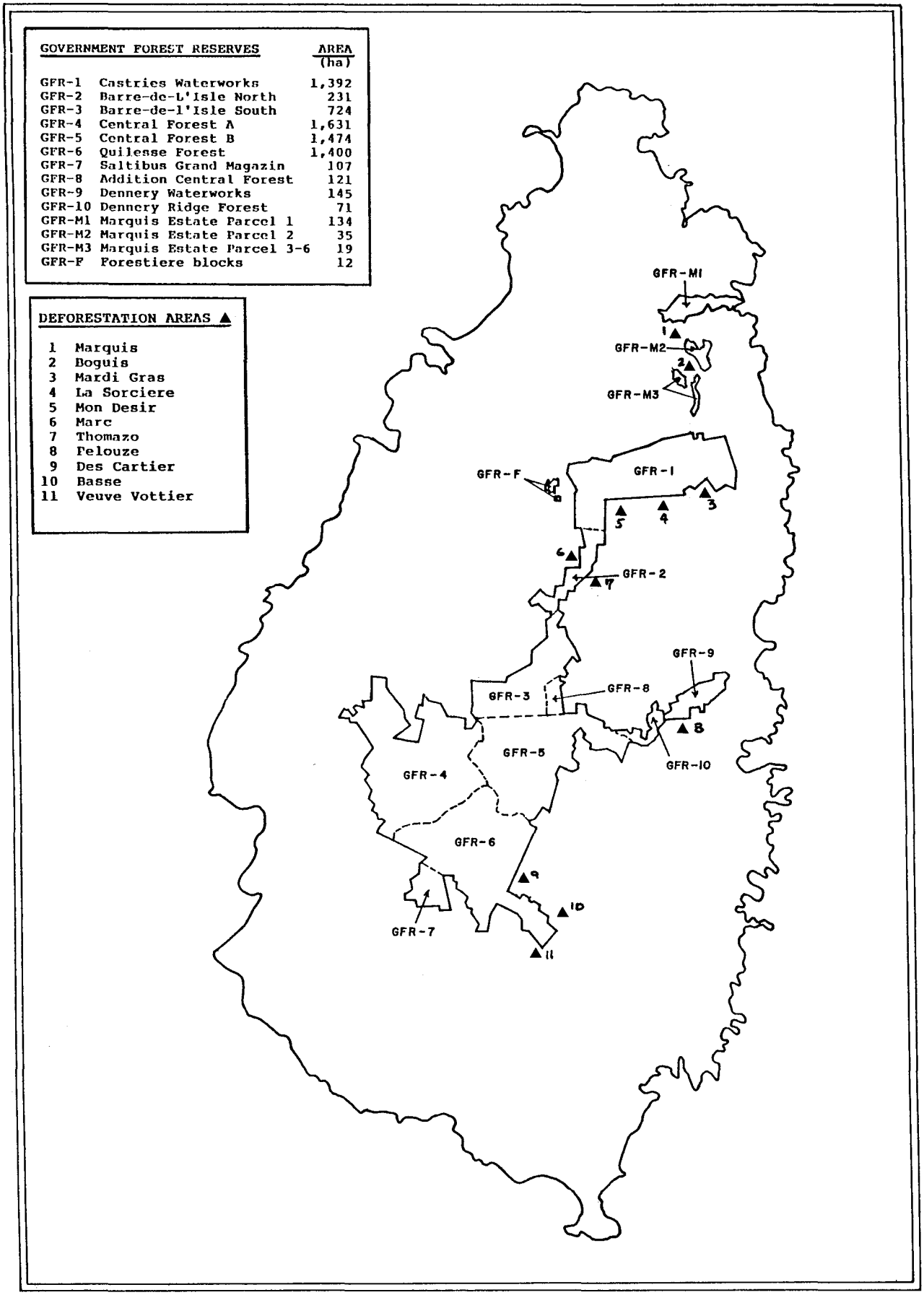


Figure 2.2(1). Forest reserves and key areas of deforestation.

THE NATURAL FOREST

Beard (1949) was the first to classify St. Lucia's forest resources by cover types with ecological descriptions of each (see Figure 2.2(2), Beard's vegetation map of St. Lucia). It is remarkable to note that at the time of his survey in the mid-1940's, Beard was able to report that there were significant remnants of virgin forests still surviving in St. Lucia. The primary types identified are provided below.

(1) **Rain Forest** (see also Table 2.2(3) and Figure 2.2(3)). Pure rain forest types (dominated by *Dacryodes excelsa* and *Sloanea* spp) are restricted to the sheltered valley bottoms of the interior on deep, less compacted red earth soils. These forests are typically three-tiered with a scattered main canopy at 24-40 meters, a second layer of specific species and a scrub layer. The ground vegetation is moderately dense and consists of semi-shrubs, seedlings of the main dominants and ferns. Epiphytes, lianas and climbers are common throughout the main canopy due to the relative openness of the stands.

(2) **Lower Montane Rain Forest** (see also Table 2.2(4) and Figure 2.2(4)). This cover type is dominated by *Licania ternatensis* and *Neoxytheca pallida* and is two-tiered in structure with a main canopy at 21-30 metres and a dense secondary shrub layer and sparse ground vegetation. Beard (1949) states that the best examples of this forest type were found along the Barre de L'Isle Ridge from Piton Flore to just south of Mount La Combe, on ridges between the Roseau and Cul de Sac Rivers and the Dennery Waterworks Reserve.

(3) **Montane Thicket/Elfin Woodland.** Montane thicket is to be found on the top of the most prominent peaks and on some of the higher ridges (see Figure 2.2(5)). Major species as recorded by Beard in this cover type include:

- Palmiste (*Euterpe globosa*)
- Bois Cote (*Tapura antillana*)
- Feuille Doree (*Micropholis chrysophylloides*)
- Grigri (*Aiphanes luciana*)
- Goyavier (*Myrcia* spp.)
- L'encens (*Protium attenuatum*)
- Bois Tan Rouge (*Byrsonima martinicensis*)
- Casse (*Swartzia caribaea*).

Elfin woodland consists of gnarled, low-growing tree species heavily covered with mosses and epiphytic plants. This cover type is essentially a "cloud forest" formation, and the only area of any size in St. Lucia is atop Mount Gimie. The most common species are *Didymopanax attenuatum* and *Chariathus coccineus* and a few other minor species.

(4) **Secondary Forest.** In general, the secondary forest woodlands of St. Lucia (see Table 2.2(5)) contain a high proportion of aggressive, light-loving species, younger trees, and trees that more easily withstand disturbances of the soil, plus a profusion of ferns and mosses. No hard-and-fast distinction can be made in St. Lucia between secondary forest and plantations because the former contains a high proportion of useful exotic species, notably Mahogany (*Swietenia macrophylla*), Blue Mahoe (*Hibiscus elatus*), Caribbean Pine (*Pinus caribaea*), and teak (*Tectona grandis*).

(5) **Dry Scrub Woodland.** St. Lucia has extensive areas covered by xerophytic vegetation particularly along its coasts and on the northern portion of the island. The vegetation is typically scattered, low-growing and predominated by Logwood (*Haematoxylum campechianum*) with some Acacia (*Acacia nilotica*). Further south on both coastlines dry scrub predominates resulting from eroded top soils due to past cultivation practices. Although some areas may support occasional large trees such as Poire (*Tabebuia pallida*) and Grand Feuille (*Cocolobis pubescens*), dense scrub and thickets predominate.

Since Beard's ecological study, a major forest inventory was undertaken in 1982 by P.O. Piitz under the auspices of the GOSL-CIDA Forest Management Project. Tables 2.2(6)and 2.2(7) compare apparent changes in the reported cover types over a 40 year period. Both identify three main forest types in St. Lucia: scrub (xerophytic woodland); primary forest (rain forest and lower montane); and secondary forest.

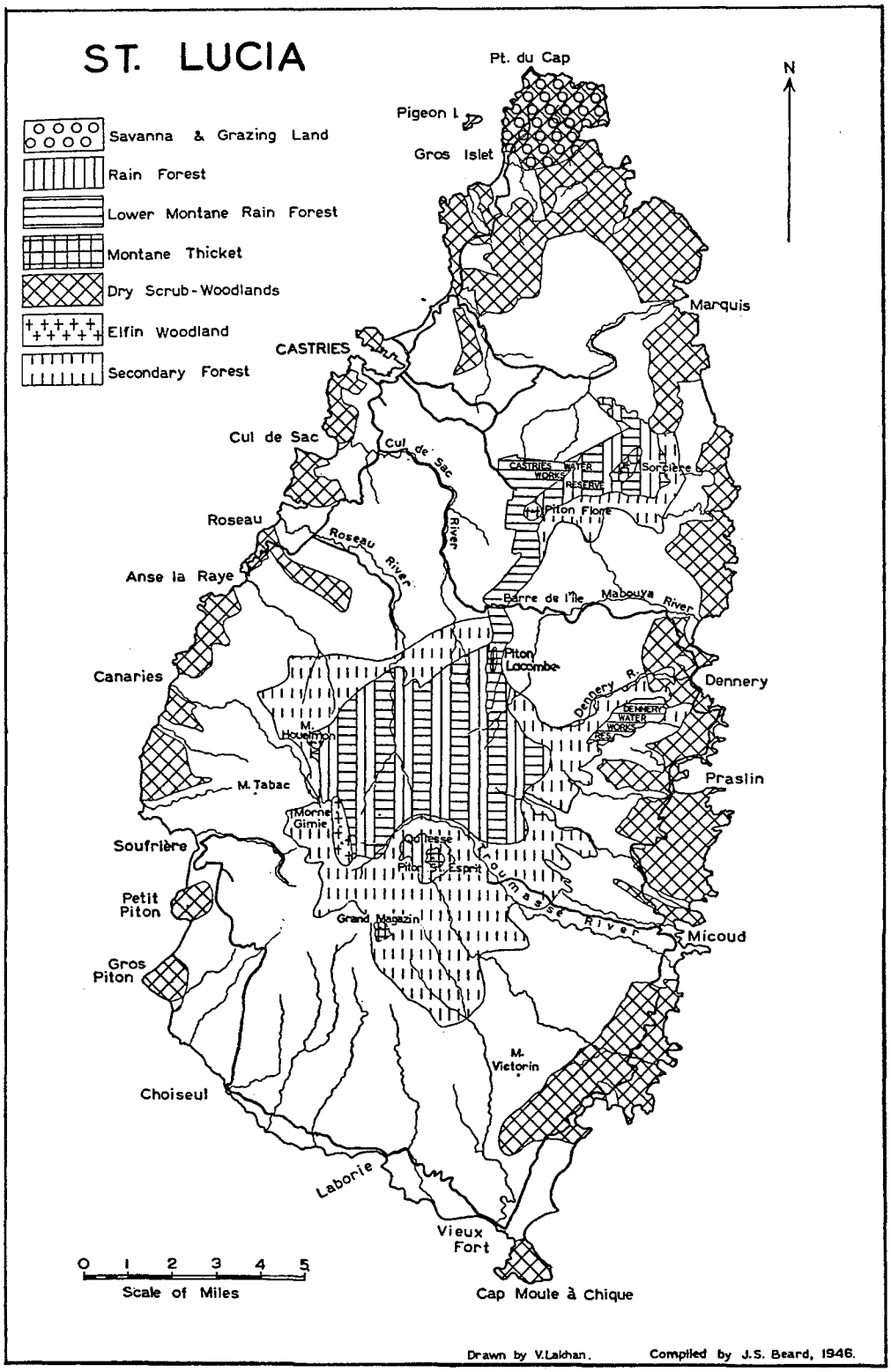


Figure 2.2(2). Beard's vegetation map of St. Lucia (source: Beard, 1949).

It should be noted that the two surveys did not use exactly the same criteria. The major difference appears to be in the secondary forest classification (Piitz' classification included mixed agriculture and open woodlands while Beard's did not). It is also more a matter of opinion than definition where the secondary forest gives way to scrub.

Given the fact that Beard and Piitz are not interchangeable, it is therefore difficult to interpret the changes in the natural forest which have occurred during the forty year period which separates their studies. Forest encroachment since Beard's survey has been severe but is not reflected in a simple comparison of Beard and Piitz as shown in Tables 2.2(6) and 2.2(7).

The difference in Beard's data and that of Piitz cannot be clarified by pointing to a difference in sample size as was noted by Piitz (1983) and the St. Lucia Forest Management Plan (1983). These documents observe incorrectly that Beard's study was based on a very light sample of only 20 acres (8 ha) out of 14,799 acres (6,023 ha), or a sample size of 0.14 percent (compared with Piitz's sample size of 1.8 percent). However, Beard writes in a methodology section of his study:

> In St. Lucia a regular grid system of north-south and east-west enumeration traverses on 100-chain squares was laid out and enumerated, totaling 2,189 chains of line and effecting a 1.5 per cent enumeration of the 15,000 acres of forest land in the interior. These lines crossed extremely broken country between elevations of 300 and 1,800 feet above sea level. Two 1-acre quadrats were also recorded and five profiles were measured (Beard, 1949).

A more convincing observation about the Beard/Piitz data is presented elsewhere in the GOSL-CIDA Forest Management Plan (1983):

> ... it is interesting to note the "apparent" increase in the area of Primary Forest [Table 2.2(6)]. This may be due to an original underestimate by Beard but is more likely the result of the dynamic of forest renewal, i.e., some Secondary Forest has developed into young primary forest over 40 years.... In spite of this apparent secondary succession, it is also very obvious that large portions of Primary Forest have been "lost" and converted to Secondary Forest-Shifting Agriculture, especially along the Barre de L'Isle ridge. The very large increase in areas classified as Secondary Forest-Shifting Agriculture illustrates the increasing pressure on remaining forest resources and the very real need for sound management planning.

Despite the lack of apparent supporting data from a direct comparison of Beard and Piitz, estimates of the rate of deforestation in St. Lucia have been made, varying between an annual loss of 0.2 percent of overall forest cover (Stevenson, 1986) to 2.0 percent (G. Charles, Chief Forester, personal communication). Such changes which have occurred can be attributed, in part, to the partially regulated harvesting of individual species, the illegal squatting by landless farmers in forested regions, and the eight hurricanes that have affected the forest since the turn of the century.

PLANTATIONS

In addition to the natural forest, St. Lucia has since 1938 established plantations of exotic species (the first plantation was a six hectare plot of Mahogany at Quilesse). Plantations were developed for a variety of reasons:

- to increase production of specific forest products;
- to reforest degraded lands;
- to control soil erosion and maintain watersheds;
- to reduce the pressure on natural forests;
- to generally improve the economy of the country by reducing imports of forest products;

Table 2.2(3). Common and scientific names of major rain forest species, St. Lucia.

LAYER	COMMON and SCIENTIFIC NAMES	% TOTAL RECORDED
Main Canopy	Gommier (*Dacryodes excelsa*)	10.8
	Chataignier (*Sloanea caribaea*)	7.7
	Mahaut (*Sterculia caribaea*)	6.1
	Bois de Masse (*Licania ternatensis*)	2.8
	Laurier Cannelle (*Phoebe elongata*)	1.8
	Bois Pain Marron (*Talauma dodecapetala*)	1.5
	Balata Chien (*Neoxytheca pallida*)	1.2
Mid Canopy	Palmiste (*Euterpe globosa*)	29.8
	Bois Cote (*Tapura antillana*)	13.2
	L'encens (*Protium attenuatum*)	2.9
	Goyavier (*Myrcia* spp.)	2.2
	Corosol Marron (*Guatteria Caribaea*)	1.7
	Bois Blanc (*Simarouba amara*)	1.6
Scrub Layer	Paletuvier (*Tovomita Plumieri*)	3.6
	Casse (*Swartzia caribaea*)	1.2
	Grigri (*Aiphanes luciana*)	1.0

Source: Beard, 1949.

Table 2.2(4). Major species of lower montane rain forest, St. Lucia.

LAYER	COMMON and SCIENTIFIC NAMES	% RECORDED
Main Canopy	Bois de Masse (*Licania ternatensis*)	5.0
	Balata Chien (*Neoxytheca pallida*)	4.9
	Gommier (*Dacryodes excelsa*)	2.9
	Bois Cote (*Tapura antillana*)	2.5
	Merise (*Ternstroemia oligostemon*)	2.1
	Feuille Doree (*Micropholis chrysophylloides*)	1.9
	Balata (*Manilkara bidentata*)	1.9
	Corosol Marron (*Guatteria caribaea*)	1.4
Lower Canopy	Palmiste (*Euterpe globosa*)	9.4
	Goyavier (*Myrcia* spp.)	4.6
	Paletuvier (*Tovomita plumieri*)	3.2
	L'encens (*Protium attentuatum*)	2.2
	Casse (*Swartzia caribaea*)	1.2

Source: Beard, 1949.

KEY TO CODE LETTERS

Am.	*Aiphanes minima*	Mi.	*Miconia* spp.
D.	*Dacryodes excelsa*	Mr.	*Marila racemosa*
Dm.	*Dussia martinicensis*	Sc.	*Sterculia caribaea*
If.	*Ixora ferrea*	Sl.	*Sloanea caribaea*
L.	Lauraceae (misc.)	Sw.	*Swartzia caribaea*
Ll.	*Lonchocarpus latifolius*	Ta.	*Tapura antillana*
Lt.	*Licania ternatensis*	Td.	*Talauma dodecapetala*
M.	Myrtaceae (misc.)	Tp.	*Tovomita plumieri*

Figure 2.2(3). Profile diagram of *Dacrydoes-Sloanea* rain forest measured by Beard at Doniol in St. Lucia (source: Beard, 1949).

- to create employment opportunities especially in economically depressed rural areas.

Plantations have typically been small, scattered in nature and established primarily to reclaim lands in the forest reserves cleared for agricultural crops or to stabilise eroding ridges, roadsides, and streambanks. Programmes to encourage regeneration of indigenous species have been abandoned in favour of plantations of exotics.

The primary plantation species (all exotic to St. Lucia) are:

(1) **Mahogany** (*Swietenia macrophylla*). Plantations of this species have been established at Edmund Forest, Quilesse-La Porte, La Sorciere, Barre de L'Isle and Union. While many of these plantations have been damaged by the Mahogany shootborer (*Hypsipyla grandella*), an insect which attacks seedlings and saplings, older trees are usually unaffected. Where shade is adequate, damage to younger trees is usually light. Logs extracted in 1980 from 1,938 plantations had diameters in excess of 61 cm (25 inches).

(2) **Blue Mahoe** (*Hibiscus elatus*). Plantations of Blue Mahoe were started in the late 1950's particularly at Edmund Forest. The tree is originally from Jamaica but grows successfully in St. Lucia where it is used in the manufacture of furniture. It is fast growing and beneficial for soil and water conservation measures.

(3) **Caribbean Pine** (*Pinus caribaea*). First planted in 1962 and subsequently planted at sites on the Barre de L'Isle, Forestiere, Saltibus and Union, this species has shown good growth and is comparable in timber quality to the US Southern Pine.

Other species that have been planted in lesser amounts include Teak (*Tectona grandis*), Eucalyptus (*Eucalyptus resinifera, robusta, kirtoniana*) and, more recently, Leucaena (*Leucaena leucocephala*).

Goodlet (1970) first attempted to estimate the area of plantations in St. Lucia. As of 1968, he estimated a total of 303 hectares (750 acres). In 1981, all surviving plantations were surveyed, compartmented and mapped. The results were tabulated in the Forest Management Plan (1984-1994) and indicated a total of 236 hectares (580 acres) of plantations up to 1978. The GOSL/CIDA forestry team is currently in the process of reactivating the plantation register and providing a survey and inventory of existing plantations. A preliminary assessment (1988), based on plantation maps and field survey of all forest ranges, reports a current total of 326 hectares (805 acres) of plantations (Table 2.2(8)). At the present time, this is very likely the most accurate figure of plantation area in St. Lucia.

ECONOMIC SIGNIFICANCE OF FOREST RESOURCES

The economic productivity of the rain forest has been decreasing in recent decades, and at present the forest industries sector plays a small role in the economy of St. Lucia. Only minor forest products are now produced for the domestic market, including fence posts, split fencing, broomsticks, and small quantities of lumber for furniture from plantations of Blue Mahoe and Mahogany.

Most of the wood and wood-derived products consumed in the country are imported, with the main suppliers being Honduras and the United States. Paper and paper products are also imported, primarily from the United States. St. Lucia ceased to be an exporter of wood in the late 1940's, and by 1984 the value of wood imported was EC$ 6 million (Stevenson, 1986). By 1986 the value of wood imported to St. Lucia had risen to EC$ 8.6 million for 14,000 cubic feet (CIDA, 1987).

The Forest Department supervises timber extraction. Although the Timber Industry Development Ordinance of 1963 created a Board to develop a wood products industry, it has not functioned effectively. The recent Forest Management Plan (1984-1994) recommends that the existing Board be dissolved and that Government-supported wood processing operations be managed by a self-financing section of the Department of Forest and Lands.

KEY TO CODE LETTERS

Am.	Airphanes minima	Mc.	Micropholis chrysophylloides
Bp.	Beilschmiedea pendula	Mi.	Miconia spp.
Ca.	Cyathea arborea	O.	Oxythece pallida
D.	Dacryodes excelsa	Pa.	Protium attenuatum
Hp.	Hirtella pendula	Pe.	Phoebe elongata
If.	Ixora ferrea	R.	Rubiaceae (misc.)
L	Lauraceae (misc.)	Sa.	Simarouba amara
Ll.	Lonchocarpus latifolius	Sc.	Sterculia caribaea
Lt.	Licania ternaltensis	Sm.	Symplocos martinicensis
M.	Myrtaceae (misc.)	Ta.	Tapura antillana
Mb.	Manilkara bidentata	Tp.	Tovomita plumieri

Figure 2.2(4). Profile diagram of lower montane rain forest measured by Beard in St. Lucia along the Barre de l'Isle ridge top, at right angles to the wind (source: Beard, 1949).

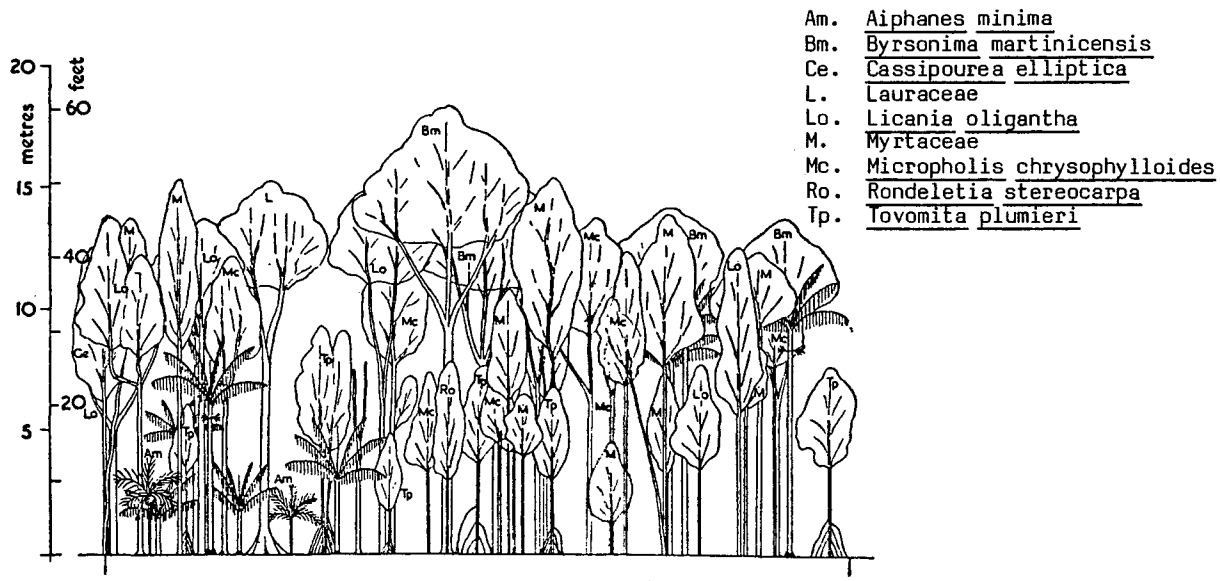


Figure 2.2(5). Profile diagram of montane thicket, normal altitudinal phase, measured at the Grand Magazin, St. Lucia (altitude: 2,117 feet) (source: Beard, 1949).

Table 2.2(5). Secondary forest species as enumerated by Beard (1949).

MAJOR SPECIES:	La Glu (*Sapium caribaeum*) Palmiste (*Euterpe globosa*) Bois Canon (*Cecropia peltata*) Bois Blanc (*Simarouba amara*) Bois d'Amande (*Hieronyma caribaea*)
MINOR SPECIES ASSOCIATIONS:	
Littoral Woodlands -	structural thickets along steep slopes and on cliffs facing the sea
Mangroves -	small patches scattered along the coasts, consisting of species including *Rhizophora* spp, *Avicennia* spp, *Laguncularia* spp, and *Conocarpus* spp
Fumarole Vegetation -	a unique and specialised association of ferns, grasses and low shrubs growing around the Sulphur Springs at Soufriere

Table 2.2(6). A comparison of reported forest cover types, by Beard (1949) and Piitz (1983).

COVER TYPE	BEARD (ha)	BEARD (ac)	PIITZ (ha)	PIITZ (ac)
Rain Forest/ Lower Montane Forest	5,989	14,799	6,780	16,752
Montane Thicket	121	299	608	1,501
Elfin Woodland	121	299	133	329
Dry Scrub Woodland	10,643	26,299	12,510	30,911
Secondary Forest* (Secondary Forest-Shifting Agriculture)	6,960	17,198	31,745	78,440 **
TOTALS	23,834	58,894	51,776	127,933

* Classification of secondary forest by Beard and Piitz are not interchangeable.

** Includes secondary forest-mixed agriculture:
Agriculture - 29,873 ha (73,816 ac)
Open Woodlands - 1,872 ha (4,624 ac)

Source: CIDA-GOSL Forest Management Plan, (1984-1994), 1983.

Harvesting practices include the more ecologically sound use of pit saws and Alaskan mills, although more widespread importation of chainsaws followed hurricane Allen in 1980. A permit, issued by the Forest Department, is necessary to buy saws. Current practices of the Department promote small lumber producers, who operate in selected forest areas under the supervision of Forestry personnel.

There is a Government-owned sawmill, the Conway Mill in Castries, which buys from the small sawyers and retails the lumber. It currently is scheduled to be razed and relocated so that the present site can be used for a redevelopment project. A privately owned sawmill near Patience obtained a concession in the mid-1970's to harvest timber on Crown Land, but due to continued financial problems, the Government bought the mill in 1980. Shortly thereafter the mill was damaged by hurricane Allen, and it now functions as a woodwork shop manufacturing furniture.

The CIDA-funded Forest Management and Conservation Project estimates that more than 15,000 hectares (37,065 acres) of forest should be dedicated to wood production in

Table 2.2(7). A comparison of stems/acre of major rain forest/lower montane rain forest species as enumerated by Beard (1949) and Piitz (1983).

COMMON NAME	SCIENTIFIC NAME	BEARD*	PIITZ
GOMMIER	*Dacryodes excelsa*	9.8	6.8
CHATAIGNER	*Sloanea caribaea*	4.7	2.8
MAHAUT	*Sterculia caribaea*	7.4	12.1
BOIS DE MASSE	*Licania ternatensis*	7.2	4.0
LAURIER CANELLE	*Phoebe elongata*	1.1	0.4
BOIS PAIN MARRON	*Talauma dodecapetala*	0.9	0.6
PALMISTE	*Euterpe globosa*	28.4	not listed
BOIS COTE	*Tapura antillana*	10.8	**
BALATA CHIEN	*Oxytheca pallida*	6.2	3.5
GOYAVIER	*Myrcia spp.*	6.5	**
COROSOL MARRON	*Guatteria caribaea*	2.6	4.4
BOIS BLANC	*Simaruba amara*	0.9	1.1
PALETUVIER	*Tovomita plumieri*	5.7	3.4
L'ENCENS	*Protium attenuatum*	4.2	4.1
CASSE	*Swartzia caribaea*	2.1	**
GRIGRI	*Aiphanes luciana*	0.6	**
FEUILLE DOREE	*Micropholis chrysophylloides*	2.1	1.7
MERISE	*Ternstroemia oligostemon*	2.3	0.2
BOIS RIVIERE	*Chimarrhis cymosa*	<1.0	2.4
LAURIER MABRE	*Endlicheria sericea*	<1.0	2.3
LA GLU	*Sapium caribaeum*	<1.0	2.1

* Values of rain forest and lower montane rain forest are grouped and based on eight hectares.

** Listed as "other" species.

Source: CIDA-GOSL Forest Management Plan (1984-1994), 1983.

support of a more viable forest products industry (CIDA, 1987). Since the majority of Forest Reserve land is in primary forest dedicated to the protection of watersheds and wildlife, most of the land required for wood production will have to be identified in the private sector. At the present time, there is little if any forestry practiced on private land; therefore, one of the objectives of CIDA's forestry project in St. Lucia is to gather and collate information on growth and yield projections which make private forestry a more attractive alternative.

While it is true that St. Lucia's forest industry is underdeveloped and the country has become a net importer of wood products, a situation deplored in a recent Caribbean Development Bank study (CDB, 1983), it should also be noted that one important objective of GOSL forest management policy is to prevent the country from becoming a net importer of yet another critical natural resource -- namely,

Table 2.2(8). Preliminary estimation of timber resource plantations, St. Lucia (March 1988).

RANGE	LOCATION	AREAS PLANTED IN ACRES 1-20 YEARS	11-20 YEARS	21-30 YEARS	31+ YEARS	TOTAL
NORTHERN	Louvet	11.8				11.8
	LoggingBay	29.3	10.0			39.3
	Desbarra	15.0	6.0			21.0
	Forestiere	21.7	21.0	29.0		71.7
	Caille Des		17.0			17.0
	Marc	5.0	27.0	7.0		39.0
Sub-Total	NORTHERN	82.8	81.0	36.0		199.8
DENNERY	LaSorciere		5.0	101.0		106.0
	Mt.LaCombe	10.0				10.0
	Thomazo	20.5	10.0			30.5
	Barre de L'Isle		24.5	13.0		37.5
Sub-Total	DENNERY	30.5	39.5	114.0		184.0
QUILESSE*	Basse	12.0	23.0			35.0
	Laporte-Quilesse	16.0	10.0	22.0	16.0	64.0
Sub-Total	QUILESSE	28.0	33.0	22.0	16.0	99.0
SOUFRIERE*	Edmund Forest	17.6	87.9	217.0		322.5
Sub-Total	SOUFRIERE	17.6	87.9	217.0		322.5
TOTALS		158.9	241.4	389.0	16.0	805.3

* Quilesse and Soufriere figures remain incomplete for recent plantations in Saltibus, Daban, Veuve Vottier and Basse.

Source: Information provided by CIDA Forest Management and Conservation Project (March 1988), based on plantation compartment maps, field checks, and new plantation registers.

water. Seen in this light, the forest lands have a major economic role to play in St. Lucia -- as interceptors and storage areas for rainwater, for soil stabilisation, and as a possible source of low-head hydro-electric power. The value of these functions can only be calculated indirectly, by identifying the cost of obtaining the same benefits in other ways. The key issue is how to establish a sustainable balance between society's need for water, wood, and wildlife.

CURRENT MANAGEMENT PRACTICES

In 1981 the Government of St. Lucia, with the technical assistance of CIDA, undertook a joint Forest Management Project which has produced a ten year Management Plan for the forestry sector (1984-1994). The Plan was officially accepted by GOSL as the basic policy document for future forestry development in the country. Policy objectives read as follows:

- to preserve and protect natural forests on slopes over 30 degrees, along river banks, in critical watersheds, on unstable soils, and which are the habitat of endangered or rare wildlife, in order to prevent erosion, provide good water and recreation;

- to manage remaining natural forests on the basis of sustained yield to give maximum benefits;

- to establish plantations of fast growing species on currently unproductive lands to supply fuelwood and lumber, thus relieving pressure on the natural forests and decreasing imports;

- to manage forests on private lands and to plan for optimum land use with all other users;

- to educate the public on the value of sound forest practices, carry out necessary research, and train Forestry Department staff.

The Forest Management Plan outlines proposals for the development of existing and new plantations, village woodlots, agroforestry, forest management and conservation, institutional development, promotion of environmental awareness, and provides suggestions for financing and implementation. It divides the natural forest into three categories according to function in order to provide a management framework for forest lands. The three land use categories are:

(1) *Protection Forest* which is afforded a complete protective status;

(2) *Protection/Production Forest* which is primarily protective but with some exploitation;

(3) *Exploitation Forest* for timber production.

An overall work plan for a five-year CIDA-funded Forest Management and Conservation Project in St. Lucia is detailed in the Project Inception Report dated October 1987 (CIDA, 1987). The project's objectives are based on the recommendations of the Forest Management Plan and call for a management approach that:

> limits harvest rates to sustainable levels, that preserves as much of the indigenous forest as possible, that restricts harvesting activities to areas that are biophysically resilient and economically accessible, and that reforests land that has been inappropriately cleared for agriculture (CIDA, 1987).

Major activities under the CIDA-supported project will focus on:

(1) institutional support to the reorganised Forestry Division (now the Department of Forest and Lands);

(2) review and revision of legislation and policies relating to forestry;

(3) implementation of a programme of forest management and conservation;

(4) forest access planning;

(5) upgrading of the island's wood products industry;

(6) promotion of activities which enhance public support for forestry.

2.2.2 Institutional Responsibilities

A Forestry Division, within the Ministry of Agriculture, was created at the time the Forest, Soil and Water Conservation Ordinance was enacted in 1946. The 1983 Forest Management Plan proposed reorganisation of the Forestry Division and upgrading of that agency to a separate Forestry Department responsible directly to the Permanent Secretary of the Ministry of Agriculture. This has now been accomplished with the creation of the Department of Forest and Lands.

Under legislative authority granted by the following statues:

- Forest, Soil and Water Conservation Ordinance (Rev. 1983);
- Wildlife Protection Act (1980) (see also Section 2.3);
- Crown Lands Ordinance (1946);
- Timber Industry Development Board Ordinance (1963),

the Department has general responsibilities to:

- survey and demarcate all Crown Lands and Forest Reserves;
- maintain map records of such lands;
- control squatting, poaching of timber and wildlife, and all other illegal uses of Crown Lands and Forest Reserves;
- collect revenues derived from the sale or lease of Crown Lands and timber;
- arrest, charge and prosecute violators of the ordinances cited above and of regulations made under them;
- buy and resell locally produced timber;
- preserve, maintain and develop the timber industry of St. Lucia.

Management responsibilities of the Department are embodied within the Cabinet-approved Forest Management Plan and include control of Crown Lands; conservation and protection of forest reserves and water catchment areas; supervision of forest utilisation activities; establishment of forest nurseries; promotion of wood products industries; afforestation and reforestation of degraded lands; and implementation of extension programmes in conservation and silviculture, research programmes, and conservation education activities.

Additionally, under the Water and Sewerage Authority Act of 1984, WASA may request that the Chief Forest Officer take action to protect any water catchment area threatened by deforestation. The two agencies have responsibilities to identify water catchment areas needing protection, but since the Forest Officer's powers are restricted to Crown Lands, his authority is limited (Lausche, 1986).

The Department is headed by the Chief Forest and Lands Officer (former Chief Forest Officer), who is assisted at a middle management level by two Senior Assistant Officers, one for Conservation and one for Operations. Field work (e.g., patrolling of forest reserves, management of plantations) is divided into five forest ranges, each under the charge of a Range Officer, plus staff.

2.2.3 Relevant Legislation

The Forest, Soil, and Water Conservation Ordinance (1946), as amended in 1957 and 1983, is the principal legislation for forest utilisation and conservation. It contains provisions for the removal of timber, declaration of forest reserves and of protected forests on private

land, control of squatting on Crown Lands, and offences. The 1983 amendments expanded the list of Government officers with enforcement powers and substantially increased penalties for squatting and other forest offences such as illegal cutting of trees, removal of forest produce, setting of fires, grazing of livestock, clearing and cultivation. Although the legislation covers only a narrow aspect of natural resource conservation, it is the only legislation with a significant impact on the control and regulation of rural land use.

The Minister of Agriculture may declare Crown Lands as forest reserves, which must then be surveyed and demarcated; no land within such reserves can be granted or sold, although this has occurred in the recent past. The Chief Forest Officer is charged with the management and protection of all forest reserves, but the power to require soil and water conservation practices on private forest lands, even where impacts may affect the public interest, is not conveyed by this legislation.

The enforcement powers for illegal uses of Crown Lands and forest reserves are broad and include the power of search, seizure, and arrest by forest officers. Most significantly, the Chief Forest Officer has the power to impose a fine without taking the matter to court for forest offences up to a maximum fine of five hundred dollars. This provision is used regularly to reduce the burden on the courts and as a deterrent to continuing violations.

For conservation purposes private lands can be declared Protected Forests, and specific management rules may be imposed. The 1983 amendments increased the possible incentives available to encourage the setting aside of private land for protected forests. To compensate for losses, landowners may be exempted from the Land Tax, may receive compensation in land or money, or the land in question may be leased to Government. However, because of fiscal constraints it may not be possible for GOSL to use such incentives (Lausche, 1986).

A proposed Crown Land Policy, which introduces the twin concepts of biophysical classification and zoning of Crown Lands, has recently been approved by Cabinet. This initiative has the potential of facilitating efforts to bring private forests under Government control for the promotion of ecologically sound management practices.

2.2.4 Problems and Issues

DEFORESTATION

Chief Forester, Gabriel Charles, estimates that loss of forest cover in St. Lucia is in the order of two percent per annum. This figure is an estimate, for there is little information available on rates of deforestation in the Caribbean (Lugo, Schmidt, and Brown, 1981, state that for seven Caribbean countries -- Colombia, Costa Rica, Guatemala, Nicaragua, Puerto Rico, St. Lucia, and Venezuela -- the deforestation rate *averages* 0.5 percent/year.)

Deforestation is not a new phenomenon; indeed, from the time human settlement began on the island, man has turned to the forest as a source of raw materials for construction and fuel. But increasing population pressure coupled with a rising demand for agricultural land have led to a marked acceleration in the rate of deforestation. Most recently, the problem has been exacerbated by the development of access roads into formerly inaccessible primary forest.

Although the Forest, Soil and Water Conservation Ordinance prohibits activities which are prejudicial to forest management policies within forest reserves, implementation of these regulations has often been ineffective. Enforcement has been hindered by:

(1) a shortage of staff to patrol the extensive areas of the Reserve,

(2) the fact that until very recently the forest reserves were undemarcated on the ground and when Crown Lands abutted private lands, boundary identification was almost impossible;

(3) the enabling legislation which gave no authority to the Forest

Department over private land, short of acquiring it and declaring such areas part of the forest reserves.

Recent events have somewhat improved this situation. The 1983 amendments to the Forest, Soil, and Water Conservation Ordinance substantially increased the penalties for offences within the forest reserves, and by 1985 the entire forest reserve boundary had been demarcated on the ground. Nevertheless significant damage had already been done. For example, from the time of its establishment in 1916 to 1985, Forestry officials estimate that more than one third of the Castries Waterworks Reserve had been denuded and illegally cultivated with bananas and root crops. Principal areas of deforestation occurring on lands bounding the Forest Reserves are shown in Figure 2.2(1).

Over time, deforestation has been exacerbated by the expanding production and cultivation of export crops. The first of these was sugar when the hillsides surrounding the cane estates were cleared to provide fuel to run the sugar factories. Principal cane valleys affected were Fond D'Or/Mabouya, Cul de Sac, Roseau and Vieux Fort.

In the mid 1950's the cultivation of sugar cane gave way to the production of bananas, with expanded impacts on the remaining forest lands. Sugar cane can only be economically cultivated on the flat alluvial plains of river

FORESTS AND SOIL

Most of the soil underlying St. Lucia's tropical rain forests is old and virtually sterile. Then why, one might ask, is there a luxurious green forest cover, canopy, and lush undergrowth? This is possible because mother nature has developed a way around the poor soil problem that works well as long as it is not interfered with.

Because the forest is "old," it has been able to accumulate chemical and nutrient components slowly, incrementally over time, using and storing the sun's energy as the driving force through photosynthesis. The forest biomass (roots, leaves, branches, stems, trunks, vines, epiphytes, and so forth) is the primary biochemical storage unit, not the soil or ground water. Furthermore, the forest has evolved as an effective mechanism for recycling nutrients contained within the decomposing leaves and dense litter on the forest floor, called humus (the organic constituent of the top layer of soil formed by the decomposition of organic matter). Some trees even seek these nutrients by putting roots upward out of the soil into the layer of humus. This is what makes it possible for lush forests to appear to grow out of poor soils. In fact they do not -- they are only rooted in place by the poor soils. Therefore, when a forest burns or slash and burn agriculture take place, the organic (and therefore burnable) forest floor of humus either burns or is subsequently washed or blown away, leaving behind a usually worthless soil.

Clearing and exposing the forest floor to the sun's heat inhibits the accumulation of humus. When soil temperature exceeds 25 degrees Centigrade (77 Fahrenheit), humus decomposes faster than it forms, and volatile ingredients, particularly nitrogen, are lost (not fixed), thus robbing the forest floor of key nutrients Opening the forest canopy a little will not raise soil temperatures to this threshold, but a larger opening can induce a general net loss for nutrients. This also explains why the slash and burn farmer has to move on after a few crops because he has used up the nutrients and none are being put back but rather lost due to overheated humus.

valleys; bananas on the other hand can also be grown on hillsides. After the 1950's the river valleys of St. Lucia became the sites for large foreign-owned banana holdings, while small farmers resorted to clearing the forested valley sides to support small-scale banana production. The introduction of the chainsaw and its widespread importation subsequent to hurricane Allen in 1980 increased the rate at which forest lands were cleared for cultivation.

Loss of forest quality is an equally significant phenomenon, for forested land may still be classified as "primary" or "secondary" but contain far fewer trees than previously. The Forest and Lands Department maintains that the relatively high price paid for bananas will continue to encourage forest cover removal by small farmers, while the lack of legislative authority by Forestry staff over private forest lands will increase the likelihood that future reforestation and afforestation efforts will fall behind the rate of forest loss.

FUELWOOD PRODUCTION

Charcoal and firewood are important fuel sources in St. Lucia, with 88 percent of households surveyed in 1981 reportedly using charcoal on either a regular or occasional basis (GOSL/CPU, 1981). Although less common, firewood was used in four percent of all households. Consumption levels of both appear to be increasing.

Charcoal has traditionally been the primary cooking fuel, and in the years preceding World War II the country was an important exporter of charcoal. Although St. Lucia no longer exports charcoal, the continued demand of poor and marginalized rural populations, in particular, for charcoal and to a lesser extent firewood contributes to the overall exploitation of forest resources. Since the early 1980's concern about the contributory role played by charcoal production in deforestation has increased, and several small-scale projects designed to improve fuelwood productivity have been introduced.

Limited experimental plantations for charcoal production have been established by the Department of Forest and Lands, the first at the Union Experimental Station in 1979. As part of a regional OAS-funded study on Leucaena (*Leucaena leucocephala*) yields, the Department currently manages six half-acre plots of this fast-growing tree and co-operates in the management of three additional Leucaena projects: at St. Urbain (10 ha/25 ac), Louvet (6 ha/15 ac), and in the Mabouya Valley (2.5 ha/6 ac). The projects near St. Urbain (at Aupicon) and in the Mabouya Valley (at La Ressource) have social forestry components, involving establishment of fuelwood plantations managed and exploited by local charcoal producers.

Proponents of the fast-growing Leucaena species had anticipated average annual growth rates of approximately 50 cubic metres per hectare per year, or about 750 cubic feet/acre, when the original experiments were established (Andrew, 1984). However, assessments of early plantings indicate actual Leucaena yields are considerably less than expected -- ranging from 16 cubic metres/hectare/year at St. Urbain to a high of 38 cubic metres/hectare/year at Union (CIDA Forestry Team, personal communication, 1987).

The current status of fuelwood harvesting and its impact on forests is difficult to state with any degree of confidence or reliability. Although several studies have been made which report on fuelwood consumption and provide demand/supply projections for charcoal and firewood, there is, unfortunately, little standardisation of what has been surveyed, measured, and reported, and thus there is substantial inconsistency in the data generated and great confusion over the policy implications of the conclusions drawn by various investigators (see Fuelwood Consumption box, page 96). What is required is a more systematic analysis of available information -- one which sorts through the contradictions and inconsistencies, standardises data and applies more rigorous criteria for comparability. Only then will resource managers be able to confirm results and select among available policy options.

In the interim, current data would seem to suggest that St. Lucia is presently capable of

meeting domestic fuelwood requirements from available production land, primarily scrub woodlands. However, due to weak public management, fuelwood harvesting probably does contribute significantly to deforestation.

Romulus (1987), using the following parameters:

- Utria's (1985) forest biomass yield rate of 7.4 tonnes per hectare per year,

- a demand rate of 5.6 t/ha/yr (derived by dividing estimated fuelwood consumption of 89,000 tonnes by 16,000 hectares of land exploited for fuelwood),

has calculated a net fuelwood surplus of 1.8 t/ha/yr. In other words, Romulus reasons that an extractive or harvesting rate of 5.6 t/ha/yr is offset by a current natural biomass (regrowth/growth) production rate of 7.4 t/ha/yr, leaving a net annual standing surplus of 1.8 metric tonnes per hectare of wood. Allowing for a 0.13 t/ha/yr increase in demand, based on an expanding population, Romulus estimates that this annual surplus will be diminished annually because there are more consumers and will disappear in about 15 years.

The problem with such projections is that any change in the assumed variables will alter the conclusion. For example, using the Romulus hypothesis, if the Utria biomass production figure (7.4 t/ha/yr) is rejected (because it assumes a high rate of regrowth) and figures are substituted which have been accepted elsewhere and which perhaps are more suitable to St. Lucian circumstances (given the variability of rainfall and its impact on secondary forest renewal), then entirely different conclusions are presented. Others (Pimentel, *et al.*, 1986 and UNDP/World Bank, 1984) utilise lower biomass regeneration figures for tropical forests ranging from one to three t/ha/yr. Taking the high, more optimistic end of this range (3 t/ha/yr) would, in Romulus' calculations, place St. Lucia in an immediate fuelwood deficit position of 2.5 t/ha/yr. But there is no guarantee that 3/mt/ha/yr is appropriate for St. Lucia!

Unfortunately, there are too many such projections, about which we really know very little for certain. Before the 1980's, the concern about deforestation focused on pressures driven by agricultural village and urban growth. Since the early 1980's, St. Lucian policy makers have generally interpreted the data to conclude that charcoal production, as an inefficient consumer of vast quantities of fuelwood, has significantly contributed to deforestation. More recent evidence is still not conclusive although demand is rising and there is plenty of evidence that some locations are being deforested by fuelwood harvesting, mostly to make charcoal.

Given the overall pressures on forests, the implications of charcoal production and its impact on forested lands are indeed important environmental issues for St. Lucia. Nevertheless, several factors need to be kept in mind in evaluating some of the research dating from the early- to mid-1980's:

(1) The 1981 Household Energy Survey sponsored by the CPU, and the subsequent estimates about fuelwood production based on survey data (Wilkinson, 1984; UNDP/World Bank, 1984) were carried out *before* world oil prices fell from their record high level during the so-called "oil crisis;" thus, there was well-founded concern about the sustainability of fuelwood resources if pressures to intensify use of low-tech energy alternatives to oil continued.

(2) Uneasiness about the level of deforestation resulting from fuelwood production intensified during the post-hurricane Allen (1980) period, a time when the forest resource base had suffered severe damage.

(3) Much illegal fuelwood harvesting in various forested areas may actually be a secondary, rather than the primary, objective of small farmers clearing land for cultivation (legal and illegal). The trees are felled to make way for cultivation, and their utilisation as fuelwood is only a revenue generating by-product.

GOSL/CPU (1986b) reported that the predominant method of harvesting was clear cutting (used by 46 percent of those surveyed), and almost 90 percent of the land so cleared was used for agricultural purposes.

(4) Harvesting methods used for most fuelwood production are low-tech strategies. GOSL/CPU, 1986b, reported that over 90 percent of harvesting was done with axe and cutlass methods and only five percent by chainsaw, suggesting an emphasis on scrub woods and littoral and dry woodland areas, not the more valuable primary forest areas which are less accessible. Most charcoal is produced on private lands, often without the owner's knowledge or permission.

Some attempts have been made to deal with the fuelwood problem through establishment of plantations for charcoal production, but these have only achieved limited success to date. Recommendations have also been made to identify fast-growing species other than Leucaena for charcoal production, to promote

FUELWOOD CONSUMPTION ESTIMATES

Over the past decade, considerable attention has been paid to estimating the amount of charcoal and firewood consumed in St. Lucia. Highlights of key studies include the following contrasting conclusions:

* In 1979, charcoal consumption was estimated by UNDP and the World Bank at 2,200 tons per year -- five percent of total energy consumption (Richter, 1979). No figure was given for firewood alone.

* Wilkinson's (1984) calculations based on the CPU's 1981 Household Energy Survey generate an annual fuelwood consumption of approximately 6,200 pounds -- over three tons -- for each of St. Lucia's 20,900 households, or nearly 65,000 short tons total. (NB. Assumes fuelwood converts to charcoal at a rate of 8.6 pounds of firewood per pound of charcoal.)

* The UNDP/World Bank's 1984 study of St. Lucia's energy sector, utilizing the same data from the 1981 household survey, generates a total fuelwood consumption figure of 80,000 metric tonnes (88,000 short tons).

* The report of a 1986 survey of charcoal producers, requested by the Department of Forest and Lands and supported by OAS, states charcoal production is only one-sixth of the consumption level estimated by the Household Energy Survey in 1981.

* A 1986 Central Planning Unit draft sector paper on energy estimates total consumption of "non-commercial" firewood, charcoal and agricultural residues to be equivalent to roughly 91,000 tons of firewood per annum (75,000 of which is used to make charcoal).

* Romulus (1987) develops fuelwood consumption figures of 98,162 (1987) short tons per year.

* The conversion of wood to charcoal in typical artisanal charcoal kilns will vary in efficiency from 4 to 30 percent (which means St. Lucia can protect the forest by wasting less wood in inefficient charcoal kilns).

utilisation of abandoned or idle scrub woodlands and secondary forest on private land for fuelwood, and to improve efficiency of production methods, including efforts to recover and carbonize waste wood (CIDA, 1987; Romulus, 1987).

WATERSHED MANAGEMENT

Watersheds are hydrologic units defined by a catchment area from which water is collected and drained by a river. While they may be easily "identified" on a map and demarcated on the ground, their functions are complex and not easily understood by policymakers.

Upland or upstream forested areas are often also referred to as catchments, but in this instance, it customarily defines an undeveloped, formally (legally) designated protected area from which unpolluted rainwater is led, via protected water courses, impounding dams, reservoirs and water intake pipes, to communities of users lower down in the watershed. Some forest reserves are maintained entirely as water catchment production areas. Undisturbed, heavily forested land captures and holds rainwater more efficiently than disturbed landscapes with fewer trees and vegetation. Upland watersheds are the principal source of water on the island of St. Lucia, but the role forest lands play in protecting this key water supply is not widely appreciated. Figure 2.2(6) identifies (from the perspective of the mid-1970's) major watersheds in the country requiring priority protection; see Section 2.4 for identification of all watersheds.

The management, conservation and rehabilitation of watershed areas has over the past decade taken on special significance in St. Lucia. Deforestation, development of access roads, and the expansion of the banana industry have placed excessive environmental stress on the country's watersheds, as is evidenced by increased river siltation, reduction in water quality, and periodic water shortages, primarily in the Castries area where most of the demand occurs.

Part of the problem stems from a division of management responsibility. The impoundment, treatment and distribution of water for domestic, industrial, and commercial uses is the responsibility of the Water and Sewerage Authority, while the management of catchment areas within the forest reserves lies with the Forest and Lands Department. Currently, WASA has domestic water intakes and catchments located in 25 upland watersheds of the island. Of these, only six catchments lie entirely within the forest reserves, while nine lie entirely outside the reserves. Other related responsibilities fall within the jurisdiction of the Engineering Division of the Ministry of Agriculture, while the proposed Land Conservation Board (see Section 3.2), with authority to regulate land use for the conservation of critical resources, would also have influence over watershed and catchment management. There has been little co-ordination between the various agencies, and it is only during the last five years that Forestry has been represented on the Board of WASA.

Despite this lack of administrative co-ordination, soil erosion in nearly all of St. Lucia's watersheds is widely regarded as a major problem in St. Lucia (see also Section 3.3), and the indiscriminate clearing of vegetation from steep, unstable slopes for banana and other crop cultivation is generally regarded as a primary cause. Some catchment areas are also partly intruded upon by residential housing, increasing the risk of erosion and surface run-off. Stream flow and sedimentation rates have been studied by the U.S. Geological Survey, the Water and Sewerage Authority and the Land and Water Use Unit of the Ministry of Agriculture. All have reported reduction in base flows, steady increases in erosion and continuing sedimentation of river courses. (See also Section 2.4.)

In view of the foregoing, the Forest and Lands Department, in co-operation with the CIDA Forest Management and Conservation Project, has instituted a programme aimed at improved watershed management. An initial phase of the programme calls for a survey of all watershed areas to re-prioritize each according to the area's potential as (1) a source of water for the population (e.g., water quality) and (2) suitability for protective measures (e.g., steepness of slopes). The study has been

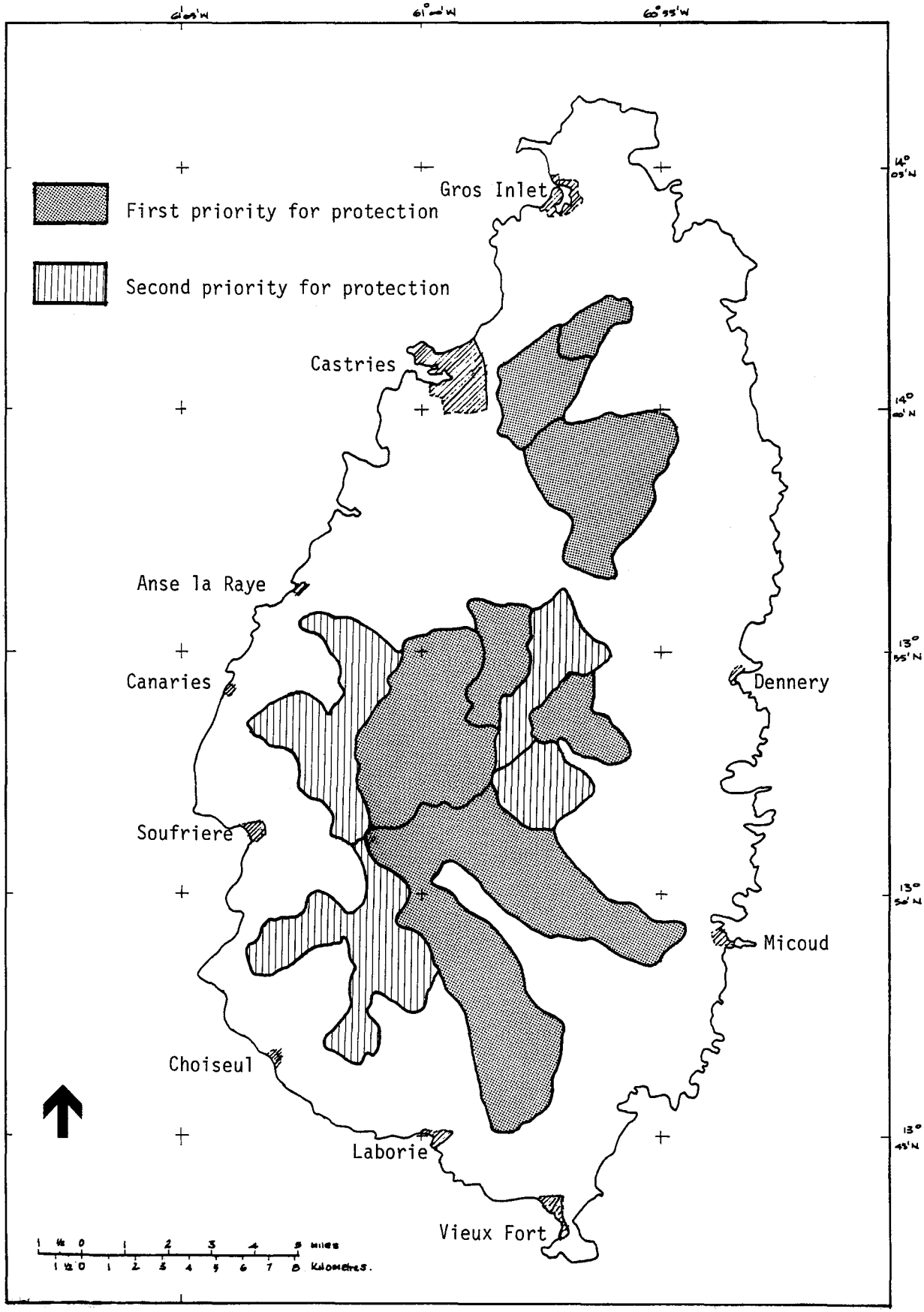


Figure 2.2(6). Major upper watershed catchment areas of St. Lucia requiring priority protection (source: printed in Caribbean Research Centre, 1980; extracted from UNDP Physical Planning Project, 1975).

completed for the north of St. Lucia with new, high priority watersheds identified in Table 2.2(9). However, there is at present no consistent system for establishing priorities and no clearly established administrative framework for implementing recommended changes in land use practices presently known to be injurious.

2.2.5 Directions for the Future and Policy Recommendations

The Forest Management Plan (1984-94), prepared by GOSL with the technical assistance of CIDA, has been accepted by Government as the policy document for future forestry development in the country. Additionally, Government has undertaken the official gazetting of forest reserve boundaries, which were surveyed during the first phase of the joint GOSL-CIDA project.

With Government's acceptance of the ten-year Plan and the demarcation of the Forest Reserve, important steps for the future management and conservation of the country's forest resources have been taken. Additional priorities and recommendations are summarised below.

Table 2.2(9). Priority watershed and catchment areas identified for the north of St. Lucia by the GOSL-CIDA Forest Management Project (1987).

a.	Grand Riviere Headwaters	- Bois D'Orange River Catchment
b.	Two branches of Upper Monier	
c.	Headwaters of Monier - north	
d.	Head of S.E. branch of Ravine La Vaccance	
a.	Head of Esperance River	- Esperance River
b.	All forested areas and streamsides of Dauphin River	
a.	Forested areas and streamsides of Ravine Peauyane	- Marquis River Basin
b.	Forested areas and streamsides of Ravine Serpent	
c.	Forested areas of Theatiste	
d.	Boguis	
e.	Ravine Elysee (plateau)	
f.	Right side Marquis River	
g.	Forested stream and south branch of Vergalier River	
a.	Forested areas Gazons River south basin	- Choc River Basin
b.	Head of Chauborg River	
c.	Head of River Feree	
d.	Head of St. Joseph River	

Source: GOSL, Department of Forest and Lands.

RESEARCH

Research efforts in the past included the use of tropical shelterwood systems (employing fast-growing native species) to encourage regeneration of indigenous species. Some native species plantations were also established prior to 1953 (CIDA, 1987). These programmes, however, have been abandoned in favour of plantations of exotics, using primarily three species -- Blue Mahoe, Mahogany, and Caribbean Pine. Experimentation with other species has been introduced with, for example, Teak planted principally along riverbanks and Leucaena planted on a larger scale (with financing from OAS), particularly on the east side of the island. Other species have been planted in small experimental plots (referred to as "arboreta") in the forest reserves.

The rationale for the current emphasis on exotic species needs to be examined. CIDA has proposed that a review of Beard's (1949) ecotype classification of the indigenous forest be carried out and that one or more indigenous and/or exotic species, adapted to each ecological condition, be identified, followed by establishment of small experimental plantations of species within each ecotype. Existing research programmes, designed to develop silvicultural prescriptions for established plantations, should continue. At the same time, however, research efforts should be initiated which focus on the most highly valued indigenous species, with a view toward establishing silvicultural prescriptions for these.

The Ministry of Agriculture's nursery at Union, near Castries, has been earmarked by CIDA for expansion and upgrading, to improve upon existing production practices, to design a nursery management plan linked to the plantation programme, and to develop a programme of applied research in the germination and propagation of indigenous and exotic species. CIDA also proposes to re-evaluate the operation of the "flying nurseries" now located in several forest ranges.

FOREST CONSERVATION AND DEVELOPMENT

The rate of reforestation and afforestation in St. Lucia continues to fall behind the rate of forest loss. Reforestation figures since the beginning of the decade (GOSL, *Annual Statistical Digest*, 1986) show that reforested acreage totals per annum have been fairly consistent since 1983-84, with 61 hectares (150 acres) being reforested in the period 1985-86. While this trend may be encouraging (only ten acres were reported in 1972), the actual cumulative totals are not large. Forest cover loss -- whether due to illegal felling of trees for timber, land clearance for cultivation, or removal of wood for fuel -- continues to be of concern in St. Lucia.

Therefore, future conservation and resource development policies should be designed to:

(1) prevent agricultural encroachment and the harvesting of trees in designated "protected" forest areas, and

(2) provide for carefully supervised harvesting on the basis of sustained yield management in the "protection/production" and "exploitation" forest areas as defined under the Forest Management Plan.

Additionally, GOSL, with assistance from Canadian forestry experts, should continue to develop new plantations, currently proposed to expand at the rate of approximately 100 hectares (240 acres) of new forest per year. Finally, water catchment areas, under the jurisdiction of the Forest Department, should be rigorously defended against encroachment and no land use other than controlled forestry permitted.

Specific recommendations to assist in carrying out these general policy goals include:

Experimentation with Agroforestry Techniques. Given the high costs of plantation maintenance and the continued infringement on protected natural forests by illegal farming, CIDA has proposed that a pilot

project in agroforestry be implemented to test its feasibility for future plantation maintenance. Farmers will interplant agricultural crops with forest trees on selected sites which will be monitored and evaluated. Agroforestry agreements have been used in St. Lucia as a method of plantation maintenance, but the system fell into disrepute when the terms of such arrangements (which permitted agricultural activities in the forest reserves if forest plantations were also maintained by farmers) were not upheld by participating farmers (CIDA, 1987).

Support for An Integrated Wood Products Industry. CIDA has also proposed a series of harvesting and manufacturing activities which support the premise that a viable wood products industry in St. Lucia is not only desirable but possible. To achieve this goal, project designers plan to rationally link processing facilities to both supply (quality and quantity of available timber) and to demand (existing markets). Most timber extraction is presently from plantations; future timber extraction proposes to include the natural forest (but excluding the forest reserves), using light cable harvesting equipment. Under the CIDA project, existing roads are to be upgraded and maintained, with road design following soil and water conservation requirements. Support will also be provided for a small saw mill to process trees harvested under the forest management programme and to provide lumber for the local, small-scale woodworking industry.

Expansion of Protected Water Catchment Areas. It has been proposed that forest reserves established primarily for water catchment purposes should be increased in size by at least 2000 hectares (Stevenson, 1985) or 3000 hectares (CIDA, 1983). Serious shortfalls in anticipated water supplies have been predicted for as early as 1990 if present population rates coupled with deforestation and/or encroachment of other land uses (especially cultivation) in watersheds are not reversed. Increasing the size of watersheds falling under protected management strategies (by incorporation as part of the forest reserves) is an option which must be seriously examined by appropriate government agencies -- WASA, CPU, and the Department of Forest and Lands.

An ordinance that will strengthen the ability of Government to protect and manage critical land areas, including watersheds, is the proposed "Land Conservation and Improvement Act," currently in draft. The Forest and Lands Department has also made a number of recommendations to further watershed management strategies, including institution of a levy on domestic water bills to raise funds for the purchase and maintenance of private forested watersheds. This is an innovative proposal and could serve as a model for the Eastern Caribbean region.

Alternative or supplemental funds generated by any such levy, fee or tax could be used to:

(1) purchase conservation easements (where the owner agrees not to do certain things, e.g., build a road, cut trees, harvest fuelwood);

(2) purchase development rights;

(3) pay a premium for improved landscape/forest management, e.g., terracing of damaged areas or reforestation;

(4) pay for a long-term lease of the watershed land needing protection;

(5) compensate landowners for downzoning (reclassifying) land as a restricted or no development, protected area (which might allow certain uses but not others, by definition).

Management of Private Forests. The ten-year Forest Management Plan identifies preferred management categories for the nation's forests; it also recognises that some of this land is privately held, and suggests that such land be brought under the influence or control of the Department of Forest and Lands. Direct purchase or exchange of private forest land for non-forested Crown Land are two possibilities to accomplish this objective (see Lausche, 1986); employment of

forestry extension services on private lands is another.

FUELWOOD

As suggested earlier in this chapter, although conclusive documentation is not presently available, it would appear that fuelwood production overall does not represent a high risk threat to forest resources at this time. For example, the absence of a major increase in the price of charcoal in recent years would suggest that there is still an adequate supply of *accessible* fuelwood available to meet demand (i.e., shortages have not driven up the costs).

What is required, however, is a more systematic evaluation of target areas and species biomass growth rates as well as fuelwood extraction rates in order to identify specific areas in St. Lucia where continued harvesting for this purpose poses a serious environmental problem. Obvious areas of concern are the forest reserves as well as primary watersheds where removal of ground cover for any reason endangers key water supplies. Key management strategies should focus on enforcement (a trespassing and policing issue) and monitoring (for example, repeated monitoring of the charcoal market to pinpoint production increases from areas of critical concern). Finally, the planning, monitoring and quantifying of fuelwood harvesting and new community-based fuelwood plantation production are sufficiently important to warrant the eventual creation of a fuelwood forester post and/or a community/social forester post within the Forest and Lands Department.

In the last analysis, the "fuelwood production issue" is as much a development issue as it is an environmental issue. As a by-product of larger land-clearing activities (i.e., for agriculture, tourist amenities or infrastructure), the fuelwood issue is but one component of intensifying land use pressures being felt throughout the country. Furthermore, as a traditional technology essential for more marginalized rural communities, it cannot be ignored as an important economic and social -- as well as environmental -- issue.

PUBLIC SUPPORT FOR FORESTRY PROGRAMMES

St. Lucia's Department of Forest and Lands (formerly the Forestry Division) is a leader in the Eastern Caribbean in the development and promotion of interpretive programmes for natural areas and conservation education materials for children and adults.

The "Rain Forest Walk," along an old access road across the height of land between Edmund Forest and Quilesse in the central forest reserve, has proven to be popular with tourists and local residents and provides a source of revenue for the Department of Forest and Lands (grossing approximately EC$10,600 per year). The Forestry Department maintains the trail and provides tour guides. A second facility, used for field trips by school children, is the Union Nursery which includes a wildlife display and is being expanded to provide a nature trail and other facilities. CIDA has proposed to construct an interpretive centre at the Union Nursery and to generally assist in upgrading printed guide materials used for the "Rain Forest Walk" and at the Union facility.

It should be noted that nature trails and interpretation centres are too often regarded as tourist amenities, thereby diminishing their importance in bringing St. Lucians closer to nature and building public support for natural area programmes.

A monthly newspaper supplement on the environment ("Bush Talk") has also been prepared by Forestry for use in local schools. Two issues of "Jacquot," a children's magazine, have been printed and distributed. The subject matter of the first was "Forest and Energy," and the second focused on "Forest, Water and Pesticides." One issue is planned annually. Development of these and other environmental education materials and their integration in the formal school curriculum will be continued by the Forest Department and expanded under the CIDA-funded forestry project.

CONCLUSION

The forests of St. Lucia perform an essential function in regulating stream flow, protecting water supplies, preventing erosion and landslides, and in maintaining a well distributed rainfall for the production of agricultural crops. The remaining natural forest owes its survival in part to the ruggedness of the terrain, lack of access and Government protection which has limited the degree of encroachment in the past. Nevertheless, given the country's expanding population base, the increased demand for agricultural land, and better roads to forest areas, the constraints of the past may not afford adequate protection in the future.

In St. Lucia, the value of timber and wood products is an extremely small proportion of the overall economic value of the forest resource base. To assess the overall importance of forests to the country, equal consideration must be given to the resource's energy value (for fuelwood), its community value (for social forestry), its wildlife value (as habitat), its water catchment and storage value (to promote soil and water conservation), its recreational and educational value (for residents and tourists alike), and the quality of landscape value afforded by access to undisturbed vegetation and green space. As a nation, St. Lucia has taken important steps in recognising the multi-dimensional value of its forests -- yet the task ahead of the country in conserving and promoting this important resource is still formidable.

2.3 WILDLIFE

St. Lucia is part of the Lesser Antillean biogeographical province which extends from the Virgin Islands to Aruba. The diverse physical and climatic conditions associated with the island's rugged terrain and high mountains support most of the major vegetational associations characteristic of the Lesser Antilles (see Figure 2.3(1)) -- it is possible in a single day's journey to travel from dry, semi-arid scrub habitat to cool, damp, semi-temperate forest.

During the last decade, much of St. Lucia's vegetation has undergone significant change, primarily due to impacts associated with agricultural development. To a lesser extent urban development and sporadic hurricanes have resulted in habitat change. These disturbances, in conjunction with largely undocumented but professionally evaluated hunting and specimen collecting, have had considerable impact on many wildlife species. Several exotic pest species (for example, the mongoose) are also responsible for significant levels of predation on certain target species.

The combined result of these impacts is that several endemic species are now considered threatened or endangered. Some of these endemic species and sub-species, being uniquely St. Lucian, are of scientific interest as well as a source of national pride. Prominent among these is the St. Lucia Parrot which, as the state bird, has become a national symbol.

Among island biogeographers, there is a theory that in going from a larger to smaller island, a division of the area by ten divides the fauna by two, or vice versa, while a size increase of a factor of ten results in only twice the number of species. Figure 2.3(2) shows that this general hypothesis was re-confirmed by the recent Corke (1987b) survey. When Corke's St. Lucia data is added, *ex post facto*, to the 20 year old data plot for seven other Caribbean islands, St. Lucia falls in its proper place in the numerical scheme developed 22 years ago by MacArthur and Wilson (1967) in their *Theory of Island Biogeography*.

2.3.1 Overview of the Resource Base

The number of avian species found on St. Lucia represents a diverse group of wildlife. Of these species, four are endemic:

- St. Lucia Parrot, *Amazona versicolor* (local name: Jako or Jacquot)
- St. Lucia Black Finch, *Melanospiza richardsoni* (local name: Moisson pied blanc)
- Semper's Warbler, *Leucopeza semperi* (local name: Pied-blanc)
- St. Lucia Oriole, *Icterus laudabilis* (local name: Carouge).

The St. Lucia Parrot and Semper's Warbler are endangered, and it is possible that the latter may be extinct as it was last observed in the mid-1970's. In 1987 an expedition from the University of East Anglia (United Kingdom) spent ten days searching and mist netting in the area where the Warbler was last recorded. The team found no signs of the species, and its status remains in doubt (Univ. of East Anglia, 1987).

The St. Lucia Wren (*Troglodytes aedon mesoleucus*) is an endemic sub-species of the very widely distributed Common Wren. The St. Lucian sub-species is considered endangered. The white-breasted Thrasher (*Ramphocinclus brachyurus*) is endemic to St. Lucia and Martinique, although the Martinique population, which is critically endangered, is by far the smallest of the two. In St. Lucia, the population is restricted to the northeast of the island (Univ. of East Anglia, 1987).

The historic literature and field observations by early explorers and contemporary naturalists attest to a period when countless seabirds, ground nesting birds and other avian species were found in abundant numbers. More recently, behavioural modifications and main island population decreases have become evident in observations of roosting and nesting on offshore islands and cays. Some species continue to feed on the mainland but retreat each night to more isolated, uninhabited coastal islets (ECNAMP and St. Lucia

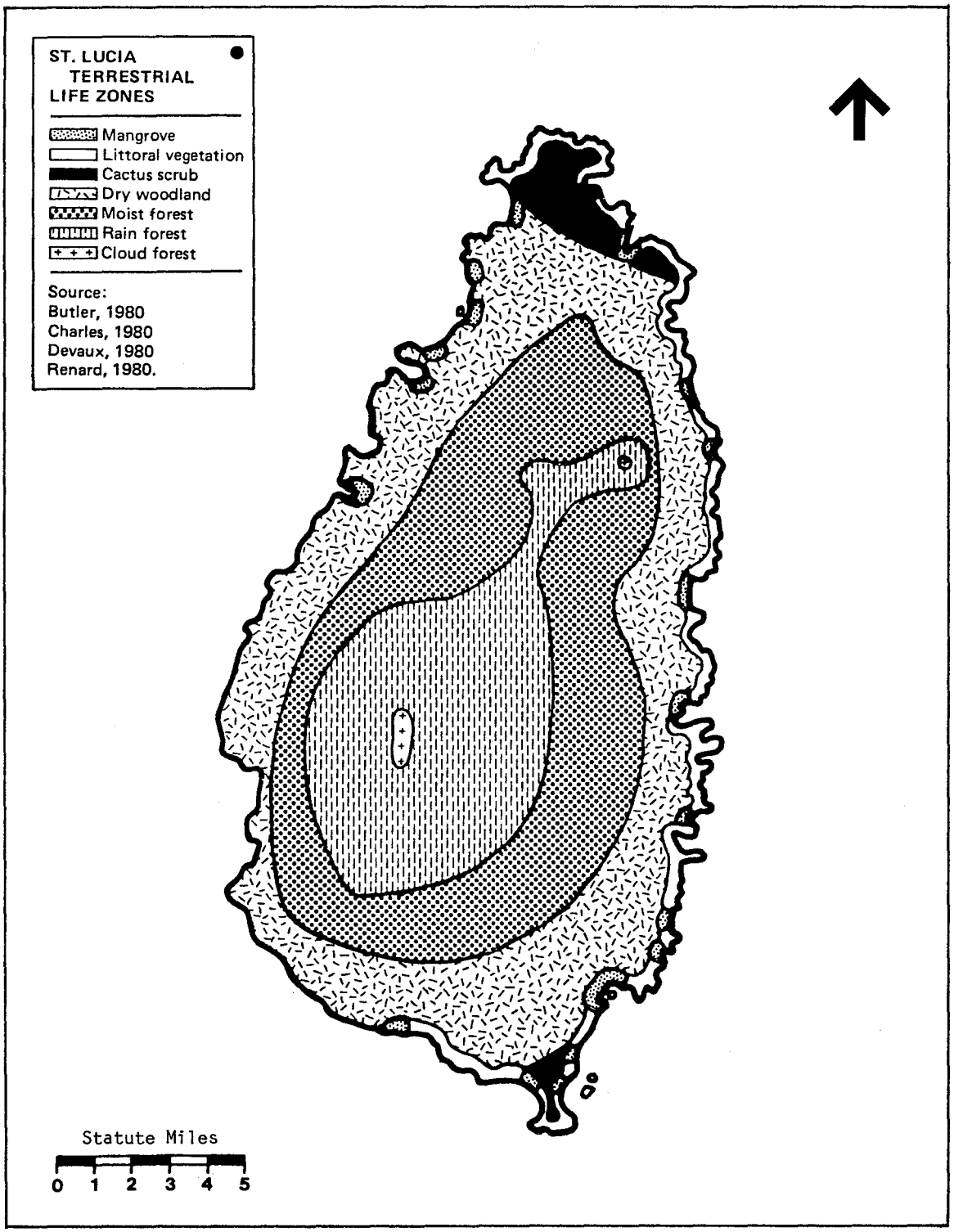


Figure 2.3(1). St. Lucia terrestrial life zones (source: ECNAMP, 1980).
N.B. The reader's attention is drawn to the fact that St. Lucia does not have any cloud forest as indicated above; what is shown as cloud forest should be elfin woodland.

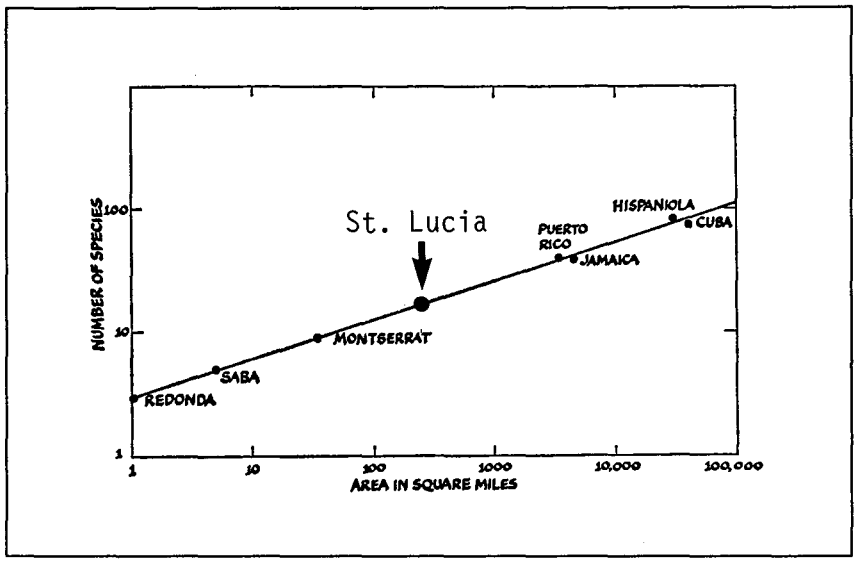


Figure 2.3(2). The area-species curve of the West Indies herpeto-fauna (amphibians plus reptiles), modified by CEP staff from MacArthur and Wilson (1967) by the addition of St. Lucia with data from Corke, 1987b, who reports 16 native species of herpeto-fauna/238 square miles.

National Trust, 1985). Table 2.3(1a) provides an overview of the current status of selected St. Lucian bird species.

St. Lucia has a limited diversity of mammalian and reptilian species. The five endemic reptile species are:

- Tree Lizard, *Anolis luciae*
- Pygmy Gecko, *Sphaerodactylus microlepis*
- Ground Lizard, *Cnemidophorus vanzoi* (Maria Islands only)
- Grass Snake, *Liophis ornatus* (Maria Islands only)
- Fer-de-Lance Snake, *Bothrops caribbaeus*.

Additionally, Corke (1987b) notes that the sub-species of Boa Constrictor found on the island (*Boa constrictor orophius*) is endemic to St. Lucia.

Predation by humans, feral animals and the introduced mongoose is thought to have contributed to the decline of many of St. Lucia's reptiles (Faaborg and Arendt, 1985). For example, the multi-coloured ground lizard (*Cnemidophorus vanzoi*) is considered endangered; and the Couresse grass snake (*Liophis ornatus*), known locally as "kouwes," was once found on the mainland of St. Lucia but now occurs only on the offshore Maria Islands (specifically, Maria Major). It is estimated that this endemic population numbers no more than 100 individuals.

Several regionally endemic reptiles also occur on St. Lucia (ICBP, 1988; Corke, 1987; Faaborg and Arendt, 1985):

- *Sphaerodactylus vincenti* (pygmy gecko species now considered rare on St. Lucia)

- *Anolis wattsi* and *Anolis extremus* (tree lizards introduced from Antigua and Barbados, respectively)

- *Gymnopthalmus pleei* (small, bronze/copper, diurnal lizards which are common on St. Lucia)

- *Leptotyphlops bilineata* (worm snake, exact status on St. Lucia uncertain).

Table 2.3(1a). Status of selected birds in St. Lucia.

Common Name	Scientific Name	Island Endemic	Regional Endemic	STATUS END.	NIT.	COM.
Bridled Tern	Sterna anaethetus				X	
Brown Trembler	Cinclocerthia ruficauda		X		X	
Caribbean Martin	Progne subis				X	
Forest Thrush	Cichlherminia lherminieri		X	X		
Great Blue Heron	Ardea herodias					X
Great Egret	Egretta alba				X	
Ground Dove	Columbina passerina					X
Lesser Antillean Bullfinch	Loxigilla noctis		X			X
Lesser Antillean Flycatcher	Myiarchus oberi		X		X	
Lesser Antillean Pewee	Contopus virens		X			X
Lesser Antillean Swift	Chaetura martinica		X		X	
Little Blue Heron	Florida caerulea				X	
Magnificent Frigatebird	Fregata magnificens				X	
Noddy Tern	Anous stolidus				X	
Purple-throated Carib	Eulampis jugularis		X		X	
Red-billed Tropicbird	Phaethon aethereus				X	
Red-necked Pigeon	Colmuba squamosa				X	
Roseate Tern	Sterna dougallii				X	
Rufous Night Jar	Caprimulgus rufus		X	X		
Rufous-throated Solitaire	Myadestes genibarbis				X	
Scaly-breasted Thrasher	Margarops fuscus		X		X	
Semper's Warbler	Leucopeza semperi	X		X		
Sooty Tern	Sterna fuscata					X
St. Lucia Black Finch	Melanospiza richardsoni	X			X	
St. Lucia Oriole	Icterus laudabilis	X			X	
St. Lucia Parrot	Amazona versicolor	X		X		
St. Lucia Wren	Troglodytes aedon mesoleucus	X		X		
Tundra Peregrine Falcon	Falco peregrinus tundrius			X		
White-breasted Thrasher	Ramphocinclus brachyurus		X	X		
White-tailed Tropicbird	Phaethon lepturus				X	
Zenaida Dove	Zenaida aurita				X	

Source: ICBP, 1988; Faaborg and Arendt, 1985; Halewyn and Norton, 1984; GOSL, Dept. of Forest and Lands.

KEY: END. = Endangered; NIT. = No Immediate Threat; COM. = Common.

In addition, some of St. Lucia's beaches are used by endangered marine turtles -- the Hawksbill (*Eretmochelys imbricata*), Green (*Chelonia mydas*), Leatherback (*Dermochelys coriacea*), and the Loggerhead (*Caretta caretta*) (see also Section 2.5.4).

The only endemic mammal, the St. Lucia Muskrat (*Megalomys luciae*), is thought to be

extinct (ICBP, 1988). Three regionally endemic bat species occur in St. Lucia, but information is not available about their status (ICBP, 1988): *Monophyllus plethodon* (fruit and nector-eating bat), *Ardops nichollsi*, and *Brachyphylla cavernum* (cave bat).

Two of the four amphibian species found on St. Lucia are common (*B. marinus* and *Eleutherodactylus johnstonei*); a tree frog (*Hyla rubra*) is present although full information on its status is not available. It appears to be restricted to moister, higher areas.

The large "mountain chicken" or "crapaud" frog (*Leptodactylus fallax*) is reportedly extinct (Faaborg and Arendt, 1985). Its existence on the island has been questioned by Corke (1987b). However, Corke's survey was very brief and concentrated on reptiles. His supposition that *L. fallax* was never found here was based mainly on failure to find museum type specimens from St. Lucia. Table 2.3(1b) provides an overview of the status of selected amphibians and reptiles in St. Lucia.

One threatened invertebrate, a subspecies of the Hercules Beetle (*Dynastes hercules reidi*), occurs in St. Lucia. It is restricted to montane areas and is threatened primarily by habitat destruction and indiscriminate use of pesticides (ICBP, 1988). It is likely there are more endangered invertebrates, but there has been no systematic survey of the vast majority of groups (Hunt and Mitchell, 1979).

Species known to be hunted or trapped in St. Lucia include the opossum, iguana, agouti and the red-necked pigeon (ECNAMP, 1980), although hunting has been reduced since enactment of wildlife protection legislation in 1980. The numbers of opossum (*Didelphis marsupialis insularis*) have recently been increasing. St. Lucia's largest lizard is the iguana (*Iguana iguana*), measuring about three-four feet in length. The mongoose is probably its worst enemy. Iguanas still survive primarily in the Louvet and Grand Anse area (Corke, 1987b). The agouti (*Dasyprocta aguti*), a large rodent resembling a rabbit and popular as a culinary delicacy, is becoming rarer and is found primarily in isolated spots along the northeast coast and lower fringes of the central forest reserve (Devaux, 1975).

2.3.2 Institutional Responsibilities and Legislative Oversight

Responsibility for the conservation and sustainable management of St. Lucia's terrestrial fauna and flora rests with the Forest and Lands Department of the Ministry of Agriculture. Recognising the dramatic decline in a number of species, in particular the St. Lucia Parrot, this Department in 1977 commenced a comprehensive wildlife conservation programme with several components.

(1) **Wildlife Legislation.** Wildlife species, principally birds, have been protected by legislation in St. Lucia since 1885 when passage of a Wild Bird Ordinance established an open and closed migratory bird hunting season and provided protection for several species recognised at that time as threatened.

This Ordinance, however, was poorly enforced, and hunting of species such as the red-necked pigeon (*Columba squamosa*) was prevalent throughout the year. Indiscriminate hunting of legislatively protected species was reported during the 1960's, but it was not until 1975 that a wildlife offence was first recorded.

The 1980 Wildlife Protection Act up-dated and expanded the almost century-old Wild Bird Protection Ordinance. The new act increased penalties for offences, included provisions for several species of mammals and reptiles, and gave authority to the Minister (who oversees the Forest Department) to alter or amend the various schedules included in the law.

Six species of mammals and reptiles and 79 species of birds are given extensive protection, while 37 species of birds are partially protected under the 1980 legislation. However, the Fer de Lance viper, the mongoose, and several pest mice and rat species may be hunted or trapped year round.

The legislation requires the purchase of hunting licenses and specifies open seasons for certain wildlife. In addition, wildlife import or export requires a licence as does the keeping of wildlife in captivity. Fines for conviction of offences under the act are set as high as EC$ 5,000 or 12 months in prison.

Table 2.3(1b). Status of selected amphibians and reptiles in St. Lucia.

Common Name	Scientific Name	Island Endemic	Regional Endemic	Status in Country EXT.	COM.	RAR.	UNC.	ERR.
Toad	Bufo marinus				X			
Piping Frog	Eleutherodactylus johnstonei				X			
Frog	Hyla rubra						X	
Mountain Chicken	Leptodactylus fallax							X
Pygmy Gecko	Sphaerodactylus vincenti		X				X	
St. Lucia Pygmy Gecko	Sphaerodactylus microlepis	X			X			
Tree Gecko	Thecadactylus rapicanda				X			
House Gecko	Hemidactylus mabouya				X			
Rock Gecko	Hemidactylus palaichthus						X	
Iguana	Iguana iguana					X		
St. Lucia Tree Lizard	Anolis luciae	X			X			
Slipperyback Skink	Mabuya mabouia			X				
Microteiid Lizard	Gymnopthalmus pleei		X		X			
Maria Island Ground Lizard	Cnemidophorus vanzoi	X				X		
Tree Lizard	Anolis extremus		X		X			
Tree Lizard	Anolis wattsi		X		X			
Worm Snake	Leptotyphlops bilineata		X				X	
Boa Constrictor	Boa constrictor				X			
Fer-de-lance	Bothrops caribbaeus	X			X			
Grass Snake	Liophis ornatus	X				X		
Snake	Clelia clelia			X				

Source: ICBP, 1988; Faaborg and Arendt, 1985 (as updated by Corke, 1987 and Corke, pers. comm., 1989). Scientific names follow Corke, 1987.

KEY: EXT. = Extinct; COM. = Common; RAR. = Rare; UNC. = Uncertain Status; ERR. = Recorded in Error - probably never present in the wild.

Declining wildlife populations and the ravages of hurricane Allen in 1980 resulted in the Minister closing the open season on specific species for a period of three years. At the same time, the Forest and Lands Department concentrated on establishing reserves and initiated an intensive environmental education programme. Forestry actions for violation of the provisions of the Wildlife Protection legislation have been infrequent, with most of these involving violations for illegal collection and possession of reptiles (Butler, 1984).

In December 1982 St. Lucia became a party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), becoming the 83rd nation (and one of the few CARICOM countries) to sign this Convention. The primary objective of CITES is to regulate international trade in endangered or threatened species of wild animals or plants.

Since ratifying the Convention, St. Lucia has assumed an active role in its implementation. A small working committee was formed with representatives from appropriate Government

agencies to establish additional permitting procedures. In addition, the Forest Department (designated as the Convention's Management Authority) has produced a number of publicity booklets as well as two exhibits which are on permanent display at Vigie and Hewanorra International Airports.

(2) **Establishment of Reserves.** In 1980, the Forest Department set aside approximately 1500 hectares (Table 2.2(1)) of rain forest in the forest reserve as a Parrot Sanctuary (see Figure 2.3(3). This protected area includes several mountain peaks and several major upper watersheds and contains virtually all known parrot nesting areas and critical habitat for other important fauna and flora, including the indigenous St. Lucia Black Finch and the St. Lucia Oriole. Artificial nesting boxes have been erected to increase breeding sites for the parrot, and planting of trees used by the birds for nests has been attempted on a limited basis.

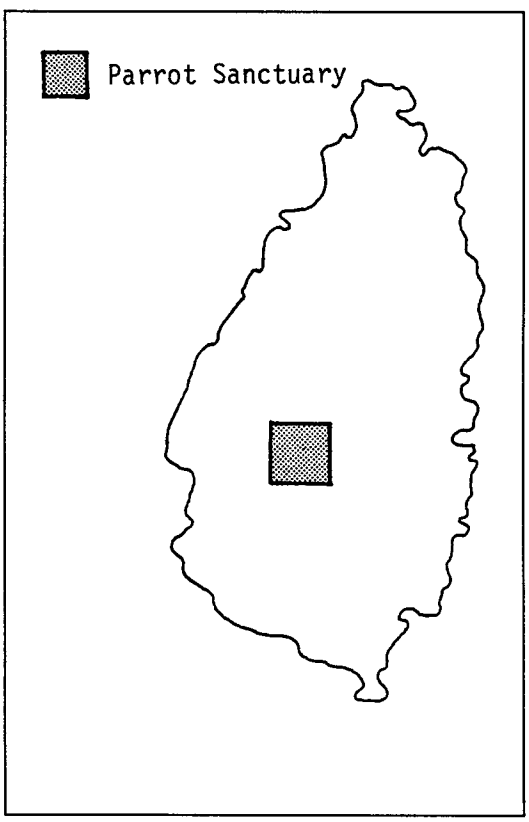


Figure 2.3(3). St. Lucia parrot sanctuary.

Funding for the Parrot Sanctuary has come from several GOSL sources as well as from the World Wildlife Fund-US (WWF-US). Additionally, a Conservation Fund has been established by the Forest Department, and monies raised from guided tours of the rain forest and other related activities is paid into the Fund to support the Sanctuary.

In 1982 the two small islets comprising the Maria Islands off the southeast coast of St. Lucia were declared a Nature Reserve pursuant to the authority of the Wildlife Protection Act. This wildlife reserve (encompassing approximately 12 hectares) was created primarily to protect the indigenous Maria Island grass snake (population approximately 100 individuals) and the Maria Island ground lizard (population approximately 1,000). Protection is also afforded the Reserve's numerous seabird colonies and marine habitats around the islands. The development of this protected area was funded by WWF-US and executed by ECNAMP in co-operation with the St. Lucia National Trust, under whose jurisdiction the Reserve has been vested. A Maria Islands Nature Centre was erected on Anse de Sables Beach opposite the Reserve.

(3) **Environmental Education.** The Forest and Lands Department of the Ministry of Agriculture has taken the lead role in the country in developing and promoting conservation education programmes. The Department regularly sponsors film shows and slide talks, publishes conservation articles in local newspapers, and produces radio and television programmes. Other visual aids (such as billboards, posters, t-shirts, bumper stickers) have been used in drawing public attention to environmental issues. (See also Section 2.2.5.)

The Forest Department has developed an educational facility at the Union Nursery. This facility includes a self-guided nature trail through plantations and dry secondary woodland, a collection of wildlife serving as a mini-zoo, and a medicinal garden. It has proved popular among children, and regular field trips are arranged by schools in the north of the island.

A children's booklet on St. Lucian wildlife has been distributed to schools, and a monthly environmental newspaper entitled "Bush Talk" -- originally conceived as a teaching aid for school children -- now reaches a larger community audience with its reproduction in the local press. In excess of EC$ 100,000 is spent annually in execution of conservation education activities by the Forest Department. Funds are provided by GOSL, the World Wildlife Fund-US, and private sector sources.

(4) **Research.** Wildlife research programmes which have been carried out by Forestry include:

(i) Bird Banding Programme - To census wild birds in order to obtain a rough index of species composition, species diversity, bird densities and population fluctuations.

(ii) Captive Breeding Programme for Endangered Endemic Species - Carried out in collaboration with external zoological institutions for the purpose of reintroducing or supplementing existing wild stocks and to improve species survival in the wild; St. Lucia is currently participating in two captive breeding programmes: (1) for the St. Lucia Parrot at the Jersey Zoo in the United Kingdom (nine St. Lucia Parrots are held by the Jersey Wildlife Preservation Trust and a single chick was successfully hatched in 1985); and (2) for the Maria Island ground lizard at the San Diego Zoo in the United States.

A recent survey and collection of the island's flora was undertaken by Forestry workers. An herbarium has been established, and information on the status and ethnobotanical uses of the island's flora collected. Additional research has been carried out by the Naturalists Society, including a WWF-US supported islandwide survey of reptiles and amphibians (Corke, 1987b). As part of its ongoing programme for the conservation and development of the Maria Islands Nature Reserve, ECNAMP has supported avifauna, vegetation, and reptile/amphibian studies of the Reserve (also funded by WWF-US).

2.3.3 Problems and Issues

Presently, the greatest threat to wildlife in St. Lucia is habitat alteration. Rain forest, critical habitat for some of St. Lucia's birds including the endemic Parrot, is being converted to other land uses. It has been estimated by the Department of Forest and Lands that the St. Lucian rain forest is being deforested at the rate of two per cent per year (see Section 2.2.1), with most of this land being altered for agriculture.

The construction of agricultural feeder roads has further exacerbated the problem of habitat destruction, opening up previously inaccessible areas and rendering them vulnerable to human disturbance. Large scale development projects such as the proposed construction of a major dam on the Roseau River could also pose a new threat to the nation's wildlife if protective measures are not taken to mitigate potential impacts.

Dry scrub woodlands found in the coastal belt are used by local populations for fuelwood and charcoal. The last vestiges of habitat for the endemic St. Lucia Wren and the near extinct White-breasted Thrasher are found in this habitat.

Other diminishing vegetative communities on St. Lucia include the mangrove forests. Of the dozen mangrove swamps existing at the turn of this century, only two or three remain relatively intact. Others have undergone significant change: Choc is now a rubbish dump, Reduit a marina, and Marigot a hotel site, although in the case of Marigot the mangrove is still largely preserved. In the past, migratory species of waders and wildfowl, such as the Fulvous Whistling Duck, were found in these habitats. Once a familiar species in the Gros Islet mangroves, it is now scarce. The bird populations in mangrove habitats are displayed in Table 2.3(2).

Table 2.3(2). Distribution of bird species in selected mangrove habitats during April 2-6, 1984.

Species	Choc Bay	La Sorciere	Fond d'Or	Micoud	Savannes Bay	Cas en Bas	Esperance	Louvet	Dennery	Man Koté	Bois d'Orange	Marigot Bay	Marquis Bay	Praslin
Fregata magnificens														
Butorides striatus														
Egretta caerulea														
Ardeola ibis														
Nyctanassa violacea														
Ardea herodias														
Casmerodius albus														
Buteo platypterus														
Gallinula chloropus														
Actitis macularia														
Zenaida aurita														
Columbina passerina														
Coccyzus minor														
Eulampis jugularis														
Eulampis holocericeus														
Orthorhyncus cristatus														
Megaceryle alcyon														
Tyrannus dominicensis														
Contopus latirostris														
Elainia martinica														
Progne dominicensis														
Mimus gilvus														
Margarops fuscus														
Margarops fuscatus														
Cichlerminia lherminieri														
Vireo altiloquus														
Dendroica petechia														
Dendroica adelaidae														
Seirus noveboracensis														
Dendroica ruticilla														
Coereba flaveola														
Quiscalus lugubris														
Icterus laudabilis														
Loxigilla noctis														
Melanospiza richardsoni														
Tiaris bicolor														
Saltator albicollis														
Length of Observation Period	20 minutes						40 minutes				60 minutes			

Key:Number of individuals Symbol

1 - 3
4 - 6
7 - 9
> 9

Source: Portecop and Benito-Espinal, 1985.

N.B. Sampling periods were replicated in larger areas, but it is not clear from the text whether the numbers of individuals reported are totals or averages.

Threats to the island's freshwater wetlands at Bois d'Orange in the north include accelerating sedimentation resulting from improper drainage and residential construction on adjacent hillsides. Boriel's Swamp near Vieux Fort is filled with rubbish, and the water line has undergone dramatic alteration resulting in frequent periods of dry conditions.

Exotic species introductions and arrivals have also caused a problem for some St. Lucian fauna. For example, the mongoose, *Herpestes* sp., first introduced to the island in 1884 to control the venomous Fer-de-lance, has caused untold damage to populations of reptiles and ground nesting birds. The Glossy Cowbird (*Molothrus bonariensis*), a relatively recent arrival to the island, is a brood parasite laying its eggs in the nests of other species. There is some evidence that its population is expanding as forest lands give way to agricultural development; it could have a detrimental effect on the population of some endemic species such as the St. Lucia Oriole.

As for the impact of pesticides on wildlife, no detailed studies have been undertaken in St. Lucia. However, a parallel investigation in Dominica, where both the environment and species at risk are similar, there did not appear to be any immediate evidence of serious impacts or a crisis in the making. Aquatic species are more threatened than avian species by the occasional excessive application or accidental spill of pesticides. Effects of build-up and longer term impacts are unknown (Rainey, *et al.*, 1987).

Finally, natural disasters have taken their toll on wildlife and wildlife habitat. Hurricane Allen in 1980 was particularly destructive, damaging an estimated 80 percent of the island's forest and killing an estimated 40 percent of the trees (Whitman, 1980). Certainly, recovery will be a slow process, extending over a period of at least several decades.

All of these pressures have led authorities to conclude that avian migratory species in St. Lucia are becoming increasingly scarce. A species endemic to the country, Semper's Warbler, has become so elusive that its survival is in doubt, while the population of the St. Lucia Parrot, the national bird, had declined by 1977 to only 100 individuals, making it at that time the world's thirteenth rarest bird according to World Wildlife Fund estimates. Table 2.3(3) summarises the status of threatened wildlife in St. Lucia.

The Forest Department, in collaboration with regional and extra-regional institutions, has initiated research and conservation programmes for the most critical of St. Lucia's endemic wildlife. Key protection strategies for endemic species are provided in Table 2.3(4). As a result of such initiatives, considerable progress in the conservation of St. Lucia's wild flora and fauna was made during the decade 1977-87. The island recorded population expansions of several species of fauna including the opossum. Of particular importance has been the reversal of the decline of the St. Lucia Parrot, which was declared the national bird in 1979.

This species is, and as far as can be ascertained always has been, restricted to the island of St. Lucia, from which it gains its common name. It was once widespread in most parts of the island, but by the 1950's the St. Lucia Parrot was reported to be rare with a severely declining population. Its decline was due largely to the illegal destruction of habitat and to the shooting of individuals for food or capture for sale as zoological specimens. By 1977, this species was on the brink of extinction; today, its population is increasing and its range expanding (see Table 2.3(5)).

2.3.4 Directions for the Future and Policy Recommendations

St. Lucia has one of the most progressive forestry and wildlife management programmes in the Eastern Caribbean. Its conservation education and outreach activities serve as models for other islands in the Lesser Antilles seeking to initiate similar programmes. Its sustained employment of research and education strategies has effectively reversed the decline of the near-extinct St. Lucia Parrot.

Nevertheless, threats to St. Lucian wildlife continue and include intrusions into forest

Table. 2.3(3). Extinct, endangered, and threatened wildlife of St. Lucia.

COMMON NAME	SCIENTIFIC NAME	ENDEMIC	EXT.	END.	THR.
AMPHIBIANS					
Mountain Chicken	*Leptodactylus fallax*		X		
BIRDS					
St. Lucia Parrot	*Amazona versicolor*	X		X	
Semper's Warbler	*Leucopeza semperi*	X	X (possibly)		
Forest Thrush	*Cichlherminia lherminieri*			X	
White-Breasted Thrasher	*Ramphocinclus brachyurus*			X	
St. Lucia Wren	*Troglodytes aedon mesoleucus*	X		X	
MAMMALS					
St. Lucia Muskrat	*Megalomys luciae*	X	X		
REPTILES					
Ground Lizard	*Cnemidophorus vanzoi*	X		X	
Couresse Snake	*Liophis ornatus*	X		X	
Pygmy Gecko	*Sphaerodactylus vincenti*				?
Hawksbill Turtle	*Eretmochelys imbricate*			X	
Green Turtle	*Chelonia mydas*			X	
Leatherback Turtle	*Dermochelys coriacea*		X		
Loggerhead	*Caretta caretta*			X	

Sources: ICBP, 1988; Faaborg and Arendt, 1985; Corke, 1987b; ECNAMP, 1980; GOSL, Department of Forest and Lands.

KEY: EXT. = Extinct; END. = Endangered; THR. = Threatened.

lands by squatters, illegal hunting, and alteration of other critical habitats (for example, mangroves). Many of these impacts are associated with accelerating pressures from population expansion into previously undisturbed areas. Constraints on the effectiveness of the Forest Department include a shortage of personnel and the need for more staff training for implementation of enforcement, monitoring, research, and education programmes.

Several actions that would improve present wildlife management are discussed below under the headings of research, wildlife data management, public education, staff support and training, protected areas, and legislation.

RESEARCH (see ICBP, 1988; Corke, 1987b; Faaborg and Arendt, 1985)

(1) Maintain ongoing research for the St. Lucia Parrot, including management of the Parrot Sanctuary and continuation of captive breeding programmes. Further studies of the reproductive ecology of the St. Lucia Parrot

Table 2.3(4). Key protection strategies for selected species of St. Lucian wildlife.

COMMON NAME	SCIENTIFIC NAME	POPULATION ESTIMATES	LEGAL PROTECTION	CONSERVATION REQUIREMENTS
Couresse Snake	Liophis ornatus	+/-100	Absolute	Strict habitat protection and prohibition of collection; ensure habitat remains rodent-free (species restricted to Maria Islands)
Ground Lizard	Cnemidophorus vanzoi	+/-1,000	Absolute	Strict habitat protection; ensure habitat remains rodent-free and glass bottles not left on island (restricted to Maria Islands)
St. Lucia Parrot	Amazona versicolor	+/-250	Absolute	Habitat protection; ensure adequate feeding/nesting areas; strict prohibition on hunting, capture, and export
White-breasted Thrasher	Ramphocinclus brachyurus	+/-120	Absolute	Protection of scrub habitat along dry river valleys from Petit Anse in north to Louvet in the south; declaration of Ravine La Chaloupe as a Nature Reserve
Semper's Warbler	Leucopeza semperi	Possibly extinct	Absolute	Almost nothing is known about this species; last seen in mid-1970's; 1987 survey did not find species in last recorded locations
St. Lucian (Rufous) Night Jar	Caprimulgus rufus	Restricted to specific habitat; nowhere common	Absolute	Requires dry scrub woodland habitat in coastal areas which are under threat of destruction from charcoal production; predation by mongoose and rats a potential problem
St. Lucia Black Finch	Melanospiza richardsoni	Widely distributed but nowhere common	Absolute	Habitat management to ensure the presence of dense vegetation and thick ground cover where the species occurs, especially within the exotic forest plantations at Edmund Forest and La Sorciere
St. Lucia Wren	Troglodytes aedon mesoleucus	Restricted to specific habitat; nowhere common	Absolute	Restricted to dry coastal scrub along the northeast coast between Louvet and Marquis; under threat from habitat clearance for charcoal and possible predation by rats, mongoose, snakes
St. Lucia Oriole	Icterus laudabilis	Widespread and locally common	Absolute	Potential threats include brood parasitism by the Glossy Cowbird and possibly from aerial spraying

Source: GOSL, Department of Forest and Lands; Corke, 1987b; University of East Anglia, 1987.

Table 2.3(5). The changing population of the St. Lucia Parrot (*Amazona Versicolor*).

YEAR	SIGHTINGS/MAN HOUR	POPULATION ESTIMATE
1977	0.65	100
1980	1.05	100 - 150
1982	3.65	150+
1986	4.08	200 - 250

Source: GOSL, Department of Forest and Lands.

are needed for future propagation and husbandry.

(2) Surveys to determine the numbers, location and habitat status of Semper's Warbler. Impacts such as deforestation and predation by the introduced mongoose should be incorporated as part of this initiative.

(3) Ecological studies of the endemic St. Lucia Oriole and the St. Lucia Black Finch. Although these species are not believed to be under immediate threat, basic information on their eco-ogy is important in predicting the effects of future land-use changes.

(4) Establishment of a research and protection programme for the White-breasted Thrasher. It is endangered on St. Lucia, and since only one other population exists, confined to a single peninsula on Martinique, co-operation with French authorities on that island is important.

(5) Surveys to determine the status of the St. Lucia Forest Thrush. Factors responsible for its scarcity on St. Lucia need to be identified, possibly by comparative study of its ecology on St. Lucia and on the other three islands where it occurs and is more common. Managing the St. Lucian population is necessary to ensure the species does not become more vulnerable in the future.

(6) Survey of the seabird population of St. Lucia as very little information is currently available.

(7) Survey of invertebrates to produce a species list.

(8) Investigation of reports of the Red-footed Tortoise, *Geochelone carbonaria*, in the wild (occurs in captivity on St. Lucia and may also occur wild on the island; Corke, 1987b), and detailed surveys of the range of selected species of reptiles such as the the Worm Snake, *Leptotyphlops bilineata* (although reportedly not uncommon, its exact status is uncertain).

(9) Assessment of the feasibility for using the Pigeon Island National Park as an appropriate site for the transfer of selected species of reptiles (for example, the iguana and the red-footed tortoise), for breeding purposes and as a feature of interest for Park visitors.

DATA BASE FOR WILDLIFE

Up-grading of the computerized information storage and retrieval capacity of the Department of Forest and Lands is essential if St. Lucia is to keep pace with the resource management data systems being developed both in the region and internationally. A data base on St. Lucian wildlife would provide up-to-date information on species status and distribu-

tion, habitat requirements, monitoring regimes, and development impacts.

This information would be useful not only for Forestry personnel but also for GOSL planners, donor agency representatives and private sector developers whose activities might alter or disturb the habitat of endangered wildlife. Such data, for example, is needed for the production of Environmental Impact Assessments (at present, only required by the Development Control Authority for selected large development projects undertaken by the private sector). Furthermore, a data entry system for wildlife information at the Forest Department would create a centralised location for the deposit of research reports and other information generated by visiting scientists and investigators. Duplicate files should be maintained by the St. Lucia National Trust.

PUBLIC EDUCATION

Adequate funding and personnel must be made available to permit the Forest Department to continue and expand its conservation education programmes which currently target school children and the general public. Funding will be provided by CIDA under its Forest Management and Conservation Project in St. Lucia to assist in further development of education materials, but GOSL must commit a suitable counterpart, fluent in patois, to work with CIDA advisors and to continue programme activities when external funding is no longer available. Further interaction with the formal education system needs to be explored to improve service/materials delivery to school children.

STAFF SUPPORT AND TRAINING

In a recent study, OAS (1986a) surveyed seven GOSL units engaged in resource management (including the Forestry Division, as it was then structured) and found that in the agencies evaluated, less than 20 percent of the manpower available is at the technical level -- the level capable of undertaking complex tasks of planning or research. Many units, including Forestry, have partially alleviated the problem by filling posts requiring specialised training or expertise with persons provided through foreign assistance programmes. This is not, of course, a satisfactory solution over the long-term. Furthermore, the fact that forestry officers working with endangered species programmes are not assigned to these projects on a full-time basis diminishes the overall effectiveness of wildlife programme staff and reduces continuity of effort and technique.

PROTECTED AREAS (see Figure 2.3(4))

Establishment of additional nature reserves (as enumerated below) should be linked to research activities which first determine species population size and range and the extent of habitat protection required. It is also noted that several of the sites recommended have also been designated as marine reserves (see Section 2.5), and mechanisms for coordinating the priorities and programmes of the Fisheries Management Unit, the Department of Forest and Lands, and the National Trust need to be identified (see also Section 2.6).

(1) For seabird protection, all **offshore rocks and islets** (with the possible exception of Rat Island because of its location near to main island hotels) should be left in a natural state and vested in the National Trust for preservation as nature reserves or bird sanctuaries (see Table 2.3(6)).

(2) Protective status should be given to the **Bois d'Orange fresh water wetlands** (south of Gros Islet), where excessive sedimentation from encroaching urban/industrial development on the margins places the site at extreme risk and has almost eliminated its use as a habitat for migrating bird species. The Forest and Lands Department has recommended the Bois d'Orange area (the only significant freshwater swamp in St. Lucia) be purchased and developed as an educational nature reserve with provision for a small interpretive centre, a raised walk and a series of blinds. Drainage ditches, dug to drain the swamp to provide land for housing, could be blocked to ensure the entire area is regularly

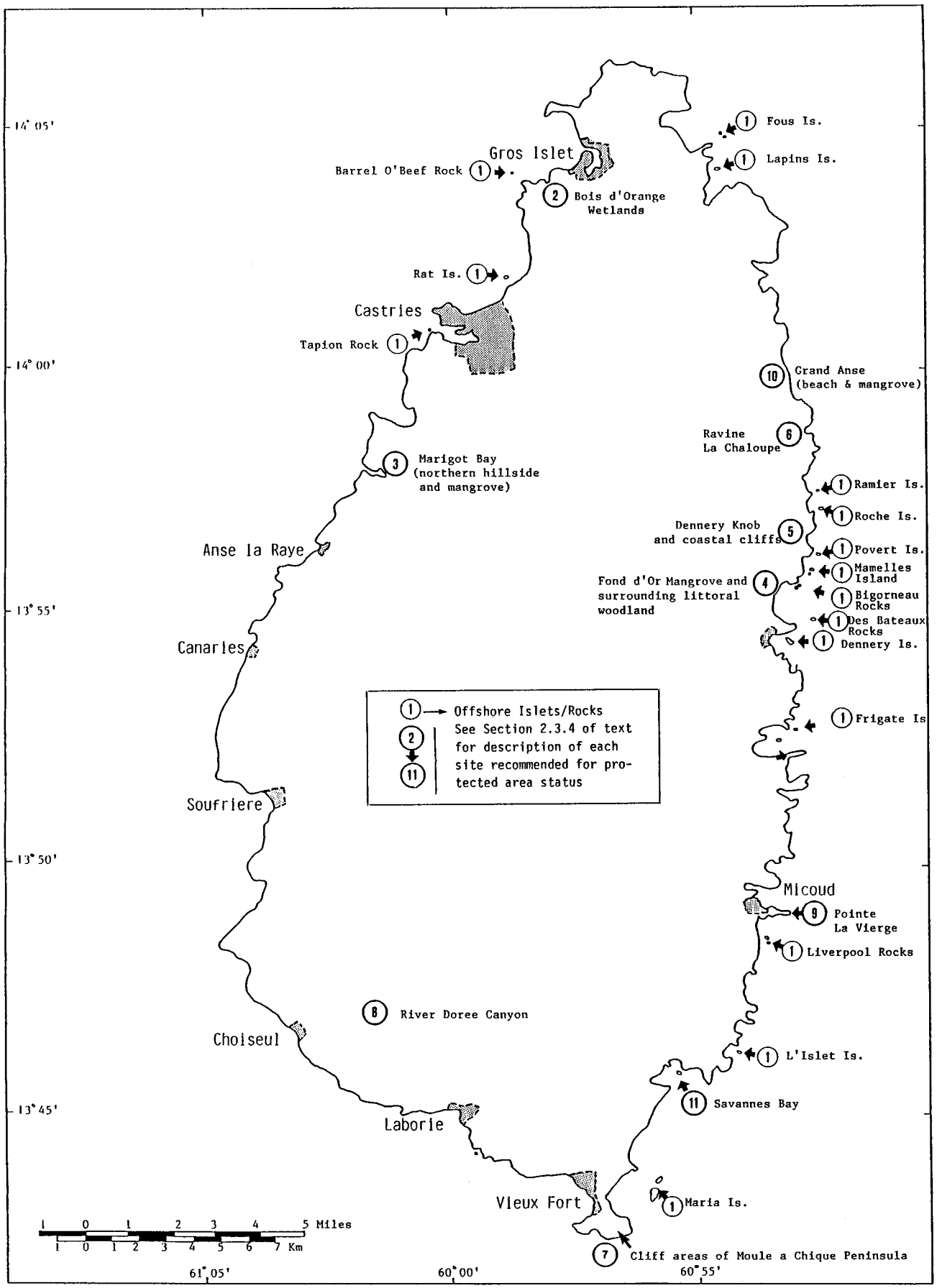


Figure 2.3(4). Recommended nature reserve sites.

Table 2.3(6). Offshore islets pending legal vesting in the St. Lucia National Trust as nature preserves or bird sanctuaries.

SITE	SIZE
- Fous Islands	0.2 acres
- Lapins Island	0.4 acres
- Ramier Island	0.2 acres
- Roche Island	3.0 acres
- Povert Island	1.0 acres
- Mamelles Island	2.0 acres
- Bigorneau Rocks	0.1 acres
- Des Bateaux Rocks	0.1 acres
- Dennery Island	4.0 acres
- Frigate Islands	0.6 acres
- Liverpool Rocks	0.3 acres
- L'Islet Island	0.5 acres
- Maria Island (Laborie)	0.1 acres
- Tapion Rock	0.2 acres
- Rat Island	3.0 acres
- Barrel o'beef Rock	0.1 acres
TOTAL	15.8 acres

Source: Devaux, 1987b.

flooded to promote its renewed attractiveness as a wildfowl refuge (Butler, 1987). Current quarrying activity in the area and its associated runoff should be evaluated as a possible long-term threat.

(3) The northern hillside and mangrove area of Marigot Bay should be managed as a nature reserve for migratory waders and wildfowl and utilised in accordance with a management plan for the area already prepared by the Forest Department in conjunction with the National Trust. Thirty acres at the site have already been donated to the Trust by the developers of an adjacent resort (to act as a green belt buffer), and GOSL has vested a small piece of mangrove at the lower end of the site. With funds recently awarded by USAID (1988), the Trust will move ahead with plans for development of the **Marigot Bay Nature Reserve**, including establishment of interpretive trails and educational materials.

(4) The **Fond d'Or mangrove and surrounding littoral woodland** should be given protected status for the protection of migratory waders and wildfowl and managed in accordance with a management plan prepared by the Forest Department.

(5) Nature reserve status should be granted for **Dennery Knob**, a rugged coastal area of huge cliffs located between Mamelles Point (Fond d'Or) and Trou Cadet Point (Louvet). This area is one of the few locations where iguana and agouti may still be found and protected in a somewhat natural environment. Additionally, numerous seabirds nest on the area's rocky ledges. It is the only area in St. Lucia where a relatively undisturbed succession of all major Eastern Caribbean vegetation types can be found. Earlier

recommendations to declare this site a nature reserve, along with two offshore islets and a number of offshore rocks, reported that the total area requiring protection encompassed slightly more than two square miles (Devaux, 1975). With funds from USAID, the National Trust will shortly undertake a project to map and survey the area and to provide preliminary recommendations for protected area status.

(6) **Ravine La Chaloupe** should be granted status as a nature reserve for protection of the White-breasted Thrasher and iguana.

(7) If warranted, following completion of investigations on seabird nesting sites (as recommended in the Research Section above), consideration should be given to protecting the cliff areas of the **Moule a Chique Peninsula** in the south of the island as a seabird sanctuary. The top of the highest hill on the peninsula is accessible by road and could serve as a suitable site for an orientation and interpretation centre for dry forest woodlands (the area is covered by a relatively well-preserved xerophytic forest). Funds recently available from USAID will help support this latter objective.

(8) The flora of the two-mile **River Doree Canyon** (Choiseul area) is quite different from most other St. Lucia river valleys . Because of its attractive array of vegetation and micro-lepidoptera, the site should be considered for protection as a natural area of merit.

(9) **Pointe La Vierge**, near Micoud, a classic example of littoral scrub vegetation increasingly threatened as a floral habitat in the Caribbean (Devaux, 1987b), should be considered for protective status because of its unique vegetation forms.

(10) A nature reserve should be established at **Grande Anse beach and mangrove**, an area situated between Tanti Point and Tortue Point on the northeast coast. Nature reserve designation for Grande Anse is needed to protect nesting leatherback turtles and to support populations of three endemic (regionally or locally) bird species (the White-breasted Thrasher, the Forest Thrush and the St. Lucia Black Finch) and two extremely rare species, the St. Lucia Wren and the Rufous Night Jar (see Table 2.3(1) for scientific names). It is also an important area for iguanas (Corke, 1987b).

(11) Three coastal ecosystems (coral reefs, seagrass beds and extensive mangroves) are represented at **Savannes Bay**. Nearby is a shallow saline lagoon surrounded by mudflats. A portion of Savannes Bay has already been vested in the National Trust as a nature reserve and declared a marine reserve under Fisheries legislation. The site is an important wetland and bird feeding habitat. Active management of the reserve has been delayed due to a lack of funding. Support recently made available under USAID's biodiversity programme will provide for initial species surveys and mapping, formulation of a management plan and establishment of an interpretation facility.

LEGISLATION

Although the Wildlife Protection Act of 1980 is comprehensive and appears to be effective in curtailing gross violations against endangered or threatened wildlife by hunters and collectors, it could be strengthened by incorporating specific CITES requirements. Such inclusions in the local legislation would be particularly important if St. Lucia became a popular transhipment point for illegal wildlife from within or outside the region.

Also, current definitions of protected species under the law refer only to higher fauna, and it may be necessary to provide lower fauna as well as selected wild plants (for example, some ornamentals or medicinal plants) and their products with legal protection.

2.4 WATER RESOURCES

2.4.1 Overview of the Resource Base

(See also Section 1.1.6)

As a result of agriculture and agroforestry and more recently because of tourism, land development, road building in the interior, and increased demand in virtually all sectors, both the quality and quantity of St. Lucia's water resources are declining. What has been happening to set off this chain of events?

In the first place, a small army of slash and burn farmers, loggers (legal and illegal), and the occasional road building crew have been whittling away at the edges of the upland primary rain forests (where all the rain falls) for so long -- since colonial times -- that there is very little left. Certainly not enough to soak up all the rainwater the way it once did like a living green sponge and then letting it out slowly, down rivers, clear and steady to the nearest, carefully installed, upland municipal water intake.

The new, less hopeful equation is very simple: less forest = less water or polluted water upstream = polluted water downstream. What we now have is a St. Lucian "tragedy of the commons" in the making. The question is: how can it be avoided?

In this context, one of the most critical problems facing St. Lucia, a problem shared by all of the higher Caribbean Islands, is management of the surviving, degraded forest lands and steeper, upland watersheds. (See also Figure 2.2[6] and Table 2.2 [9].) What is sorely needed is an ecosystem recovery *and* management strategy, one that includes a long range remedial plan and probably a public investment component to make up for past and continuing environmental insults and indiscretions. But this is a very hard thing to accomplish, in part because contemporary society finds it difficult, if not politically impossible, to invest in environmental infrastructure designed to generate environmental benefits for the future. Nevertheless, the problem will not go away.

In the first place, at the core, there is a silently growing demand for higher rates of water extraction from all watersheds near urban areas or near clustered coastal tourism facilities. At the same time, there is a rising demand to clear undeveloped forested areas for more agricultural land in small plots for landless farmers. Thirdly, there is a demand for more irrigation water for downstream farmers in the alluvial valleys and drier coastal plains.

Furthermore, in nearly every river basin/drainage area, some severely wounded by excessive feeder road cuts and itinerant slash and burn farmers, it is common to find that chemical pollutant loading from fertiliser, pesticide and herbicide run-off is matched by erosion inputs from exposed soils and disturbed terrain cleared of its protective vegetational cover. The resulting load of suspended sediments and displaced chemicals in solution flows toward the sea, generating complaints from downstream water users and communities. Some want more water, while others want less pollution (or more dilution). The objection to the pollutants is not unreasonable since they feed undesirable algae, kill larval fish, injure seagrass, lower system productivity, and slow down the growth of coral reef storm barriers. Along the shoreline, sediments smother living things and reduce coastal water clarity.

KEY CATCHMENT AREAS

Almost all water consumed or used in the country is the runoff product of catchment areas in the upper reaches of seven major river basins, most of which have headwaters in the same general montane area of south central St. Lucia, not far from Mt. Gimie. These seven are (see also Figure 2.4(1); basin numbers are from this Figure):

- Marquis River # 4
- Roseau River # 31
- Vieux Fort River # 16
- Canelles River # 14
- Troumassee River # 12
- Fond D'Or River # 6
- Cul de Sac River # 33.

Among the lot, the Roseau River has the largest watershed (Fond D'Or is second), but it also has one of the highest demands for water since it is a major centre of agriculture. It is facing a deficit which endangers any future land development in the area. The watershed of the Vieux Fort River is also threatened by a demand exceeding supply situation. The Troumassee and Canelles Rivers have surpluses, making water transfer to the Roseau and Vieux Fort watersheds to alleviate the water shortages a possible, but most likely only a temporary, solution.

If all the irrigation projects referred to in Table 1.1(15) were to become a reality, the 5,000 acres (2,000 ha), all of which are in the seven river valleys mentioned, would require 25 millions gallons per day (mgd), and all rivers would be placed in a water deficit position vis a vis their domestic, commercial and industrial customers or clients. Some very difficult policy decisions lie ahead -- in fact, just around the corner.

CONSUMPTION

The subject of water use is dealt with in more detail in Section 1.1.6. Demand is expected to reach about 40 million litres (in round figures, approximately 10 million gallons) per day by 1990 (Stevenson, 1986 and GOSL/CPU, 1977). This projected 15 year increase of 6.5 mgd from a base figure of 3.5 mgd in 1975 (GOSL/CPU, 1977) is the by-product of rapidly expanding tourism, domestic use levels, urbanization, and industrialization. There is also some wastage, little attempt at conservation and fairly loose accounting regarding system withdrawals. A full-scale water budget for each network is not maintained.

Neither has the GOSL been land-banking watershed catchment areas. In fact, it has on occasion done the exact opposite -- permitting squatters, loggers, and others to break the law on some of its Crown Lands which serve as watershed protection areas or forest reserves.

St. Lucian agriculture is primarily rain-fed, although small irrigated plots consume as much as 1,500 Ml/year. Since agricultural and potable water involve different sets of standards, there is always a problem of how to optimize the system of distribution. Obviously, separate parallel distribution systems do not make much economic sense except to areas where both kinds of water are needed in large quantities (HTS, 1986). This point is recognised by the Water and Sewerage Act (1984) which calls for "least cost" solutions by WASA in an attempt to satisfy both demands.

SURFACE WATER

Surface water is the primary source for domestic, industrial and agricultural purposes. Rivers radiate outward from the centre of the island, which receives the largest amounts of rainfall (Oelsner, 1981). Flow rates vary throughout the year depending on the amount of rainfall but usually reach a minimum toward the end of the dry season when reserves stored by the forests are used up (Migeot and Hadwen, 1986).

Thirty-seven specific watersheds have been identified (Figure 2.4(1); Table 2.4(1)). Of these, the Roseau, Troumassee, Vieux Fort and Canelles River Basins are of primary importance because of the agricultural, industrial, and population centres they serve. General characteristics on each of the seven watersheds follow (area figures are from OAS, 1987).

(1) **Marquis River Basin**. Located in the northeastern portion of the island, it encompasses 7,483 acres (31 square kilometres) with an average rainfall of 88 inches or 92,240 mm. Tropical dry forest characterises the lower portion of its valley, while the upper part is tropical moist forest. Near the coast the rainfall is about 70 inches (1,778 mm), but in the upper river basin it is more than 100 inches. The upper watershed requires total protection since it serves as a water source for Castries. Any human

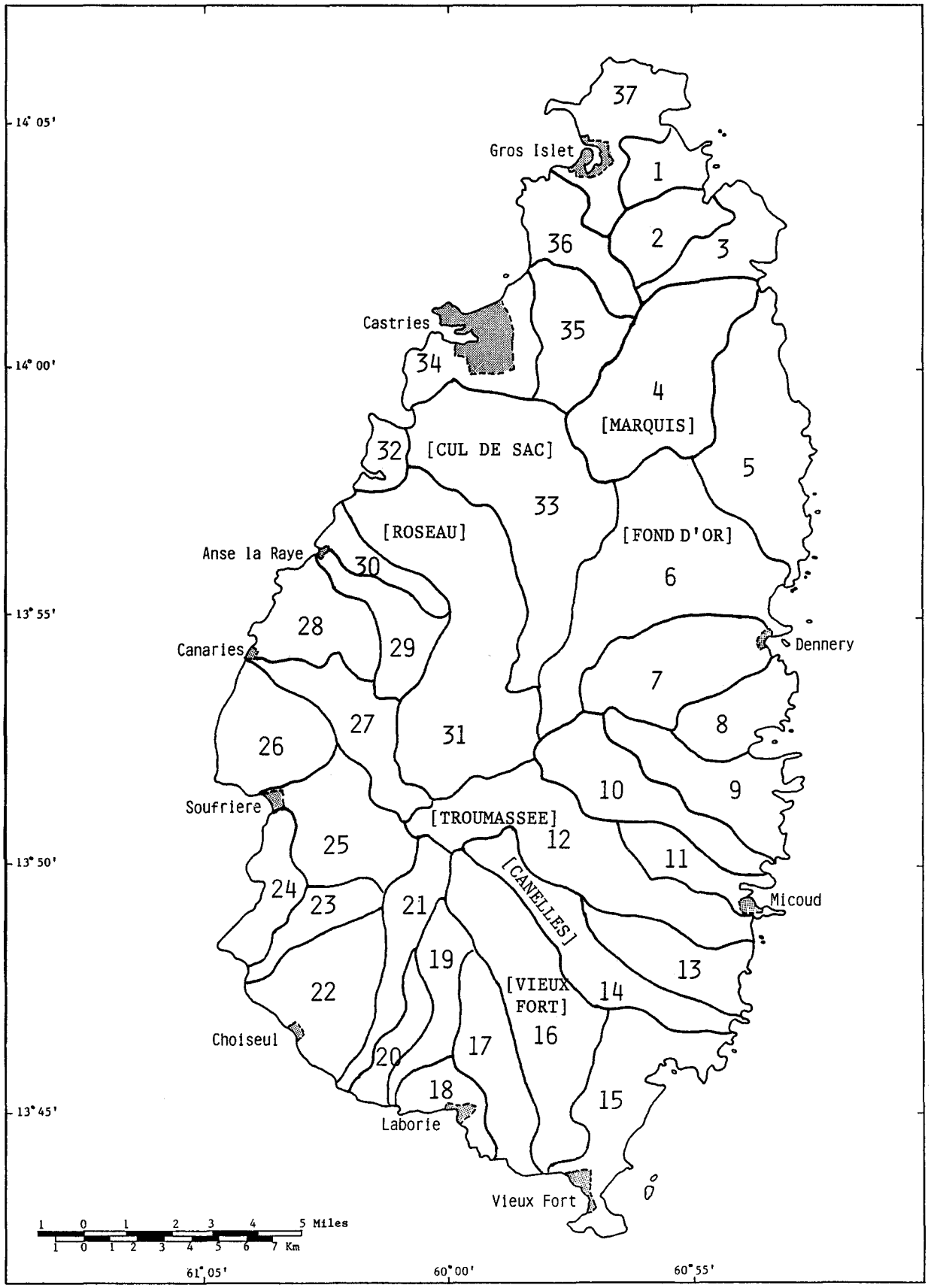


Figure 2.4(1). River basin catchments, with seven key river basins identified (see also Table 2.4(1)).

Table 2.4(1). St. Lucia water catchments by number, names, and size. See also Figure 2.4(1).

Number	Catchment name	Area (km^2)
1	Sallee / Lapins	6.7
2	Esperance	9.7
3	Trou Grauval / Dauphin	10.0
4	Marquis	31.0
5	Grande Anse / Louvet	29.2
6	Fond d'Or	41.0
7	Dennery	21.4
8	Riviere Galet / Trois Islet	11.0
9	Mamiku / Patience	16.0
10	Fond	18.1
11	Volet	8.6
12	Troumassee	31.7
13	Micoud / Ravine Bethel	13.1
14	Canelles	17.3
15	Roarne/Rugeine/Palmiste/St.Urban	22.8
16	Vieux-Fort	28.8
17	Black Bay	15.2
18	Laborie	5.5
19	Piaye	9.6
20	Balembouche	5.2
21	Doree	11.1
22	Choiseul / Trou Barbet / Trou Marc	18.1
23	L'Ivrogne	6.5
24	Pitons.	7.1
25	Soufriere	17.2
26	Mamin / Mahaut	13.7
27	Canaries	14.6
28	Anses la Verdure / Cochon / Galet	13.1
29	Grande Riviere de Anse-la-Raye.	8.9
30	Petite Riviere de Anse-la-Raye.	5.7
31	Roseau	49.1
32	Mt. Bellevue	4.8
33	Cul de Sac	40.9
34	Castries	14.3
35	Choc	12.7
36	Bois d'Orange	11.3
37	Cap	15.4
	TOTAL AREA OF SAINT LUCIA	616.4

Source: Migeot and Hadwen, 1986.

intervention within the catchment area will increase erosion and sediment loss. Irrigable land area totals 378 acres (153 hectares) with a water demand of 1.89 million gallons per day (8.6 Ml/day).

(2) **Roseau River Basin.** This is the largest river basin in the country, covering 11,838 acres (48.5 square kilometres). Development is constrained by a continuing water deficit. Average rainfall ranges from 70 inches (1,778 mm) to 150 inches (3,810 mm). The upper reaches are subtropical rain forest, the middle is tropical moist forest and the lower end is tropical dry forest. Management of the upper watershed in the Forest Reserve requires absolute protection to prevent degradation and adverse effects on downstream areas. Protection is also needed to maintain stable water flows for both domestic and industrial use. Irrigable land constitutes 1,332 acres (539 hectares) with a water demand of 6.66 million gallons per day (30 Ml/day).

(3) **Vieux Fort River Basin.** The basin covers about 7,129 acres (29.1 square kilometres) and originates in a forested areas which receives over 150 inches (3,810 mm) of rainfall. The average temperatures in the upper basin are less than 24 degrees C. The upper watershed requires protection and, because of the steep topography, fairly strict soil conservation practices need to be enforced should any expansion of intensive agriculture be attempted. Current irrigable areas are 163 acres (66 hectares) requiring 0.8 mgd (3.5 Ml/day) of water.

(4) **Canelles River Basin.** The Canelles River has its origin in the area of St. Lucia with the highest recorded rainfall. The forest cover of the headwaters should be completely protected. It is a long narrow basin covering 4,142 acres (17 square kilometres). Average rainfall is 60 inches (1,523 mm) in the coastal area and more than 150 inches (3,810 mm) in the headwaters. There are 240 acres (101 hectares) of potentially irrigable land requiring 1.25 million gallons per day (6 Ml/day) of water.

The upper watershed, lying within the Forest Reserve requires protection because, if vegetation is removed, the combined effects of heavy rainfall and the steep topography will induce massive erosion of the light volcanic soils. The upper watershed is also parrot habitat; thus, there is a double reason for strict protection of the elevated portions of this watershed.

(5) **Troumassee River Basin.** This river basin is located in the southeast and has 8,013 acres (30.5 square kilometres). It originates in an undisturbed forest area which receives over 150 inches (3,810 mm) of rain annually. Basin temperatures range from 26 degrees C on the coast to a chilly 17 degrees C at the top of Mt. Gimie. The soils peripheral to the central valley are subject to slumping. In the centre of the valley there are 643 acres (260 ha) suitable for irrigation, according to OAS, 1986a, and 299 acres (124 ha) if the reader prefers OAS, 1987.

(6) **Fond D'Or River Basin.** This basin (with 9,898 acres or 40.5 square kilometres) contains the largest expanse of potentially irrigable land, but it has shallow soils and in the lower reaches an average rainfall of only 79 inches (2,007 mm) at La Caye. The upper limits of the basin lie within the Forest Reserve and should be maintained. An environmental impact assessment on the implications of the current Fond D'Or integrated development project was completed by Shriar (1987). Irrigable land is 1,169 acres (473 hectares) requiring 5.8 mgd (25 Ml/day).

(7) **Cul de Sac River Basin.** The third largest river basin (9,508 acres or 45 square kilometres), Cul de Sac has about 1,545 acres (584 hectares) of land suitable for irrigation requiring 7.22 million gallons per day (32.8 Ml/day) of water. The area of the Forest Reserve should be extended, according to OAS, to include the steeply sloping lands near the Barre de L'Isle both to prevent soil erosion and to enhance the catchment effect. Erosion control must be maintained because sediment downslope movement is intruding upon valley floor drainage systems.

GROUNDWATER

Groundwater at the present time is not very important as a source of water in St. Lucia. Only one operating well has been identified on the island, located at the Anse Chastanet Hotel near Soufriere. The well produces only a few litres per second which is insufficient for anything other than a small-scale operation.

Groundwater tends only to be used where surface water supplies are inadequate or of poor quality. It generally requires less treatment than surface water but has not been successfully developed in significant quantities (Stanley, 1987). Groundwater discharge is manifested in the form of perennial streams and springs (Migeot and Hadwen, 1986).

An inventory of springs was undertaken by the Department of Forest and Lands in 1984 . Springs were found high up in the watersheds, mainly in the southwest of the island, associated with uprooted trees or faults. Water discharge rates tend to be less than 1 l/s (0.2 gal/s) (Migeot and Hadwen, 1986).
The former Central Water Authority (now the Water and Sewerage Authority) undertook a drilling programme in the 1960's in Bois D'Orange, Cul de Sac and other unspecified areas. The results were disappointing, since the groundwater found was of poor quality, with substandard hardness, salinity, iron content or colour. The technical details of this programme relating to waters levels, water quality and well location have been lost. It has been suggested that further exploration should be undertaken and that poor construction and implementation methods, as well as inadequate maintenance of equipment, may have contributed to the not very promising results of the earlier drilling programme (Migeot and Hadwen, 1986). Resistivity surveys in 1985 suggest good quality groundwater in the Fond D'Or and Roseau areas. At the very least, the case for or against significant usable groundwater supplies remains unresolved. Local smaller scale supplies will certainly be found and proven economic as piped water prices rise.

CURRENT MANAGEMENT PRACTICES

Storage. Surface water is stored prior to extraction by either natural means within the forests or by artificial means using water impoundments such as reservoirs or dams. The current Roseau Basin water development and dam project, now in the engineering design phase, is the most significant of recent efforts to improve water storage capability in the country.

Since the early part of this decade, discussions by GOSL about ways to address the growing water shortage have focused on the possibility of constructing a major storage dam on the upper end of one of the larger rivers -- either the Roseau, Cul de Sac, or Troumassee. The Roseau dam site was identified in a CIDA-funded study in 1983 as the preferred location among the three for construction of a river basin water storage scheme. The primary objective is to increase the water supply to Castries and the rapidly expanding urban and tourism sector in the northwest corridor. Study is presently ongoing to produce conceptual designs and cost estimates.

Additionally, a series of pre-feasibility studies and related environmental assessment efforts, mostly focusing on establishing flow profiles of target rivers, have been mounted, some of which are still underway. An elaborate stream gauging strategy was put in place to determine whether it was possible to extract water from other nearby rivers to feed, via a tunnel, into the upper reaches of the Roseau River, thereby supplementing its normal water supply obtained from the slopes of the Roseau Valley. OAS has proposed a series of four water diversion schemes (OAS, 1987) which are also displayed in the OAS "Rainfall and Drainage System" Map (OAS 1984).

The proposed Roseau Dam will increase water supply by increasing the amount of runoff intercepted. Other reservoirs have been proposed for other watersheds in St. Lucia, e.g., the Vieux Fort and Fond D'Or River Basins. However, such schemes raise several environmental, health and social issues, most significantly, the increased risk of Schistosomiasis, reduction in downstream water quality, agricultural and forest land loss,

relocation of residents and altering of their water supply, and loss of wildlife habitat.

In the case of the Roseau Dam, the site was chosen because the impacts appeared less than those associated with the alternative sites, the Troumassee or Cul de Sac River Basins. Proposed steps to reduce negative environmental impacts include monitoring and control of the snail population, as well as manipulating water flow rates in order to maintain water quality and supply downstream (Stanley, 1987 and Stevenson, 1986).

Extraction. The Water and Sewerage Authority (WASA) and other bodies engaged in extracting water for domestic or agricultural uses do so by means of a large number of small intakes, most of which are gravity-fed from small dams near the top of the respective watersheds (see Figure 1.1(12) in Chapter 1). At Choc, Marquis, Troumassee, Vieux Fort and Sarot intakes, pumps have been installed. There is no information on flow rates since flow meters are only installed at the treatment plants (Migeot and Hadwen, 1986). A few springs are tapped, but have very low yields and are of minor importance. To maintain water supplies, in some cases, intakes have been moved upstream as a response to reduced dry weather flow which quite often is the result of deforestation and cultivation upstream of the intakes (Stevenson, 1986).

Treatment. After extraction, the raw water proceeds via pumping stations to the treatment plants. Examination of raw water quality and variability throughout the year is required in order to determine the type and extent of treatment needed. In St. Lucia, raw water quality deteriorates after storms for a period of one to two days, as turbidity often exceeds the limit allowed. During these periods, only reservoir water may be usable since it is less susceptible to excessively high turbidity values. In some cases, this can result in water shortages as the total water output must be curtailed (Stanley, 1987).

Most treatment plants in St. Lucia are small. Treatment involves filtering the water and adding chemicals (alum, lime, chlorine) to make the water suitable for domestic use. The critical parameters, turbidity, colour, iron and magnesium content, are treated to fall within WHO guidelines.

Distribution. The treated water is distributed along pipelines (100-450 mm in diameter) designed to handle the maximum daily demand. The water is temporarily stored in several small reservoirs with capacities mostly less than one million litres before it reaches the consumer. These small reservoirs are intended to act as short term reserves in the event of breakdowns (Stanley, 1987).

2.4.2 Institutional Responsibilities

The institutions most directly involved in water resources are the Water and Sewerage Authority, WASA (and its predecessor, the Central Water Authority, CWA) and the former Land and Water Utilisation Unit (LWUU), now the Water Resources and Irrigation Unit (WRIU) of the Engineering Services Division in the Ministry of Agriculture. Additionally, the role of the Department of Forest and Lands in watershed management is discussed in Section 2.2.

WASA. WASA is charged with planning, development and management for the country's water system. Its responsibilities extend to both domestic and industrial water supplies and also to sewage disposal. The only municipal sewerage system in St. Lucia is confined to the Castries urban area; elsewhere St. Lucians depend on septic tanks, latrines and other similar methods of human waste disposal (a more detailed discussion is found in Section 4.2.2). Among the responsibilities of WASA is protection of the catchments from deforestation, although it lacks the legal and financial means to be effective (Oelsner, 1981).

WRIU. WRIU is primarily responsible for the planning and development of irrigation systems for agricultural use. One of its tasks is the centralisation of hydrometric activities, as well as hydrologic, land and hydrometric statistics. The WRIU initiative for development of a water resources data centre is

a first-class concept and will eventually eliminate some of the present surfeit of confused and erroneous natural resource information.

Management of St. Lucia's water resources suffers from a lack of well-co-ordinated management policies and practices by the various agencies that are involved in the development and utilisation of these resources, i.e., the WRIU, WASA, Department of Forest and Lands, and the Central Planning Unit. Problems of resource co-ordination are discussed in more detail in Section 5.3 of the institutional chapter of this Profile.

2.4.3 Relevant Legislation

There are two important laws that relate to water resource management in St. Lucia: the Water and Sewerage Authority Act (1984) and the Public Health (Water Quality Control) Regulations (1978). Both pieces of legislation have serious inadequacies; for example, they do not sufficiently address certain critical issues such as ownership and exploitation rights, the resolution of disputes, and watershed protection (Lausche, 1986; OAS, 1986a).

The Water and Sewerage Authority Act transferred the functions of the old CWA to the new WASA, under the Ministry of Health, and gave that agency control for the development and management of the water supply system and for sewage disposal. Under present laws, WASA may ask the Chief Forestry Officer to protect catchments from deforestation, but since that official only has jurisdiction over Crown Lands, privately-owned forest lands are effectively unprotected. Powers for water conservation and the protection of water catchment areas are specified in the WASA legislation, but regulations have not yet been enacted to fully implement the law (Lausche, 1986).

The Public Health Act provides general regulations, applying to both the public and private sectors, for the monitoring of potable water quality by the Ministry of Health, through its Environmental Health Branch, and for ensuring a safe water supply which meets acceptable public health standards.

2.4.4 Problems and Issues

ENGINEERING MATTERS

(1) **Contamination.** The excessive use of septic tanks can in some cases result in waterlogging and contamination of both surface and groundwater. Agricultural inputs, for example certain pesticides, can produce long-term contamination of the groundwater, soil and eventually the surface water, which in turn can adversely affect human and marine communities. Watersheds above intakes must be kept clean and free of pollutants if the run-off water is to be of high quality. Fencing and patrols may be required.

(2) **Supply.** Other problems faced by water resource planners in St. Lucia are clustered around issues of supply, including designation of adequate catchment areas, selection of intake sites, and the complexities of having to simultaneously merge technical requirements with social issues -- such as population dispersal, pressure on upland watersheds from competing resource users, and implementation of conservation education programmes to help control water consumption. The loss of water from the distribution system due to broken pipelines can be significant and, if not dealt with effectively, can become an extremely serious problem.

(3) **Reservoirs.** Building artificial reservoirs is an expensive substitute for natural storage. Impounded water losses through accelerated surface evaporation raise the cost of delivered water even higher. Furthermore, any lack of conservation upstream of the reservoirs can lead to siltation within the reservoirs resulting in a shortening of the life span of the impoundment structures. Increased threat of disease is also a problem. By far, the preferred strategy favours an emphasis on water conservation practices rather than investing in reservoir systems.

POLICY MATTERS

(1) **Conservation of water catchment areas.** To determine the optimum location and required extent of catchment areas requires more information on base flows than is readily available in St. Lucia. Present initiatives to accumulate such data with stream gauges and the like are to be encouraged.

(2) **Optimizing flows by expanding catchments.** OAS's water resources study indicates that base flows vary greatly in different catchment areas. Run-off can be as little as 0.33 litres/second/sq km or as much as 17.0 litres/second/sq km. The average in the main catchment areas appears to be in the order of 5 to 6 litres/second/sq km. At 5 litres/second/sq km, it takes the run-off from 4,860 hectares to supply 21 ML of water per day. To supply 25 Ml would require a catchment of 5,800 hectares. If infiltration rates are reduced by removal of tree cover, the catchment area required would be many times greater. Present agricultural policy planning regarding future irrigation possibilities makes it especially important to acquire land for new water catchment areas sufficient to keep pace with demand levels for both domestic and industrial water supplies and for irrigation.

(3) **Selection of sites.** In the short-term, it is possible to get cleaner water by moving the intake upstream to a less disturbed, less polluted portion of the watershed. This can be a self-defeating tactic, however, because the intake taps a smaller catchment area and therefore generates less water, albeit clean water. Conservation and preservation of catchment areas serving existing intakes is a better long-term policy. Selection of sites for water impoundment and storage is a complex process involving consideration of geological and engineering site suitability as well as cost-benefit and environmental impact assessments. Site selection for purification works is largely determined by availability of suitable land in relation to supply and consumers.

(4) **Clustering of settlements.** Nucleation of settlements facilitates water supply, as it does the delivery of all utilities and social services. Settlement policy cannot simply be determined by water supply capability, but certainly it has to be taken into account.

2.4.5 Directions for the Future and Policy Recommendations

(including those of Stevenson, 1985 and OAS, 1986a)

(1) Water catchment areas should be rigorously defended against encroachment and no land use other than controlled forestry permitted.

(2) Water catchment areas should be increased in size by at least 2,000 hectares in anticipation of future requirements and, more immediately, for essential protection above existing intakes that are outside the protected areas.

(3) Investigations should be undertaken into the feasibility and cost of increasing pumping and storage capacity as an alternative to conserving and enlarging catchment areas.

(4) Hydro-meteorological recording capability should be continually improved and updated, especially with a view to quantifying changes in run-off resulting from changes in land use.

(5) Public awareness of water conservation needs (both for water consumption practices and regarding the importance of catchment areas) should be promoted.

(6) WASA, the CPU and the Department of Forest and Lands should work closely on planning issues for water catchment, impoundment and distribution, particularly as these relate to settlement planning and critical environmental impacts.

(7) The Department of Forest and Lands has recommended that legislation be enacted to protect 20 metres of forest along each side of rivers for the protection of stream flow water quality, reduction of bank erosion, and enhancement of wildlife habitat.

(8) Water resource legislation should be reviewed and revised to declare water a nationally-owned commodity (like sand), requiring that usage rights be acquired by the private sector. Legislation should define watercourse and utilisation rights and the use of overspills and right-of-ways for infrastructure, as well as provide the legal means to resolve conflicts between individual ownership rights and the water protection requirements of the state (OAS, 1986a; Oelsner, 1981; HTS, 1986; Stevenson, 1986).

2.5 COASTAL AND MARINE RESOURCES

2.5.1 Overview of the Resource Base

PHYSICAL FEATURES

St. Lucia is part of the "West Indian arc" of islands that borders the eastern edge of the Caribbean lithospheric plate. Its origin and most of its exposed rocks are volcanic, the exception being minor limestone outcroppings in the vicinity of Soufriere (Roberts, 1972) and several hectares of granular limestone inland from Grand Anse beach north of the Sorciere River (OAS, 1984, Geology Map). The eastern and western coasts are quite steep; the 183 m contour lies within 2 km of shore from Vigie Point to Choiseul. Particularly on the windward (eastern) coast, the shoreline is very irregular with numerous exposed volcanic islets formed by intense erosion. The coastal shelf (55,000 ha) is considerably broader to the north and south, where the "100 fathom" (183 m) curve may be as far as 8.4 km from shore.

Dominant currents are primarily wind-driven and set north to northwest with an average velocity of 1.26 m/sec (2.5 kn). The current divides off Brandon Point (Moule a Chique) and sets north along the east and west coasts. Close to shore, currents are variable with easterly set and velocity of approximately 50 cm/sec (1 kn) off Cap Point, and westerly set and velocity of 22 cm/sec (half a knot) in the vicinity of Vigie Point and the Maria Islands. When the wind-driven current is weak, a south- or east-setting tidal current has been observed.

FISHERIES RESOURCES

Recorded landings of major fish species for 1983-85 are summarised in Figure 2.5(1) and by month for 1985 in Figure 2.5(2).

Migratory oceanic pelagic fishes (species living offshore and not associated with bottom habitats such as dolphinfish, kingfish or wahoo, tunas, and flying fish), harvested by hand trolling from outboard powered canoes, account for roughly 70 percent of annual landings. The "high season" for these stocks is from early December to mid-June, with peak landings during March and April and a dramatic drop-off from July to December (Figure 2.5(3)). During the "low season" the catch is more evenly spread when landings also include coastal pelagic (jacks, halfbeaks, herrings, anchovies, etc.), reef (hinds, parrotfish, triggerfish, angelfish, lobsters, etc.), and "bank" (snappers and groupers) species captured by fish traps, bottom gill nets, and bottom longlines. Spiny lobster, queen conch, sea eggs, and sea moss also are regularly harvested, but no estimates are available of present landings. Information on the status of these stocks is summarised in Section 2.5.4.

The FMU landing statistics programme is the most extensive one among the OECS countries, but there is no pretense of comprehensive coverage. Major landing sites are indicated in Figure 2.5(4). Statistics collectors do not cover all landing sites; daily samples do not include all boats at a given site; samples are not taken during all hours on all days during which fish are landed. Based on the proportion of fish landed at the Castries Fisheries Complex during "off" hours and the proportion of fishermen at sites not covered by collectors, the FMU has estimated that the recorded catch represents approximately 55 percent of actual landings (ca. 1,000 tonnes per annum).

Because it is difficult to estimate the quantity of fish directly exported to other islands, figures for "actual" landings may be somewhat low. The primary purpose of the statistics collection programme is not to obtain absolutely precise figures for total landings, but rather to provide a means for recognising major trends that can guide management efforts.

Estimated fisheries landings have declined over the past 40 years (Figure 2.5(5)): 1,553 tonnes in 1945 (Brown, 1945); 1,620 tonnes in 1969 (Vidaeus, 1969); 1,391 tonnes in 1978 (Carleton and Wirth, 1980); 1,000 tonnes in

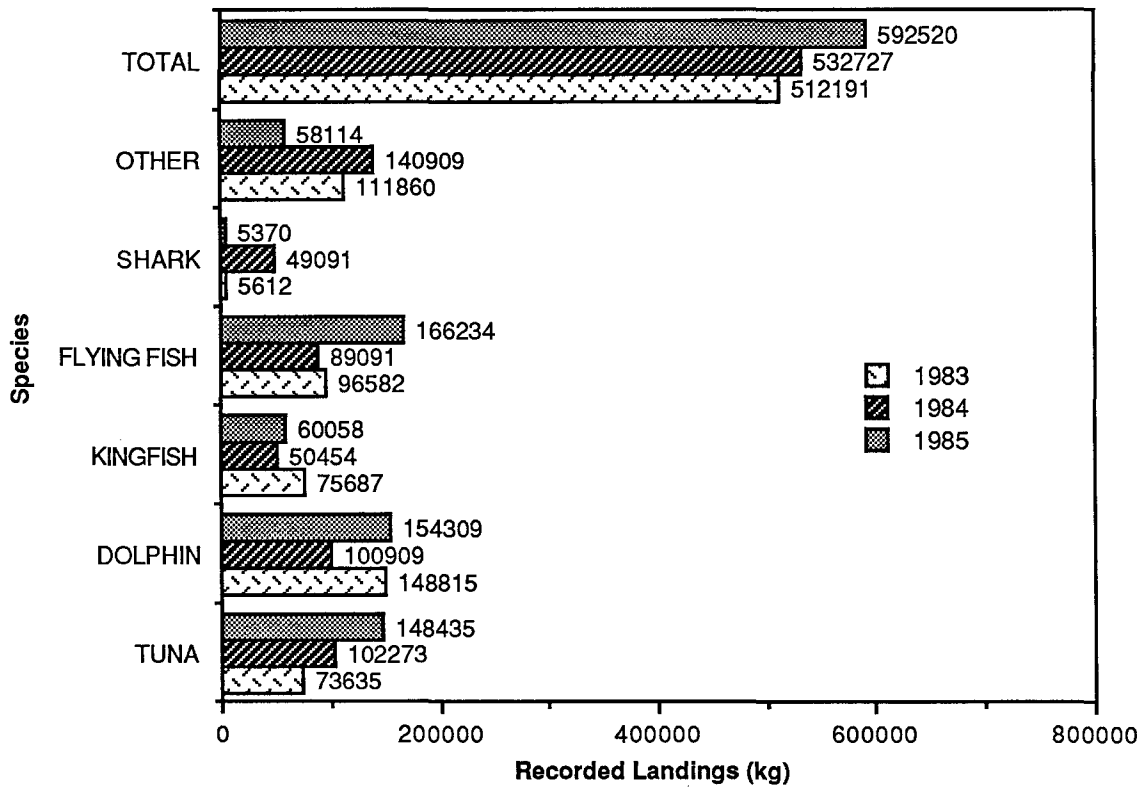


Figure 2.5(1). Recorded landings of major species, 1983-85.

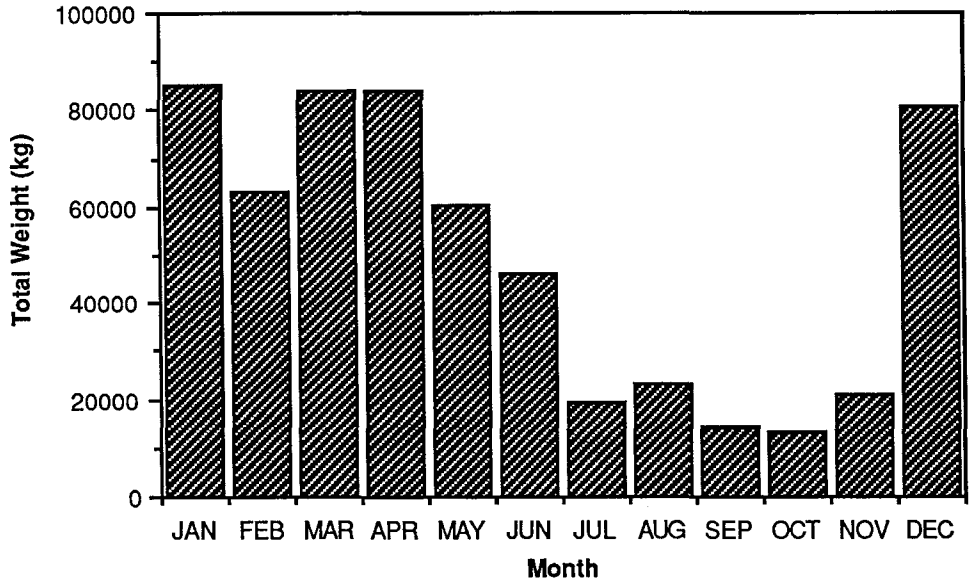


Figure 2.5(2). Total reported fish landings for 1985 by month.

1986 (FMU). It is sometimes hard to tell who has and who has not adjusted for "non-reporting" and for fish caught but not landed in St. Lucia, when fishermen go directly to a French buy-boat or to Martinique. There is, therefore, considerable uncertainty attached to these estimates, but at best these figures are not indicative of an expanding industry. There are even more striking trends in at least one heavily utilised traditional fishery: Brown reported the expected yield from beach seines to be 22,700 kg/seine/yr in 1945, but Vidaeus estimated the 1969 yield from this fishery to be 11,300 kg/seine/yr. This decline in catch per unit effort apparently was temporarily offset by a doubling of the number of seines in operation -- a classic scenario of overexploited fisheries.

In recent years, fisheries management and development plans have relied on stock abundance or yield estimates determined by extrapolating results from experimental fishing or visual census in selected sites to larger areas. This method may provide a helpful starting point, but is not useful for oceanic pelagic species (which are of greatest importance to St. Lucia fisheries). Goodwin, *et al.* (1985) point out that resulting estimates vary widely and do not provide a basis for precise quantification of economic development potential.

Several recent reviews of fisheries development opportunities (Goodwin, *et al.*, 1985; Gibbons-Fly, *et al.*, 1987), however, have concluded that fishery resources throughout the Eastern Caribbean are comparatively limited and can easily be overexploited with available technology. This does not mean that these resources are unimportant, nor that there is no potential for development. On a small island scale, the fishery sector can have significant local impact: 2000 St. Lucian fishermen produced an annual catch valued at more than EC$ six million, and that generated export revenues exceeding EC$400,000 in 1985 and 1986.

As noted, annual fish landings have at best remained constant, while the population has increased from 72,000 in 1945 to about 140,000 in 1988. Coupled with rising costs of imported fish and availability of less expensive imported chicken, it is not surprising that Mitchell and Gold (1982) noted per capita consumption of fish has declined. Even so, the fisheries sector remains important to local communities as a source of both income and employment.

Aquaculture development in St. Lucia has been directed primarily toward freshwater species. A project to culture *Tilapia nilotica* has been underway for the past eight years at Union (supported by EDF), and some farmers have adopted the technology to produce fish on a subsistence scale. An expanded project to produce fish for animal feed is under consideration. A pilot-scale project to produce freshwater prawns (*Macrobrachium rosenbergii*) has been in operation for the past two years, although actual production has only recently begun.

Culture of other non-fish marine species has been confined to sea moss (algae, *Gracilaria* spp.). These algae provide the base for a drink popular throughout the Eastern Caribbean (see box on Sea Moss Cultivation). Concern about over-harvesting of wild stocks of sea moss and a desire to increase the availability of the product led to the establishment in 1982 of an FMU project, supported by the International Development Research Centre (IDRC), to develop techniques for cultivating two *Gracilaria* species. An extension project was carried out in 1986/87 with funding from the Canadian High Commission as a joint effort of the FMU and the Eastern Caribbean Natural Area Management Programme (ECNAMP).

At present, ten farmers are engaged in part-time cultivation of sea moss in the southeast of St. Lucia. An informal Southern Sea Moss Growers Group has been established as a precursor to a co-operative and has produced a system for sea moss farm development, crop quality standards, and improved prices for the cultured product. A procedure has been introduced in which farmers reserve the healthiest plants in their harvests for use as seed material, which reduces the dependence on wild populations and progressively upgrades the cultured stock.

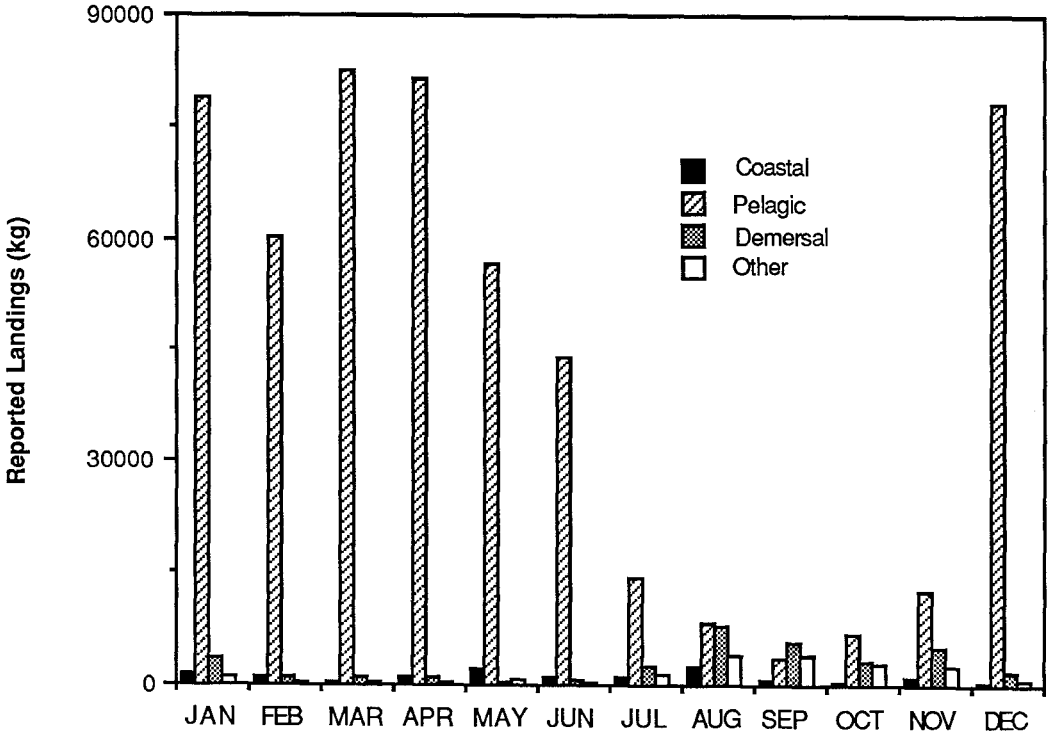


Figure 2.5(3). Monthly composition of landings by major group for 1986.

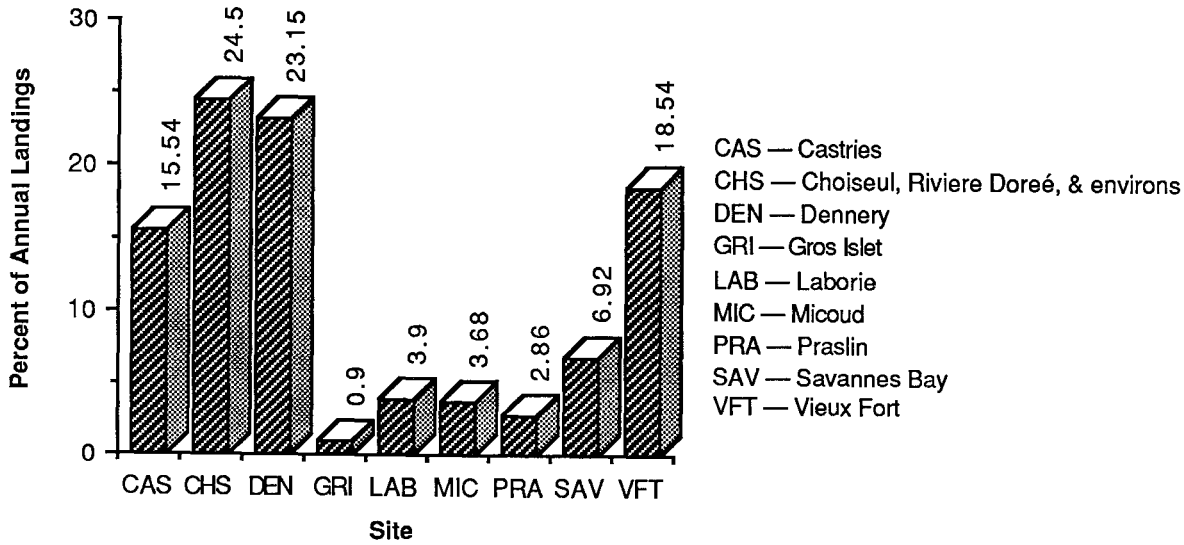


Figure 2.5(4). Contribution of major landing sites to annual catch, 1985-86.

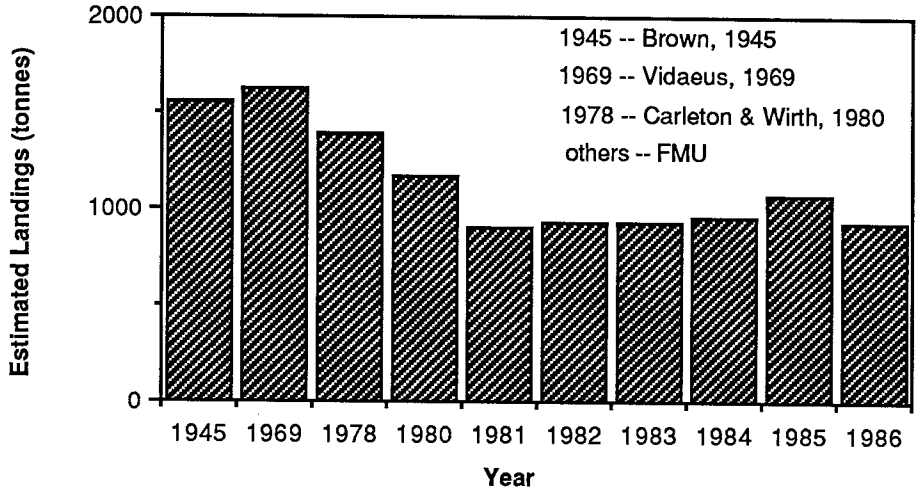


Figure 2.5(5). Historic fish landings, 1945 - 1986.

A survey of the market potential of sea moss was recently conducted, with support from Canada's International Centre for Ocean Development (ICOD). This provides an overview of regional inter-island trade and will help guide future development of the sea moss industry. A Grenada-based extension of the concept is currently underway.

SYSTEM INTEGRITY, PRODUCTIVITY, AND CRITICAL HABITATS

Three nearshore habitats -- coral reefs, seagrass beds, and mangroves -- are critical to marine productivity in St. Lucia (Figure 2.5(6)). In this context, "productivity" has two meanings.

> (1) In a biological sense, the term refers to the rate of production of organic material necessary to sustain life within the food chain. Production is either from inorganic substances (primary production) or through consumption of other organisms (secondary production).
>
> (2) In an economic sense, "productivity" describes the direct income that is (or could be) derived from using resources (e.g., fishing, diving excursions), as well as the indirect value of these resources (such as free "breakwater services" by coral reefs offering coastal protection from erosion).

Nearshore habitats do not function independently but are closely coupled systems that also interact with adjacent terrestrial habitats. For example, run-off from forests, agricultural lands, and construction sites directly affects the growth of coral reefs and seagrasses. Unless disturbed by human activity, mangroves often buffer these effects by acting as "sinks" that help control sediments and nutrients borne by run-off. The presence of mangroves and reefs in coastal areas also reduces the rate of erosion. On a larger scale, the sea -- along with riverine inputs and tidal action -- is the link which couples St. Lucia's marine habitats into ever more complex ecosystems.

Recent declines in black sea urchin populations (thought to be caused by water-borne disease) and the "bleaching" of corals (possibly due to changes in water temperature) illustrate the susceptibility of coastal habitats to external influences. This kind of interaction explains why site-by-site management of the coastal environment is inadequate; effective management requires attention to the entire coastal system.

Even knowledgeable individuals may not fully appreciate the complex and therefore easily upset nature of the marine environment, assuming, as many do, that terrestrial resources are most used and therefore most threatened. To be sure, extinctions of endemic species are

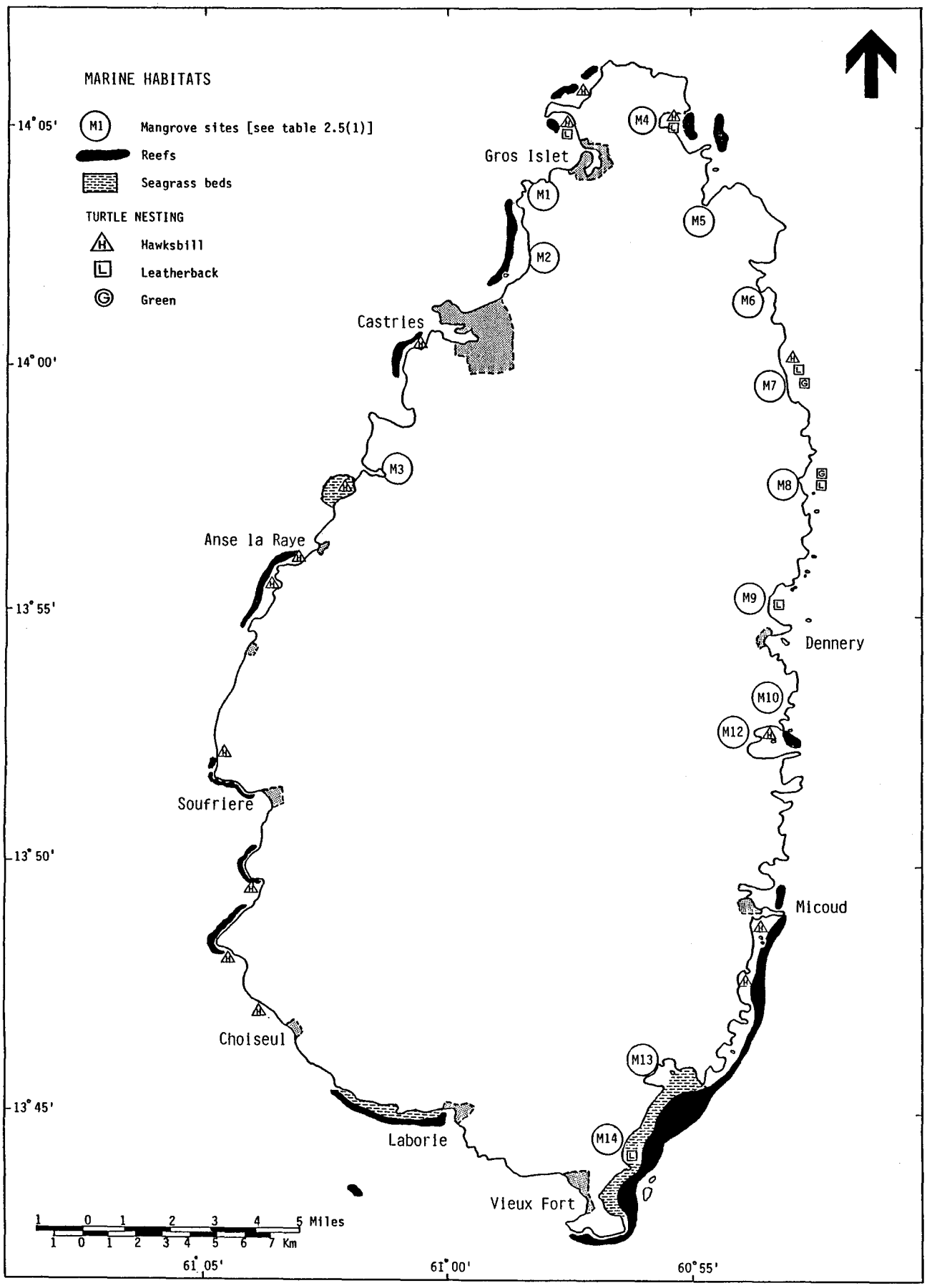


Figure 2.5(6). Marine habitats and turtle nesting sites.

less likely to occur in the marine environment because the sea provides links with other land masses which serve as gene pools. Nevertheless, marine and coastal habitats are areas of high energy, high risk and intense resource conflict. They are also the least known and probably the most poorly managed. Perhaps as high as 80 to 85 percent of the problems affecting the marine environment and its associated ecosystems originate from land-based sources.

(1) **Coral Reefs.** Coral reefs and coral veneers are found on all of St. Lucia's coasts (Roberts, 1972), but there is considerable variation among these areas in terms of species diversity and overall structure. Available information on the status of St. Lucian coral reefs is summarised by Wells (1986). Many areas identified as "reefs" are actually veneers of coral and associated organisms on volcanic rock substrates. Reefs that have been largely produced by corals are found primarily on the south and east coasts. These are patch reefs or small fringing reefs; large barrier reefs are not present.

Coral species typical of St. Lucia reefs include *Colpophyllia natans* (brain coral), *Acropora palmata* (elkhorn coral), *C. amaranthus* (brain coral), *Porites porites* (finger coral), *Montastrea annularis* (star coral), *Diploria strigosa* (brain coral), *Siderastrea siderea* (starlet coral), and the hydrocoral *Millepora* sp. (fire coral).

Biological productivity in the vicinity of coral reefs is significantly higher than that of the Caribbean Sea in general. This is primarily because biological productivity is based upon the process of photosynthesis in which inorganic nutrients are converted to organic substances, most often by plants that use the energy of sunlight to make this transformation. Although the Caribbean Sea has abundant sunlight (except when turbidity reduces water clarity), inorganic nutrients are scarce except near river mouths where suspended sediments reduce light penetration and productivity.

This limitation to biological production is improved in coral reefs by the presence of algae that can convert atmospheric nitrogen to the scarce nutrients. There are also complex mechanisms within reef systems for recycling consumed nutrients, thus reducing dependence upon external sources of these materials. Coral systems thus are directly responsible for the production of nutrients important to sustaining the life of fishes and numerous other organisms associated with these reefs.

It is important to note that coral reefs do not exist despite nutrient-poor waters; they exist *because* of these conditions. Abnormal increases in dissolved nutrients upset the dynamic balance between reef-dwelling species, causing certain bottom-dwelling algae to proliferate and compete with corals for surface space. Coral reefs are consequently particularly susceptible to adverse impacts as a result of nutrient enrichment (e.g., from municipal waste water and septic tank discharge, runoff from dump sites, rivers and streams containing agricultural fertilisers).

Direct economic productivity from coral reefs historically has been related to fisheries. Particularly on the southeast coast, reefs together with associated seagrass and mangrove habitats provide major habitats for fishes, sea eggs, and spiny lobsters. Reef-dwelling species are the major component of fish landed during the "low" fishing season, and the same reefs provide nursery and breeding areas for commercially important fishes that do not live in these habitats as adults.

Recently, economic productivity has been increasingly linked to the attractiveness of coral reefs to tourists. Coral "veneers" (corals over a rock substrate) in the vicinity of Soufriere (Anse Chastanet, Grand Caille Point to Rachette Point, and the Pitons) in particular provide spectacular attractions for divers. Other sites important to the diving industry include Anse Cochon, Anse La Raye, Anse Galet, Anse L'Ivrogne, and Anse Mamin.

Elements of risk are associated with both fisheries and recreational uses. Of primary concern is mechanical damage resulting from diver contact, boat anchors, and fishing gear (especially nets and traps that are often dragged across reef surfaces during retrieval). Equally serious risks, however, are posed by sediment loading due to poor land manage-

ment and dredging. These risks are discussed in Section 2.5.4.

Corals are also susceptible to a variety of diseases. Black band disease results in destruction of coral soft tissue and is caused by an algal infection. The disease has been known to become more severe with increased nutrient concentrations. White band disease also results in soft tissue damage, but its cause is unknown and does not appear linked to human activity. Other infections and tumors have been reported from various locations. The long-term effects of coral "bleaching" (an appearance resulting from the loss of pigmented algae that normally live within the coral soft tissue) and depleted populations of black sea urchins (*Diadema antillarum*), as well as the precise causes of these phenomena, are simply not known. Recovery is a natural process.

(2) **Seagrasses**. Seagrasses typical of St. Lucia include *Thalassia testidunum* (turtle grass), *Syringodium filiforme* (manatee grass) and *Halodule wrightii* (shoal grass). Major seagrass beds occur in close proximity to coral reefs along the north, south, and southeast coasts at Laborie, Anse Epouge, and from Brandon Point to Saltibus Point (ECNAMP, 1980). (See Figure 2.5(6).)

The plants form extensive mats that produce large amounts of organic material. This biological production provides the basis for a complex system that includes grazing fishes, conchs and other snails, green turtles, sea urchins, and numerous small organisms and bacteria that live on and among the plants. Some reef-dwelling species (e.g., the sea urchin *Diadema*, parrotfish, grunts, snappers, spiny lobsters) derive a significant portion of their nutrition from feeding in seagrass beds (Ogden and Gladfelter, 1983).

Economic production from seagrass beds is directly related to their contribution to the nutrition of commercially important food species such as conch, spiny lobsters, and a variety of fishes as well as the provision of nurseries for these and other species. Seagrasses also contribute to coral reef production by trapping fine sediments in their interwoven rhizomes and thus provide control of sediment loading to adjacent coral systems. Finally, the stabilising effect of seagrass rhizomes on bottom substrates helps to prevent erosion by water movement close to shore.

(3) **Mangroves**. Isolated mangrove communities occupy a total of 179.3 hectares in St. Lucia (Table 2.5(1)); a recent update of mangroves and wetlands (by Robert Devaux of the St. Lucia National Trust) puts total mangrove area closer to 200 hectares. Mangroves are found mainly along the east and northwest coasts, for example, at Esperance, Marigot Bay, Marquis, Praslin, Savannes Bay, Trougascon, and Volet (Scott and Carbonell, 1986). (See Figure 2.5(6).) A fairly recent study (Portecop and Benito-Espinal, 1985) of 14 principal mangrove areas has shown that most of these are riverine, with a few basin and fringe types. Devaux (1988) correctly notes the unfortunate omission from this otherwise excellent study of an important, mostly undisturbed mangrove area at Anse Ger south of Micoud Point.

The study also lists flora and avifauna (see Table 1.1(12) and Table 2.3(2)) and assigns a value to each mangrove based upon the degree of tree felling, sediment stabilisation, pollution, contribution to fisheries, wildlife, size, and education possibilities. Savannes Bay and Praslin mangroves are least degraded and have the greatest fishery potential, followed by Marquis Bay, Man Kote and Esperance whose usefulness has been diminished by tree felling.

The Man Kote mangrove has been particularly used as a source of wood for charcoal production. Monitoring of standing stock, stem density, and seasonality of litterfall, flowering and fruiting is being carried out by ECNAMP. Preliminary results indicate that white mangrove and red mangrove are being overharvested in some areas in Man Kote; this, in turn, led to development of a fuelwood reforestation project using leucaena (see also Section 2.2.4).

The remaining mangroves were described as having limited value owing to their small size, destruction by cutting, and paucity of wildlife. However, the authors conclude that:

> ... despite their small individual size, the concentration of these mangroves, especially on the east coast, creates significant ecological zones whose combined effect is beneficial, especially on fisheries. Furthermore, some mangroves, notably Savannes Bay, may be suitable for aquaculture projects.

In the latter regard, measurements made in the course of an earlier survey (Goodwin, 1984) found water in the vicinity of mangroves at Savannes Bay to have lower concentrations of dissolved oxygen and higher biochemical oxygen demand compared to adjacent waters outside the Bay, and noted surprisingly little biological growth on mangrove prop roots, i.e., conditions not particularly conducive to mariculture. These measurements represent but a single point in time and are in no way conclusive; they do, however, suggest some degree of uncertainty and, more importantly, underscore the need for site-specific technical evaluation prior to extensive investment in any mariculture development at any location.

Table. 2.5(1). List of major mangroves in St. Lucia (areas displayed on Figure 2.5(6)).

LOCATION	AREA (ha)	PERCENT OF COUNTRY TOTAL	FOREST TYPE
Northwest Coast			
Bois d'Orange	2.59	0.004	B
Choc Bay	12.95	0.021	R
Marigot	6.22	0.010	F
East Coast			
Cas en Bas	5.44	0.009	R
Esperance	17.35	0.028	R
Marquis Bay	2.59	0.004	R
La Sorciere	5.18	0.008	R
Anse Louvet	17.35	0.028	R
Fond d'Or	21.00	0.034	R
Dennery	6.00	0.010	R
Praslin	17.35	0.029	F
Micoud	1.29	0.002	F
Savannes Bay	24.61	0.040	F
Man Kote	39.37	0.064	B
	---	---	
	179.30	0.29%	

Key To Mangrove Forest Types:
F - Fringe B - Basin R - Riverine

Source: Adapted from Portecop and Benito-Espinal, 1985. N.B. Because these are dynamic, growing systems, the total shown here may be as much as 20 ha too low.

Mangroves contribute to biological production in the marine environment by providing nutrients from leaf decomposition as well as dissolved organic matter leached from living plants. Birds and marine organisms that shelter in mangroves and feed in adjacent marine habitats move nutrients between these systems through excretion and (eventually) decomposition.

Mangroves contribute directly to economic production primarily as a source of fuel and are also related to production associated with coral reefs and seagrass beds. Besides supplying nutrients needed for fisheries production, the prop roots of red mangroves provide breeding and nursery areas for some species (although the actual contribution of the relatively small mangrove stands found in St. Lucia has not been determined). Equally important is the tendency of mangroves to trap and retain sediments that would adversely affect seagrass and coral habitats. In addition, mangroves protect coastal areas from erosion by storm waves and are often associated with "protected anchorages" used by small vessels in severe storms.

HISTORIC USE OF THE COASTAL ENVIRONMENT

For more than 300 years, St. Lucia's economic development potential has been determined largely by two physical attributes -- extremely fertile land for agriculture and exceptional natural harbours. As the only port in the British West Indies (other than Jamaica) at which ocean-going vessels could come alongside wharves, for many years Castries Harbour enjoyed great prominence as a coaling station. After the opening of the Panama Canal the coaling trade declined, but its sheltered location and proximity to abundant supplies of pure water for visiting vessels continued to mark Castries as an important port of call in the West Indies. At the same time, emphasis on agriculture and the need for export markets helped to maintain the pivotal importance of marine shipping facilities in the nation's economy.

Other historical evidence demonstrates the influence of the coastal environment in St. Lucia's development. The major population centres in the country have been located in coastal areas, a settlement pattern reflecting the country's rugged interior terrain and its dependence on marine transportation. Particularly along the south and east coasts, mangroves and coralline structures have been important (though often unrecognised) controls of shoreline erosion. Fisheries have provided the major source of indigenous animal protein for the local population.

The well-established practice of using mangrove wood for fuel has been noted in Section 2.2.4. But neither this tradition, nor fisheries, nor even the importance of natural harbours has stimulated a national commitment for improved understanding and management of coastal resources. Historically, the importance of these resources has not been widely appreciated, perhaps because traditional uses have been partitioned among different resource users in different sectors. Recently, however, with the emergence of tourism and its heavy reliance on the coastal environment, there is new incentive for developing a broader, more holistic management approach for this resource sector.

CURRENT DEVELOPMENT TRENDS

(see Figure 2.5(7))

Tourism. Tourism is one of St. Lucia's major sources of foreign exchange earnings and is emphasised in GOSL plans for national development along with agriculture and manufacturing. In the marine sector, these priorities are reflected in efforts to expand marine food production, harbour services, and coastal recreation facilities.

Tourism is particularly dependent upon marine resources. The traditional importance of commercial ports to agriculture and manufacturing continues, but is now augmented by cruise ship arrivals and opportunities for new ports to provide marina industries to service pleasure craft. In St. Lucia expansion of tourism has been accompanied by opportunities for new enterprises based upon recreational pursuits, many of which are water-oriented. Mitchell and Gold (1982) estimated that coastal and marine-related industries and

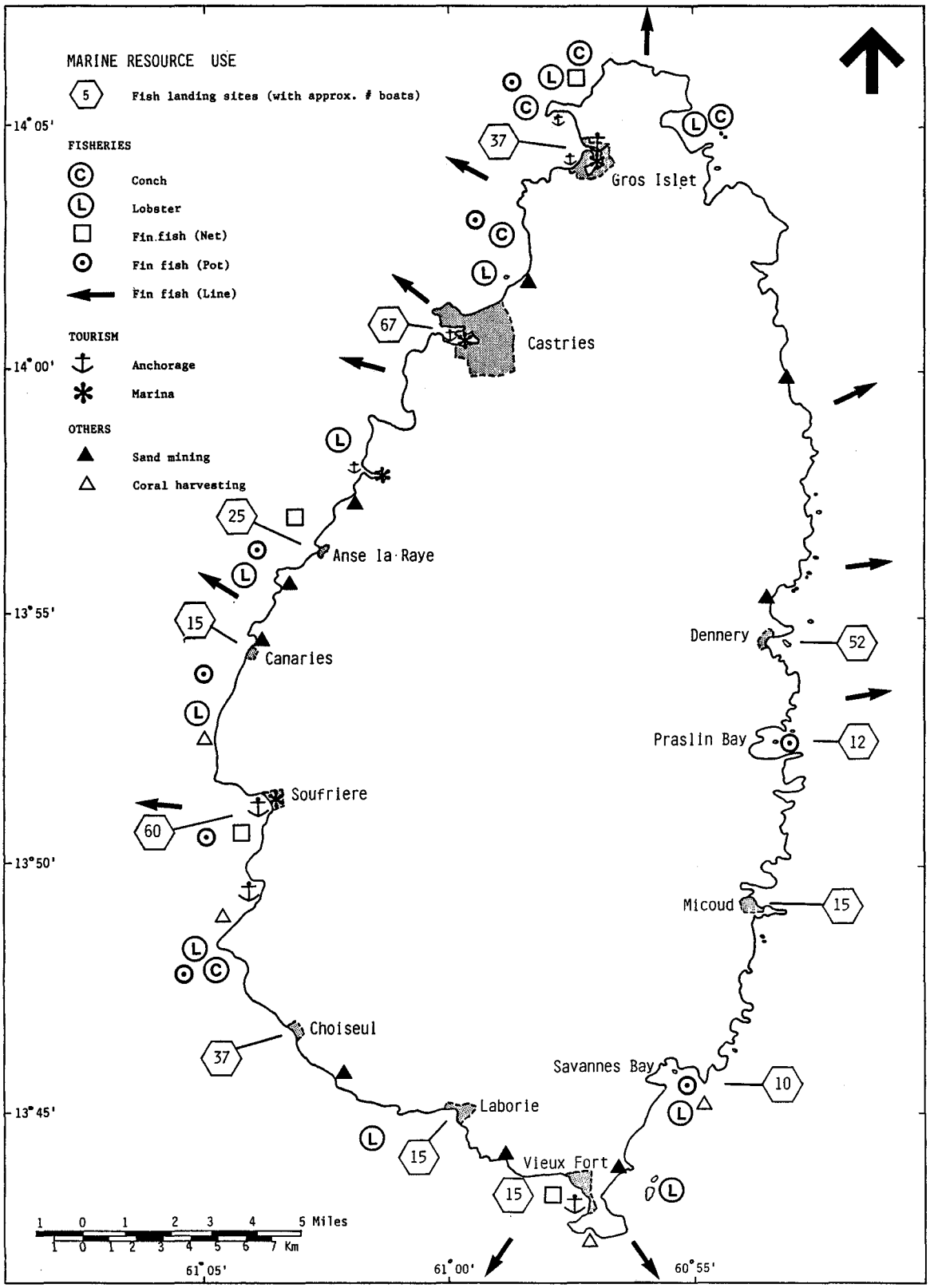


Figure 2.5(7). Distribution of coastal and marine resources, uses and facilities in St. Lucia.

economic activity contributed 33 percent of St. Lucia's GDP in 1978. Data are not available to establish the precise economic contribution of particular marine resources and associated commercial sectors, but concentration of tourist facilities along the coast and emphasis on water-related activities in promotional advertising are indicative of its considerable importance.

The nearshore marine habitats upon which many fishery resources are dependent (coral systems, seagrass beds, mangroves) also have potential for recreational activity -- diving, nature excursions, sport fishing, boating, and so forth. Actual tourist expenditures on coastal recreation are not known but are likely to be substantial; Laist, *et al.* (1986) report that recreational divers in the United States spent an average of US$ 1,151 per diving trip in 1983. Marine recreational activities often produce a broad spectrum of economic benefits through sales of fishing tackle, bait, ice, fuel, boat charters, marina services, diving equipment, guide services, etc. Furthermore, divers and sailors often favour guest houses or smaller hotels which have higher economic multipliers (see Section 4.1).

Many of these activities are not inherently extractive of natural resources and can actually complement resource management objectives if, for example, the added value (business income and tax revenues) associated with recreational tourism is viewed as an incentive for sound resource management. However, such activities may also exacerbate management problems. Popular dive sites, for example, frequently suffer significant damage from careless divers and anchors of visiting boats, effects that have already been reported at Anse Chastanet in St. Lucia.

Ports and Harbours. Major port improvements are being undertaken in Vieux Fort as part of an integrated industrial park development. Port facilities in Castries are also being expanded, with emphasis on tourism as well as commercial operations. The extent to which commercial and tourist-oriented port operations can co-exist remains to be determined, but there are already signs of conflict. For example, development of tourist facilities at Pointe Seraphine forces some of the larger freighters to use tugs when cruise ships are in port.

The Ministry of Communications and Works has recently established Rodney Bay, Marigot Harbour and Soufriere as "sport and leisure ports," a special designation which emphasises that they are preferred ports of entry for the yachting industry. The Air and Sea Ports Authority has been seeking ways of promoting the yachting-based industries, while separating yachting activities from the commercial operations of the Authority. With input from a Tourism Industry Advisory Committee, the designation of these new leisure ports is hoped to provide facilities for more expeditious entry and clearance of yachts and to encourage yachtsmen to spend more time and discretionary money in major shoreside attractions. Yachting industry spokesmen cite the co-operative attitude by customs and immigration authorities as a significant positive element in attracting a disproportionate number of yachts to St. Lucia from both Martinique and St. Vincent and the Grenadines.

Although port facilities at Castries and Vieux Fort provide essential infrastructure for principal economic sectors, they are managed as discrete income-generating operations; 1985 import and export duties are estimated at more than EC$ 26 million. GOSL revenue generation at this level increases the importance of the Authority's operations, which may naturally be seen by some interests as a significant factor in raising the cost of goods.

Marinas. Harbours at Soufriere/Pitons, Marigot, La Toc Bay, Choc Bay, and Rodney Bay are naturally attractive to visiting yachtsmen, and marinas have been developed at Marigot, Castries, and Rodney Bay. Available services (Table 2.5(2)) illustrate the extent to which well-designed marinas can become focal points for community activities, restaurants, shops, and residences. Direct and secondary economic benefits accrue through added employment, sales of boats and marine equipment, repair services, and opportunities for developing insurance and other financial institutions servicing marine industries.

Table 2.5(2). Yacht services in St. Lucia.

SITE	SERVICES PROVIDED						
	A	C/I	D	MS	RM	SF	YC
Rodney Bay	X	X					
- Trade Winds							
- Yacht Charters	X			X	X		X
- Stevens Yachts	X			X	X		X
- Rodney Bay Marina	X			X	X		
- Mako Watersports			X			X	
Pigeon Island/St. Lucian	X						
Castries Harbour		X					
Castries Harbour/Vigie			X				X
- Castries Yacht Center					X		
- St. Lucia Yacht Services				X		X	
Marigot Harbour/Moorings	X	X		X	X		
Soufriere Harbour	X	X					
Pitons	X						
Vieux Fort Harbour	X	X					

KEY:

A	Anchorage	D	Diving Services	RM	Repair/Maintenance
C/I	Customs/Immigr.	MS	Marina Services	SF	Sport Fishing
YC	Yacht Charter				

Despite these potentials, creation of additional marinas is constrained by the availability of suitable sites -- although development of ancillary yacht services is contemplated as part of the OAS-supported development scheme for Soufriere. Micoud Bay is a good harbour, but access is difficult and involves passage through the typically rough waters of the southeast coast. Marina development schemes occasionally rumoured for Savannes Bay have raised issues typical of concerns when such developments are proposed: competition with existing uses (artisanal fisheries in the case of Savannes Bay), loss of natural habitats through clearing and dredging, pollution from sewage and residues from maintenance operations (such as antifouling compounds).

Integrated Planning. These potential impacts are not inevitable but do pose a challenge to development planning. When the response is to ignore the challenge (i.e., through lack of integrated planning or by not establishing monitoring regimes), potential impacts become actual management problems. This is evident at Rodney Bay, where lots for private housing have been created adjacent to a commercial tourism and marina development. The result is that domestic sewage from homes and commercial establishments using septic tanks and soakaways is contributing significantly to deterioration of water quality in the marina and along adjacent beaches (Archer, 1985).

The growth of tourism guarantees that coastal resource development will be expanded. But the current approach in St. Lucia is to con-

sider each new project as an isolated activity. This trend toward "compartmentalized" development suggests a conceptual, structural planning problem already exists, one which increases the risk of user conflicts and adverse impacts and which can only be avoided through a more comprehensive approach to coastal resource planning and management and through the adoption of more formal environmental impact assessment (EIA) procedures as an antecedent requirement for all coastal and marine development projects.

A neglect of integrated planning is also evident in efforts to improve the fisheries sector. While St. Lucia does have a Fisheries Development Plan, which was approved by Cabinet in November of 1984 for the years 1984-1991, that document does not emphasise the need for integrated resource management in the fisheries sector. Rather, its bias is directed toward commercial fisheries development, most apparent in the inclusion of a framework for development of the Castries-based, CIDA-funded Fisheries Complex and for establishment of the St. Lucia Fish Marketing Corporation. The Plan was based on the recommendations of an earlier consulting report (North-South Intermedium, Ltd., 1984) and also includes components for training and organisational structuring of the FMU.

A variety of fisheries development projects have been implemented since the middle 1970's, including the IDRC/FMU sea moss project, a marine mechanic training project funded by the Co-operative Development Foundation of Canada, establishment of the CIDA-funded St. Lucia Fish Marketing Corporation Limited, and an island-wide programme to upgrade landing site facilities. These and a variety of other projects have been relatively successful in meeting specific objectives but will fall short of full potential without adequate consideration for long-term planning, project follow-up, and integration with more comprehensive marine resource management efforts.

For example, at present, it is not clear whether the FMU's mission is to increase the supply of inexpensive fish to the local population, or to provide attractive seafoods to tourist markets, or to generate income, or to expand exports to optimise foreign exchange, or to provide opportunities for local employment. Until the goals are better resolved, fisheries "development" will continue to be undertaken as a sequence of short-term, uncoordinated activities, an approach often fostered by technical assistance agencies.

The importance of coastal resources to economic development should logically stimulate greater concern for their maintenance. Paradoxically, however, increased attention has not been accompanied by increased understanding or concern. The present trend in St. Lucia has been to pursue coastal development as a series of unrelated activities on a site-by-site basis without regard for the inherent limitations or interrelations of important natural resources. This is not the only possible approach, but it has become the more customary pattern in St. Lucia.

RESOURCE MANAGEMENT PRACTICES AND CONTROLS

Among Eastern Caribbean nations, St. Lucia has been noteworthy in the establishment of planning and development control functions, enactment of environmental legislation, and the advancement of public and private sector initiatives promoting conservation. Yet a comprehensive natural resource management programme does not exist, and there is growing concern that coastal and marine resources, in particular, are at risk from human activity associated with development efforts. While a variety of management controls are available, they are not fully utilised. A 1986 OECS-sponsored workshop on environmental standards held in St. Lucia concluded that

> ... lack of appropriate environmental standards is not in itself a problem. Practical environmental standards could become a very decisive factor in decision making if depletion of a specific natural resource is seriously considered by the public, politicians and administration and if willingness is there and inputs available to tackle the depletion.

In the marine sector, even though some stocks (such as migratory pelagics) appear to be in no serious danger as yet, nearshore reef fishes, conch and spiny lobster urgently need to be conserved. Under the Fisheries Act of 1984, regulations have been enacted to provide a minimum trap mesh size of 45 mm, to provide a closed season and minimum legal size (95 mm carapace length) for spiny lobsters, to prohibit taking conch of less than 1 kg total weight, and to require permission from the Chief Fisheries Officer for sea egg harvest.

Efforts to initiate experimental management of coral systems have been undertaken through ECNAMP, Environmental Research Projects (ERP, a regional NGO), and the FMU with support from World Wildlife Fund-US. A training programme was conducted by ERP (1984-86) to acquaint FMU staff and volunteer divers with coral reef monitoring techniques, and a system for undertaking monitoring surveys has been established. Personnel shortages, however, restrict the regular application of these capabilities to one or two sites (Maria Islands and Anse Chastanet). With assistance from students of Cambridge University, the FMU recently completed a survey of nearshore marine habitats along approximately one-third of the leeward coast.

Procedures have not as yet been developed for regularly summarising, analysing, and distributing the data generated by these activities, nor for applying this information in strategies to actively manage reef resources. Management presently consists of efforts to control activities known to be detrimental and attempts to recognise changes in key habitats of particular concern. A framework does not exist within which monitoring information can be applied to improve these resources or for forward planning to avoid anticipated adverse impacts. Although St. Lucia is a signator to the Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, it has not yet developed and drafted the standards required under this Treaty.

Marine Reserves. A number of marine areas were officially declared as reserves in 1986 under the provision of the Fisheries Act; these are listed in Table 2.5(3) and located on Figure 2.5(8). Of the nineteen gazetted marine reserves, two had already been vested to the National Trust in 1982 (the reefs and seagrass beds adjacent to the Maria Islands Nature Reserve and the state-owned portion of the Savannes Bay mangrove). Overlapping authority for management of these two areas is shared by the Trust and FMU. The five designated marine reserve sites in the Soufriere area (Anse Mamin Reef, the reef between Grand Caille and Rachette Point, Anse L'Ivrogne Reef, the reef at Malgretoute, and the reef at Anse de Pitons) have been earmarked as a potential marine park under GOSL/OAS tourism initiatives currently in a planning phase for Soufriere.

Table 2.5(3). Areas declared as marine reserves in St. Lucia (15 October, 1986). Areas are displayed on Figure 2.5(8).

1	Cas-en-Bas Mangroves	10	Maria Island Reef
2	Esperance Harbour Mangroves	11	Anse L'Ivrogne Reef
3	Marquis Mangroves	12	Reef at Anse de Pitons
4	Grand Anse Beach and Mangroves	13	Reef at Malgretoute
5	Louvet Mangroves	14	Reef between Grand Caille and Rachette Point
6	Fond D'Or Beach	15	Anse Mamin Reef
7	Praslin Mangroves	16	Marigot Bay Mangroves
8	Savannes Bay Mangroves	17	Choc Bay Mangroves
9	Anse Pointe Sable-Man Kote Mangroves	18	Bois D'Orange Mangroves
		19	Rodney Bay Artificial Reefs

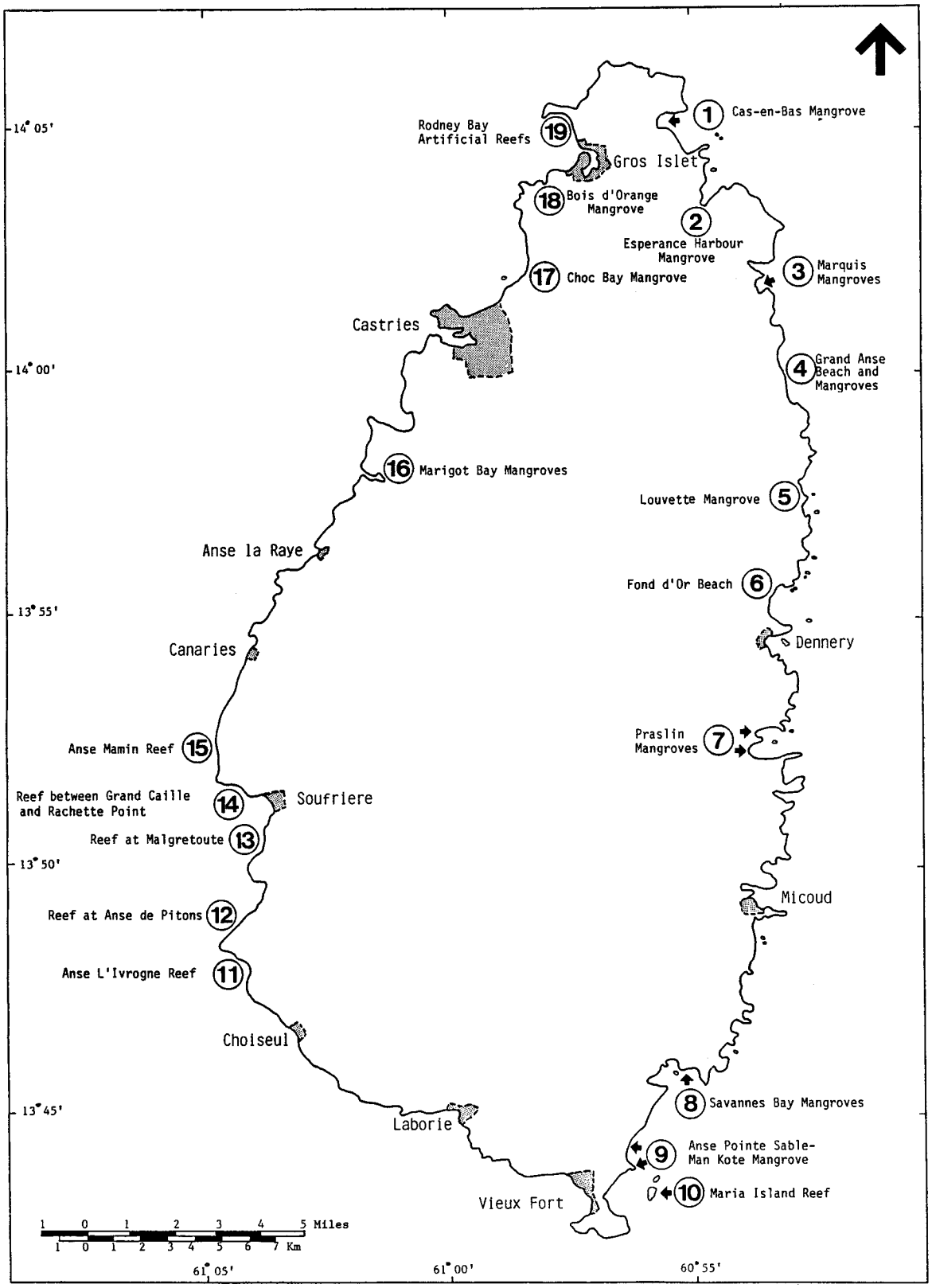


Figure 2.5(8). Location of declared marine reserves.

Very limited planning for the remaining 12 marine reserves has been carried out since 1986. Subsequent analysis of these sites by FMU has led to the conclusion that management requirements could be better served (in terms of the size of the resource base to be managed and the level of intrusion on traditional use of the resource) by limiting the size of the reserved areas. In effect, broad and undemarcated areas were declared "marine reserves," and now the boundaries of these areas have to be defined and specific management objectives outlined. Oversight/management authority for the reserves, including clear responsibility for monitoring and control, also need to be clarified.

The establishment of artificial reefs is an ongoing programme sponsored by the FMU. The artificial reef serves several purposes: for fish stock replenishment, as a recreational diving attraction, and as one method for dealing with solid waste disposal. To date four reefs have been created by the FMU:

(1) Reef at Rodney Bay, approximately 150 m south of Groyne at Pigeon Island with a maximum depth of 60 ft. First put in place in 1985 (using large metal cabinets donated by Cable and Wireless) and since expanded three times, most recently in April 1988. FMU officials say this is the most successful of the artificial reef experiments to date.

(2) Reef at Vigie Bay, one mile west of the Couples Hotel at the northern end of the Vigie Airport runway at a maximum depth of 50 ft. Also established in 1985 from large scrap metal (remains of barges), this reef is quite productive but less so than the reef at Rodney Bay; it is particularly important for lobsters.

(3) Reef at Anse Cochon, established in June of 1986 from an aging 400 ton cargo vessel deliberately sunk for the purpose of providing a structure for the reef (maximum depth of 65 ft). The site is important for juvenile lobsters and as a diving attraction.

(4) Two reefs at Moule a Chique, the first 270 ft. long with a maximum depth of 100 ft. Established in 1983 from a 4-5,000 ton cargo vessel with the assistance of local dive tour operators, the site has not been highly productive. The second reef is smaller, also with a maximum depth of 100 feet, established in 1984, and the least productive of all the artificial reefs.

FMU staff monitor the artificial reefs which have been particularly useful in attracting lobsters. Officials state that exploitation by fishermen is a problem and have proposed that the artificial reef sites be included in the next list of Marine Reserves gazetted under the Fisheries Act.

Available legislative controls are summarised in section 2.5.3. In theory, these provide the means for effective resource management, but full implementation of the regulations is impeded by a variety of circumstances that interfere with enforcement: for example, officials with requisite authority appear to avoid their responsibilities (particularly in rural areas); the Marine Unit of the Royal St. Lucia Police Force is constrained by limited mobility; enforcement is counterproductive to the mission of fisheries extension personnel; and inadequate communication systems prevent field personnel from reporting offences in time for violators to be apprehended.

The danger is that the existence of legislative controls and their occasional application creates the illusion that management is taking place. Similarly, measures taken to manage particular areas or a few species are important steps, but do not obviate the need to manage and plan the development of all resources.

Exclusive Economic Zone. The Draft Convention on the Law of the Sea provides that nations may declare exclusive economic zones (EEZs) or fisheries zones up to 363.6 km (200 nautical miles) from the territorial sea baseline in which the coastal state has sovereign rights. Such authority is granted for

the purpose of conserving and managing living natural resources for economic exploitation and for protecting and preserving the marine environment. In conserving fishery resources, states declaring EEZs are empowered to determine allowable catch and must grant other states access to any surplus in excess of the national harvest capacity. Though the Convention has not entered into force, some countries have already applied the EEZ provision, and a precedent thus exists for similar action by others (FAO, 1981).

While establishment in 1984 of an EEZ gave St. Lucia access to larger fishing areas (possibly with more extensive fishery resources) and greater control over management of these areas, such action also poses problems. The most obvious is delimitation of the EEZ boundaries since a 363.6 km (200 mi) EEZ for St. Lucia would overlap with similar zones for other Eastern Caribbean countries -- St. Vincent, Barbados, Venezuela, and the French dependency of Martinique. The complexities involved in negotiating the numerous requisite agreements could delay actual application of EEZ authority for some time.

Enforcement capability within its EEZ presents another problem; St. Lucia presently cannot provide adequate surveillance within its 19.2 km (12 mi) territorial sea. Furthermore, if the Convention eventually enters into effect, coastal states will be obliged to provide adequate management and protection for their EEZs; failure to do so could constitute a breach of international law. Regional co-operation offers the best management solution for all Eastern Caribbean states, but it is far from a reality at the present time.

2.5.2 Institutional Responsibilities

A large number of government agencies are responsible for coastal and marine resource management in St. Lucia, with no formal mechanism in place for programme co-ordination or overall regulatory control. A recent OECS report (Lausche, 1986) summarises the problem:

> ... there does not appear to be a statutory means whereby the sectors come together to deliberate on cross-sectoral ramifications and control activities that are counter-productive to the overall objective of maintaining a sound and safe coast. Thus, management of coastal natural resources is left to the case-by-case application of sector laws, which may have different and at times conflicting goals.

The principal institutions involved in coastal and marine resource management in St. Lucia are discussed in the next section.

Caribbean Environmental Health Institute (CEHI) -- Although a regional (CARICOM) institution, CEHI is the lead agency concerned with water pollution and water quality control in St. Lucia, a programme it carries out in co-operation with and on behalf of the Ministry of Health.

It is presently focused upon quantifying anthropogenic (man-made) inputs to coastal waters. Among the parameters being investigated are benthic community structure, bacterial pollution, concentrations of organochlorines and polychlorinated biphenyls, and development of monitoring capabilities for petroleum hydrocarbons. Results of its monitoring activities in St. Lucia are transmitted to the Ministry of Health, which is responsible for distribution to relevant ministries and departments. While CEHI's mandate is regional, much of its work takes place in St. Lucia. Because of this, the Institute provides unique technical services to GOSL that would otherwise be unavailable.

Ministry of Agriculture, Lands, Fisheries and Co-operatives -- The lead agency within this ministry concerned with marine resources is the Fisheries Management Unit (FMU), responsible for promoting the fishing industry, as well as for managing fishery resources. The latter authority extends to regulating the harvest of virtually any marine species as well as advising the Minister on the designation of marine protected areas.

Ministry of Communications, Works and Transport -- This Ministry has primary responsibility for issuing sand mining permits, but "permission" reportedly is also granted by local village councils in their exercise of control over beaches located within territorial boundaries. It also exercises oversight over the Air and Sea Ports Authority and establishes ports of entry. The Ministry additionally is charged with the development and maintenance of major infrastructure, including that constructed within the coastal zone.

Ministry of Health, Housing, and Labour -- Responsibility for monitoring water quality falls to the Ministry of Health under the general health and safety provisions of the Public Health Act of 1975. The Water and Sewerage Authority within the Ministry has broad powers for water conservation and waste management (including standards for hotel sewage disposal systems), but regulations for this authority have not been enacted.

Ministry of Trade, Industry, and Tourism -- The Parks and Beaches Commission is responsible for maintaining beach facilities and public parks, prescribing sanitary conditions in these areas, and may advise the Minister on matters related to beach erosion. The Tourist Industry Development Board has broad powers to promote and develop amenities related to tourism and might logically spearhead an integrated programme of coastal resource development and management.

National Trust -- Authority for managing national parks and reserves has in some instances been delegated to the National Trust by Government. The Trust is responsible for management of the marine components of the Maria Islands Nature Reserve and the Pigeon Island National Park and for the Savannes Bay Marine Reserve.

Air and Sea Ports Authority -- This agency is responsible for developing and managing St. Lucia's sea port facilities, especially at Castries, Vieux Fort and Cul de Sac.

National Development Corporation -- NDC is charged with the promotion of investment and industrial development in St. Lucia. In this capacity, the Corporation represents the Government's holdings in several development enterprises, including the Point Seraphine Cruise Ship Terminal, the St. Lucia Fish Marketing Corporation, and Rodney Bay Limited (a real estate corporation responsible for development of the Rodney Bay Lagoon area). The Corporation also owns approximately 6,000 acres in Vieux Fort, probably the largest single tract in the coastal plain.

In aggregate, these agencies and their various mandates provide a solid basis for managing coastal resources. In practice, however, effectiveness is limited by inadequate coordination and cooperation, a lack of regulations under authorising legislation, inadequate enforcement (often left to local police who are not specifically trained or for whom such activities are not a priority), and penalties that are insufficient to deter repeated offences.

These problems are typified in the Fisheries Management Unit, whose personnel are responsible for enforcing fishery regulations, acquiring and interpreting biological data for management, monitoring critical marine habitats, and implementing fisheries extension programmes to improve the fishing industry. Aside from the obvious operational conflict of attempting to simultaneously collaborate with fishermen while enforcing restrictive legislation, the FMU faces personnel shortages due to off-island assignments, woefully inadequate physical facilities, and no clear directives as to level of priority that should be assigned to its varied missions.

Th lack of co-ordinated programme planning and implementation in St. Lucia's marine sector has resulted in ad hoc development of the resource base, lack of accountability by both resource developers and resource managers, and the execution of isolated programme agendas by responsible GOSL resource management agencies. These problems are compounded by the fact that some agencies (for example, the Port Authority) operate autonomously and are difficult to influence because of the economic importance of the sector for which they are responsible.

2.5.3 Relevant Legislation

Primary legislation pertinent to marine resources in St. Lucia includes (Lausche, 1986):

Water and Sewerage Authority Act (1984) -- grants broad powers to the Water and Sewerage Authority (Ministry of Health) for water conservation and protection of watersheds, and for preparing, constructing, operating and maintaining sewage disposal facilities throughout the country.

Pesticides Control Act (1975) -- establishes a Pesticides Control Board to prepare and enforce regulations to control use of pesticides, including excessive application or accidental spills which can result in pesticide absorption by marine organisms in coastal habitats (if the chemicals are carried by streams or rivers to the sea).

Tourist Industry Development Act (1981) -- establishes a Tourist Board with powers to promote and develop tourism including coastal amenities that may attract tourists.

Parks and Beaches Commission Act (1983) -- establishes a Parks and Beaches Commission overseen by the Ministry of Tourism to maintain facilities in public parks, gardens, and beaches for tourism; the Commission may also advise the Minister on matters related to coastal erosion.

Beach Protection Act (1967) -- assigns responsibility for controlling sand mining to the Ministry of Communications and Works and provides penalties for offenders.

Fisheries Act (1984) -- provides for creation of marine reserves, fishing priority areas, aquaculture sites, and regulations for fisheries management; recently approved regulations include protection for sea turtles, minimum size limits for spiny lobster (95 mm carapace length) and conch (1,000 g total weight); closed season for lobster, and licencing requirements for harvesting sea eggs, corals and sponges.

The thematic range of these instruments is relatively broad and covers major coastal resource management concerns. Specific legislation (such as the Water and Sewerage Act, Pesticide Control Act, Beach Protection Act, Fisheries Act) delegates regulatory powers to specific agencies, but without clearly defined lines of responsibility or enactment of enabling regulations, administrative overlap or conflict may occur. More likely, there will be gaps in regulatory authority, resulting from the assumption that "another" agency has responsibility.

2.5.4 Problems and Issues

Problems with coastal resources per se result primarily from impacts of human activities that adversely affect the quality of these resources. Overexploitation, water pollution, coastal erosion, sediment loading, and mechanical damage are discussed below. Equally serious, however, are the issues emerging from institutional responses to these problems.

ENDANGERED AND THREATENED SPECIES

All marine turtles are considered endangered by IUCN. Four species of sea turtle are known to exist in the waters of St. Lucia: the green (*Chelonia mydas*), the hawksbill (*Eretmochelys imbricata*), the leatherback (*Dermochelys coriacea*), and the loggerhead (*Caretta caretta*) (d'Auvergne, 1984). It is known that for one beach a minimum of 12 leatherback turtles nest on St. Lucia (d'Auvergne, Murray, and Sparks, in press), although it is estimated that as many as 29 may actually do so (Murray, 1987).

Hawksbills nest to some extent on nearly all St. Lucia beaches (April-October); leatherbacks are largely confined to the east coast where their main nesting site at Grande Anse has been badly damaged by sand removal, and turtles are reportedly illegally killed and their eggs taken (Corke, 1987b). Loggerheads and greens nest less frequently (Carr, *et al.*, 1982). Expanded, more rigorous monitoring would undoubtedly reduce mor-

tality levels, as would the example of prosecution of poachers.

For these and other species, the FMU has established a management programme to: (a) determine species distribution; (b) gather biological data; (c) determine the extent of exploitation; and (d) develop management measures (d'Auvergne, 1984). Fisheries regulations prescribe minimum legal sizes and a closed season, but survival prospects for these species in St. Lucia would be improved by an extended closed season of up to a minimum of two years. The impact of nesting habitat loss due to beach destruction or tourist-related activities has not been adequately evaluated, but is likely to be increasingly serious as coastal development continues.

Queen conch (*Strombus gigas*) are classified as "economically threatened" by IUCN, and fishing is regulated under existing legislation. As noted above, fishing pressure on these stocks is likely to increase, and the levels of depletion observed in other countries is a distinct possibility. Recently enacted fishery regulations provide for management options that include minimum size and closed seasons.

The human component of the coastal/marine ecosystem also faces a variety of development-related risks. Cultural pressures on traditional fishing villages, intensified by increased exposure to tourists and North American and European media, threatens the social fabric of many coastal communities in St. Lucia. Deterioration of marine habitats due to conflicting use of the coastal environment jeopardises the economic livelihood of many who traditionally earned their living from the sea. And finally, inadequate safety standards continue to threaten the lives of artisanal fishermen as well as an increasing number of recreational boaters.

COASTAL WATER POLLUTION

Although quantitative pollution assessments in the wider Caribbean region are constrained by the absence of reliable data, sufficient information is available to link moderate bacterial sewage pollution with serious health problems (Rodriguez, 1981). For example, more than thirty cases of typhoid were linked to freshwater pollution by sewage in St. Lucia during the spring of 1987. Higher levels have been associated with fish kills in Jamaica (Wade, 1972 and Rodriguez, 1981). The absence of extensive site specific information prevents quantitative comparison of pollution in the Caribbean with that of other areas, but enough isolated data is available (CEHI has data on some locations in St. Lucia, for example) to indicate a growing problem and need for more stringent control of polluting activities.

The following pollution sources should be monitored in St. Lucia:

(1) **Agricultural chemicals and non-point source pollution.** Pesticide monitoring in Castries Harbour and Vigie/Choc Bay conducted by CEHI in 1984 showed levels of Lindane and PCB (Arochlor 1254) three to four times higher than presumed background levels measured at Cas en Bas, but still well within permissible levels for these chemicals. Additional monitoring at these and other sites in 1986 showed a reduction in pesticide levels at Castries Harbour, and concentrations at other sites were far below critical limits and generally below those found in coastal waters of North America. The scope and frequency of the sampling regime, however, was very restricted and remains to be upgraded to more regular, comprehensive, and anticipatory data gathering for environmental management decisions.

In January 1985, a fish kill reported in the Ganter's Bay area (off Castries Harbour) was believed to have been caused by dumped washings from a pesticide container. Analyses of seawater and tissue samples from dead fish revealed contamination by a fungicide containing thiophanate-methyl. Concentration in fish muscle tissues from the site was 100 times greater than that in clean reference seawater samples. Coral reefs are particularly susceptible to the adverse impacts (i.e., algal overgrowth) resulting from such nutrient enrichment, which can also be caused by municipal waste water and septic tank discharge as well as run-off from dump sites, rivers and streams containing agricultural fertilisers.

(2) **Sewage.** Sewage collection systems in St. Lucia generally discharge directly into the sea without treatment. The Rodney Bay area is one exception, with the St. Lucian Hotel and the developed housing areas of Rodney Bay being serviced by a treatment plant located at the St. Lucian Hotel. Recently, the plant was upgraded with the addition of two aeration pumps so that it can better cope with the anticipated increase in housing and tourist developments. The treated effluent is discharged through an outfall pipe into Rodney Bay. A Rodney Bay Ltd. spokesperson maintains that the plant is meeting Ministry of Health and WASA requirements, although this does not account for periods of power outages when pumps are not functional and untreated effluent may be discharged.

Several other island hotels have package sewage treatment plants, but operating efficiencies, breakdown histories, and effluent data are all undocumented, although some of these management problems have been informally reported to CEHI.

CEHI monitors selected sewage treatment facilities and especially their discharge areas. At Rodney Bay, Reduit Beach, and Marigot Bay, for example, it has detected fecal bacteria concentrations within EEC limits for recreational water quality, except on Reduit Beach in the vicinity of Gros Islet. Human excreta are common on Gros Islet beach and the shore at Vieux Fort. (See also Section 4.2.2.)

The impact of sewage from yachts in marinas appears insignificant. While fecal coliform counts are relatively high in the marina at Rodney Bay lagoon, the primary source is from housing developments upstream; the Fairview Ravine is a major source of sewage pollution. An expanded and improved treatment facility is needed in the lagoon area. However, a Waste Water and Waste Treatment Management Plan for the entire area, including Gros Islet, should be completed first in order to properly address various design, sizing and siting questions vis a vis any treatment plant.

(3) **Industrial waste.** Industry in St. Lucia is light and not heavily water intensive (see also Section 4.2.(2)). Archer (1984) estimated that 534,500 cubic metres of waste and waste water are discharged annually from distillery, brewery, soft drink, dairy products, edible oil and margarine, soap, coconut meal, and meat products operations. The primary effects of these water-borne wastes is to increase biochemical oxygen demand and suspended and dissolved solids, making the receiving water murky and prone to excessive algal growth.

(4) **Solid waste.** Archer (1984) identified storage, collection, and disposal of refuse to be serious problems in St. Lucia and throughout the Eastern Caribbean (see also Section 4.2.2). Disposal is by open dumping and periodic burning or by dumping into rivers and the sea. The former approach (as at Choc Bay where dump management is quite unsatisfactory resulting in fires, smoke, odors, and loose trash) causes disposal areas to be major breeding grounds for flies and mosquitoes, while the latter directly pollutes coastal waters. Garbage, agro-industry wastes (especially bananas), and garden refuse account for 72 percent of the total solid waste load. Solid waste management clearly is for St. Lucia a serious, unresolved, and growing environmental problem in nearly all coastal areas where tourism, residential housing, industry, commerce, and recreation are all concentrated.

The contribution of recreational boating and commercial shipping to solid waste contamination in St. Lucia is unknown, but plastic bags used in the banana industry are frequently found close to and on shore. Beaches on the windward coast are chronically strewn with a variety of plastic debris and heavy fishing nets washed ashore from unknown sources. Similar contamination from commercial shipping is an increasing problem in other coastal areas. Increasingly, this sort of debris is being linked to injury and death of marine mammals and turtles (Gentle, 1987; Davis, 1987; Coleman, 1987). Considering that very few ships have any means of solid waste processing (e.g., compactors) overside disposal is a virtual certainty. At present, there are no controls on waste disposal from

ships within territorial waters (12 miles) or even while in port.

(5) **Petroleum.** Tanker traffic and the Hess Oil Storage Terminal at Grande Cul de Sac Bay offer the potential for catastrophic pollution through a major spill or accident. The dimensions of such a disaster are increased by virtue of the fact that Cul de Sac Bay is exempted from GOSL's Oil Spill Contingency Plan (see also Section 4.2.2).

This potential has been the focus of contingency planning by the Caribbean Disaster Preparedness Committee, the Caribbean Marine Pollution Research and Monitoring Programme under UNESCO's Intergovernmental Oceanographic Commission, and the International Maritime Organisation. Additionally, a variety of activities contribute to low-level petroleum contamination, including cleaning of storage tanks, run-off from roadways, losses during transfer operations, and at-sea discharge from shipping (tar balls on beaches along the windward coasts provide ample evidence of the latter). CEHI is now monitoring both beach tar and petroleum hydrocarbons at several locations around St. Lucia (D. Shim, CEHI, personal communication).

While the negative impacts of major oil spills have been documented, there is little information on the long-term effects of chronic low-level discharges of petroleum in the coastal zone. These effects may pose as significant a threat as a major spill. Archer (1984) cites devastation of mangroves, coral reefs and fisheries within the Gulf of Paria and of mangroves on the northwest coast of Antigua as indicative of the problem. While these sites are not directly comparable to St. Lucia, they provide clear indication that chronic non-catastrophic (and therefore ignored) pollution is linked to adverse impacts in the marine environment.

COASTAL EROSION, SAND MINING AND DREDGING

In any discussion of coastal erosion and sand mining, it is helpful to understand that (1) coastal erosion is normal but can be greatly accelerated inadvertently and (2) beach sand is both a renewable/non-renewable resource, depending on the beach. These issues are at the heart of management policies and practices. Theoretically, management practices should be determined at the micro-level, i.e., what is the sand productivity rate and loss rate at *this* point and what is the sustainable yield, *if any*. Because of rising sea levels and in the absence of convincing evidence of a major "exportable surplus" at a *given site*, sand generally should be treated as a *non-renewable* resource complete with *"severance taxes"* to the State.

Sedimentation due to coastal erosion caused by sand mining and to a lesser extent dredging (major dredging projects in St. Lucia have been completed) is one of the most pervasive threats to St. Lucia's nearshore marine environments. Suspended sediments reduce the amount of light needed for photosynthesis and can exert an oxygen demand which may stress reef species at night. When suspended particles settle, they can reduce shelter and food supply for bottom feeders, interfere with filter-feeders, silt over spawning beds, and smother reef organisms. Reduced light intensity is probably less damaging than smothering effects. Anaerobic conditions may result, with the effects similar to those described for sewage. Resuspension of bottom sediments can carry adsorbed heavy metals, pesticides, and other chemicals into the water column.

At Rodney Bay, siltation has reduced the average lagoon depth by three feet in 12 years (Archer, 1985). Heavy sediment loading has been reported at a number of reefs along the west coast. Reefs in the vicinity of river mouths are particularly vulnerable to increased sediment loads due to upland construction as well as run-off containing agricultural chemicals. Roberts (1972) reported that in 1969, *Diploria clivosa* and *Porites astreoides* were the chief contributors to reef growth in the vicinity of the Maria Islands. Eleven years later, Goodwin (1984) found *D. clivosa* to be a minor component of coral communities in this area. Sedimentation was suggested as a probable cause, as *D. clivosa* is known to be sensitive to chronic sediment loading (Rogers, 1983), and sedimentation rates measured in the area during 1983 were high enough to affect some coral species.

Beach loss is caused primarily by sand mining and wave erosion (see also Section 4.2.2 on "Sand Mining"). In 1970, 17,810 tons of cement were imported and used in concrete that consumed an average of 110,000 cubic yards of sand extracted from local sources for the period 1969-70 (Deane, *et al.*, 1972). In 1984, cement imports had increased to 21,713 tons, requiring 134,000 cubic yards of sand. While the official policy of the Ministry of Communications and Works is to restrict sand mining to river mouths, significant extraction of sand has been reported from beaches as well (Cambers, 1985; DuBois, 1985). In any event, sand from rivers also contributes to maintenance of beaches, and its removal means that less is available to replenish losses to erosion.

Beach sand has traditionally been used in the construction industry in St. Lucia, but it was not until World War II, with construction of the Vigie Airport runway and of U.S. military bases, that demand for sand increased significantly. Vigie and Choc beaches were mined extensively from 1942 until 1969 when both beaches collapsed under the impact of normal winter swells (during the period 1960-62, they accounted for perhaps 90 percent of all sand mining). By 1969-70, mining activities had shifted to Reduit (12%), Anse La Raye (28%), Dennery (8%), and Black Bay (48%), which together contributed 96 percent of the total. Since then, although attention shifted away from weakened beaches at Vigie, Choc and Reduit (and despite implementation of the Beach Protection Act), sand mining activities have persisted in response to the demands of an expanding construction industry, notably at Dennery (both Fond D'Or and the Dennery Village), Anse La Raye, and Vieux Fort (Black Bay/Pointe Sable). Major new sources have developed in the north, including Anse Lavoutte, Esperance, and Grand Anse (Williams, 1985a).

Beaches at Cas En Bas, Comerette, Anse Canot, Micoud, Cocodan, Black Bay, Anse Noir, Choiseul, Anse L'Ivrogne, Malgretoute, Canaries, and Marisule have experienced beach erosion, while beaches at Fond D'Or, Urbain, Piaye and Anse la Raye also show signs of increasing instability due to sand mining. Grand Anse beach, the largest in St. Lucia, is now experiencing severe structural instability (Devaux, 1987b).

Beach loss is also evident in the Rodney Bay area. Wind-driven waves approaching the east coast of St. Lucia are refracted around Cap Pt. and Pigeon Island to impact the shore in Gros Islet Bay. The Pigeon Island causeway effectively blocks the flow of sand from north to south that would otherwise be transported by incoming waves. As a result, erosion is evident close to Pigeon Island along the north causeway, opposite the "Banana Split" at Gros Islet, and off the St. Lucian Hotel on Reduit Beach.

Major dredging operations in St. Lucia have been carried out at Vieux Fort, Castries Harbour, Cul de Sac, Rodney Bay, Vigie Beach, and Pigeon Island. Sand mining and dredging at Vigie Beach have caused serious damage to coral and algal communities in the area. Similar communities in the vicinity of Pigeon Island have been destroyed by extensive dredging associated with construction of the causeway linking Pigeon Island to the mainland. With adequate planning these impacts could have been reduced, and the costs for restoration eliminated.

For example, one study (DuBois and Towle, 1984) estimated that the total investment of public funds to protect and restore Vigie Beach following long term beach sand extraction was US$ 469,245. Since sand cost US$ 1.87 per yard in 1980 to replace on the beach, the overall restoration costs represent slightly more than twice the adjusted market value of the sand previously removed, legally and illegally. There was a costly lesson for St. Lucia in beach dynamics and resource management (see also Williams, 1985a).

OVER-FISHING

Data on maximum sustainable yields of offshore oceanic fishes are not available, although work done by Oxenford (1985; Oxenford and Hunte, 1987) suggests that at least one species (dolphinfish) is not presently threatened by fishing pressure. While St. Lucia fisheries officials feel that the situation is similar for other migratory pelagic species,

they also note that fishing mortality of wahoo increased between 1982 and 1983 (Murray and Sarvay, 1987). Work is in progress to determine recent effects of this trend.

Catch per unit effort of species captured during the "high" season ranges from 22.7 - 50 kg per fishing excursion. There are no apparent indications of overexploitation among these species, but improvements to marketing and expansion of fishing fleets planned for Barbados, Grenada, St. Vincent, St. Lucia, and Dominica can reasonably be expected to greatly increase the fishing pressure on these stocks. In addition, the same stocks are being targeted by commercial fishing vessels from non-Caribbean nations. The present trend of expansion without regard for probable carrying capacity jeopardises the fishery resources as well as economic investment in the fishing fleets.

Catch per unit effort of species targeted during the "low" season ranges from 4.5 - 13.6 kg per excursion and appears to be declining with increasing fishing effort (Murray 1985). Maximum sustainable yield (MSY) in this case appears to be between 336,364 and 350,000 kg per year at an optimum fishing effort between 12,000 and 17,000 excursions per year for demersal fishes (i.e., present landings of 273 - 364 tonnes per year are close to MSY). Species targeted during this period include both reef fishes and "bank" species. Because the latter appear to be only lightly exploited, reef stocks are probably more severely overfished than the above figures would suggest.

Management measures under consideration for these stocks include enforcement of larger minimum mesh sizes in fish traps and possible restriction or prohibition of the use of gill and trammel nets. Diversion to underutilised stocks may help to alleviate the impact of such restrictions on fishermen.

While the status of spiny lobster and conch stocks is not known, these species are considered to be exploited at or beyond maximum sustainable levels in most countries of the region. Considering the expanding pace of tourism development and the resultant demand for fresh and exotic seafood, it seems probable that a similar situation exists in St. Lucia, an impression borne out by reported fluctuations in landings during recent years.

Overfishing of sea eggs (sea urchins, *Tripneustes ventricosus*) is believed to have contributed to a sharp decline in population size following hurricane Allen in 1980. Some recovery has been noticed in recent years, and recently enacted fisheries regulations (1987) prohibit harvest of this species without permission of the Chief Fisheries Officer. A study of the dynamics of populations on the north, northwest, southeast and south coasts of St. Lucia is being carried out by ECNAMP and the Fisheries Management Unit to provide the basis for future management.

Sea moss harvest is not regulated and occurs throughout the year when water conditions allow access. Plants are collected by walking along the shore and picking them from rocks or by free diving on shallow reefs. Although the practice is discouraged by the FMU, in most cases the harvester pulls the entire plant from the substrate, preventing regeneration. Because recruitment rate appears low for many sea moss species, this harvesting technique is believed to be the primary cause of an observed decline in wild stocks.

Overfishing has not yet been seen by fishery policy makers to pose serious problems for St. Lucia. This can be attributed to two factors: first, the absence of information adequate to identify specific problems, threats, or advance signals of a collapse and, second, the relatively high landings of migratory pelagics in the first six months of the year seem to indicate that these resources have potential for years of further exploitation, even with the use of improved fishing techniques. But Hunte (1986) has cautioned that pelagic stocks "... are susceptible to collapse [and] ... we must control our increases in fishing effort prior to the point of stock collapse."

OTHER IMPACTS

All nearshore marine environments are subject to periodic perturbations from storms which are most severe in shallow waters. For example, damage to coral and seagrass

SEA MOSS CULTIVATION

As in many islands, a variety of red seaweeds known as "sea moss" are harvested in St. Lucia from wild stocks and used in the preparation of drinks and puddings.

The following species are utilised in St. Lucia:

Gracilaria cervicornis (Turner.) J. Agardh
G. cornea J. Agardh
G. crassissima (P. & H. Crouan in Chramm & Maze)
G. domingensis Sonder ex Kutzing
Gracilaria sp.(subgen. Gracilaria)
Grateloupia filicina C. Agardh.

Much of the collection takes place on the northeast, southeast, and southern coasts of the island. The raw weed is washed, sun-dried, and sold locally or exported to neighbouring islands such as Barbados or Trinidad and Tobago. In St. Lucia, the product is sold for approximately EC$ 8 per pound, but smaller quantities fetch the equivalent of EC$ 16 per pound with 30-50% moisture content.

Cultivation methodology has been described by Smith (1986b) and Smith, *et al.* (1984 and 1986). Plants are cultured on polypropylene ropes (which are buoyant) strung across floating bamboo rafts (2.5m x 1.5m) anchored in 1 - 2 m of water in bays with good water exchange and some protection from heavy wave action. Rafts hold 6 - 10 lines (each 2.5 m in length) and cost EC$25.00 each. Preliminary data indicate that harvests average between 100 and 120g/m of line dry weight after ten weeks' growth. Harvested plants are washed and sun-dried. The cultivated product is cleaner than plants harvested from wild stocks, and sells locally for EC$4.00/100g (return from a six-line raft = EC$60/per harvest).

habitats was reported following hurricane Allen (Rogers, 1985). Changes in the direction of prevailing winds and waves, associated with cyclonic storms, can completely alter beach configuration in less than a day. Because these are unusual circumstances, the resulting changes may persist for many years.

Mechanical damage caused by man can take place in much deeper waters that are normally protected from this type of stress. Damage from divers and fish traps is a particular concern at Anse Chastanet and the Pitons area. Anchor and anchor chain damage to reefs and seagrass beds from recreational boating has not been quantified, but has been enough of a problem in other areas (for example, the Florida Keys, Virgin Islands, and Netherlands Antilles) to stimulate installation of permanent moorings (Robinson, 1987). Other threats to coral systems include fishing with explosives and collection of live corals for sale as curios.

2.5.5 Directions for the Future and Policy Recommendations

The potentials and concerns described above define the agenda for effective management and development of coastal resources in St. Lucia. To a large extent, optimal development depends upon a continuous flow of information on the status of marine resources and their response to development efforts. Monitoring and data collection activities needed to provide this information are dis-

cussed below. Even more important, however, is the capability to put such information to effective use.

MONITORING AND DATA COLLECTION

Information needs related to monitoring and data collection are summarised in Table 2.5(4). Major deficiencies have been identified for water quality monitoring, marine habitat inventory, critical habitat monitoring, and fishery stock assessment. Local technical capability exists to meet these needs, but deficiencies are likely to persist because of limited personnel and financial constraints. These limitations are appropriate targets for development assistance efforts, but such help should be co-ordinated by and provided through indigenous institutions rather than external consultants. Volunteers have been used to assist the FMU in implementing its coral reef monitoring programme, and this approach could be useful in other projects provided the monitoring regime is tightly designed and people and data are efficiently managed.

Under the supervision of CEHI, long-term water quality monitoring programmes are being carried out by the Ministry of Health at Castries Harbour and Rodney Bay, while short-term monitoring programmes have been established for Vigie/Choc Bay, Reduit Beach and Smuggler's Cove. Baseline surveys of water quality of selected coastal areas have also been conducted and reported on by CEHI, including:

Table 2.5(4). Monitoring and data collection needs in the marine sector.

AREA OF CONCERN	INFORMATION NEEDED	CURRENT ACTIVITY
Loss of Habitat	Dimensional changes of major habitats (e.g., seagrass); changes in species diversity; changes in indicator species status	None
Reefs and Coastal Fisheries	Same as Above	Monitoring at Anse Chastanet and Maria Islands (FMU); benthic community structure at Castries, Vigie, Rodney Bay and Reduit (CEHI)
Turtles	Status of nesting and nesting beaches	None
Overfishing	Stock size; condition; sustainable yield	Catch-effort for some species (FMU); sea egg population dynamics (ECNAMP and FMU)
Water Pollution	Concentration of bacteria, nitrates, phosphates, metals, pesticides, petroleum; source? cycle?	Bacteria, organochlorine, PCB analyses at selected sites (CEHI)
Erosion and Sediment Loading	Soil loss; sediment input to major habitats; source?	None

- Castries Harbour (1982-84)
- Vigie/Choc Bay (1982-84)
- Cas En Bas (1983-84)
- Rodney Bay Marina (1985-86)
- Reduit Beach (1985-86)
- Marigot Bay (1985-86)
- Soufriere (limited survey of coastal waters, 1982)
- Vieux Fort (limited survey of coastal waters, 1982).

Present water quality monitoring sites should be extended to include all coastal waters, with the site-visit sampling frequency adjusted proportionately to the levels of public use and risk at any given bay.

A comprehensive coastal habitat inventory has been proposed for several years by the FMU but still awaits funding. Periodic monitoring in major habitats should include percentage of live and dead cover, identification of major benthic species, water temperature, and transparency. If possible, estimates should also be made of sediment loading and dominant fish species. Beach monitoring should include the profile and dimensions of the beach from low water line to the primary sand berm or dune, slope, and relative extent of human use.

Monitoring activities would be particularly useful if they were targeted toward developing indices of ecosystem quality. Admittedly, this is not easy. O'Connor and Dewling (1986) suggest five criteria to be applied to potential indices of marine degradation (that apply equally to "health" or "quality"):

(1) characteristics should be measured that are of interest to people and their governments;

(2) measured characteristics should be easily understood by laymen (that is, the public, managers, and policy makers);

(3) indices should be scientifically defensible;

(4) indices should be quantitative;

(5) measurements should be cost effective.

Rational fisheries development plans require reliable estimates of available stock sizes. This is particularly true for spiny lobster, deepwater demersal, and migratory pelagic resources. An improved fisheries data collection system was recently proposed for St. Lucia to allow catch and effort information to be collected (Murray, Charles, and Mahon, 1987). The proposed system, like an earlier study (North-South Intermedium Limited, 1984), emphasises catch/effort data in preference to stock assessments and research, although the collection of catch/effort data has not proven to be a particularly effective technique for determining the status of fishery resources. Catch/effort data are useful for management and planning purposes when these data are integrated into a research programme directed toward producing competent stock assessments. Such assessments are particularly important in the Eastern Caribbean where many fishery stocks have been shown to be easily overexploited.

OTHER RECOMMENDATIONS

Marine Resource Development Plan. The need for integrated national goals for the marine sector in St. Lucia, combining resource management and resource development objectives, has been identified as an area requiring new public policy initiatives in St. Lucia. To this end, a multi-agency effort should be undertaken to prepare a "Marine Resource Management Plan" in much the same way that a Forestry Management Plan was developed for that sector.

It should be noted that too often national development plans (with an economic focus) and national conservation strategies (with an environmental focus) are prepared as separate endeavors, an approach that will perpetuate the segregation of economic development and natural resource management. The proposed Marine Resource Assessment and Management Plan should focus on the growth potentials represented by the country's marine resources and identify activities, including traditional enterprises, that will contribute to the

sustainable development of these resources. A national focus is preferred to the present site-by-site development approach. A review of legislation on effluent standards and a plan for improving coastal environmental monitoring capabilities should accelerate the development of EIA procedures.

Fisheries Development. Available information suggests that currently utilised fishery resources are not sufficient to warrant major investment in greater harvest capability. Management efforts should focus on stabilising the trend of declining landings and optimizing the harvest of species important to local nutrition and tourism. Development of fisheries for new stocks should be scaled to probable yields as determined through exploratory activities. Pilot-scale efforts should be directed toward potentially underutilised stocks (e.g., sharks, deepwater bottom fishes, squids, octopi). Hydraulic hauling equipment is needed to exploit deepwater resources.

There is probably some potential for new mariculture ventures. Simple cage culture techniques for jacks, drum, and bass have been applied on a small scale in Martinique and appear promising. The most suitable sites for this type of culture are also those favoured for marina operations, although the two activities are not mutually exclusive. Culture of oysters in mangrove areas (e.g., Savannes Bay) has been suggested for many years, and has been attempted in Jamaica. Protected grow-out of spiny lobster juveniles, abundant in the shallow waters of the southeast coast, is a similar opportunity that has resulted in activity in Grenada and Antigua.

It is stressed that the initiation of aquaculture ventures in other islands does not validate similar activity in St. Lucia; nor does the failure of technically sound ventures elsewhere necessarily mean that such ventures will fail in St. Lucia. These options (as is the case for all mariculture ideas) should be evaluated by competent professionals through small-scale pilot projects before extensive financial or human resources are committed.

Coastal Zone Management. The ECNAMP-sponsored CZM pilot studies and training exercises, done jointly with students from the UWI-CERMES programme, are an excellent first step in the development of a national coastal zone management strategy, but a greatly expanded, more broadly-based assault on various elements of a comprehensive CZM programme for St. Lucia should have a high priority within Government. Some early first steps should include a marine recreational facilities plan, improved oil spill contingency planning, and an expanded coastal water and beach sand monitoring programme. The latter item should not be left to CEHI to perform alone.

2.6 RESOURCE CONSERVATION AND HERITAGE PROTECTION

In a developing country such as St. Lucia, still engaged in the difficult art of nation building and the day-to-day politics of transforming a dependent colonial society into a viable nation-state, the trade-offs between the long-term benefits of conservation and resource protection and the more immediate, short-term benefits of resource exploitation are not easy to determine. The role of conservation/preservation programmes (parks, reserves, sanctuaries, archives, museums) in defining that delicate balance -- between preserving resources for the future and using resources to meet today's demands -- will be examined below. The reader should also note that additional information on forest resources and reserves is provided in Section 2.2 of this Profile, on wildlife/nature reserves in Section 2.3 and on marine resources and protected areas in Section 2.5.

2.6.1 Archaeological and Historical Sites

ARCHAEOLOGICAL SITES

The island of St. Lucia was occupied by at least three Amerindian cultures before the arrival of Europeans in the fifteenth century. The first, the Ciboneys -- a pre-ceramic culture -- occupied the island about two thousand years before Columbus. Most Ciboney sites in coastal areas have been submerged, if not destroyed, by rising sea levels. The sites of Arawaks, whose civilization became rooted in St. Lucia about 200 A.D., are relatively well preserved due to their long occupation of the island. Carib migrations to the island began about 1200 A.D. and, following the arrival of the Europeans, resisted displacement until the 1660's when they vacated the island to the English. Carib sites along the coast are still intact, but may be threatened as sea levels continue to rise or development in the coastal zone expands into previously undisturbed areas.

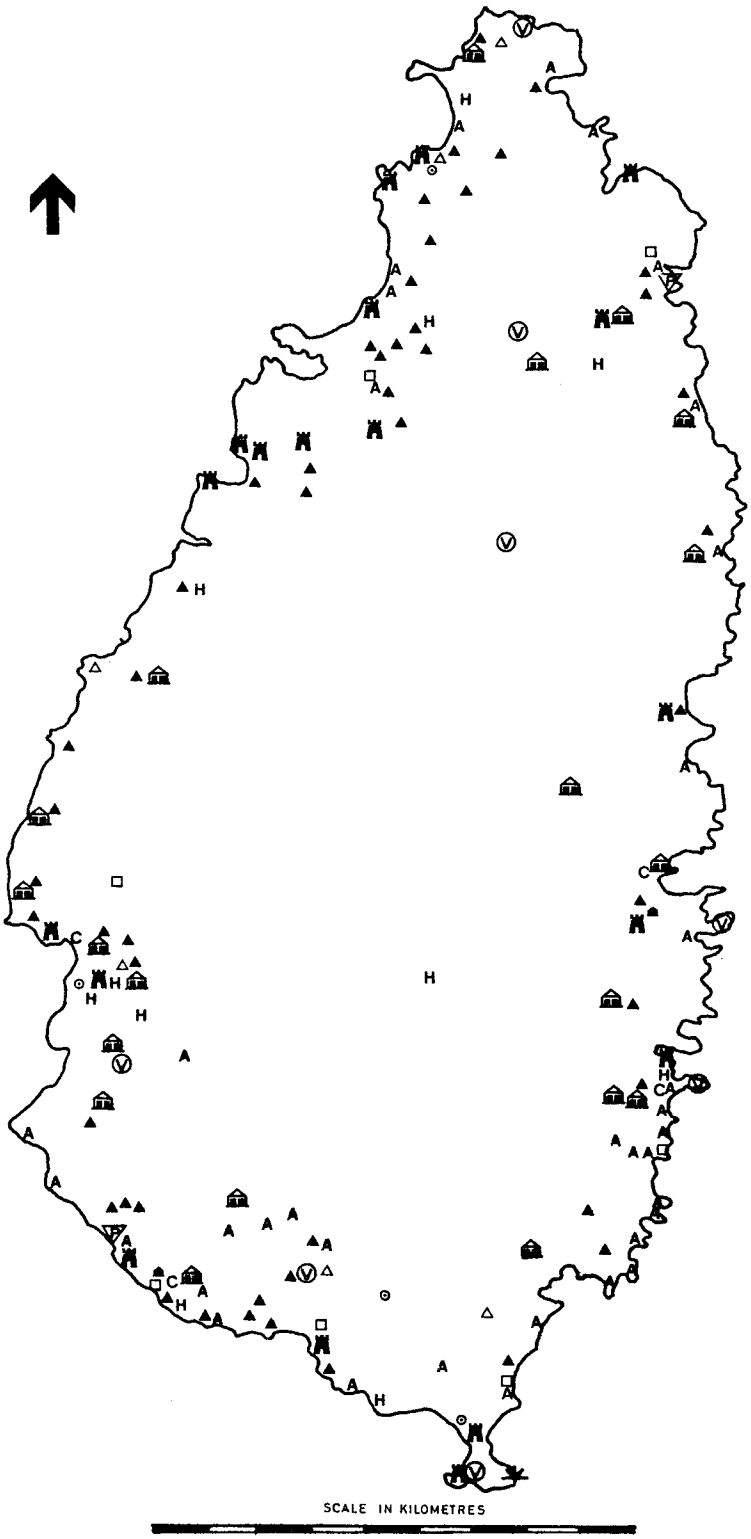
An inventory of 61 archaeological sites (most along the east coast of the country) has been compiled by and is retained in the files of the St. Lucia Archaeological and Historical Society. Sample specimens have been obtained for each site, and these have been documented and catalogued for future reference. The Society's inventory of sites is confidential, however, given the long history of artifact removal from the country.

Over the years, professionals and souvenir hunters alike -- both expatriates and locals -- have taken artifacts from the island or retained them in local private collections. Even though several major excavations were carried out from 1955 to 1969, much of the material recovered from those digs left St. Lucia, and only a small portion has ever been returned. By contrast, during the last five years, multidisciplinary excavations were carried out by the University of Vienna at one important site on the southeast coast (Honeymoon Beach), and all finds are retained by the Archaeological and Historical Society.

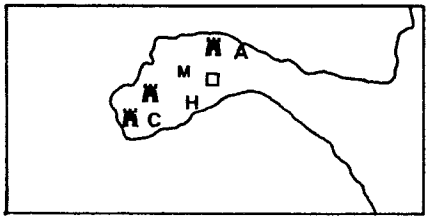
In 1973 GOSL designated the Archaeological and Historical Society as custodian of the nation's "cultural heritage." The Society has custody of all collections of archaeological specimens not held privately or off-island, and these are housed at the Vigie Barracks, where the Society shares offices with the National Trust.

HISTORIC SITES

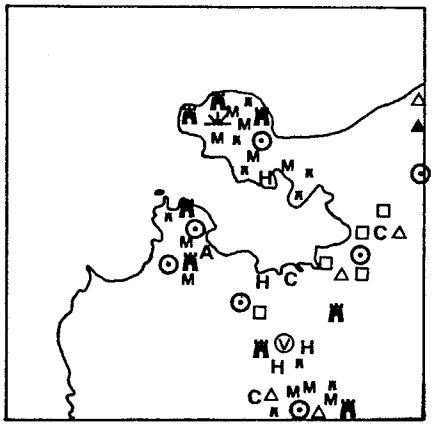
The principal historic sites of St. Lucia are associated with the island's military history. During the seventeenth, eighteenth and early nineteenth centuries, St. Lucia changed hands more than a dozen times between the French and English. With such intense rivalry for control of the island, it was perhaps only natural that St. Lucia, particularly its coastline, was heavily fortified by both European powers. As late as 1898, the English were still fortifying the Morne, Vigie and La Toc.



HISTORIC SITES GROS ISLET AREA



HISTORIC SITES CASTRIES AREA



LEGEND

ARCHAEOLOGICAL SITES	A
ARCHITECTURAL SITES	□
CANNONS	⊙
CEMETERIES	C
ESTATE HOUSES	
FORTS	
HISTORIC SITES	H
LIGHT HOUSES	
LOOKOUTS	Ⓥ
MILITARY BUILDINGS	M
MONUMENTS	△
PETROGLYPHS	
SUGAR MILLS	▲

Figure 2.6(1) Important historical and archaeological sites and features (source: adapted from Devaux, 1975).

Of the four military areas in St. Lucia -- Morne Fortune (the Morne), Vigie, La Toc and Pigeon Island, all located on the northwest coast near Castries -- only one (Pigeon Island) has been preserved in its entirety. The Morne was subdivided during the period 1965-70 and sold in lots to private individuals. Only a small part of the most historic section surrounding old Fort Charlotte has been spared, with five historic sites at the Morne now vested in the National Trust for preservation. The historic character of La Toc and particularly of Vigie, where outstanding examples of nineteenth century military architecture are to be found, has not been incorporated into private developments there (Devaux, 1975).

An experiment at the Morne in the adaptive use of historic buildings has generally failed to realise the full potential of the site. On the one hand, the attempt has been functionally successful in identifying appropriate institutional uses for larger buildings (e.g., OECS headquarters, Teachers College), most of which still retain their historic character. Nevertheless, the overall effort has been aesthetically unsuccessful, with major intrusions occurring of incompatible buildings and functions not in keeping with the architectural style and historic nature of the district. Additionally, the Morne will never recover the economic potential it once had for adaptive use, for the fragmented nature of development there has diminished the intrinsic value and historical quality of the site forever.

St. Lucia does not contain many architecturally important buildings. Castries, its primary urban area, was destroyed by fire four times, most recently in 1948. Hurricanes have also caused considerable destruction to the built environment both in Castries and elsewhere on the island so that only a few historic buildings survive, dating primarily from the late nineteenth century. Ruins of various structures associated with eighteenth and nineteenth century sugar estates and factory compounds are still scattered around the island. However, many such structures were destroyed during the devastating hurricane of 1780 or when caught in the crossfire of late eighteenth century warfare.

Vernacular architecture should not be overlooked in assessing the built environment, and many fine examples can be found in towns and villages away from the capital. Soufriere is a good example in this regard.

The St. Lucia National Trust is charged with responsibility for holding and preserving historic sites for the nation. In its first publication (Devaux, 1975), the Trust identified historic sites it deemed worthy of preservation, also including in its inventory non-historical categories such as caves, natural areas, open spaces, and endangered fauna. In a more recent publication (Devaux, 1987b), sites of historic interest were listed by the Trust in the following general categories, with the number of entries within each:

INVENTORY CATEGORY	SITES LISTED
Archaeological Sites	68
Cemeteries of Historic Value	8
Forts, Batteries and Redoubts	38
Historic Buildings	40
Historic Monuments	13
Historic Sites	18
Mounted Canons	20
Petroglyphs	6
Shipwrecks	20
Sugar Mills and Factories	69

Locations of important historical and archaeological sites and features are identified on Figure 2.6(1). Most historic sites and approximately 15 percent of the archaeological sites in St. Lucia are in private hands (Devaux, 1987b).

2.6.2 Conservation of St. Lucia's Historical and Natural Heritage

MUSEUMS

The St. Lucia Archaeological and Historical Society, founded in 1954, had as one of its primary objectives the establishment of a museum. This became a partial reality in 1964 when the Society obtained from Government use of one room at the Officers Mess on the Morne. This limited facility had to be vacated

in 1981, and the museum was temporarily transferred to the Pigeon Island National Park.

GOSL also gave the Society custody of the deteriorated Batman's Quarters on the Morne for the purpose of housing a National Museum. Although the building lacked a floor and roof, it was in relatively sound condition and has 17 rooms which could adequately serve as exhibit space and offices. A museum building fund was established to cover costs of restoration which was completed in 1987 at a cost of EC$ 200,000. Assistance from OAS museum consultants has been secured to plan and design exhibits. Twelve "theme" rooms have been planned (sponsorship for each is sought from the private sector), and GOSL is prepared to meet recurrent expenses. Opening of the Morne museum to the public is projected for 1989 under the auspices of the Society and Trust.

Future plans call for the restored Morne facility to be the country's National Museum, with additional exhibits at Pigeon Island to focus on military history. The Maria Islands Nature Centre, funded by WWF-US, was developed as a joint venture by the National Trust and a local NGO, ECNAMP. With a focus on natural history and on human uses of coastal resources, the Centre provides an introduction for visitors to the Maria Islands Nature Reserve. Some planning has been done by the Archaeological and Historical Society and the National Trust on a museum at Soufriere, in conjunction with OAS assistance. Additionally, the Bellevue sugar mill at Vieux Fort has been earmarked by the Trust as a "satellite museum" for interpretation of the country's industrial heritage and for development of a botanical garden of plants of historical significance. Plans for the museum are presently being formulated by ECNAMP. Table 2.6(1) summarises current and projected museum and interpretive centre programmes in St. Lucia.

ARCHIVES

St. Lucia first acknowledged the need for a state archival programme in 1965 when it enacted the Public Records Ordinance. However, it was not until 1974 that Government, acting under provisions of the earlier legislation, appointed the St. Lucia Archaeological and Historical Society as the official "Preserver of Records." The spacious Vigie Barracks building was designated as the physical location for the "St. Lucia National Archives" and has been refurbished to accommodate this purpose. Government provides an annual subvention to the Society for Archives support.

To date, the Society has primarily confined its work to the preservation of historical records. The Society is custodian of a considerable collection of historical documents, maps and prints which have been catalogued by U.S. Peace Corps volunteers and others. An herbarium collection has also been established and is housed at the Archives in Vigie.

However, a formal and systematic archival management programme, including the collection, inventory, assessment, and conservation of the public records of Government, has not yet been established, although the Society, with advice from archival experts, has made recommendations for implementation of a full records management programme throughout the Government service.

PROTECTED SITES AND AREAS

In addition to the proclaimed Forest Reserves (see Section 2.2), the recently (1986) declared marine reserves (see Section 2.5), and the historic sites vested in the National Trust (on the Morne in Castries and at Pigeon Island), the following protected areas have been established in St. Lucia (see also Table 2.6(2)):

- **Parrot Sanctuary**: 1500 hectares in the Central Forest as protected habitat for the St. Lucia Parrot and other endangered forest wildlife, under Forestry Department management;

- **Maria Islands Nature Reserve**: two small islets off the southeast coast for protection of endangered wildlife, particularly the

Table 2.6(1). St. Lucia museum and interpretive centre programme development.

MUSEUM	THEME	STATUS* OP.	DEV.	PRO.	MANAGEMENT RESPONSIBILITY
Maria Islands Nature Centre	natural history	X			St. Lucia National Trust
Pigeon Island Museum	military history	X			St. Lucia National Trust
St. Lucia National Museum (The Morne, Castries)	national museum		X		Archaeological/Hist. Soc. St. Lucia National Trust
Soufriere Museum	geology and ethnography		X		Archaeological/Hist. Soc.
Bellevue Sugar Mill (Vieux Fort)	sugar industry		X		St. Lucia National Trust
Apostle's Battery (Castries)	harbour defence		X		St. Lucia National Trust
Savannes Bay Nature Area	fishing techniques			X	St. Lucia National Trust
Frigate Island Nature Reserve	avi-faunal reserve			X	St. Lucia National Trust
Dauphin Petroglyph	Amerindian cultures		X		St. Lucia National Trust
Anse Ger Historic Site (Micoud)	Amerindian cultures			X	St. Lucia National Trust
Delcer Sugar Mill (Choiseul)	sugar industry			X	St. Lucia National Trust

*KEY: OP. = operational; DEV. = in developmental stage; PRO. = proposed

Source: R. Devaux, St. Lucia National Trust.

endemic Ground Lizard and Couresse Snake; managed by the National Trust with the advice of a multi-institutional committee and technical assistance from ECNAMP;

- **Pigeon Island National Park**: national historic park under National Trust management on the northwest coast with ruins of numerous late eighteenth and early nineteenth century military buildings; once an offshore island but now joined to the mainland by a causeway;

- **Savannes Bay Mangrove Area**: St. Lucia's largest mangrove, still in a relatively undisturbed state, vested in the National Trust for preservation but no active management or funds allocated for development of the reserve.

If the Forest Reserves are not included in totals, the aggregate amount of land held in protected area status in St. Lucia is relatively small. The entire holdings of the National Trust, for example, represent 0.3 percent of the total land area of St. Lucia.

Historic and archaeological sites are not protected unless vested in the National Trust. Despite the fact that under the Crown Lands Vesting Order of 1982 this can easily be accomplished, to date only five historic sites at Morne Fortune and those included as a part of the Pigeon Island National Park have been so preserved.

There is no national parks legislation per se in St. Lucia, although the National Trust Act gives that body authority to manage national parks. Pigeon Island is designated a "national historic park," but it was not established under a broad mandate for national park protection or development. Rather, its establishment was an undertaking of the St. Lucia National Trust which encouraged Government to promote a park concept for the site as an extension of the Rodney Bay integrated tourism and land development project for the Gros Islet area.

Perhaps most significantly, St. Lucia has not yet attempted to develop an integrated plan for a "parks and protected areas system." While attempts have been made by agencies of Government (CPU, Forest Department, FMU), by external consultants (for example, Stevenson, 1986), and most notably by the National Trust (Devaux, 1975, 1987b) to provide lists or inventories of areas requiring protected area status, the country still needs to:

- classify and evaluate potential sites more systematically,

- establish priorities which assess high risk as opposed to less threatened sites,

- evaluate the tourism potential of potential sites and assess the compatibility of tourism and protected area status on a site-by-site basis,

- put in place an acquisition schedule, and

- develop management criteria which minimise and regulate intrusions or disturbances within protected areas.

2.6.3 Institutional Responsibilities and Relevant Legislation

The primary institutions with responsibilities for the management of protected areas and development of conservation programmes are:

(1) **The St. Lucia National Trust.** The Trust is a statutory body established by Parliament in 1975 and run by a Council of 11 members. Its quasi-government nature is reflected in the composition of the governing Council whose members are either appointed by Government, by the Archaeological and Historical Society, or elected by the general membership. It is charged with protecting and promoting the natural and cultural heritage of St. Lucia; Government supports the Trust with an annual subvention, and entrance fees are collected by the Trust at Pigeon Island National Park and the Maria Islands Nature Centre/Reserve. [Enabling Legislation: St. Lucia National Trust Act of 1975]

(2) **The Archaeological and Historical Society.** The Society is a non-government organisation founded in 1954. It is the custodian of the country's archaeological and historical collections and serves as "Preserver of Records." For these services, it receives a subvention from Government. The Trust and the Society share offices at Vigie in space leased by Government; the Archives and archaeological collections are also housed at this location.

(3) **The Department of Forest and Lands of the Ministry of Agriculture.** Management of the forest reserves and parrot sanctuary (see also Sections 2.2 and 2.3). [Enabling Legislation: Forest, Soil and Water Conservation Ordinance of 1946 and the Wildlife Protection Act of 1980]

Table 2.6(2). Protected areas in St. Lucia, by type, legislative authority, size, and management responsibility.

SITE/NAME	TYPE	DATE ESTABLISHED	LEGISLATION	SIZE (ha)	MANAGEMENT
FOREST RESERVES (see Section 2.2 for names of specific reserves)	forest reserve	Castries Waterworks Reserve set up in 1916; others followed	Since 1946 Reserves have been established under Forest, Soil and Water Conservation Ordinance	7496.0	Department of Forest and Lands
CENTRAL FOREST PARROT SANCTUARY	nature reserve	1980	Wildlife Protection Act (1980)	1494.0	Department of Forest and Lands
MARIA ISLANDS NATURE RESERVE	nature reserve and marine reserve	1982	Wildlife Protection Act (1980); Maria Islands Vesting Order (1982)	12.0	National Trust
PIGEON ISLAND NATIONAL PARK	national historic park	1978	Pigeon Island National Park By-Law (1982)	20.0	National Trust
SAVANNES BAY MANGROVE AREA	nature reserve and marine reserve	1982	Savannes Bay Vesting Order (1982)	500.0	National Trust
MORNE FORTUNE (5 sites)	historic site	1984	5 vesting orders	5.0	National Trust
CHOC PARK	park	1985	Donation	.2	National Trust
MARIGOT RESERVE	nature reserve	1987	Donation	13.0	National Trust
GAZETTED MARINE RESERVES: [NOTE: Boundaries of marine reserves not yet delimited; see Figure 2.5(8).]					
- Anse L'Ivrogne Reef - Anse Mamin Reef - Anse Pointe Sable-Man Kote Mangroves - Bois D'Orange Mangroves - Cas-en-Bas Mangroves - Choc Bay Mangroves - Esperance Harbour Mangroves - Fond D'Or Beach - Grand Anse Beach and Mangroves - Louvet Mangroves - Maria Island Reef (see above) - Marigot Bay Mangroves - Marquis Mangroves - Praslin Mangroves - Reef at Malgretoute - Reef Between Grand Caille and Rachette Point - Reef at Anse de Pitons - Rodney Bay Artificial Reefs - Savannes Bay Mangroves (see above)		All marine reserves were declared in 1986 except Maria Islands and Savannes Bay which were previously vested to the National Trust	Fisheries Act (1984)	80.0 (estimated)	Fisheries Management Unit

(4) **The Fisheries Management Unit of the Ministry of Agriculture.** Management of declared marine reserves (see also Section 2.5). [Enabling Legislation: Fisheries Act of 1984]

(5) **The Parks and Beaches Commission.** Created in 1983 as a statutory body responsible to the Ministry of Trade, Industry and Tourism, the Commission is charged with management of the nation's public parks and beaches (although the parks and beaches are not vested in the Commission). Its functions are primarily focused on the maintenance of park and beach facilities and licencing of businesses in these areas. [Enabling Legislation: Parks and Beaches Commission Act of 1983]

The National Trust Act, along with Crown Lands Vesting Order of 1982, have conveyed to the National Trust sufficient authority to acquire property (public and private), to raise funds for the management of sites under its control, and to make necessary regulations for the conservation and use of property it holds. Additional nature or wildlife reserves can be established under the provisions of the Wildlife Protection Act (and such protected areas may then be vested in the Trust for management), and the Fisheries Act provides for the creation of additional marine reserves, fishing priority areas, or sites for aquaculture.

Since there is no single "conservation authority" in the country, or something akin to a national parks framework to administer all protected areas under one management agency, it is necessary that the various institutions responsible for "conservation of the nation's heritage" attempt to work co-operatively, both within Government and with appropriate private sector organisations external to Government.

For example, the quasi-governmental National Trust works closely with the non-governmental Archaeological and Historical Society, sharing office space, personnel, and programme responsibilities, such as museum development. The Maria Islands Nature Reserve is under the direct supervision of the National Trust, but primary funding for its development came from a U.S. NGO (World Wildlife Fund), and it is presently managed by a committee comprised of representatives from Government (FMU, Forest Department, and Ministry of Tourism) and from the private sector (Naturalists Society and ECNAMP).

Despite such evidence of co-operation, the current status quo, which permits overlapping authority to be granted to several agencies for the management of the same designated protected area, would appear in the long-run to diminish rather than enhance conservation strategies for the country. A few examples will suffice.

The Savannes Bay Mangrove on the southeast coast near Micoud has been vested to the National Trust, but protection is presently limited to the state-owned portion. The FMU has also declared the site a Marine Reserve, while the Department of Forest and Lands in a recent Statement of Mission has identified Savannes Bay as a "national park" which it will "operate and maintain." Despite this outward appearance of adequate protection provided for an environmentally sensitive area, there is presently no active management plan or authority for Savannes Bay, nor have funds been allocated by any of the oversight agencies for development of the reserve.

Other examples of legitimate but overlapping claims to management responsibilities for areas earmarked by GOSL agencies for protection include:

- Marigot Bay, where the Trust received a donation of 30 acres of land which it has designated a nature reserve, where the FMU has selected the mangroves as a marine reserve site, and where a nature reserve management plan has been developed for the northern hillsides and mangroves by the Forest Department in conjunction with the National Trust;

- Fond d'Or swamp and surrounding littoral woodland targeted by the Forest Department as an area of concern and for which it has prepared a management plan, while

the FMU has also selected the site as a marine reserve;

- Five declared marine reserve sites in the Soufriere area which also figure largely in the tourism development schemes being planned for Soufriere by the Ministry of Tourism, in conjunction with OAS;

- Bois d'Orange mangrove which has been designated a marine reserve by FMU but also figures prominently in the nature reserve/educational planning of the Department of Forest and Lands.

2.6.4 Problems and Issues

Development pressures on: (1) land suitable for designation as national parks or protected areas or (2) sites with unique historical or cultural features have effectively limited promulgation of a comprehensive policy of resource conservation in St. Lucia. Generally, the economic and social benefits to be derived from the protection of historic sites, natural areas, endangered species, or cultural landmarks have not been fully appreciated. The result has been an unco-ordinated, fragmented policy which has had only limited success.

On the positive side:

- There is fairly comprehensive body of legislation which, with sufficient political support and enforcement procedures, could be utilised on behalf of a more effective "protected areas" system in St. Lucia.

- Government has provided consistent support for the National Trust and the Archaeological and Historical Society in the form of an annual subvention to both and has made a commitment to cover the recurring costs for the projected National Museum.

- The St. Lucia National Trust is an established and respected local institution which has, with a limited budget and staff, developed a programme of education, research, and conservation during its 13 year history; its objectives are effectively complemented by the environmental programmes of St. Lucia's NGO sector, in particular, ECNAMP, the Archaeological and Historical Society, the Naturalists Society, and, more recently, the National Research and Development Foundation.

- St. Lucia can point to several "success" stories, for example, the recent increases in the population of the near-extinct St. Lucia Parrot or the establishment of the Maria Islands Nature Reserve, the latter combining the resources and expertise of public and private sector organisations.

On the less positive side:

- Protection for the nation's historical and archaeological resources is inadequate. Historic sites are without protection unless vested in the Trust (as very few have been). Furthermore, there is no antiquities legislation regarding the ownership or disposition of artifacts salvaged from archaeological sites, including marine shipwreck sites. In the past, this has resulted in the fragmented and "compromised" development of important historic districts (such as the Morne and Vigie) or the plunder of archaeological excavation sites by souvenir hunters.

- Financial resources to support management programmes for protected sites have not always been available after "protected area" designation has been granted. For example, while the Savannes Bay Mangrove Area has been vested in the National Trust as a nature re-

serve, funds for management and protection of the site have not been provided; nor is specific funding earmarked for management of the declared marine reserves by the FMU.

- There has been no co-ordinated, multi-disciplinary approach by Government to the establishment of protected areas, including a national land use policy which clearly identifies "areas of particular concern" and defines management criteria for each.

- The present policy of vesting property in the Trust for protection and management purposes is done on an ad hoc or piecemeal basis. The full force of the National Trust legislation is thereby diminished, while the Trust itself is too often placed in the position of "reacting" (to examples of environmental degradation) rather than being in a stronger position to initiate or promote policies of resource protection.

- While GOSL views the Archaeological and Historical Society as its best advisor for archival programmes in St. Lucia, the full role of the Society as the "Preserver of Records" is not clear. The Society has no legal status and hence no authority to legally administer archival functions and enforce a records management programme throughout the Government service. Thus, its activities as the conservator of the St. Lucia National Archives have been largely limited to the preservation of historical documents.

In one attempt to strengthen the position of the central government in support of resource conservation programmes, the Central Planning Unit in 1985 identified the following as justification for GOSL support of protected area programmes:

(1) Natural areas and the indigenous species associated with these habitats are part of the country's heritage, and destruction of habitat or extinction of species represents a loss of national patrimony.

(2) Natural resources, particularly those found in coastal and marine environments, are important components in determining productivity and providing revenues in certain economic sectors; lobsters, sea urchins, seaweeds, conchs, and other marine species, for example, have commercial value and their long-term viability must be ensured.

(3) Insular areas have a relatively high rate of endemicity, and therefore the loss of indigenous species in an island like St. Lucia will foreclose forever any future benefits which might be derived from endemics.

(4) The interrelatedness of natural ecosystems in sustaining life cannot be underestimated in making judgments about land use and long-term development options.

(5) Natural areas, historic sites, museums, national parks, and protected reserves all have important educational, recreational, and cultural values which not only affect the quality of life of St. Lucians but impact upon their social and economic development as well.

2.6.5 Directions for the Future and Policy Recommendations

Little significant progress in integrated resource conservation and heritage protection programmes will be made in St. Lucia without Cabinet-level support for a comprehensive Protected Areas Management Programme. Official Government action, giving policy-level endorsement to the concerns identified by the

CPU in 1985, would be an important first step.

With GOSL support in place at the highest levels of Government, development of a comprehensive programme plan for a Parks and Protected Areas System is a logical next step. Such planning, however, if it is to be effective in eliciting political support, must move beyond the site specific inventory approach generally used by St. Lucian planners in the past and begin to confront the hard resource utilisation decisions required for the future.

Protected area programme planning needs to be placed within a "resource use" framework which reflects overall national requirements for development priorities, as well as for environmental diversity and the preservation of natural and cultural assets. Resource allocation choices need to be predicated on a full appraisal of available site/resource management options, including:

- resource conservation and preservation,
- limited resource use with controls in place, or
- full resource utilisation consistent with established national goals and environmental quality standards.

With regard to protected area programme planning, St. Lucia must begin to evaluate and classify potential sites and establish procedures which assess high risk as opposed to less endangered sites. Management criteria need to be established for different classes and types of protected areas, including sites which have tourism potential. Such guidelines, to control the use of protected areas and to minimise impacts, must not only be promulgated but must be enforced, or the "protected area" designation will have minimal or even negative impact, if, in the latter case, the protected status leads to a false sense of security about the long-term viability of the resource.

Whatever strategy is employed, St. Lucia must:

- establish its priorities for protected area designation;
- develop a process for selection and means for acquisition;
- determine a phasing-in schedule to bring new sites within the system;
- establish management guidelines for each protected area class or category, including non-compatible uses not permitted within protected areas;
- provide for enforcement procedures;
- designate a central management authority to oversee the programme;
- determine inter-agency mechanisms for integrating established protected areas, such as the Forest Reserves managed by the Department of Forest and Lands, within the new management system; for "integration" purposes, the execution of inter-agency co-operation agreements may be all that is initially necessary to ensure inter-ministerial co-ordination in carrying out protected area programme objectives.

A protected areas programme for St. Lucia does not necessarily mean creation of a highly structured national parks system. Indeed, this may well be the wrong approach for a country the size of St. Lucia and given the current demands on the Government bureaucracy. With additional staff and Government support, the National Trust is well-positioned to take on new responsibilities for the management of a protected areas programme. It is time for the Trust to move ahead to the next stage of its development, and one important step in this process would be its drafting of a comprehensive, long-term plan for the selection, acquisition, and management of sites and areas of critical concern, in other words, development

of a programme plan for a national parks and protected areas system.

GOSL should also give consideration to enactment of some form of antiquities legislation to provide better protection of the nation's historical and cultural resources. At present, protection is afforded only if the resource is vested -- on a site-by-site basis -- in the National Trust.

It is probably too late to consider an "historic district" preservation/restoration policy in St. Lucia since the integrity of the most significant districts of historic and architectural value -- the Morne and Vigie -- has been destroyed through the indiscriminate employment of non-compatible uses. It is not too late, however, to enact legislation to establish a Registry of Historic Sites under the supervision of the National Trust. Criteria could be set for the selection and certification of Registry sites (including buildings indicative of vernacular architecture). Cer-tain controls and restoration/rehabilitation guidelines would also be needed, as well as social and perhaps economic incentives (i.e., an awards system or tax benefits) which encourage and promote historic preservation and restoration.

Archaeological sites -- terrestrial and marine -- could be protected by their inclusion on the Registry. Such action would tend to deter disturbance of these sites except under the controls established in the antiquities legislation. (See Table 2.6(3).) Given the increasing number of "treasure hunters" and amateur divers in the Eastern Caribbean, it is important that the Government of St. Lucia also recognise historic shipwrecks as non-renewable resources which must be protected and managed in the public interest -- not exploited for private gain. Existing land-oriented antiquities laws in the region need to be updated to address issues of shipwreck site protection, search procedures, salvage activities, artifact disposition, and recreational diving on historic wreck sites. Given the interest of the National Trust in this subject, St. Lucia could provide a leadership role for region.

Table 2.6(3). Important marine archaeological sites in St. Lucia.

VESSEL NAME	DATE OF WRECK	LOCATION
CACIQUE DEL CARIBE	1950	Louvet
CHARLOTTE	1851	Trou Diable
FISHERMAN'S HOME	1882	Dauphin
HATTI P	1912	Trous Gras Point
HENRY HOLMES	1933	Cul de Sac Bay
HMS BEAVER'S PRIZE	1780	Savannes Bay
HMS CORNWALL	1780	Point Seraphine
HMS FAME	1780	Pigeon Island
HMS THETIS	1781	Point Seraphine
MARY JANE	1831	Micoud
PRINCE JOHN	1800	Liverpool Rocks
ROYAL CHARLIE	1876	Trou Zambe
SHANNON	1880	Marquis
SS PENELOPE	1868	La Ville Point
SS VOLGA	1893	Vigie Point
VILLE DE CAYENNE	1912	Fond Blanc

Source: Environmental Commission, 1982.

2.7 NATURAL HAZARDS

2.7.1 Overview

Natural hazards in St. Lucia are primarily associated with hurricanes, storms, earthquakes, volcanic activity, land and rock slides, and wave action. Although such natural phenomena occur only intermittently, the consequences of these hazards can be of disastrous dimensions in terms of impact on the physical, economic and social structure of the country.

This section of the Profile does not address man-made or technological disasters which also have potential for adverse environmental impacts. Some of these include: air crashes; ship accidents and marine search and rescue emergencies; oil spills in harbours and on the high seas; fires (historically the most damaging single source of man-made risk on St. Lucia); and toxic substance accidents. Many of these technical disaster issues are discussed elsewhere in appropriate sections of the Profile.

2.7.2 Major Natural Hazards

VOLCANIC ACTIVITY

Unlike Martinique or St. Vincent, St. Lucia has no historic record of active volcanic eruptions with attendant loss of property or life. Nevertheless, the island is geologically young, with active volcanic outlets at the Qualibou caldera near Soufriere, which contains 18 lava domes and seven craters. There is an account from 1766 of a minor explosion which spread a thin layer of cinders over nearby areas (Alvarez, 1984).

Based on the historic record -- or its lack -- volcanic activity is probably most significant in St. Lucia for its contribution to earthquakes. However, even if there is a major re-activation of the Qualibou caldera, damage to life and property in the relatively isolated and sparsely populated Soufriere area is unlikely to have severe consequences, *until* completion of Government's projected geothermal electrical generation system. With 60 percent of the country's baseload electrical generation capacity scheduled to be linked to geothermal sources, even a minor resurgence in volcanic activity could have a disastrous effect on electrical users.

It is for this reason, among others, that, despite the recent (March 1988) confirmation of 5 megawatts (MW) of geothermal steam at the Sulphur Springs, GOSL has elected to proceed with construction of a new petroleum-powered generation plant at Cul de Sac -- as part of the island's electrical grid.

EARTHQUAKES

Earthquakes in St. Lucia, as in neighboring islands of the Eastern Caribbean, derive directly from the tectonic interaction of the Caribbean and Atlantic plates (see also Section 1.1.4) and indirectly from volcanism associated with the tectonic activity. Alvarez (1984) lists four major historic earthquakes, but no loss of life. DuBois (1985) reports 70 earthquakes in St. Lucia between the period 1530 to 1960. Two intense tremors occurred in 1946 and 1953, both of intensity 7 on the Richter Scale.

Damage from quakes in St. Lucia could be severe given the lack of seismic design standards for virtually all construction and the probability of major landslides being triggered by earthquakes. A secondary concern derives from earthquake- (and volcano-) driven tsunamis ("tidal waves") which could cause considerable damage and loss of life in low-lying, densely populated coastal areas lacking barrier reefs or other natural buffering systems. Although there are apparently no known tsunamic damage reports from St. Lucia, waves of a metre or more have been reported on the nearby islands of Antigua, Guadeloupe, Martinique, and Barbados. (DuBois, 1985)

HURRICANES AND OTHER STORMS

Hurricanes, and their predecessor tropical storms and depressions, are the most common and damaging natural disasters with potential for severe impacts on St. Lucia. Hurricanes occur between June and November, with 80 percent of those affecting St. Lucia occurring between July 15 and October 1. See Table 1.1(6) for an account of hurricanes and tropical storms affecting St. Lucia.

In order of decreasing severity, the major causes of damage from hurricanes are: flooding from rainfall; coastal flooding and damage from storm waves; landslides; and winds. Although high winds are hurricane's most distinctive feature, usually the most damaging winds affect a very small radius (as small as 20 miles) of the entire storm system, whereas torrential rains can be encountered from one edge to the other of an entire 300 mile diameter storm. Ten inch rains from well-developed tropical storms are not unusual.

The counterclockwise circulation of winds from hurricanes and tropical storms which pass north of St. Lucia -- as most do -- cause strong northerly to westerly waves and swells which can do great damage because they are so infrequent and unexpected in a region where the winds from the east dominate 95 percent of the time (see Table 1.1(1)). A similar, though usually less severe effect, is encountered during the winter months when occasional storms coming off the North American continent -- some of which never approach the Caribbean -- generate long-period northerly swells (ground seas) which can bring three to five metre waves to exposed northerly shores for days at a time.

Hurricanes and gales are such an ingrained feature of life in St. Lucia that most disaster preparedness and planning activities are automatically targeted at hurricanes. On the other hand, there may also be a degree of fatalistic acceptance about periodic hurricane devastation which stands in the way of better awareness and response to disaster mitigation activities. This fatalism can be a special problem in trying to stimulate public sector concern about the unnecessarily increased risks which result from ill-planned development activities.

In other words, if it is commonly accepted that there will always be a risk of severe damage from storms, reinforced by local stories about the devastations wrought by storms occurring within present generation life spans, then it will be more difficult to engender a sense of urgency about hurricane mitigation strategies. If hurricane damage is viewed as an inevitable affliction visited upon the island from time-to-time -- rather than a remedial condition -- there is a danger of complacency and fatalism overtaking hazard mitigation and emergency planning efforts. Some of this apparent fatalism may stem from a survivor's perspective and a pride in the community's resilience and recovery efforts from the effects of the "last" hurricane or storm.

2.7.3 Environmental Damage from Major Natural Hazards

The major sources of damage from natural hazards are wind, various forms of flooding and wave action, and rock and landslides. Fire is a major emergency problem, but it is generally the result of man-made, rather than natural, disasters.

WIND

Wind damage in St. Lucia usually becomes a major problem only when winds exceed hurricane velocity (64 knots, or 120 kilometers per hour). Based on the historic record, winds of this velocity seem to occur once or twice every fifty years (DuBois, 1985).

Wind damage, however, is strongly conditioned by the direction of the wind. Hurricane force winds from the east will cause far less damage than the same force winds from the west. All life in St. Lucia is so acclimated to the prevailing easterlies that it is very tolerant to stronger winds and gusts from the east and remarkably susceptible to damage from winds from the west. This is especially true in the case of coastal communities with exposed west-facing, leeward coast harbours and roads

-- basically every port on the west coast of St. Lucia except Rodney Bay and the inner harbour at Marigot. In these communities storm winds from the west have a clear fetch until they come up against the land with full force and accompanied by wave action to scour the usually calm leeward beaches.

Wind damage is especially critical for the expanding maritime industry in St. Lucia, being the major source of damage to boats at sea or on secure moorings in protected anchorages.

FLOODING

Floods account for most property damage and a large fraction of the historic loss of life from natural disasters in St. Lucia. Flooding is not, however, a single-cause phenomenon. Floods can be created by rain going downhill, by seawater driven inland under abnormal tides and surges, and by a combination of the two. In addition, flooding from the sea can be aggravated by waves, swells, and spray caused by wind.

There is a secondary or indirect effect of flooding which also has serious consequences in St. Lucia. Flooding reduces the friction which holds soils together. In the case of clay-rich soils, which are characteristic of St. Lucia, waterlogged soils on the steep slopes of the interior of the island become extremely prone to landslides.

Land-based Flooding. Flooding from the land is the direct consequence of the amount of rainfall, the slope it falls on, the porosity of the surface it lands on, and the size and shape of the river basin it eventually flows through. Being in a hurricane belt, St. Lucia is subject to large amounts of rain in relatively short periods of time (see Section 1.1.2). The island's relative geologic youth and steep slopes further contribute to rapid run-off and downstream flooding.

Most unimproved soils in the centre and northern parts of the country are clays, with low porosity. Flooding risk is increased by siltation and other river channel obstacles, which are a feature of river bottoms for major valleys, such as Mabouya, Roseau, Fond D'Or, or Cul de Sac.

Damages from land-based flooding include: simple water damage to (normally dry) property; physical damages from the force of the waters and associated mud, silts and rocks; bio-chemical damages from the introduction of large volumes of freshwater to the nearshore marine environment; and destruction of sea life from overloading with silt and nutrients washed from the land.

Flooding from the Sea. St. Lucia has virtually no low-lying fringing barrier islands or reefs to absorb the energy of offshore waves. This means that most coastal settlements in St. Lucia are directly exposed to the effects of major ocean waves, with very minimal buffering systems. Except for Rodney Bay and the inner harbour at Marigot Bay, even moderately high storm seas are capable of doing substantial shoreside damage directly as the result of storm wave action.

STORM TIDES

On low-lying coastal areas, the effects of storm surge or tides which frequently accompany hurricanes are judged to be more damaging than any other characteristic of the hurricane. Storm tides are simply "mounds" of water which are carried by a major storm, partially caused by sea water being pushed up ahead of the major quadrant winds in the storm, but mostly being "sucked up" by the extreme low atmospheric (barometric) pressures of the centre.

In the vicinity of St. Lucia, hurricane storm tides for the 50-year hurricane are estimated to be one foot above normal along open coasts (DuBois, 1985). The actual shoreline impact of this tide can be much higher than the one-foot height, depending on the configuration of the shore and the submarine shelving present.

If the storm tide coming ashore at St. Lucia coincides with the diurnal high tide or, even worse, with a spring high tide, the base water level can easily be ten feet above normal tide levels, which guarantees extensive flooding for

"BLACK MONDAY"
An Eye Witness Account from St. Lucia
November 1938*

The full story of St. Lucia's "Black Monday" (22 November, 1938) will probably never be known. Piecing together survivors' stories, it seems that after very heavy rains (50 inches in three weeks), part of the northern ridge at Ravine Poisson gave way, burying a number of houses and their inhabitants, as well as a group of men who were at work repairing the roads from previous slides. The dead and wounded were removed a quarter of a mile down the Cul de Sac Valley, only to be buried, with the crowd that had collected, by a second and larger slide later in the morning. The death toll was 99.

Harold E. Box, a botanist in St. Lucia collecting specimens for the British Museum, was camped on a forest ridge on the northwest slopes of Mt. Gimie when he learned about the series of landslides in the Cul de Sac Valley. He reported on why they happened.

> *... all the evil effects [of deforestation] are in evidence throughout. Except for a small reserve maintained in connexion with the Castries water supply, not even the sources of the principal rivers, nor their watersheds, show evidence of protection and those that are under forest owe their escape to their comparative inaccessibility rather than to any planned effort.*

At Ravine Poisson in the Cul de Sac Valley, site of the natural disaster, Box goes on to say:

> *... on both sides of the valley, the hill slopes are steep. Instead of having a forest covering or alternatively a system of contour drainage, to serve as a protection for the valuable agricultural lands below, these ridges, the subsoil of which is a very soft yellow clay ..., have been almost completely deforested. ... in 1934-35 very serious encroachments were made [into the forests] in connexion with the development of the banana industry, ... [despite warnings by many] who feared serious flooding in the valley as a result of these ill-advised clearings.*

* Taken from "Observations on the Landslides in St. Lucia, B.W.I." by Harold E. Box, published in The Empire Forestry Journal, Vol. 18(1), July 1939.

most coastal communities, including Castries. The disturbing fact, however, is that the storm tide is simply the base from which the enormous hurricane waves are built and measured.

WAVES

According to Deane, *et al.* (1973) and DuBois (1985), the 20-year hurricane storm wave for St. Lucia is 25 feet high. A worst case scenario would put a slow moving major hurricane moving west-northwest across the northern fourth of the island (the eye passing over Choc Bay). This would put Vigie Bay and Castries Harbour at risk, facing the prospect of waves exceeding ten feet high.

The major damage from storm waves comes from the physical destruction caused by the waves dashing against and being refracted by man-built structures along the shore. The raw power of ocean storm waves unbuffered by swamps, river deltas, or barrier islands is awesome.

Storm waves also contribute to flooding both by their own bulk and by blocking the egress of surface and groundwater flowing off the land. They are especially destructive of marine or coastal water dependent industries, including boats at anchor or in docks, piers, marine railways and lifts, warehouses, and fishing facilities. Storm waves are also "deep reaching" and can stir up bottom sediments (and fish traps) in as much as 100 feet of water. It is commonly accepted that storm waves, by damaging reefs and other underwater substrates, contribute to a blooming of the organisms which cause ciguatera fish poisoning and great distress to fish eaters.

The most subtle but potentially damaging, long-period waves are tsunamis, caused by an underwater earthquake or volcanic eruption. Historically, they are not a major source of flooding in the Caribbean and are a natural hazard consideration less because of the direct damage they are likely to cause in isolation, but more because of the possibility that the tsunami may accompany major earthquake or volcanic activity. Deane, *et al.* (1973), in a list of tsunamis recorded for the Eastern Caribbean for the period 1530-1964, do not show any for the island of St. Lucia. In the Pacific basin tsunamis are an extremely destructive natural hazard responsible for a long history of coastal damage and human disasters.

LANDSLIDES

Apart from the physical destruction caused directly by seismic action (shaking, uplift, fracture and faulting), earthquakes are responsible for damage through two troublesome side effects: liquifaction and landslides. Liquifaction occurs in clay-like soils which, when subject to sudden stress (such as flooding and shaking at the same time), lose cohesion and become semi-liquid, like quicksand. Liquifaction has been reported in St. Lucia and could be a problem in many coastal areas where buildings are set on clay soils near a water supply.

Landslides are caused when gravity pulls soil downward; in effect, the forces of gravity exceed the sheer strength of the soil material. In most cases, landslides are highly localised and are a function of soil type and steepness of slope. They are particularly hazardous due to the difficulty of predicting their occurrence (DeGraff, 1985).

The presence of trees and ground cover reduces landslide risk for several reasons:

- Tree roots tend to bind soils together, increasing the effective coefficient of friction of the soil, permitting it to rest at higher angles of repose;

- A canopy of leaves and a layer of rotting leaves in the floor of the forest reduces the rate at which water permeates soils. Water in soils contributes to increased landslide risk both because water lubricates the soil and because the weight of the water increases the stress on the soil.

Landslides are a major cost in the construction and maintenance of roads in St. Lucia. For example, landslide repairs account for five percent or more of the annual road construction budget (DeGraff, 1985). In 1938, a landslide on a road construction crew killed 68 workers, one of the highest death tolls from any natural disaster in the history of the island. Rockslides are known to occur in Soufriere and Dennery, but no serious damage has been recorded (St. Helene, 1986).

Areas of general landslide risk have been mapped at large scale (1:50,000) for St. Lucia by OAS. In addition, OAS has developed a methodology for applying more detailed analyses of landslide risk at the level of individual development sites (Vermeiren, 1987).

2.7.4 Trends Affecting Future Natural Hazard Risk

Population Increase and Concentration in Coastal Areas. As St. Lucia's population grows and as the country continues to urbanize, more people -- and a higher pro-

portion of the total population -- will be living and working in the country's relatively narrow coastal plain and small river bottoms. These are the areas of the country which are most at risk from the most common sources of damage from natural hazards -- flooding from both surface waters and storm tide and waves.

In addition to simply placing more people at risk, the higher density of settlement in the coastal plain will stimulate more capital investment in "modern" modifications to the natural landscape, most of which will increase the risk of damage from future natural hazards. Examples include:

- offshore dredging to eliminate sandbars and shallows which normally absorb sea wave energy and prevent inland damage;

- filling of salt ponds and swamps which absorb energy and sediments of out-flowing surface waters as well as buffering incoming storm surges and waves;

- bulkheading and other shoreline structures which redirect the energy of reflected waves, threatening normally protected areas and facilities within a harbour or semi-enclosed bay;

- the construction of higher density, higher value-added structures (like resort hotels and condominiums) closer to the shoreline, creating both the probability of greater damage from natural hazards plus a constituency with a vested interest in further development of the shorelines.

Global Sea Rise. Geologists emphasise that St. Lucia is a young and growing island, which accounts for its steep slopes and precipitous streams. In the short run, however, between now and the year 2000, St. Lucia is going to be more affected by the gradual increase in world sea levels, which will further endanger coastal development in the country. A median estimate is that sea levels will rise between one-quarter and one-half metre between now and the year 2020.

Deforestation. Steep slopes, denuded of trees, permit and encourage rapid rain run-off, leading directly to greatly increased volume and risk of flooding. Rapid saturation of soils, caused by removal of the leaf canopy and the carpet of decayed leaves on the forest floor, increases the risk of landslides. Gradual decomposition of the subterranean root systems of the former forest, which are an important stabilising feature, will further facilitate the occurrence of landslides.

A secondary aspect of deforestation is the increase in the silt load carried off by surface run-off into streams and out to sea. This has multiple negative consequences (discussed in more detail elsewhere in the Profile). As a contributory factor to natural hazard damage, siltation has the effect of increasing flooding by creating river channel and mouth blockages.

River Channel Obstacles. Human settlements on the banks of many of St. Lucia's major rivers have resulted in direct or indirect blockages of the river channels, contributing to increased flood risk and damages. Such man-created blockages include roads, levees, undersized bridges, culverts, and even trash dumped in the river channel.

Sand Mining. The extraction of vast quantities of beach sand for construction is gradually reducing St. Lucia's already limited sand buffers to storm waves and tides, thus increasing the damaging impacts of these naturally occurring phenomena. (The environmental impacts of sand mining are discussed in more detail in Section 4.2.2.)

2.7.5 Institutional Responsibilities

St. Lucia has perhaps the best organised disaster preparedness and response system in the Eastern Caribbean. The National Emergency Organisation operates as an independent office, directly under the Office of the Prime Minister. It has responsibility for organising and rationalising the diverse and cross-sec-

toral information base which needs to be tracked and then published in the National Disaster Plan, which provides a framework for GOSL emergency response capability. That Plan was recently revised and republished, for the second time in three years.

Credit for this advanced state of disaster preparedness in St. Lucia (as compared to neighbouring islands) must be shared by GOSL with the OAS. Since 1980, the OAS Natural Resources Management and Agricultural Development Project has provided considerable technical assistance to St. Lucia for the development of policy-making tools which assess natural resource disaster risk in coastal areas and as a consequence of landslides. In addition, the project developed a vulnerability analysis methodology for St. Lucia's coastal communities and, using local emergency committees, applied that methodology to the production of detailed vulnerability maps of ten coastal communities around the island.

Disaster preparedness planning became an early priority for the Regional Technical Co-ordinating Committees which were created as a part of Government's new Decentralisation Policy in 1987 (see also Section 5.1). The Regional Technical Co-ordinating Committees have emerged as the logical counterparts to the local Emergency Committees which had long been established at the town and village level under the old Hurricane Disaster Plan and were subsequently incorporated into the broader National Disaster Plan.

Disaster preparedness planning, management and mitigation is by definition a complicated multi-sector process. It is hard to do well, and until a genuine disaster has occurred, people are seldom motivated to confront the issues. In this context, St. Lucia is doing a good job. One missing component, however, is an environmental protection and recovery plan.

2.7.6 Directions for the Future and Policy Recommendations

(1) The National Emergency Organisation or the Central Planning Unit should establish a file or data base for hazard reporting, based on a commonly understood classification system for hazards and an island-wide geographical location system. This is a low cost project which provides a vital planning tool, useful for all other hazard mitigation activities.

(2) The Ministry of Communications and Works, or the CPU, should keep a file of the costs and location of public expenditures for hazard repairs.

(3) Government-controlled lending programmes, especially the St. Lucia Development Bank, the Commercial Bank, and the Banana Growers Association, should revise their policies to include hazard risk assessment as an important loan criterion.

(4) Property insurance companies should be encouraged to develop differential rates for new policies, based on the new information available about the degree of risk present for different properties and uses proposed for different parts of the island.

(5) Coastal and landslide hazard assessment should be a standard feature of all major development proposal reviews by the Development Control Authority.

(6) Coastal development standards should be reviewed to determine if shoreside setbacks are sufficient to preserve dunes and associated vegetative buffers to storm waves.

3. THE RURAL/AGRARIAN ENVIRONMENT

Throughout its history, agriculture has been the mainstay of St. Lucia's economy. Although sugar did not become an important crop here as early as it did in other West Indian islands, by the nineteenth century it had superseded early export crops such as tobacco, cotton and ginger. When the sugar market declined, the country at first turned to alternative economic pursuits (for many years, St. Lucia was the chief coaling station in the West Indies), but when these sources of income and employment disappeared in the 1950's, St. Lucia again focused on agriculture as its primary revenue source. Over time, bananas emerged as the lead economic crop, particularly after the collapse of sugar markets in the late 1950's released large fertile valleys for banana cultivation. By 1965, bananas formed nearly 90 percent of the country's total exports, making St. Lucia the first Caribbean country dependent on the monocultivation of bananas (OAS, 1987).

In recent years other activities such as tourism, service industries, and light manufacturing have become increasingly important; nevertheless, agriculture output remains significant, accounting for just under 17 percent of GDP in 1986 (see Section 1.5) and, together with forestry and fishing, almost 34 percent of employment (GOSL, 1986 *An. Stat. Dig.*). Yet, despite the importance of this sector to the country's economic and social well-being, old patterns of environmental degradation have grown more serious and pervasive, representing an expanding threat to the long-term viability of agricultural production. Without sound resource management, not only will St. Lucia's export agriculture become less efficient (and hence lose market share to other producers), but, also, its environmentally damaging agriculture practices will hamstring the country's efforts to develop other sectors such as tourism or local infrastructure.

As in other sectors, environmental management and economic development are fundamentally linked, i.e., without sound resource management practices, the economic sustainability of agriculture will decline over time. Unfortunately, agricultural land use patterns created during the colonial period have not been easy to alter, and even today these contribute to continuing deterioration of the resource base at an ever-increasing rate. The monoculture production system, for example, was never particularly appropriate for a naturally diverse tropical environment capable of supporting more mixed agriculture. The resulting environmental costs have been high, despite present economic gains, and entrenched practices regarding land tenure, preferred cropping systems and farming methods have made it difficult to formulate and implement new policies or directions for this resource sector.

3.1 OVERVIEW OF THE AGRICULTURAL SECTOR

LAND CAPABILITY

Land capability for agricultural purposes is largely determined by soil structure, climate and topography. While these characteristics will influence how the land "performs" and establish its biophysical limits of performance, they may not necessarily affect how the land is actually used, a choice often made on the basis of other factors -- social, economic, legal, historical. Land capability is simply an index of the ranges of the ideal use, a clue as to what it, like soil, can or cannot do.

The soils covering St. Lucia's land area are all volcanic in origin, and a large number of soil types have developed due to the country's high relief, widely varying rainfall patterns, and a diverse array of geologic structures and forms (despite similar lithologies). Soil types were studied, classified (into 49 series), and mapped by Stark, *et al.* (1966). (See also Section 1.1.4.)

Soils derived from andesitic agglomerates are most extensive, covering almost half of the island's land area. Main characteristics include low to medium fertility, low pH levels (i.e.,

acidity), and occurrence on slopes of up to 40 degrees. These soils commonly have drainage problems and are often susceptible to erosion. The country's other soil types display somewhat similar characteristics, with the exception of the relatively flat and fertile alluvial soil series. These soils are suited to intensive crop production despite slow to moderate drainage in many areas.

Another factor affecting land use is precipitation which, on St. Lucia, is distributed unevenly, both spatially and temporally (see also Section 1.1.2). Rainfall is generally lowest along the coasts, particularly on the windward side and often substantially higher in the interior, with local variations dependent upon topography and elevation. The extreme south and north of the island are notably lower in elevation, flatter and drier than elsewhere. Seasonal variation is such that a dry season occurs between January and May, occasionally with sustained drought periods lasting upwards of six weeks. Irrigation, for certain crops and locations, is required through these months to ensure high production levels throughout the year.

At present only about 200 hectares of land are irrigated, consuming an estimated 300 million gallons (1,400 Ml) of water per year. Roughly 150 mm-ha/month (2.4 in-ac/month) are required, assuming a high efficiency rate for irrigation and an evapotranspiration rate of approximately 6 inches (150 mm) per month. However, more than ten times this amount -- 2,000 hectares of prime agricultural lands -- is considered to have potential for benefiting from irrigation. A total of 25.17 mgd (114.4 Ml/day) of water would be required in the event that this potential was realised (Oelsner, 1981; OAS, 1986), considerably less if mulching and drip or trickle irrigation techniques were used for selected crops.

When low cost water is readily available in relatively large quantities (i.e., in million gallon/day units), irrigation has the highest payback of any agricultural investment and would be especially important for accelerating the development of import substitution and even new regional and extra-regional markets for St. Lucia. Admittedly, irrigation can be a major argument against the small farm strategy since it tends to require large-scale public, rather than private, development of irrigation facilities which demand fairly sophisticated management. This is difficult to accomplish in the small farmer context. On the plus side, however, land use practices associated with irrigation are very good, especially as they relate to erosion control and sediment reduction.

Another important limitation which affects land capability is slope. As is indicated in Section 1.2, the amount of flat land in St. Lucia is relatively small (Table 1.2(2)). Stark, *et al.* (1966) recommend that land with a slope of 20-30 degrees should only be used for tree crops, and most of this for deep rooted, canopy-type tree crops, while acreage of over thirty degrees slope should not be used for agriculture at all as a permanent vegetative cover is necessary. Only land with slopes less than 10 degrees (a little less than 20 percent of St. Lucia's land base) should be farmed intensively.

Based on criteria of fertility, stoniness, drainage, depth, and erosion hazard, St. Lucia's land mass was placed into eight capability classes by OAS (modeled after a classification scheme devised by the U.S. Soil Conservation Service) . The main features of each class are described in Table 3.1. Unfortunately, the "cultivable" lands (Classes I-IV) comprise a very small portion of the island's total resource, just under six percent. If Class V lands are added to this figure (to include zones which potentially can be cultivated on a sustainable basis through irrigation or other special management provisions, a questionable assumption at best), the total still remains below 10 percent (Table 3.2).

The spatial distribution of arable lands is similarly skewed (OAS, 1987). Some 56 percent of the total in Classes I-IV is found in five river valleys: Fond d'Or, Cul de Sac, Roseau, Troumasse, and Marquis. On the other hand, Class VII lands (the largest segment of the total land base) are very widely dispersed. Class VI land are broadly distributed as well but primarily in hilly areas along the coast. Class VIII land, found primarily on the island's steeper ridges, requires protection from erosion, rockslides, slumping and mudslides.

Table 3.1. Description of land capability class system.

Land suited for cultivation	
Class I	Level soils suitable for cultivation with almost no limitations that restrict their use.
Class II	Level to nearly level soils suitable for cultivation with some moderate limitations that reduce the range of choice of plants and require moderate conservation practices.
Class III	Level to undulating soils, suitable for cultivation with severe limitations that reduce the choice of plants and/or require special conservation practices.
Class IV	Level to undulating soils, suitable for cultivation with severe limitations that restrict the choice of plants and/or require very careful management.
Land not suited for cultivation	
Class V	Level soils without erosion hazard; not suited for cultivation except in certain areas where rice can be grown. Suited chiefly for improved pasture.
Class VI	Very undulating to hilly soils with severe limitations that make them generally unsuited for seasonal crops and limit their use mainly to tree crops, pastures, or woodland.
Class VII	Very steeply sloping soils with severe limitations that make them unsuited for cultivation and restrict their use largely to woodland and wildlife.
Class VIII	Very steeply sloping soils, beach sands, or mangrove areas, have severe restrictions that preclude their agricultural use.

Source: Shriar, 1987 (adapted from Pretell and Polius, 1981, and from U.S. Soil Conservation Service). For map, see OAS, St. Lucia Development Atlas.

This class also includes beaches and mangrove areas which require protection to sustain their natural functions as barriers to storm wave impacts.

Table 3.2 shows the land area identified by OAS within each capability class and lists some potential crops which can be sustainably produced in a given zone without degrading the land base. Limitations to land capability are also presented in this table.

Table 3.2. Land capability classes in St. Lucia by total area, cultivation potentials, and limitations.

CLASS	LAND AREA (acres)	% Of TOTAL	POTENTIAL CROPS/USES	LIMITATIONS
I	3,989.70	2.65	Food crops, bananas, plantain, sugar cane	Almost none
II & III	1,422.03 1,809.57	0.94 1.20	Food crops, bananas, plantain, sugar cane, ginger	Erosion, slope, drainage, shallow soils, fertility
IV	1,178.08	0.78	Limited food crops, fruit/other tree crops	Drainage,slope, stoniness, fertility,
V	5,757.58	3.82	Pasture	root restriction
VI & VII	25,477.51 101,050.70	16.90 67.01	Permanent tree crops, forest: timber and charcoal species, agroforestry plantation systems, some annual crops	Slope, erosion, fertility, stoniness, aridity, land slippage
VIII	10,103.90	6.70	Forest/wildlife reserve, national park	Slope, salinity, erosion, no agriculture potential

Sources: OAS, 1986a; OAS, 1987.

ACTUAL LAND USE

Examination of actual land use patterns in St. Lucia makes it apparent that usage corresponds only minimally to land capability guidelines. According to OAS figures, a total of 51,386 acres is under cultivation in the country, almost 35 percent of the land base surveyed (Table 3.3 and Figure 3.1). Studies by Wirtshafter, *et al.* (1987), conducted with a geographic information system (GIS), have shown that only 12.5 percent of the land *devoted to farming* is being farmed in accordance with optimal use. In fact, 57.5 percent is being farmed "non-optimally," while 30 percent is being farmed "marginally".

If, however, the frame of reference regarding agricultural land use is switched to total land in St. Lucia, then 55 percent is currently being dedicated to uses that are consistent with the capabilities of the land, i.e., intensive, large scale, commercial farming on land Classes I or II, and Classes VII and VIII in sustainable forest categories (OAS, 1988).

In looking at a particular crop, bananas for example, Table 3.4 reveals that this crop is cultivated on some 13,200 acres, despite the fact that bananas are considered suitable only for areas within land capability classes I-III, an overall total of 7,220 acres (Table 3.2).

Table 3.3. Land use classifications and acreage as identified by OAS.

CLASSIFICATION	ACREAGE	% OF TOTAL
Primary Forest	18,995.8	13.1
Secondary Forest	22,344.7	15.4
Scrub Forest	31,311.9	21.6
Grass Land	3,804.7	2.6
Open Woodlands	2,778.8	1.9
Large Scale Agriculture	18,801.7	13.0
Intensive Small Farming	17,008.6	11.7
Mixed Small Farming	15,575.0	10.8
Rural Settlement	9,399.4	6.5
Urban Settlement	4,743.4	3.3

Source: OAS, 1987.

N.B. The reader is cautioned in using this table except for appreciating the ranges and proportional split among various land uses. The total acreage shown for St. Lucia (144,764 acres) is over 7,000 acres less than the total acreage of the country (152,000 acres).

With respect to grazing the situation is somewhat better than that of cropping. Of the 6,584 acres used for grazing, 37 percent is being used optimally. But again, a considerable amount of grazing land is utilised non-optimally (53 percent) or marginally (10 percent). The negative environmental effects of inappropriate land uses are discussed in Section 3.3. (See OAS, 1987 and Rojas, 1988.)

Table 3.3 summarises other land uses identified by OAS. The "large scale agriculture" category refers to medium and large-sized estates devoted primarily to commercial agriculture. Major crops include banana, coconut, cocoa, fruit trees, and pasture, grown on either a monoculture or intercropped basis. "Intensive small farming" refers to areas where at least 70 percent of the surface is devoted to small holder agriculture, typically with a wide variety of crops grown on the same parcel. The "mixed small farming" category includes areas where between 25 and 70 percent of the surface is devoted to agriculture organised as scattered individual holdings.

Secondary forest lands form the predominant non-agricultural land coverage, while "rural settlement" areas comprise clusters of rural housing with surrounding areas devoted to small gardens and orchards. Each of these land uses, as well as the others shown on Table 3.3, have been mapped by OAS (1984).

Table 3.4, based on data from the 1986 agricultural census, clearly demonstrates that banana and coconut are by far the most important crops grown on the island. Unfortunately, the census provides no indication of the degree to which intercropping is carried out. This is an important practice from an environmental management perspective (as it conserves water, reduces erosion and minimises pest damage) and should be considered for systematic monitoring in the future.

LAND TENURE

Like many other Eastern Caribbean countries, St. Lucia's land tenure situation is a complicated blending of British common law and local traditions, some imported from Africa. Further confusion results from the survival of

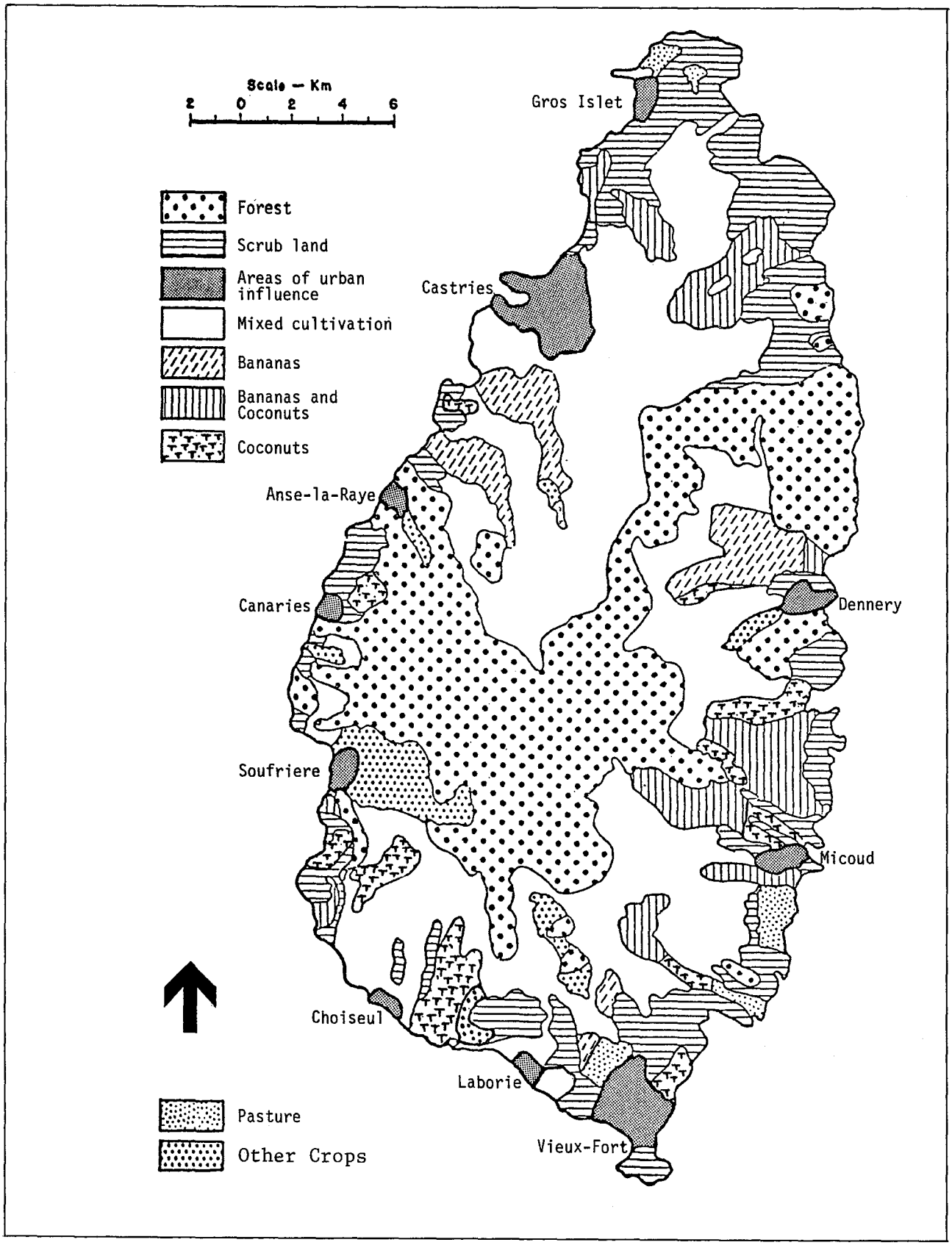


Figure 3.1 Agricultural land use map (adapted from CARDI, 1986). For more detailed information, see OAS Land Use and Vegetation Map, 1984, at a scale of 1:50,000.

Table 3.4. Crop distribution in St. Lucia.

CROP	ACRES UNDER CULTIVATION
Banana	13,200 acres
Coconut	12,400 acres
Plantain	400 acres
Cocoa	700 acres
Coffee	100 acres
Sweet Orange	900 acres
Avocado	400 acres
Lime	200 acres
Grapefruit	600 acres
Mango	1,200 acres
Breadfruit	1,800 acres

Source: GOSL, 1986 Census of Agriculture (1987).

elements of the French civil code, in particular, the laws of intestate succession and inheritance whereby a deceased's land is frequently divided among many heirs in the extended family tradition. While more individuals gain access to land by this process, the pattern of ever increasing land fragmentation can make it more difficult for the agricultural sector to benefit from economies of scale.

However, fragmentation does not necessarily have to lead to less efficient resource management or production. If access to credit, capital, and management expertise is assured, the subdivision of large agricultural estates can actually result in a marked increase in productivity (see box on St. Lucia Model Farms). This is due to more aggressive, intensive exploitation and, in large part, to higher individual incentives associated with private land ownership.

Whatever the consequences, the fact remains that agriculture production in St. Lucia has changed from a plantation system, dominated most recently by large sugar and later banana estates, to small-scale agricultural expansion characterised by small holdings controlled and operated by rural farm households or families.

The present trend is displayed in Table 3.5 which shows that in the period between the agricultural census of 1973/74 and the most recent census in 1986, the number of agricultural holdings increased from 10,938 to 11,551, the result largely of land fragmentation. The number of holdings in size categories A to C (0-4.9 acres, 5-9.9 acres, and 10-24.9 acres) has increased, while the number in all the larger size categories has fallen. Concurrently, the absolute amount of area within these three categories increased, while in the larger aggregates it decreased. But the increase in the number of holdings (5.6 percent) is less consequential than the decrease (20 percent) in the total land held. This is very significant as is the fact that the number of landless holdings, representative of farmers with just livestock, also increased during the period between censuses.

The agricultural land tenure situation in 1973/74 was such that 45 landholders (0.4 percent of the total) with holdings of 200 plus acres in size, controlled 48.7 percent of the island's agricultural land. On the other hand, 92.7 percent of the holders (10,142 in all), each with less than ten acres, collectively farmed only 24.7 percent of the land base.

This skewed distribution of agricultural land continued well into the next decade. Data from the 1986 census (Table 3.5) indicate that 30 holders (0.3 percent of the total), with

ST. LUCIA MODEL FARMS

St. Lucia Model Farms, an internationally financed project to reorganise production at the Roseau Estate formerly owned and operated by a multinational corporation, was established to create a projected 175 new farms that were to be transferred to selected farmers through lease-sale agreements. The agreements stipulate farmers would adhere to a centrally defined farm management plan and the centralised marketing of crops. Long-term national goals for diversification of the agricultural sector were postponed to devote all valley farms (on five acre holdings) to the monocultivation of bananas and hillside farms (of 10-15 acres each) to bananas and fruit and tree crops. By the end of 1986, a total of 79 farms, each five acres, had been settled, most of them producing bananas (NDC, 1986).

St. Lucia Model Farms, Ltd. is a non-profit company set up in 1983 to organise and manage the project; ownership of the company is shared equally by GOSL through the National Development Corporation, the Commonwealth Development Corporation, and Geest Industries. Capital for the venture was provided by the shareholders with additional major assistance from the European Development Fund.

St. Lucia Model Farms, Ltd. is responsible for providing and maintaining basic infrastructure, redevelopment of valley lands (drainage, roads, irrigation), providing access to and terracing on hillside farms and -- with assistance from new farmers -- planting crops before turning the farms over to the small landholders. The farms will be held by the individual growers in a leasehold agreement with the company, which includes an option to purchase at the end of 15 years. This form of tenure was selected as one means to avoid fragmentation of the holding -- at least until the end of the lease period.

Banana yields from valley farms have been substantially higher than national averages (15-20 tonnes/acre compared to island-wide yields of 5-10 tonnes/acre) (World Bank, 1986). The company produced 7,841.8 tons of bananas in 1986, representing seven percent of national production (NDC, 1986). If income projections hold firm, participants will be able to improve their standards of living substantially over time while also working toward legal ownership of their farms. Despite these gains, all valley farms are dependent on banana production and therefore at some risk until the agricultural diversification proposed by Government is extended to these prime lands.

The feasibility of using this project as a model for future resettlement programmes is questionable to the extent that a substantial amount of capital was required (for land purchase, field development, small holder housing, and infrastructure) (OAS, 1986a). A further requirement for replication of the project is the need to employ a centralised management structure to ensure the use of adequate agricultural practices and to control production inputs and export marketing.

holdings of 200 or more acres, control 38.7 percent of the land base. Holdings of 50 acres or more account for nearly half (46.3 percent) of the land in holdings but represent only 0.8 percent of the total number of farms. At the other end of the spectrum, a larger share of the island's agricultural land (34.7 percent) is now in holdings of less than 10 acres. There are, however, more farmers working these small farms, both in absolute and relative terms (10,811 holders/93.6 percent).

The agricultural land tenure situation is also characterised by a low level of ownership. In

Table 3.5. Agricultural land tenure in St. Lucia by size categories.

CATEGORY (size in acres)	NO. OF HOLDINGS 1973/74	(%)	1986	(%)	AREA (acres) IN HOLDINGS 1973/74	(%)	1986	(%)
Landless	502	(4.6)	850	(7.4)				
A) 0 - 4.9	8,558	(78.2)	8,770	(75.9)	10,204	(14.2)	12,350.0	(21.3)
B) 5 - 9.9	1,082	(9.9)	1,191	(10.3)	7,068	(9.8)	7,802.4	(13.4)
C) 10 - 24.9	475	(4.3)	560	(4.9)	6,396	(8.9)	7,763.1	(13.4)
D) 25 - 49.9	199	(1.8)	98	(0.9)	6,299	(8.8)	3,218.6	(5.6)
E) 50 - 99.9	58	(0.5)	35	(0.3)	4,282	(6.0)	2,338.0	(4.0)
F) 100-199.9	19	(0.2)	17	(0.2)	2,690	(3.7)	2,233.5	(3.9)
G) 200-499.9	26	(0.2)	17	(0.2)	8,160	(11.3)	4,881.0	(8.4)
H) 500+	19	(0.2)	13	(0.1)	26,902	(37.4)	17,430.0	(30.0)
	10,938	(100%)	11,551	(100%)	72,001	(100%)	58,016.6	(100%)

Source: GOSL, 1986 Census of Agriculture (1987).

fact, as Table 3.6 indicates only 3,611 or less than 27 percent of the country's 13,500 parcels are owned. The remainder are rented, squatted, family lands, or sharecropped.

Given the fact that there are 13,500 parcels but only 10,700 holdings (excluding landless holdings), the average number of parcels per holding is 1.26. Some holdings, however, consist of six or more parcels.

FARMING SYSTEMS

The agricultural sector in St. Lucia has long been characterised by two very distinct farming systems which have operated side by side:

(1) the commercial, export-oriented plantation system which, from an economic standpoint, has always been dominant;

(2) the small, subsistence-based individual farm unit system which has developed on the island's more marginal agricultural lands.

The Estate System. A plantation-based land tenure pattern developed during the colonial period whereby estate-type farms were, and continue to be, concentrated in the most fertile and more accessible areas of the island. OAS, 1988, estimates that between half and three-quarters of the best agricultural lands -- Classes I-IV -- are currently located on estates of 50 acres or more (Table 3.7).

Table 3.6. Number of agricultural land parcels by form of tenure.

TYPE OF TENURE	NUMBER OF PARCELS
Owned	3,611
Family Land	6,132
Rented (private)	1,717
Rented (government)	383
Squatting (government)	790
Squatting (private)	680
Other	217
	13,530

Source: GOSL, 1986 Census of Agriculture (1987).

Table 3.7. Land uses on land with capability classes I through IV.

	Percentage of land in capability class dedicated to particular land use			
	CLASS I	CLASS II	CLASS III	CLASS IV
Large scale farming	63.6	84.6	55.9	44.7
Small farming (intensive and mixed) and rural settlements	20.9	7.4	9.2	30.0
Urban	2.6	5.4	9.4	2.1
All others	12.9	2.6	25.5	23.2

Source: OAS, 1988.

The estate system traditionally specialised in the primary export crops which continue to be cultivated for the most part on a monoculture basis. Sugar was dominant for most of the country's agricultural history, but since World War II there has been a shift of focus to bananas. Because both sugar and bananas are best suited to flat valley-bottom lands, the hillsides of most estates are generally covered with tree crops such as coconut and cocoa which are also cultivated for export. In some

parts of the island tree crops are grown in valley bottom areas as well.

Given the export orientation of these estates, fluctuations in supply and demand on the world market influence economic conditions in the country. Furthermore, with the shift to bananas, a very labour intensive crop, success of these estates has also come to depend increasingly on management's ability to control the labour force. The continuing strength of St. Lucia's labour movement, and resultant higher labour costs, contributed in some measure to making many large estates less economically viable operations. And for some large landowners, like Geest Industries, as marketing and shipping bananas became more profitable than producing them, divestiture was a logical option (OAS, 1986a).

The varied responses of estate owners to decreasing profitability have included:

- termination of operations but with continued "unproductive" possession of agricultural property for speculative purposes;

- sale (intact) to a private buyer, who may or may not convert the land to non-agricultural ventures;

- sale to Government, the intention of GOSL in purchasing such lands being the maintenance of rural employment (slowing the draft to urban areas) or for the execution of land reform policies (for example, St. Lucia Model Farms);

- estate subdivision and sale to private buyers, for agricultural *or* non-agricultural purposes;

- abandonment of production on the estate's marginal lands (e.g., the hillsides) with a focus of all agricultural activity on prime lands (e.g., valley bottom areas);

- gradual sale of parcels on the fringes of the estate, thereby raising capital for ongoing production in the core.

This process of large estate subdivision or transformation has accelerated since 1973, with the number of large estates (50 acres and over) decreasing by one-third between 1973 and 1986, from 122 to 82 estates (GOSL, 1986 Census of Agriculture). From an environmental perspective, the most critical aspects of this trend are manifested in three ways.

(i) First, decline in employment on many of the plantations has increased pressure on hillside areas for subsistence cultivation by landless farmers with no other economic options. In some areas small landless farmers are invading or squatting on unused portions of estates or in the forest reserves. Frequently inappropriate cultivation practices are employed, for example, the cultivation of annual crops or bananas where conditions (such as slope) require a cover of permanent crops.

These problems have occurred in the Fond d'Or Valley, for example, where employment on the Dennery Farmco Estate fell to less than 300 by 1985 from a level of over 1,200 workers in the late 1970's. The direct result of these developments has been deforestation and soil erosion on the hillsides and intense siltation and flooding in the lower valley (Shriar, 1987); in some areas, coastal and marine resources are affected by run-off from farmed hillsides.

(ii) Even when large estates have been legally sub-divided and sold, if hillside plots are subsequently made available to small farmers generally intent on short-term economic gain rather than long-term land conservation, the environmental impacts can be similar to those described in (i) above.

(iii) Finally, in some cases the transformation of large estates has coincided with the loss of agricultural lands. Statistical data from the Ministry of Agriculture indicate that the area of land used for agricultural pursuits declined by 19.4 percent between 1973/74 and 1986. In urban growth regions such as the northwest corridor subdivided parcels have commonly become the focus of residential or commercial development.

RURAL DEVELOPMENT PLAN FOR THE FOND D'OR RIVER BASIN

The decline of St. Lucia's large agricultural estates has frequently contributed to degradation of the agricultural resource base. In the Fond d'Or River Basin (also known as Mabouya or Dennery Basin), one of the country's most important agricultural areas, an economic downturn on the Dennery Farmco Estate beginning in the 1970's has contributed to high unemployment, widespread land squatting, intensified hillside cultivation, and poor drainage maintenance on farmed lands. These conditions in turn produced increased deforestation and soil erosion in the uplands and widespread flooding in the lowlands. In fact, by the early 1980's a total of 110 ha of prime agricultural land was rendered completely unproductive due to both flooding and waterlogging (HTS, 1984).

The Government of St. Lucia purchased Dennery Farmco Estate, a total of 1057 ha, from a private owner in 1978. By 1985, only 216 ha (of an original 488 ha) were under cultivation.

Serious management difficulties with the Estate led to creation of an interagency committee to formulate an integrated development plan for the entire Basin. Key components included:

- maintenance of a core estate of 826 acres but with the subdivision of estate hillside areas to provide land to forest reserve squatters and other landless farmers;

- watershed conservation through reforestation and the establishment of protected forest zones;

- zoning and infrastructure improvements in valley settlements, in part to prevent encroachment on high quality agricultural land;

- drainage works in the lower valley to alleviate flooding and waterlogging.

The core estate will continue to be managed by Farmco while other components of the programme, including extension training on soil conservation, will be co-ordinated by a Mabouya Valley Development Authority. This bifurcated management strategy may produce problems.

An environmental evaluation of the plan (Shriar, 1987) concluded that the *sustainability* of the plan's beneficial environmental impacts remains questionable. One important reason for this is that the plan's focus is on the lowlands of the watershed, clearly seen in the project budget with major expenditures earmarked for drainage works and settlement infrastructure, *rather than upland conservation requirements*. In addition, the drainage works have already been implemented -- prior to any substantial reduction in the rate of hillside erosion. Therefore siltation rates remain high.

This short-term approach conflicts with fundamental tenets of watershed management. High siltation levels will make it increasingly difficult for the EC$2 million drainage network to function effectively. Despite these concerns, Shriar's environmental impact study concludes the plan's full implementation, with efficient management, "will ... improve the overall socio-economic and environmental conditions in the [Fond d'Or] Basin in the short term."

Encroachment of urban land use on Class I-IV lands (i.e., those with the highest agricultural potential) should be prohibited as a matter of public policy, for such choices are irreversible and the impacts are significant on an island faced with a scarcity of good agricultural land.

The decline of the traditional estate system is a strong trend and is expected to continue. The pattern is generating a more equitable distribution of land, but it is important that redistribution not be accomplished at the expense of land resources. Government efforts to address some of the negative impacts of estate subdivision are encouraging, for instance the St. Lucia Model Farms programme in Roseau and the integrated rural development plan for the Fond d'Or Valley (see pages 186 and 190). The latter will involve not only an orderly land redistribution programme, but also watershed protection measures, drainage works (already established), and settlement improvements.

The Small Farm System. Most of St. Lucia's farmers are classified as small farmers since more than 83 percent of 1986 holdings were under five acres in size and over 93 percent under 10 acres. However, all holdings of less than five acres account for only 21.3 percent of the country's total agricultural land base, and the land included in this figure is of relatively poor quality compared to that occupied by the country's large estates. Despite these limitations, George (1981) estimates that small farmers contribute roughly 60 percent of the income generated by the agricultural sector. In fact, this figure may now be higher, given the increased involvement of small growers in banana production.

Traditionally, the small farming sector formed a subsistence-based agricultural system, focusing primarily on food crops. This situation has gradually changed as many small farmers have turned to cash crops (for example, bananas) particularly in locations of relatively higher land capability. Where land is less fertile and along the periphery of large estates (e.g., on the small plots of estate workers), this trend has been less pervasive. In general, the extent of cash cropping within the sector has been variable, increasing when economic conditions have been favourable, as they have been for banana cultivation since the mid-1980's (see Figure 3.2).

Other common characteristics of the small farming system include:

- geographical dispersion, both nationally and at the local level;
- poor access to markets due to topography and lack of communication infrastructure in rural areas;
- small holdings which are frequently divided into smaller parcels.
- uncertain and often complex land tenure;
- a high degree of autonomy often with limited support from national institutions (due to development of the small farm system either against or outside the main thrusts of agricultural production in the country);
- multi-cropping systems, largely to minimise economic and environmental risk.

According to a survey of St. Lucia's small farmers conducted by UWI's Extension Department, crop categories appearing on a single farm may include tree crops, fruit crops, root crops, cereals, grain legumes, and vegetables (George, 1981). With the exception of bananas, crops are grown in random fashion rather than in regular rows. Plots of one crop or a combination of several are generally small and commonly are scattered at various locations on a single parcel.

Although this pattern appears to be unorderly and random, it serves to exploit different micro-ecological conditions favourable for a particular crop. It also takes advantage of available sunlight, for instance, through the common use of a three tiered combination with tree crops like mango and/or breadfruit at the top, banana and/or plantain in the middle, and root crops at the bottom. The

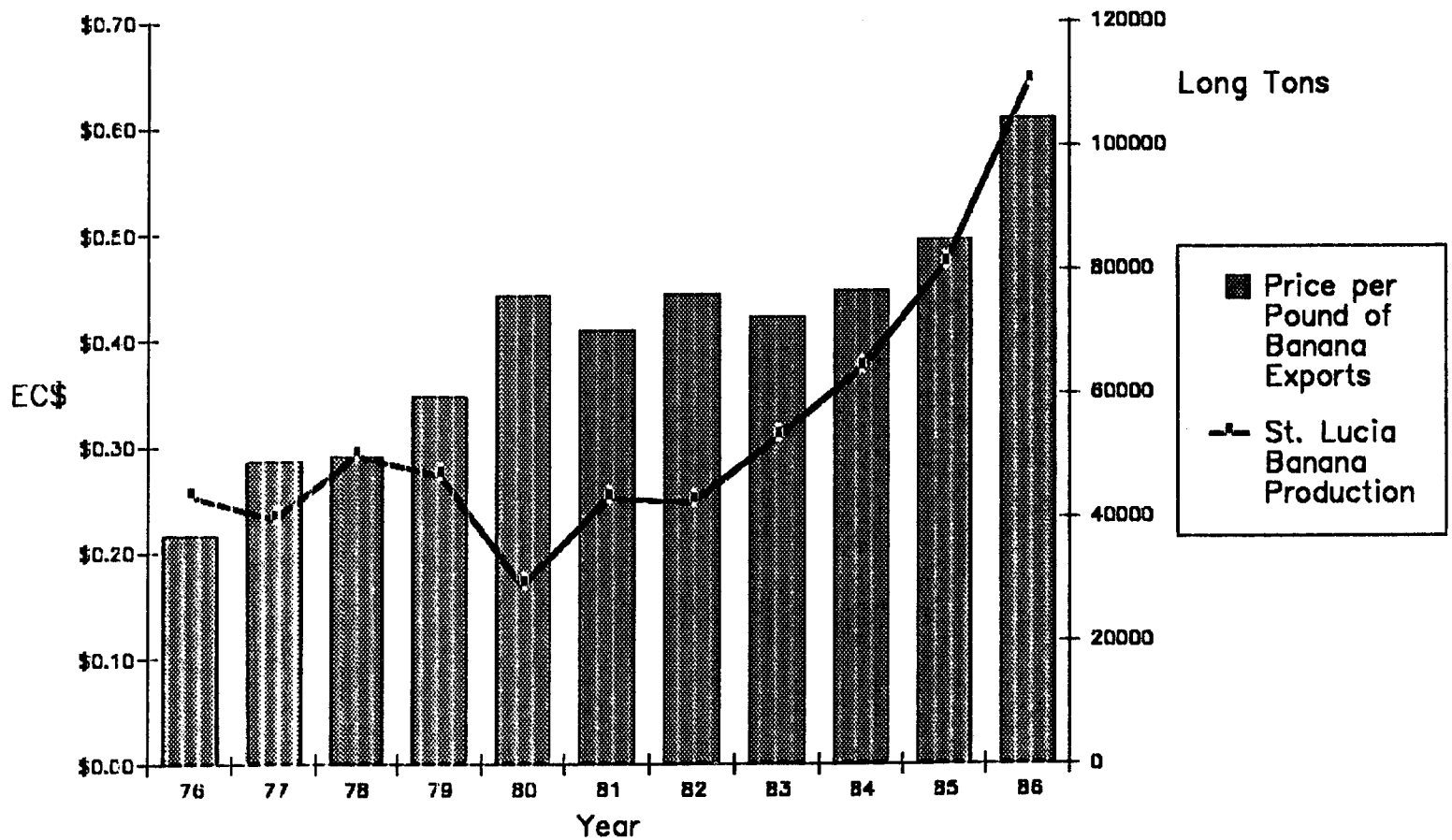


Figure 3.2. The relationship between price paid for bananas and production levels in St. Lucia, 1976-1986. Prepared by using WINBAN (1987) data.

diversity of crops generates some cash along with a wide range of food items throughout the year.

The same survey (George, 1981) also found banana cultivation to be the highest income generating activity on roughly half of the 21 farms surveyed. In all, 18 of the farmers grew bananas, but only 15 could be considered commercial growers. Where conditions were ill-suited to banana cultivation, vegetable production was found to be the dominant activity of the small farmers.

But in the years since the 1981 survey, the focus on bananas by small farmers has intensified as overall production levels have increased. The factors which account for these trends are:

(i) The price for banana exports increased from slightly over 40 cents per pound in 1981 to 60 cents per pound in 1986 (see Figure 3.2 for the relationship between recent price increases and accelerated production levels).

(ii) Because of the secure weekly market, banana cultivation is attractive to small farmers as it affords them a rather steady cash flow.

(iii) Feeder roads have been constructed in many areas which previously did not have easy access to the banana market.

(iv) A well established support network exists for banana growers through organisations like the St. Lucia Banana Growers Association (SLBGA) and the Windward Islands Banana Growers Association (WINBAN).

(v) Relatively stable weather conditions during this period were favourable to banana cultivation (a notable earlier exception was Hurricane Allen in August of 1980 which resulted in zero production levels from August through December of that year).

(vi) Supplies of inputs to banana cultivation have been secure and steady, and their price has been moderate, in fact, has decreased relative to the unit price of bananas (because of dollar exchange rate changes) over the past three years.

Unfortunately, this marked increase in banana cultivation is having a negative impact on the agricultural resource base. Over three-quarters of all land in St. Lucia is classified in Classes VI and VII (Table 3.2), largely because of slope and erosion risks, and is generally not suitable for cultivation without implementation of soil management practices. However, this is also the land class where most small-scale agriculture takes place (see Table 3.8) and where most land clearing to open up new hillside areas for small-scale cultivation is concentrated. The fact that small farming is not in any significant way practiced on more suitable agricultural lands (Classes I-IV) presents not only an environmental but also a social problem for St. Lucia (OAS, 1988).

Animal husbandry is also important to the small farm system. The 1986 Agricultural Census reports that a large proportion of the country's livestock is raised by small (including landless) farmers. For example, almost 80 percent of St. Lucia's poultry supply is raised on holdings of less than ten acres. Overall livestock production has increased in recent years as more farmers have become involved in commercial livestock enterprises. These efforts have been assisted by the Ministry of Agriculture in collaboration with the St. Lucia Association of Farmers Co-operatives, with the latter focusing primarily on pig and poultry production. The potential for cattle expansion has not been fully exploited, primarily because the relatively large number of small-scale and landless cattle farmers serves as an impediment to more viable commercial operations. Overgrazing by livestock has been reported, for example in the Vieux Fort area where the loss of fertile top soil has been due primarily to overgrazing by cattle.

Table 3.8. Small farming and related land uses by land capability class.

	Percentage of land in capability class dedicated to particular land use			
	CLASS VI	CLASS VII	CLASS VI & VII	ALL OTHER CLASSES
Intensive Small Farming*	33.9	59.7	93.6	6.4
Mixed Small Farming**	26.8	67.2	94.0	6.0
Rural Settlements	36.5	51.4	87.9	12.1

* intensive use of all available land in a mix of crops for export (principally bananas), for the domestic market (vegetables and fruits) and for subsistence

** less than 70% of the land dedicated to the same mix of crops, with secondary and scrub forests covering the remaining lands not under cultivation

Source: OAS, 1988.

OTHER RESOURCE-BASED ACTIVITIES IN RURAL AREAS

The utilisation of natural resources in St. Lucia's rural sector is largely directed toward economic and social patterns which minimise risk through a diversification of activity. Even in agriculture per se, practices such as multi-cropping help to achieve this overall objective. Such risk diversification represents a logical adaptation of the rural population to the change and uncertainty associated with both the natural and economic environment within which it operates -- i.e., including the periodic occurrence of hurricanes and drought, shifting land tenure practices, and employment insecurity. These can be catastrophic events, threatening not only economic livelihood but even survival.

Diversification of activity, common throughout the Eastern Caribbean, therefore functions as a kind of insurance policy, permitting people to focus on alternative activities if any single one must be curtailed. In some areas of St. Lucia it helps accommodate a rapidly growing rural population which must engage in pursuits other than farming to ensure economic viability.

Most resource-based rural activities in St. Lucia are engaged in by both farmers and non-farmers alike as each group strives to satisfy basic needs rather than a maximization of profit. In fact, statistics from the 1986 Agricultural Census report that over 50 percent of all farm holders earn less than half of their household income through agriculture. Depending on the region, important non-farming activities in St. Lucia include handicrafts, fishing, and charcoal production. Craft production, for example, is very evident in the Choiseul district on the southwest coast of the island. Fishing prevails along the western coastline, while on the east coast charcoal production is the most important natural resource-based activity next to farming. Many rural individuals commute significant distances to urban, commercial and industrial

areas, drawn by the prospect of wage employment.

3.2 INSTITUTIONAL RESPONSIBILITIES AND RELEVANT LEGISLATION

GOVERNMENT ORGANISATIONS AND SERVICES

The Ministry of Agriculture, Lands, Fisheries and Co-operatives has broad responsibilities for agricultural services (including soil conservation), administration of Crown lands (through the Department of Forest and Lands), for fisheries (see Section 2.5), for forests (see Section 2.2), and wildlife (see Section 2.3).

The Ministry comprises four major sections or departments: Forestry and Lands, Fisheries, Co-operatives, and **Agricultural Services**, the last including extension services, research and development, agricultural engineering services, livestock development, veterinary services, and forestry (per Estimates of St. Lucia, 1987/88). Agencies concerned with natural resource conservation (other than Fisheries and Forestry, covered elsewhere in the Profile) are: (1) the **Extension and Advisory Division** and (2) the **Engineering Services Division** (both of which fall under Agricultural Services). The Pesticides Control Board, a quasi-independent statutory body, is also responsible to the Minister of Agriculture.

With a field staff of approximately 40 agents, the Extension Division's duties include providing advice to farmers on soil conservation, protection and rehabilitation practices. The Engineering Division implements programmes and services for land clearing and drainage, irrigation, and soil conservation, and is the central depository for the collection and maintenance of hydrological and meteorological information. The primary sub-units within the Engineering Division responsible for carrying out these responsibilities are the Water Resources and Irrigation Unit, until recently known as the Land and Water Use Unit (LWUU), and the Soil Conservation and Drainage Unit (HTS, 1986).

Agricultural land use on small government-controlled holdings (not more than five acres in one or more parcels) falls under management of the Ministry of Agriculture as per the Agricultural Small Tenancies Act of 1983. This legislation requires that tenants on such holdings follow good soil and water conservation practices to the extent that is "reasonable and fair under the circumstances." The Ministry is empowered to make regulations requiring more specific measures for good crop husbandry (Lausche, 1986).

The present ratio of extension officers to farmers is seen as one impediment to the Ministry's more active role in promoting soil conservation among small farmers. As reported by Dodd and Jackson in their 1982 assessment of St. Lucia's agricultural sector, the Ministry's support services to small farmers are not adequate because of:

- the inaccessibility of many small holdings to Extension Division personnel;
- limited incentives for extension personnel due to low wages, inadequate transportation and housing, lack of experience and teaching aids, and assignment of staff to non-extension tasks such as survey and data collection.

Further constraints to the Ministry's efforts to promote soil conservation by small farmers are: (1) the large-scale, commercial agriculture focus of much of its work and (2) inadequate funding for experimental plots in hillside areas to demonstrate environmentally sound cultivation practices. The Ministry's modest research programme is centred at the Union Experimental Station just outside Castries; a few smaller stations have been established elsewhere on the island. The Union laboratory is the only research facility in St. Lucia which attempts to carry out limited bacteriological analysis for food quality control. All of its research efforts, including those for crop protection, are hindered by

shortages of qualified technical staff and trained research officers.

The **Pesticides Control Board** (created by legislation of the same title in 1975) is chaired by the Director of Agricultural Services and includes representatives from the Ministries of Agriculture and Health, the Chamber of Commerce and Industry, IICA and CARDI. The Board has prepared a list of banned agrochemicals, and in December of 1987 regulations were approved with procedures for licencing the importation of pesticides, for the licencing of premises for storing, handling and distribution of pesticides, and for controlling the labelling of pesticides. A good working relationship exists between the Agriculture and Health ministries and has been particularly effective in the development of educational materials on pesticide use. The Inter-American Institute for Co-operation on Agriculture (IICA, see below) and CARDI also work closely with the Pesticides Board, with IICA having provided funding for many Board-sponsored publications.

The Ministry of Agriculture's Land Conservation and Drainage Programme has implemented drainage projects in the Dennery, Roseau and Cul de Sac watersheds, the three primary agricultural areas on the island. This programme was designed by a British consulting firm (Hunting Technical Services) in 1984, and financial support for executing the drainage project has been provided by the European Development Fund. Provision was made for the formation of local **Land Conservation and Drainage Boards** which are advisory in structure.

The Ministry of Agriculture has drafted a Land Conservation and Improvement Act which creates a statutory **Land Conservation Board**. According to the provisions of the Act, the Board will be entitled to regulate land use in areas considered critically important for the conservation of land resources and will be given enforcement powers to implement regulations. Furthermore, the Board will have authority to acquire lands where public control is considered essential for the conservation of land resources and related infrastructure. If approved by Government, this legislation would put in place a statutory body specifically concerned with land conservation and able to co-ordinate related Government actions.

NON-GOSL AGRICULTURAL SUPPORT SERVICES AND ORGANISATIONS

The **Windward Islands Banana Growers Association** (WINBAN) provides shipping and marketing co-ordination of banana exports for the islands of St. Lucia, Dominica, St. Vincent and Grenada. It established a research centre in St. Lucia (at Roseau) in the mid-1960's which now is the largest agricultural research unit in the Eastern Caribbean, carrying out research on all aspects of banana production, including pest control and the interplanting of bananas with other crops. The centre also provides training for banana extension officers from the four Windward Islands. WINBAN is funded by the local banana growers associations in St. Lucia, Dominica, St. Vincent and Grenada and additionally receives assistance from foreign donors, including Great Britain.

The **St. Lucia Banana Growers Association** (SLBGA) was established in 1967 and serves as the exclusive export agent for bananas from St. Lucia. It is a quasi-government body in that it was created by an Act of Government (Banana Growers Association Ordinance of 1967). It is also a membership organisation of local banana growers, for whom SLBGA provides goods and services at relatively reduced costs (the **St. Lucia Coconut Growers Association** provides like services for coconut farmers and is also quasi-governmental). SLBGA provides extension services to farmers, but its services are limited to banana growers. Among the goods provided for members are a wide range of insecticides and herbicides. While SLBGA does not regulate how agrochemicals are used, it does exercise some limited control by stocking only those chemicals which have been approved by WINBAN.

SLBGA does not have the authority to control cultivation practices by its members; it purchases bananas from farmers regardless of where or under what conditions they are grown. The position of the Association rela-

tive to soil conservation is that GOSL has sufficient authority to establish standards (e.g., no bananas to be grown on soils of "X" class or unterraced slopes greater than "Y" degrees). In the absence of such defined land use regulations from Government, the Association maintains that it is not its responsibility to regulate its members.

The **Caribbean Agricultural Research and Development Institute** (CARDI) is the agricultural research arm of CARICOM; its unit in St. Lucia was established in 1977. The work carried out under the aegis of CARDI is focused primarily on the region's small and medium farming sector. Its research efforts emphasise a high level of on-farm studies, farmer participation, and appropriate technology, with a view to developing and promoting alternative, more productive farming systems.

Questions have been raised (Dodd and Jackson, 1982) as to how effectively CARDI, MOA, and WINBAN plan and co-ordinate research programmes or share available facilities and resources. To the extent that this does not happen, the overall benefits of research or improved agricultural technologies will be diminished.

In addition to WINBAN, SLBGA and the Coconut Growers Association, St. Lucia has a number of other farm producer organisations, including:

- **St. Lucia Agriculturists Association**: organised in 1950 to promote the production and marketing of agricultural products; membership in 1982 was reported at about 1,200.

- **St. Lucia Pig Producers Co-operative and St. Lucia Egg Producers Co-operative**: with 1982 memberships at about 130 and 60, respectively, the two groups undertake marketing services for members and purchasing/importation of production supplies and feed required by members.

- **St. Lucia Association of Farmers Co-operatives (STAFCO-OP)**: comprising five farm producer co-operatives, including pig and egg producers, the Association has been credited with stimulating the local self-sufficiency St. Lucia now enjoys in the production of eggs and certain pork products. STAFCO-OP is emerging as the marketing and service agency for small farmers in much the same way that the larger growers associations perform these functions for the major exporters.

Donor-supported agricultural programmes operating in St. Lucia include:

- **Inter-American Institute for Co-operation on Agriculture** (IICA): an international agricultural research and technical assistance organisation recognised as a "specialised Inter-American agency" under the Charter of OAS. In the Windward Islands, IICA has given priority to the development of fruit tree crops in support of the general agricultural diversification goals of these countries. In St. Lucia, IICA has supported research on coconut mite control, sponsored training seminars in pesticide safety, and assisted the St. Lucia Pesticides Control Board with selection of a pesticide dumping site and study of hazards associated with pesticide usage near water catchments.

- **Organisation of American States/Natural Resources and Agricultural Development Project**: a series of projects carried out in St. Lucia since 1980 by the Department of Regional Development of OAS, in co-operation with the Ministry of Agriculture. Under its St. Lucia programme, OAS has produced a "St. Lucia Development Atlas", with a series of thematic maps (at a scale of 1:50,000) including to date: land use, land capability, land distribution and tenure, water resources, life zones, and geology (adaptation of earlier UN work). OAS has also been involved in a model land registration project, implementation of specific land development programmes, and publication of technical reports dealing with natural hazards, natural resource conservation, land use zoning, and land redistribution policies.

In 1986 GOSL and the OAS initiated a project to prepare a "Physical Development Strategy," designed to guide decision making on land development matters in the country. A subcomponent of the project, dealing with preparation of a "Conservation Strategy," has re-

cently put forward a conservation strategy for agricultural lands (OAS, 1988) to be followed by similar proposals for development of land resources of importance for tourism and for the development of urban areas.

- **U.S. AID's HIAMP Project** (High Impact Agricultural Marketing and Production): AID's new HIAMP project is designed to furnish assistance to the agricultural sector of participating countries by improving the investment environment for agricultural enterprises. In St. Lucia, HIAMP's project officer plans to initiate four new projects a year (the first was launched in December of 1987 to promote the export of tropical plants and foliage to England and Europe from a 50 acre nursery in the village of Choiseul); new projects will focus on agricultural ventures with HIAMP taking an equity position in such operations.

THE ENVIRONMENTAL IMPACTS OF BANANA CULTIVATION

Despite its dominant role in the overall economic development of St. Lucia, banana cultivation comes with an environmental price tag which should not be overlooked.

In the first place, most of the "marginal" agricultural areas now supporting banana production have steep slopes which, if cropped at all, should be planted only with tree crops to ensure against soil erosion. The banana, however, is a herbaceous perennial species which, unlike a true tree crop, has a very shallow rooting system and no tap root. Therefore, while the plant's large leaves afford protection against rainfall damage where cropping patterns are dense, erosion can be significant as the roots do little to stabilise the soil.

This is less of a problem where ground provisions or other crops are interplanted with bananas, for example, on many small family farms. But in many instances, steep slopes, including those in the forest reserve, are the focus of commercial banana growers seeking short-term profits with little regard for long-range impacts.

The ongoing destruction of forest cover, which has coincided with expansion of more profitable banana cultivation onto forested lands, is drastically altering the island's hydrological cycle. Without forest cover to slow the overland flow of water, less water is infiltrating the ground; and as more water is running off, less is stored within the natural water system. One critical result is a lowered base flow in streams during dry periods, a development which is threatening St. Lucia's water supply. In conjunction with high sedimentation rates resulting from accelerated erosion in unprotected upland areas, drainage ditches fill, culverts clog, streams overflow, and flooding has now become a major problem in many prime valley bottom agricultural areas and in coastal urban areas like Castries.

Mono-crop agriculture, whether on marginal or cultivable lands, will not provide a sustainable yield agro-system. Single crop farming exhausts the natural nutrients in the soil, and these are only somewhat replaced with artificial ones in the form of fertilisers, in part because much of the fertiliser input is lost through leaching. Monocrop agriculture also is vulnerable to pest infestation and requires more pesticide use to control disease.

The importance of this "green gold" crop to St. Lucia's economy has for too long disguised the fact that the natural and physical environment to support banana production is becoming increasingly marginal -- a situation in no small measure resulting from the very impacts which banana cultivation has created.

3.3 PROBLEMS AND ISSUES

SOIL EROSION

St. Lucia's steep topography, its subjection to torrential rains, the fact that many areas (such as the interior upper catchment regions) are highly susceptible to soil loss, and the indiscriminate removal of natural vegetation cover have all contributed to a serious erosion problem. It represents one of the most critical environmental risks confronting the country and degrades the very resource base upon which much of the population and economy are dependent. Unfortunately, the prospects for reversing its direct causes do not appear promising at the present time.

Estimates of soil loss for five erosion hazard classes are presented in Table 3.9 for the catchments of three important agricultural valleys in St. Lucia: Roseau, Fond D'Or and Cul-de-Sac. The same erosion classes are mapped for the entire country in Figure 3.3. On a small island, with a limited amount of prime agricultural land, the rates of erosion described represent a serious environmental threat to a key economic sector.

On one level, the direct causes of the country's extensive soil erosion can be readily identified: the clearing (often illegal) of forest cover and the cultivation of steep slopes using poor farming practices are the most obvious. What is not so clear is how to deal with the underlying motivations and circumstances which give rise to these harmful practices. As OAS has pointed out (1988), over-exploitation of agricultural land in St. Lucia is a rational response on the part of small farmers to the multiple social and economic problems they face.

Looking first at the direct causes of the country's soil erosion problem, several factors have been identified.

(1) **Indiscriminate clearing of lands.** As discussed elsewhere in this section of the Profile, as long as the demand for acreage for banana cultivation by small farmers steadily increases, the imprudent clearing of forest lands in areas of steeper slope will continue. With the removal of tree roots which help to hold the soil in place, the cleared hill slopes become very susceptible to both erosion and slumping, as is evident in the upper Cul-de-Sac and Roseau catchments.

(2) **Poor land management.** Areas where soil erosion is considered most severe in St. Lucia, Choiseul/Delcer in the southwest and Vieux Fort in the south, are good examples of why more appropriate land management strategies need to be employed in the country. In these areas, which are relatively dry with very shallow, slowly regenerating soils and only partial ground cover, the predominant crops are root crops which provide for very little protection from erosion and subject the land to over-tillage. In addition, some areas have also been overgrazed by livestock, and little can now be done to remedy the loss of the fertile top soil.

Slash and burn cultivation is still utilised in St. Lucia. Although sheet erosion takes place on most of the cultivated hill slopes, areas where such burning is also practiced are even more susceptible to subsequent loss of surface soil.

(3) **Inadequate control of run-off.** The occurrence of gully erosion is widespread on the island. In the development of hillside farms, very little if any provision is made for drainage. The presence of foot paths often predisposes the land to gully formation. Such gullies are rarely protected, and considerable land loss occurs. Where drainage channels and main waterways do exist, farming (especially of bananas) continues to the very edge of the channel. Under these circumstances, the use of herbicides requires caution, especially with regard to its secondary effects on field edges, windbreaks and stream and drain borders. Excessive weed killing with herbicides exposes the soil to the erosive power of rainfall leading to possible bank erosion and blocking of drains.

(4) **Feeder roads.** Construction of feeder roads has opened previously inaccessible lands and thereby indirectly encouraged further encroachment on forest lands for cultivation purposes. Such encroachment is very visible in the Floissac, Sarot and Maisonneuve areas of the

Table 3.9. Annual estimates of soil erosion loss for three major agricultural valleys in St. Lucia.

SITE/EROSION CLASS		% AREA*	% EROSION
Fond d'Or			
0	None	12.5	0
1	Slight	23.0	19
2	Moderate	46.0	52
3	Severe	10.0	21
4	Very severe	3.0	8
Cul de Sac			
0	None	14.0	0
1	Slight	11.0	25
2	Moderate	38.0	32
3	Severe	19.0	30
4	Very severe	7.0	13
Roseau			
0	None	12.0	0
1	Slight	33.0	27
2	Moderate	33.5	37
3	Severe	10.0	20
4	Very severe	6.0	16

* excludes settlement areas

EROSION KEY:

0	0	3	47.20 tonnes/hectare
1	18.88 tonnes/hectare	4	62.94 tonnes/hectare
2	25.17 tonnes/hectare		

Source: Hunting Technical Services Ltd., 1984.

Cul-de-Sac catchment, the upper Marquis/ Babonneau catchment, the areas of Errard, Basil and Mt. Panache, among others. Control of run-off from feeder roads is also a problem. Drains provided are often inadequate, and in many cases run-off is simply concentrated into one or more holdings resulting in extensive loss of valuable land.

In addition to these problems, drain blockages and the creation of river course obstructions, caused by the deposition of sediment and debris from cultivated hillsides, have created numerous adverse environmental impacts such as meandering rivers, bank erosion, reduced channel capacities, increased flooding, loss of fertilisers and nutrient-rich topsoil, and ultimately damage to marine and coastal environments as large quantities of sediment are carried to the sea.

In the Cul-de-Sac Valley, following subdivision of hillsides and increased squatting, the required desilting of drains in valley lands has increased from once annually five years ago to four times in 1986 and possibly five in 1987. In the Roseau Valley, where there is some control over the management of the

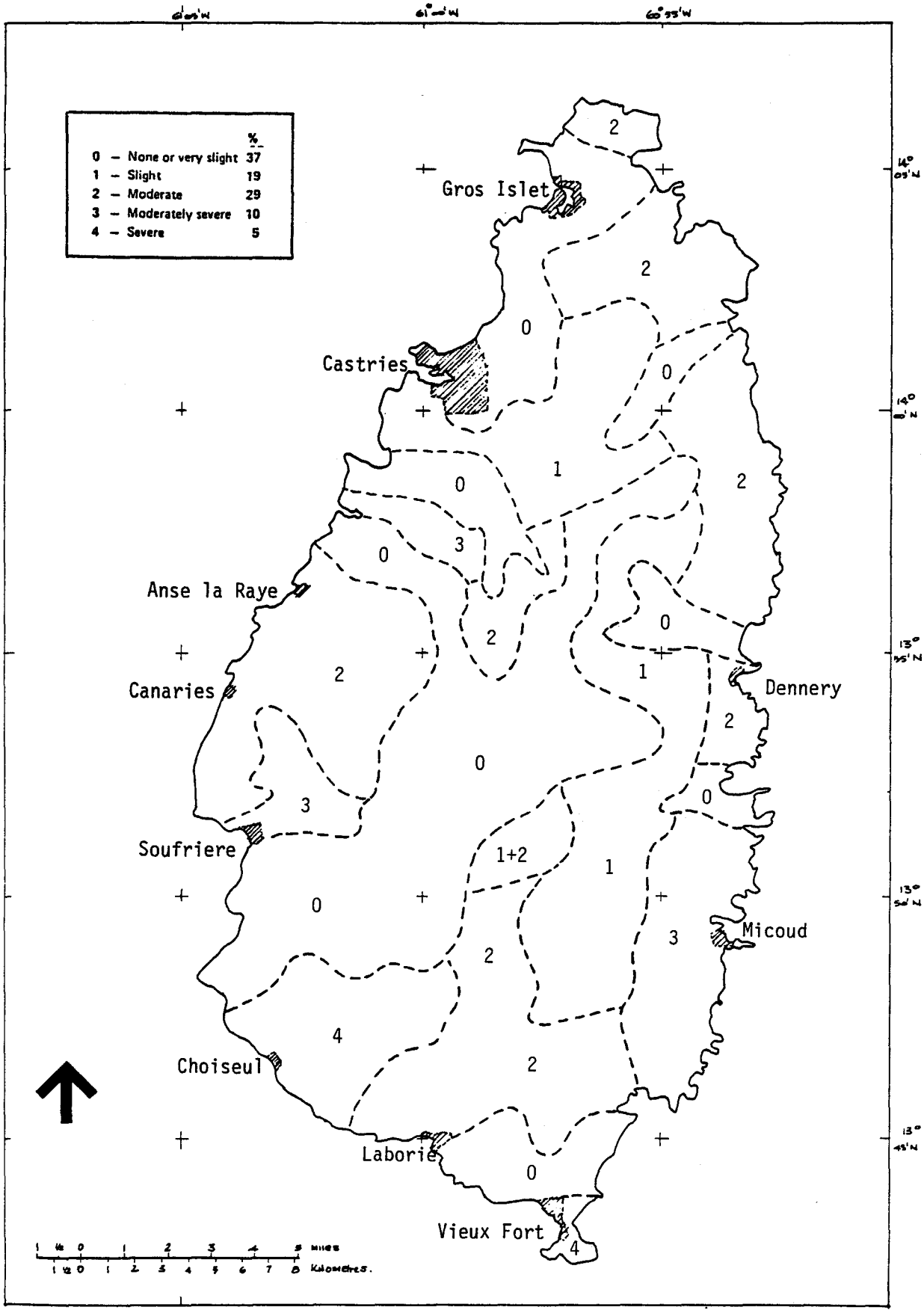


Figure 3.3. Five erosion hazard classes mapped by area (source: Hunting Technical Services Ltd., 1984).

hillsides, such desilting is necessary two to three times annually (per unpublished documentation from MOA for the CEP report). Increased maintenance costs are incurred by the Water and Sewerage Authority as periods of heavy rainfall result in the silting-up of reservoirs and intake structures, often causing treatment plants to experience temporary shutdown.

CULTIVATION OF MARGINAL LANDS

Closely related to the issue of soil erosion are those associated with the cultivation of "marginal" lands. As indicated in Section 3.1, most of the country's land base is marginally or completely unsuitable for agriculture. Some 84 percent of the land base falls in capability classes VI and VII, both of which are characterised by susceptibility to severe erosion hazard.

Nevertheless, marginal land has historically been cultivated in St. Lucia, for instance the peripheries of estates where workers traditionally have planted crops for their own subsistence. On a small scale, such activity was not a serious environmental problem. In recent years, however, cultivation of steep or otherwise marginal lands has intensified to the point where rich top soil is rapidly washing away and problems of siltation, flooding, and waterlogging are occurring in some lowland areas.

Several interrelated factors account for this change in cultivation patterns:

(1) Since the 1970's employment on the large agricultural estates has declined significantly as a result of the lower economic productivity of the large plantation-type farms. This has forced a significant share of the rural population to turn to independent cultivation as a means of economic survival.

(2) Despite the subdivision or sale of some estates, the country's prime agricultural land is still monopolised by large land holdings, and those seeking cultivation sites increasingly turn to the marginal slope lands, including those within the forest reserves.

(3) St. Lucia's population growth rate in many areas is as high as three percent per year, implying a doubling of population every 20 years. In the absence of alternative economic opportunities, an expanding rural population is relying on hillside agricultural production more than ever before.

(4) The large scale construction of feeder roads in recent years has facilitated the overall process of agricultural expansion to marginal areas. For 1987/88, the Government's investment budget includes EC$ 4,718,000 allocated for feeder roads, financed primarily by external sources (World Bank, 1986).

ENVIRONMENTALLY HARMFUL CULTIVATION PRACTICES

The fact that there is a widespread discrepancy between land use capability and actual land use in the agricultural sector can be attributed to: (1) continued expansion of banana cultivation on marginal lands; (2) insecurity of land tenure; and (3) the need for improved agricultural support services for small farmers. These factors in turn contribute to the perpetuation of production practices which significantly threaten the sustainability of the resource base.

(1) **Emphasis on banana cultivation.** Bananas are an attractive crop for the small farmer in St. Lucia, primarily because the farmer earns more money per unit of effort than for any other (legal) crop. Furthermore, a protective market exists for the crop in the United Kingdom under preferential trade terms (see Section 1.5). Unfortunately, equally attractive markets in terms of security and size do not exist for alternative tree crops which would be more suitable to hillside agriculture.

Coconut cultivation, for example, is more appropriate but its production represents a longer-term investment and is not as steady or as profitable an income, either per man-month of work or per acre. Since the crop is affected by a coconut mite disease, it is also a riskier venture for the small farmer. As far as cultivation of perishable products is concerned, the marketing system for domestic (including tourist) consumption or regional trade is poorly organised and thus provides minimal incentive for profit-oriented production.

It has been argued that St. Lucia's small farmers are not responsive (in terms of either production or quality) to price incentives which might encourage alternative crop cultivation. The overall drudgery of agricultural labour, the added income derived from the overseas remittances of relatives working off-island, and the fewer constraints to maintaining a subsistence lifestyle in a tropical setting are cited as reasons for this reported disinclination. However, it has also been reported that on occasion small farmers, responding to advertised fixed prices for targeted commodities, have either been refused or offered lower prices by the Agricultural Marketing Board (Dodd and Jackson, 1982).

(2) **Insecurity of Tenure**. Only about 27 percent of the farm holdings in St. Lucia are owned. The remainder fall under tenure categories of family land, rental, squatting, and so forth. Furthermore, until implementation of the recent Land Registration and Titling Project (funded by USAID), only a small proportion of the country's landholdings had been properly surveyed and registered; thus few farmers had clear and legal title to their land.

This situation in turn has contributed to the perpetuation of environmentally unsound cultivation practices in hillside areas and thus to land degradation in general since it was difficult for most small farmers (without legal land title) to secure credit for long-term investments in tree crops, terracing, or soil improvement methods.

The "family land" issue stands out as a particularly problematic factor in St. Lucia. Under this form of tenure, characteristic of 45 percent of all holdings according to the 1986 Agricultural Census, land is held jointly by members of an extended family, sometimes hundreds of individuals, each with a legal and undivided right to cultivate a portion of the land. Even when one person has been farming all or most of the holding for an extended period, a distant relative may at any time call into question the individual's right to continue cultivation. This uncertainty acts as a barrier not only to credit, but also to a commitment on the part of the farmer to overall land conservation since the benefits of doing so may only be enjoyed by him or his immediate family for a short period of time.

(3) **Agricultural Support Services**. Until recently and thus for most of St. Lucia's agrarian history, small farming has been neglected by the national government. Within the colonial framework, only the large, export-oriented agricultural estates were viewed as important, and unfortunately this pattern of overlooking the small farm sector continued into modern times. The consequences of small farm underdevelopment are important not only economically but are equally critical as environmental issues. Without adequate control, support and management from central Government agencies, the small farm system has developed with a high degree of autonomy and without a proper regard for national concerns or goals regarding erosion control, deforestation, or soil conservation.

USE OF AGRO-CHEMICALS

Fertilisers. Chemical fertilisers are in widespread use in St. Lucia. NPK (nitrogen/phosphorus/potassium) types of fertilisers are most commonly used (CARDI, 1986), apparently at a rate of 0.9 kg per mat per year which amounts to up to 225 kg per hectare per year. The total amount of fertiliser used by farm size is shown in Table 3.10. Sulphate of ammonia, a source of nitrogen, is also popular as an input to banana production and is clearly more popular with the small farmer. The greatest potential risks from such use in the St. Lucian environment are reported to be soil deterioration and

Table 3.10. Number of bags of fertiliser used by type and by size of holding in 1986.

SIZE GROUP (acres)	TYPE OF FERTILISER Lime	NPK*	Sulph. Ammonia	TOTAL
Under 5	128.0	85,240.0	7,794.0	93,162.0
5 - 9.9	110.0	46,921.0	4,564.0	51,595.0
10 - 24.9	141.0	31,990.0	3,446.0	35,577.0
25 - 49.9	4.0	6,007.0	1,492.0	7,503.0
50 - 99.9	-	2,510.0	413.0	2,923.0
100 - 199.9	-	1,063.0	385.0	1,448.0
200 - 499.9	-	1,970.0	822.0	2,792.0
500 and over	-	22,142.0	1,660.0	23,802.0
TOTAL	383.0	197,843.0	20,576.0	218,802.0

* NPK = Nitrogen, Phosphorus and Potassium; a 50 kg bag cost EC$ 33.00 in 1986.

Source: GOSL, 1986 Census of Agriculture (1987).

nutrient overload in downstream and coastal receiving waters (CARDI, 1986).

Pesticides. Agriculture generally and banana growing in particular have become increasingly dependent on "inputs" not only of chemical fertilisers but also large amounts of a broad spectrum of pesticides, some applied by back pack sprayer and a larger portion sprayed from airplanes. The liquid carrier in both cases is a petroleum- based mineral oil, known generally as Spray-Tex. Table 3.11 shows the amount of spray oil used in 1987 and scheduled to be used in 1988. The oil is mixed at different ratios with the various pesticides selected as is displayed in Table 3.12. For farmers raising bananas (and of course many have some bananas as part of an intercropping strategy), all pesticides are available in bulk from and handled through the St. Lucia Banana Growers Association.

Among the different pesticides available, insecticides, nematicides, herbicides and fungicides are the most critical from an environmental perspective. Each group has its own characteristics and represents a special challenge to the resource manager who must seek to use them with the least possible damage.

Organochlorine insecticides such as DDT, Heptachlor and Chlordane, although no longer in use in developed countries, are still widely used in St. Lucia. These chemicals, which can cause acute poisoning in vertebrates (including humans and fishes) are not easily broken down in the environment (i.e., decomposed), and hence they persist for long periods after application.

Due to the high run-off from agricultural lands which are predisposed to erosion, residues of these organochlorines in water can be locally high, even though drainage water (i.e., water that has infiltrated the soil) from treated fields is almost free from contamination because of high absorption into soil particles.

The synthetic pyrethroids, another class of commonly used insecticides that impact

Table 3.11. St. Lucia Banana Growers Association spray oil (Spray-Tex*) use.

	1987	1988
Ground Spraying	146,101 gallons	114,325 gallons
Aerial Spraying	191,067 gallons	176,000 gallons
TOTALS	337,168 gallons **	290,325 gallons **

* Spray-Tex is a petroleum-based mineral oil. SLBGA has three distribution tanks (provided by Texaco) strategically located around the island for the convenience of the growers. It expects six more tanks in 1988. Ground spraying fluctuated between 5,000 and 20,000 imperial gallons/month during 1987.

** Imperial Gallons

Source: St. Lucia Banana Growers Association.

Table 3.12. St. Lucia Banana Growers Association pesticide/fungicide spray mixture ratios (1988 schedule), and potential coverage.

	AMOUNT	LEVEL OF APPLICATION	POTENTIAL TREATED ACREAGE
Benlate (benomyl)	3,000 kg	0.10 kg/acre	30,000 acres
Calixin (tridemorph)	10,800 litres	0.24 litre/acre	40,000 acres
Tecto-B	1,650 litres	0.11 litre/acre	15,000 acres
Sigma (thiophanate methyl)	3,600 litres	0.24 litre/acre	15,000 acres
Tilt	2,462 litres	0.16 litre/acre	15,000 acres

N.B. Oil (Spray-Tex) is applied at the rate of 1.3 gallons/acre after being mixed with one of the pesticides at the appropriate ratio shown. Spraying is done several times -- sometimes six or more applications per year -- depending on the need as determined by field inspections.

Source: St. Lucia Banana Growers Association.

negatively on the environment, are not as persistent as the organochlorines. Examples of synthetic pyrethroids are Ambush, Decid and Karate. Like the organochlorines, these chemicals are toxic to fish and economic insects such as bees. Thus, in the absence of a well- managed, on-farm spraying regime, the chances of endangering aquatic and useful insect life will be substantial.

The safest class of insecticides are the organophosphorus compounds, such as Malathion, Basudin, Metasystox-R and Phosalone. Preferential use of these insecticides is advocated in light of the fact that they are non-persistent and not very toxic to vertebrates and bees.

Nematicides, which are used to control the spread of nematodes and soil insects, are very toxic to vertebrates, invertebrates, and wildlife. Due to the fact that they decompose quite easily, fear of a potential build-up of residues of this chemical in the environment is unwarranted. Nevertheless, care needs to be taken when these chemicals are applied to crops because the available granular formulations of the most commonly used nematicides -- Furadan and Nocap -- are very water soluble and therefore likely to leach into underground springs, rivers and other water catchments.

Among herbicides, most are toxic but do not pose serious threats to animal life because these compounds either are absorbed into soil particles or decompose quickly. Paraquat -- commonly known as Gramoxone -- is widely used in St. Lucia for the chemical control of weeds, in spite of the fact that this chemical has an extremely deleterious effect on vertebrates and the environment. Its use is prohibited or restricted in developed countries.

A significant problem associated with agrochemicals in St. Lucia is the high level of misuse. Sprayers can often be seen wearing inadequate skin protection (e.g., bare feet and chests) and no face masks. It is regrettable that many of the field workers using back pack pesticide sprayers often tend to be young teenage children, a sad state of affairs in an otherwise modern country. Furthermore, chemical containers are commonly washed out in streams and disposed of indiscriminately. It is common for usage recommendations to be disregarded, for instance in terms of frequency of applications (CARDI, 1986).

Since December, 1987, when the new Pesticide Regulations went into effect, all importing, exporting, sales, storage, and labeling will now be regulated by the Pesticide Control Board. One problem is that farmers use pest control inputs --issued for bananas -- on other crops as well and are also known to obtain the chemicals from SLBGA for resale to other farmers. This makes assessing the locational or specific impacts somewhat more difficult and less precise. Secondly, some donor-sponsored impact assessments of pesticide use ignore the inputs provided by other donors.

3.4 DIRECTIONS FOR THE FUTURE AND POLICY RECOMMENDATIONS

AGRICULTURAL DIVERSIFICATION, MARKETING, AND AGROFORESTRY

The need for diversification of St. Lucia's agricultural sector, away from the traditional emphasis on a single or a few crops, has long been a national goal. Until recently, however, the small size of the local market required that crops be developed almost exclusively for export, generally to large, extra-regional markets.

With the increasing importance of tourism in St. Lucia and neighbouring islands, a growing market for food crops is emerging which could over time not only accelerate the need for crop diversification but also diminish the loss of tourist revenues now going to import food for hotels and restaurants.

While economies of scale make it difficult for a small island to compete with large agro-producers, a local comparative advantage does in fact exist for certain items and needs to be exploited. According to Dodd and Jackson (1982), there are opportunities available to market greater amounts of avocado, mango,

pineapple, ginger, cloves, hot peppers, cinnamon, turmeric, and various juices (such as passion fruit, citrus, and guava), particularly to the local hotel trade. Penetration of more distant markets also can be achieved through increased produce differentiation.

Crop diversification is important not only for economic but also for environmental reasons as the dominance of banana cultivation poses a broad range of environmental problems particularly in hillside areas (see box on "Banana Cultivation"). Given the fact that hillside agriculture is not decreasing but expanding, greater emphasis on agroforestry systems would seem to be another suitable alternative. Agroforestry techniques have been used in the past in St. Lucia, and CIDA has proposed a pilot project to study the feasibility of agroforestry, an effort it will support under its current Forest Management and Conservation Project. Agroforestry can provide a variety of products -- cash crops, tree crops, food crops, fuelwood, fodder -- making it well suited for national programmes of agricultural diversification and soil conservation. But it does require good planning and mostly full-time, not part-time, participation.

In general, one important long-term goal for St. Lucia in the agriculture sector lies in the promotion of policies which diversify the mix of crops being cultivated by small farmers, moving from the current emphasis on annual subsistence and semi-perennial export crops, like bananas, to a pattern incorporating tree crops capable of providing the required permanent cover of land on steep slopes. To make such cropping patterns profitable, appropriate input pricing, extension services, soil conservation investment subsidies, and marketing assistance all need to be considered by GOSL, much along the line of successful approaches taken for the introduction of bananas after the collapse of sugar production in the late 1950's (OAS, 1988).

LAND TENURE AND SOIL CONSERVATION

With the recent completion of USAID's Land Registration and Titling Project, one important barrier to agricultural development in St. Lucia has been removed. A larger number of landholders now have clear title to their agricultural lands and -- it might be speculated -- will in the future have better access to credit and greater personal incentive for investing in more long-term soil conservation practices, such as tree crop planting, drainage system improvements, terracing, and the like.

While land tenure security is helpful in strengthening the agricultural sector, more than this is needed. Other changes, directed at improved agricultural extension services, including education and training programmes in soil conservation techniques, are also required.

Current Ministry of Agriculture efforts to promote soil conservation by small farmers seem to be primarily limited to the overseeing of several demonstration plots in hillside areas, funded and maintained on a somewhat ad hoc basis. However, very little is likely to change until GOSL creates new financial incentives for soil conservation, including terracing, water course pond construction, and stream edge planting, among other landscape and soil investment practices. These constructive resource management and conservation activities will take more than good will; they will require a substantial commitment of time and effort on the part of both Government and the farmer or land owner. At the very least, Government needs to expand its soil conservation activities, as an integral part of the Ministry's outreach programmes for small farmers, and to provide specific guidelines for cultivation of hillside lands.

Furthermore, completion of the Land Registration and Titling Project has not resolved the problem of jointly held "family lands," a systemic problem which will continue to perpetuate patterns of insecure land tenure and over-exploitation of small farms under temporal control. The Government of St. Lucia may need to consider more innovative and short-term forms of reward, incentive, or subsidy to encourage the practice of environmentally-sound land management by small farmers -- many of whom will continue to lack a long-term claim to their land. Individuals are not likely to have funds for the construction of bench terraces, grass and stone barriers, con-

tour drains, stepped waterways, wind breaks and similar soil conservation techniques, which are often very labour intensive. Some part of the expense may have to be financed by Government, on a fairly large scale, in order to be effective.

RESEARCH, EXPERIMENTATION AND DEMONSTRATION FARMS

St. Lucia's three primary experimental farms are all located in lowland areas -- the Ministry of Agriculture's farm at Union, the WINBAN research facility in the Roseau Valley, and the CARDI site in the Fond d'Or Valley (the Ministry of Agriculture maintains two other agricultural stations at Barthe, Soufriere and Beausejour, Vieux Fort). As such, they are primarily useful to those cultivating farms with higher land capabilities. Such sites do not adequately address the problems associated with the rather different biophysical and socio-economic environments of upland agricultural areas. St. Lucian farmers in such locations would benefit from the demonstration effect of experimental facilities on hillsides, particularly as they integrate local and traditional knowledge about crop cultivation with methods for making production systems more efficient and less destructive of the natural environment.

Furthermore, attempts at land reform, land redistribution or resettlement projects in St. Lucia (for example, the Model Farms project in the Roseau Valley or the rural development scheme for the Fond d'Or River Basin) have been situated, by and large, in valley regions. Similar consideration for land reform projects needs to be given to the upland regions of the country where there is a high incidence of squatting and sharecropping, the very circumstances which foster poor resource management practices by landholders.

There is also a need for further study of Class VI and VII lands. These two land classes, which comprise well over three-quarters of St. Lucia's land base, are not suitable for cultivation of seasonal crops. Since actual use exceeds land use limitations for the two classes, further research is needed to identify suitable combinations of environmentally benign cropping systems which at the same time provide a reasonable rate of monetary return for the small farmer.

ZONING CRITERIA FOR AGRICULTURAL LANDS

Throughout the Eastern Caribbean, highly productive agricultural lands are a scarce resource, both in terms of quantity and availability to the rural population. Rojas and Meganck (1987) estimate that in almost all the OECS islands they studied, good agricultural lands represent less than five percent of the total land area. St. Lucia is no exception with only 4.79 percent of its lands classified as "cultivable" (Classes I, II, and III).

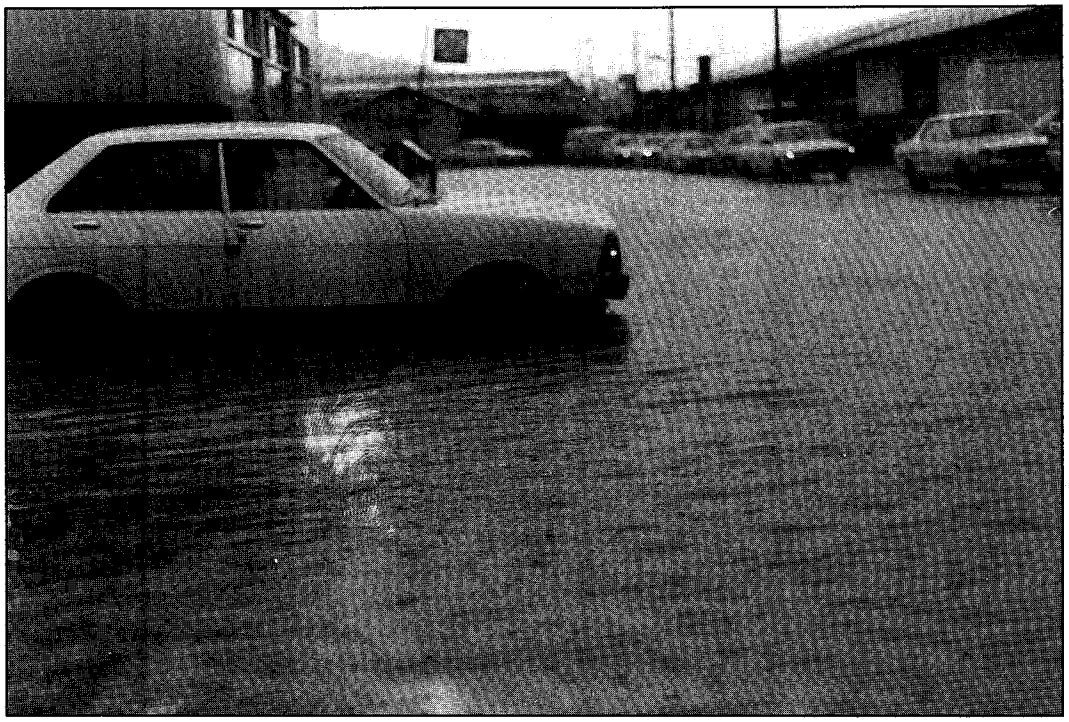
Not only is there a scarcity of agricultural lands, but there has been a significant decline in the total area of land occupied by agricultural holdings. Lands used for agricultural purposes -- including arable lands, lands under permanent crops, grasslands, and forests -- dropped by 19.4 percent between the Agricultural Census of 1973/74 and the more recent Census of 1986; almost 14,000 acres of agricultural lands were diverted from cultivation to alternative uses during the 12 year period. This represents an annual rate of decline of 1.49 percent, which is consistent with the 1.46 percent rate of decline recorded between census years 1961 and 1973/74.

While this level of encroachment onto agricultural lands by human settlements is not a widespread problem, OAS (1988) found that over 60 percent of the agricultural land used for settlements had been taken from three watersheds, Dennery, Roseau and Cul de Sac, which collectively contain the largest concentrations of the highest quality agricultural lands.

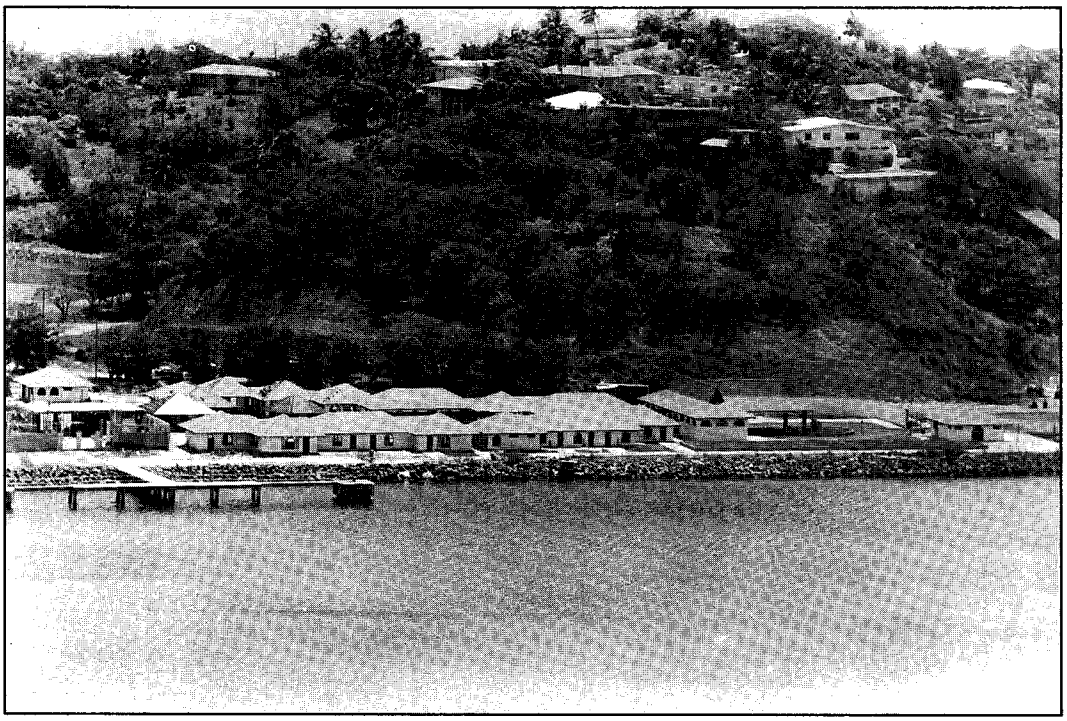
In view of these statistics, St. Lucia needs to identify an appropriate method *to reserve its remaining agricultural lands for agricultural pursuits, particularly those with the highest land capabilities*. If present trends continue, further fragmentation and subdivision of these lands for housing, infrastructure, tourism, urban, and other commercial development will not lessen. A small island, particularly one

with a growing population, cannot easily afford to sacrifice its limited yet prime food-producing land resource base to satisfy short-term economic interests.

A plan for island-wide zoning which classifies and protects certain categories of land (e.g., for agriculture, recreation, forestry, water catchments, and wildlife) is increasingly important. It is particularly critical in the rural sector to prevent further displacement of small farmers to urban areas and to ensure the availability of suitable lands for ecologically sound and profitable agricultural production, aimed at rural employment, export earnings or import substitution of food stuffs.



Flooding in downtown Castries.



Pointe Seraphine tourism complex, Castries Harbour.

4. THE URBAN/INDUSTRIAL ENVIRONMENT

4.1 TOURISM

4.1.1 Overview of the Tourism Sector

Tourism is emerging as the lead sector in the post-war restructuring of the St. Lucian economy. Rapid growth in stayover visitors (in excess of 10 percent annually since the 1960's) has been largely due to the country's favourable tax concessions for foreign investors, to expansion of airport, harbour, and road infrastructure, and most of all to development of natural features and recreational amenities as touristic assets. Other supportive attributes include the country's proximity to major visitor markets in North and South America and Europe, political stability, a pleasant climate, and superlative and variegated scenery. More recent promotion efforts have focused on the island's distinctive French Creole culture and history, on developing access to the sulfur springs at Soufriere, and on exploiting the country's sailing and diving potential as a base to explore both south through St. Vincent and the Grenadines and north to the contrasting experiences of Martinique and Dominica.

GROWTH TRENDS

According to Bryden (1973), St. Lucia became an early tourism leader in the Lesser Antilles with annual growth rates exceeding 20 percent for stayover visitors between 1961-1968. This growth was partly due to the island's colourful natural beauty that appealed to veteran vacationers. It also stemmed from being one of the first Eastern Caribbean destinations to successfully tap the European market (Spinrad, 1982).

Such buoyancy continued during the 1970's when overnight visitors grew at an average rate of 17 percent per year. According to data for 20 comparable destinations in the Eastern Caribbean (Albuquerque and McElroy, 1987), this performance ranked in the top third and rivaled all islands with a similarly developed tourist plant with the exceptions of the Caymans and the British Virgin Islands.

Growth slowed to less than seven percent during the early 1980's because of worldwide recession, intensifying regional and international competition, and some tour operator reaction against the government elected in the late 1970's. Post-1986 indicators suggest, however, a return to the pre-1980 growth pattern of 10-15 percent increases in stayover visitors per year. Visitor figures reached an all time high of 169,360 in 1986-87, and the projection for 1987-88 is a record 200,000 (*Caribbean Update*, March 1988).

The number of cruise ship passengers had been declining since 1977, with arrivals bottoming out during the trough of the world recession (1981) but climbing again to pre-recession levels by 1986. This fluctuation has been due partly to the Caribbean cruise industry's use of larger, more fuel-efficient carriers (not as easily accommodated in St. Lucia) and partly to the industry's demand for shorter trips from the gateway port in Miami. Nevertheless, since 1986 cruise ship visitors have continued to increase, in part, in response to the advantages afforded smaller vessels now able to lie alongside at the newly completed Pointe Seraphine pier and shopping facilities.

Despite the numerical importance of cruise visitors in St. Lucia's tourist mix -- roughly one-third (58,756 passengers) of combined cruise and stayover visitors (totaling 174,218 in 1986 per GOSL Annual Migration and Tourism Statistics) -- they contribute only a small portion of the total tourist expenditure because of their brief on-island stay (approximately 3 hours) and low per capita (less than $US 50) spending. Cruise ship arrivals jumped from 149 in 1980 to 214 in 1987 (GOSL *Statistical Digest*).

VISITOR PROFILE

Table 4.1(1) provides information on the St. Lucia visitor mix. Between 1980 and 1986, U.S. and Caribbean markets have grown

Table. 4.1(1). Percent distribution of tourist arrivals in St. Lucia in 1980 and 1986, by country of residence.

	1980	1986
U.S.A.	17.7%	31.2%
Canada	16.3%	10.8%
Europe	39.4%	31.0%
Other Caribbean	23.8%	25.3%
Other	2.7%	1.7%

Source: CTRC, 1987a.

apace, while relative declines have occurred in Canadian, European (mainly United Kingdom), and other markets. This changing visitor composition has been common throughout the region during the 1980's in all but the smallest islands (CTRC, 1987a). In St. Lucia, the U.S. share increased over 12 percentage points between 1980-1986; the Caribbean ratio rose marginally, while Canadian and European shares fell six and eight points respectively.

The sheer persistence of these trends across the 19-country sample used by CTRC indicates they stem in part from cost/price differences based on market distances in an era of expensive aviation fuel and in part from the exchange rate realignments (dollar appreciation and pound depreciation) that took place over the period; these favoured U.S. and Caribbean dollar-denominated markets and raised costs/prices in the declining currency markets of Europe and Canada. With the more recent depreciation of the U.S. dollar, St. Lucia has been well positioned for an increase in European visitors, especially French and Germans.

The unusual balance and relatively even mix of the St. Lucia visitor profile is also illustrated in Table 4.1(1). In 1986, for example, St. Lucia maintained one of the lowest U.S. ratios (31%) among Eastern Caribbean destinations, absolutely the highest European ratio (31%), and average shares for Canadian (11%) and Caribbean (25%) markets.

FACILITIES, SEASONALITY AND OTHER SPECIAL CHARACTERISTICS

The quality and variety of accommodations available is important in attracting a diversified visitor base. In St. Lucia, the blend of hotel, apartment, and guest house/villa facilities is well balanced. In 1986, for example, exactly one-third of some 45 properties listed were hotels, apartments, and guest house/villas, respectively (GOSL, Annual Migration and Tourism Statistics, 1986).

According to Table 4.1(2), the distribution of rooms across these accommodation types was also relatively balanced. Data from CTRC for 1985 show less than 60 percent of available rooms were in hotels and even shares for apartment hotels, apartments, and guest house/villas. In addition, the number of rooms available in larger hotels with 100 rooms or more represented approximately one-half (47 percent) of the total rooms.

These findings suggest that St. Lucia possess a good fit between its visitor vacation preferences (demand) and the variety and style of its accommodations (supply). The special satisfaction of St. Lucia's visitors is supported by average length-of-stay statistics assembled by CTRC (1987a). Among the 21 islands compared between 1980 and 1985, St. Lucia recorded the highest average stay (10 days). It was also one of only a few destinations where the average stay rose over the period. In terms of the island's market segments, in 1985

Table 4.1(2). Type of tourist accommodation in St. Lucia, 1980-85, with number of rooms available by each type.

	1980	1981	1982	1983	1984	1985
Hotels	1043	1043	1043	1080	1080	1001
Apt. Hotels	235	235	235	281	312	263
Apartments					65	223
Guest Houses	106	106	106	81	71	71
Villas					177	177
TOTAL # ROOMS	1384	1384	1384	1442	1705	1735

Source: CTRC, 1987a.

stays were longer for Europeans (12.3) and Canadians (10.0) and shorter for Americans (7.3) and West Indians (4.8) (CTRC, 1987a).

The island enjoys one of the lowest levels of seasonality in the region. Monthly data in Table 4.1(3) covering 1980-87 indicate visitors are evenly distributed between the high-season of December through April and the off-season between May and November. Furthermore, the winter-summer fluctuations are modest by regional standards. Albuquerque and McElroy (1987) developed a seasonality index based on the variation of stayover visitors from highest to lowest month for 1980-1986. They discovered that St. Lucia's score (.521) was lowest for the 20 small islands compared, with the exceptions of Aruba (.362) and Bonaire (.432) which both enjoy year-round shoppers from nearby Venezuela. Index values above .650 were recorded for the more mature and/or rapidly growing destinations like Antigua, Bermuda, British Virgin Islands, the Caymans, St. Maarten, and U.S. Virgin Islands.

This year-round tourism pattern may reflect in part the increasing importance of St. Lucia in the off-season as a Caribbean centre for business meetings and other conferences related to the OECS Secretariat. The very high ratio of package tours, over 40 percent of total summer visitors and roughly 55 percent year-round (World Bank, 1985), may also play a role in stabilising activity during the slack season and in maintaining the high level and longer stay of European vacationers.

4.1.2 The Economic Impact of Tourism

The importance of tourism in St. Lucia's open economy is measured below for 1986 in terms of the industry's contribution to:

(1) GDP,
(2) government tax revenues,
(3) overall employment, and
(4) foreign exchange earnings.

Although these calculations are based on the most complete and up-to-date data and methods available, they should be considered somewhat cautiously and represent "best guess" estimates that must await further analysis and refinement.

(1) **GDP Contribution.** Five steps are required to determine the overall and sectoral contributions of tourism to St. Lucia's GDP.

First, the total number of tourists is calculated for the three major categories of visitors: stayovers who use hotel

Table 4.1(3). Monthly tourist arrivals, St. Lucia, by air and sea excluding excursionists.

	1980*	1981	1982	1983	1984	1985	1986	1987
January	8621	7259	7561	7024	8268	8175	9545	10842
February	8696	5622	7881	7612	8859	9007	11043	11846
March	8400	7164	6906	7126	8755	8784	11839	10882
April	7566	5671	6559	6786	8600	7646	9634	10878
May	6562	4698	4402	5230	5790	6920	8193	9339
June	5979	4116	3416	4680	5008	5930	7125	8501
July	7243	5116	5141	6027	6292	8181	10658	10072
August	3868	5536	5423	6770	7004	8727	11716	11493
September	4022	3665	3819	5321	5444	6249	5778	7338
October	3970	4952	4785	5610	5668	6675	7127	9147
November	6008	6589	6035	6616	7244	7449	7885	10776
December	8759	8171	8286	8962	9306	10774	11192	12210
TOTAL	79694	68559	70214	77764	86238	94517	111684	122624
% Dec-Apr [Average = 50%]	52%	49%	53%	48%	51%	47%	48%	46%

* Data for visitor arrivals by air, including excursionists.

Source: CTRC, 1986; St. Lucia Tourist Board.

accommodations, cruise passenger excursionists, and other daytrippers, primarily those who arrive by private yacht.

Second, average daily per capita expenditures are estimated for each category of visitor.

Third, total expenditures for each category are determined by multiplying the first two variables (i.e., number times average expenditures) and factoring in respective length of stay and the proportion of overnighters who use commercial accommodations as opposed to private homes.

These 3 procedures combined yield total gross tourist expenditures.

Fourth, the overall macroeconomic contribution of tourism is estimated by multiplying the aggregated sum of gross expenditures for all visitor classes employing a tourist income multiplier (TIM).

Finally, the sectoral contributions of tourism to agriculture, manufacturing, transportation activity and so on are developed by employing tourism weights previously established for each sector against the aggregate tourist GDP contribution.

These calculations are provided in detail in Annex A to Section 4.1. Using the equation described in the Annex reveals a total tourism impact of EC $106.5 million (US $39.4 mil-

lion) in island GTP (the amount of domestic product due to tourism). This contribution represents roughly 22 percent of the total GDP of EC$ 494 million (US$ 183 million) estimated for St. Lucia in 1986. Assuming a 1986 population of 139,529, this tourist GDP amounts to EC$ 763 (US$ 282) for every island resident. This represents 22 percent of the estimated 1986 per capita GDP of EC$ 3,542 (US$ 1,312) in current dollars.

The breakdown of tourism GDP is calculated in Table 4.1(4), following the categories developed in Spinrad's 1982 study for IDRC. These calculations are also discussed in more detail in Annex A.

Predictably, the findings underline the service nature of St. Lucia's visitor industry. To illustrate, the distribution of tourism GDP is heavily weighted toward hotels/restaurants and other services which together accounted for 70 percent of the total. Thirty-three percent of the visitor GDP is contributed exclusively by hotels and restaurants. This is not surprising since a 1983/84 CTRC visitor survey revealed that winter tourists in St. Lucia spent 73 percent (EC$ 154 or US$ 57) of their daily average expenditure on room accommodations, meals, and drinks (CTRC, 1987b, September). Another 40 percent of tourist GDP is contributed by the trade, transport/communications, and finance sectors combined. The minor sectors of government, construction, agriculture, manufacture/mining, and utilities contributed an average of five to six percent each to total tourism GDP.

Table 4.1(4). Sectoral distribution of tourism product 1986 (EC$ millions).

Sector	GDP Distribution*	% From Tourism**	Sectoral Tourism GDP***
Agriculture	81.5	10	8.2
Mining	3.0	--	--
Manufacturing	39.0	6	2.3
Electricity/Water	18.8	17	3.2
Construction	36.6	25	9.3
Trade	75.1	20	15.0
Hotels/Restaurants	34.0	97	33.0
Transport/Communications	48.4	30	14.6
Finance/Realty/ Other Services	52.0	20	10.4
Government	105.7	10	10.6
TOTAL	494.1	22	106.9

* Source: Table 1.5(1) of the St. Lucia CEP.

** Based on Spinrad (1982) and adjusted for 1986 conditions.

*** Column (1) times Column (2).

(2) **Tourism Tax Revenue.** The operation of GOSL depends on some 16 different tax sources based on a variety of economic transactions, as well as on other non-tax revenues. World Bank (1985) data on revenue performance for fiscal years 1977/78 through 1984/85 indicate that during the eight-year period taxes have averaged over 90 percent of total current revenue. The major tax categories are: income taxes, local consumption taxes, and import duties which combined amounted to over 70 percent of the total. Regarding performance, World Bank figures (1985) suggest tax revenues have kept pace with overall island growth averaging between 25-26 percent of GDP between 1977-1984.

In order to estimate the amount of taxes stimulated by tourism, it is necessary first to identify those tax sources most directly related to tourist expenditures. In St. Lucia these direct sources of tourism taxes are the following seven:

(1) a room occupancy tax of 8 percent;

(2) a sales tax on food and beverages at establishments of over ten rooms;

(3) a travel tax of 2.5 percent of ticket cost for travel within CARICOM and 5 percent of ticket cost for travel outside CARICOM;

(4) an airport departure tax of EC$ 10.00 per person for destinations within the Caribbean and EC$ 20.00 for other destinations;

(5) import and other duties on goods consumed by tourists;

(6) income taxes on salaries and wages earned by employees in the tourist industry;

(7) a 45 percent company tax on the profits earned by hotels (this tax is, however, offset by Government's granting of a seven-year tax-free holiday to hotels from the commencement of operations).

Indirect tourist taxes are assumed to be those revenues flowing from the secondary respending (on local and imported goods/services) generated by the original visitor expenditures. These are primarily income and local consumption taxes and import duties.

Because GOSL statistics do not conveniently break down taxes either by tourism and other sectors or by direct and indirect components, it is necessary to estimate the tourist contribution in each specific tax category. This requires developing tourist tax ratios for all related tax sources. The ratios in this study are broadly based on those derived by Spinrad (1982) for 1978 data, using upward adjustments to account for the increased growth and maturation of the industry since 1978.

Table 4.1(5) reports preliminary estimates for all tax categories for 1986. Four tourist tax ratios are employed: 100%, 60%, 20%, and 10%. By definition the occupancy tax is totally assigned to tourism. The relatively high 60 percent ratio for foreign exchange transactions and travel taxes is self-explanatory. The relatively low 20 percent ratio for licenses, import duties and stamps roughly conforms to Spinrad's figures which range between 15 and 30 percent. The 20 percent ratio for income tax is justified by the GDP analysis and assumes that tourist employment and hence wages, income, and taxes also roughly cover 20 percent of their respective totals.

Finally, the 10 percent ratio for local consumption and excise taxes and for postage stamps is taken from Spinrad's five percent estimate and doubled because of the 100 percent increase in resident days contributed by tourism since 1978. Whereas tourists contributed one percent of resident days in 1978 (Spinrad, 1982), the calculations developed in Table 4.1(6) indicate they accounted for two percent in 1986.

Applying these estimated tourism tax ratios to the various tax sources in Table 4.1(5) yields a total tourism tax contribution of $EC 31.4 million or $EC 225 ($US 83) on a per capita basis. This figure represents approximately 21 percent of total tax revenues provisionally projected for St. Lucia for 1986.

Table 4.1(5). Estimated contribution of tourism to GOSL taxes, 1986 (EC$ millions).

Tax Source	Total 1986*	% to Tourism **	Tourism Taxes	% Total Tourism Taxes
Income	45.6	20%	9.1	29.0%
Property	1.3			
Goods/Services	42.8			
Consumption	32.0	10%	3.2	10.2%
Excise	1.0	10%	0.1	0.3%
Hotel Occupancy	4.8	100%	4.8	15.3%
Licences	3.6	20%	0.7	2.2%
Other	1.4			
Trade	58.9			
Import Duties	32.7	20%	6.5	20.7%
Export Duties	0.7			
Stamp Duties	18.6	20%	3.7	11.8%
Foreign Exchange	4.3	60%	2.6	8.3%
Hess	2.0			
Travel	0.6	60%	0.4	1.3%
Other (Stamps)	2.8	10%	0.3	1.0%
TOTAL	151.4		31.4	100.0

* Source: GOSL, Annual Statistical Digest for 1986.
** Authors' estimates.

As expected, this percentage contribution is somewhat higher than the 18 percent recorded by Spinrad (1982) for 1978 data. It is roughly equal to the 22 percent impact of tourism in the GDP analysis.

Likewise, this impact reveals a higher tourism expenditure tax multiplier (TTM or Ktt) than the 0.14 figure found by Spinrad. In 1986, for example, total tourist spending of EC$ 177.5 million is associated with $31.4 million in tourist-induced taxes. According to the multiplier equation:

$$Ktt = Rt/T$$

where Ktt is the tourism expenditure tax multiplier, Rt is tourist taxes, and T is gross tourist spending, the TTM for St. Lucia is 0.177 (31.4/177.5) for 1986. This suggests that every dollar in injected tourist spending produces between 17-18 cents in government tax revenue.

Results from the distribution of tourism taxes across the various tax categories are similar to Spinrad's findings. For example, the three largest sources of tourist taxes remain income

Table 4.1(6). Estimation of tourist resident days in St. Lucia for 1986.

Type	No.	Length of Stay in Days	Resident Days
VISITORS *			
Stayover	111,685	9	1,005,165
Cruise	58,756	1	58,756
Yacht	13,787	3	41,361
		Total Visitor Days	1,105,282
RESIDENTS **	139,529	350***	48,835,150
		Total Visitor and Resident Days	49,940,432
	Visitor Days/Total Days (1,105,282/49,940,432)	=	2.2%

* Source: GOSL, Annual Migration and Tourism Statistics, 1986.
** Source: GOSL, Annual Statistical Digest, 1986.
*** Authors' estimate.

taxes, import duties, and hotel occupancy taxes. Together they accounted for two-thirds of all tourist taxes and over 13 percent of all tax revenue projected for St. Lucia in 1986. Another 30 percent of tourism taxes are evenly contributed by local consumption taxes, stamps, and foreign exchange transactions. The tourist revenues from these three tax sources also account for over 6 percent of total 1986 taxes from all economic activities.

(3) **Tourism employment.** Estimating the impact of tourism on employment is complicated in St. Lucia because of the poor quality of GOSL labour force and employment data (see also box on "Data Problems for Employment Estimation").

The most effective method to reduce definitional and estimation problems and to maintain consistency with previous analyses of tourism's impact on GDP and taxes is to update Spinrad's work in 1978, which is still considered the most comprehensive analysis of tourism employment in St. Lucia. Background population of labour force data are extrapolated to 1986, and the methodology is slightly modified to incorporate refinements introduced by Boxhill (1982). These improvements enable local government statisticians to annually update tourism-induced employment without the need for making yearly establishment surveys (as Spinrad did). They also provide consistent estimates that can be compared with other destinations in the region.

Determining total tourism employment requires calculating both direct and indirect components. Each is derived separately below and the results recorded in Table 4.1(7).

Direct tourism employment, representing those jobs most directly linked to visitor expenditures, is determined by estimating those jobs exclusively in tourist accommodation facilities with the use of an employee per room ratio (E/R). This is followed by factoring in additional direct employment in non-hotel establishments like restaurants, bars, nightclubs and the like.

Table 4.1(7). Estimated tourism employment in St. Lucia for 1986.

(1) DIRECT

Type of Employment	Rooms	Employees per Room (E/R)	TOTAL
Accommodation	2006*	1.37**	2,748
Non-Accommodation	2006	0.38***	762
		Subtotal	3,510

(2) INDIRECT

Direct Employment	Indirect-Direct Ratio (ID/R)	TOTAL
3,510	1.36****	4,774

(3) TOTAL DIRECT + INDIRECT 8,284

* Source: CTRC, 1987a.

** Year-round average estimated from Spinrad's winter (1.47) and summer (1.26) E/R ratios (Spinrad, 1982).

*** Adapted from Boxhill's (1982) 0.30 figure to conform to Spinrad's (1982) definition.

**** From Spinrad, 1982.

Since there were an estimated 2,006 (CTRC, 1987a) hotel/apartment/guest-house/villa rooms available in St. Lucia in 1986, applying Spinrad's year-round average number of employees per room of 1.37 yields direct tourist accommodation employment of 2,748 (see Table 4.1(7)). Direct non-accommodation employment is assumed to be 0.38 workers per available room. This ratio is adapted from Boxhill's 0.30 estimates to conform with Spinrad's job classifications. This procedure yields an additional 762 jobs for a total of 3,510 jobs directly attributed to visitor spending in 1986.

Indirect Employment represents those jobs more remote from direct tourist spending, but nonetheless deriving from these spending impulses. In addition to suppliers of the primary tourist facilities, these jobs include many workers in businesses that cater to the consumption needs of tourist and government employees whose wages/salaries are dependent on the visitor industry.

Such employment is commonly estimated by applying an Indirect-to-Direct Ratio (ID/R) to total direct employment. The ID/R is interpreted as the number of indirect or secondary jobs (workers) supported by each direct job (worker) in the tourist sector. Spinrad's estimate of the ID/R is 1.36, suggesting each hotel job creates an additional 1.4

DATA PROBLEMS FOR EMPLOYMENT ESTIMATION

Estimating employment, unemployment and related economic measures is complicated by major errors and methodological inconsistencies even for basic population figures in published reports of external agencies like the World Bank (1985) and the U.S. Agency for International Development (USAID, 1985). As a result, there are widely conflicting estimates of island unemployment that range from 14 to 25 percent, as well as serious differences in the amount of employment attributed to tourism.

For example, a sampling of the literature reveals the following differences in tourism employment:

(1) Spinrad (1982): 5190 for 1978
(2) Boxhill (1982, reported in OAS, 1984): 6035 for 1981
(3) CTRC (1984a): 5805 for 1981
(4) World Bank (1985) and USAID (1985): 4000 for 1983.

Although some of this variation could be reconciled by definitional and methodological differences, a significant portion of the discrepancies reflects disagreements over the population and labour force parameters on which these definitions (direct versus indirect) and estimation procedures are based. Much of the confusion is due to "the huge unexplained jump in labour force from 36,500 in 1980 to 43,800 in 1983" (USAID, 1985). Given this high degree of uncertainty, more than the usual caution is justified in interpreting results.

jobs in other local non-tourist businesses. Applying this ID/R to the estimated 3,510 in direct tourist employment yields 4,774 workers indirectly employed as the result of tourism activity in 1986. Thus, direct and indirect employment total 8,284 (see Table 4.1(7)).

In order to determine the proportion of total employment these 8,284 tourist jobs represent, it is necessary to estimate the total level of employment in 1986. To remain consistent with Spinrad's analysis, this is accomplished by using an employment-to-population ratio of 0.276. This value is only marginally (5%) higher than the 0.261 factor derived from the World Bank and USAID reports. In effect, this ratio makes the standard assumption that the growth of employment between 1978 and 1986 parallels the 17 percent growth in the population from 118,927 to 139,529. This extrapolation procedure yields total employment for all industries of 38,510 of which 8,284 or 21.5 percent is due to tourist activity.

As expected, these results are measurably higher than Spinrad's 15.8 percent tourism employment impact. They are also quite similar to and consistent with findings from the GDP and tax impact analyses. Most importantly, they reveal the significance of tourism, suggesting that one in every five jobs in the St. Lucian economy is dependent on the visitor industry. From a different perspective, the analysis suggests that each job is associated with EC $21,411 in gross tourist expenditure. Put another way, since each stayover visitor contributes EC$ 1,593 ($177 per day x 9.0 days), the number of stayover visitors needed to produce one job is 13 ($21,411/$1593). The same job would require the spending of roughly 180 cruise passengers.

(4) **Foreign Exchange Impact.** The small economies of the Eastern Caribbean Islands are notorious for their chronic merchandise trade deficits. These result from obvious imbalances in the narrow structure of production and the diversified structure of consumption heavily reliant on imports. In St. Lucia, for example, over the recent 1977-1986

period, trade deficits (exports minus imports: X-M) averaged between 50 and 60 percent of the total GDP (see Table 4.1(8)).

In small islands throughout the region, foreign exchange earnings from tourism have alleviated these imbalances by providing access to foreign capital and technology and essential food and fuel imports. As a result, islanders have achieved standards of living beyond the limited productive capacity of their physical resource endowments.

Calculation of the foreign exchange impact model is detailed in Annex B to Section 4.1. The result of this calculation indicates that 29 percent of imports are financed by tourism. This 29 percent ratio is considerably higher than the 19 percent Spinrad estimated with 1978 data. This signifies that in 1986 the tourism industry provided St. Lucian residents and businesses with the opportunity to purchase an additional EC$ 702 (US$ 260) per capita in foreign goods and services as compared with just eight years before.

4.1.3 Tourism Style and Environmental Implications

The economic indicators discussed in Section 4.1.2 (and earlier in Section 1.5) point to the highly open structure of the St. Lucian economy and underline the strategic role of exports in supporting island livelihoods. Analysis of the operation of the macroeconomy reveals every dollar in export revenue creates, on the average, a dollar in island GDP. Given this export dependence and the unstable foreign markets for traditional food exports, the post-war era has witnessed a major restructuring of the economic base towards export manufacturing and tourism. Today, the economy in St. Lucia, and across much of the Caribbean, is characterised by a balanced reliance on agriculture, tourism, manufacturing, and government services.

Short term aberrations (such as the more recent "banana boom") aside, tourism has emerged as the leading sector of the economy, roughly equivalent in size to agriculture and government, as well as manufacturing and construction combined. Between 1962 and

Table 4.1(8). Estimated trade deficits to gross domestic product ratios, St. Lucia, 1977-1986 (US$ millions).

Year	Merchandise X-M	GDP	X-M/GDP %
1977	-37	69	54
1978	-56	82	68
1979	-69	101	68
1980	-78	113	69
1981	-87	126	69
1982	-77	134	57
1983	-57	141	41
1984	-61	151	40
1986	-72	183	39
Average 1977-86			56

Source: World Bank, 1985.

1986, for example, tourism's direct contribution to GDP increased from under 7 percent to over 17 percent (see also Section 1.5).

Since 1978, the tourism sector of the economy has matured. Since that year, tourism's sectoral GDP contribution (direct and indirect) rose to 22 percent, and the industry's impact on employment and tax revenues increased from 16 to 21 percent and from 18 to 21 percent, respectively. In addition, the ratio of net foreign exchange earned by tourism to merchandise imports -- a measure of tourism's effect on St. Lucia's capacity to import -- rose from 19 to 29 percent.

The country's superlative scenic and recreational assets and its strategic central location providing access to major North American, European and Caribbean markets have contributed to the successful development of tourism since the early 1960's. In addition, a number of other definable qualities make St. Lucia distinctive among its major small-island competitors in the region. These include:

(1) the longest average stay for stayover visitors (1980-86);

(2) the largest percentage of Europeans in the visitor mix (1986);

(3) the most evenly balanced market shares among Americans, Europeans, and West Indians (1986);

(4) one of the most even distributions of rooms between large hotels (100+ rooms) and apartments/guest houses and like accommodations;

(5) one of the lowest levels of seasonality (1980-86).

Such findings suggest that St. Lucia may posses a certain stability or congruence between its visitor mix (demand) and the supply of its natural amenities and the price, quality, and variety of accommodations and other services. It is this particular blend of qualities or style that has been primarily responsible for producing sustained visitor growth year after year and for reducing seasonal swings in employment and income which have proved so troublesome to many of St. Lucia's neighbours. The basic contours of this style -- low density, selective, long-staying, high-spending, diversified, "European" -- seem to be dominant in the strategies of other emerging tourist destinations like Montserrat, Saba, and Anguilla (Albuquerque and McElroy, 1987).

But the country also demonstrates other elements -- low seasonality, relatively high proportion of large hotels, tour charters -- common to the high density, mass market, short-staying, "American" style of the more mature destinations: Aruba, Barbados, Bermuda, the Bahamas, Curacao, St. Maarten, and the U.S. Virgin Islands. This evidence indicates that the St. Lucian visitor experience is a unique blend of the two styles and reinforces the conclusion that key elements in its success are a diverse market mix and locational access on the demand side and a variety of facilities and natural amenities on the supply side.

It would appear that, along a continuum of tourism styles, St. Lucia represents an intermediate position between the low-density "European" type and the high-density "American" type. This intermediary stage has policy implications because historically it has represented a transitional phase toward high-density mass tourism. If the experiences of other more mature destinations are any guide, and in the absence of strong regulatory controls such as in Bermuda, completing this transition is invariably associated with increasing environmental stresses.

Elsewhere in the Eastern Caribbean, these have included destruction of coastal vegetation, beach erosion, decline in water quality, destruction of reefs and mangroves, increase in sewage and solid waste, rise in vehicular traffic and noise, and significant shoreline deterioration (Blommestein, 1985). Such amenity losses threaten the comparative advantage provided by the tropical island environment and mark the transition away from natural attractions toward high-volume, man-made attractions such as duty-free shopping and gambling.

The policy dilemma now facing St. Lucia is whether to devise strategies to compete more

fully in the riskier, high-density, mass tourism market or to resist that transition in favour of the low-density tourism style that has succeeded in the past. While this is a policy issue open to debate, the latter approach has demonstrated comparative advantages elsewhere, including improvement of the rate of domestic return, diminishment of import leakages, and enhancement of the long-term viability of cultural and environmental amenities. Some of the factors which inform this judgment include:

- *Market conditions*. The fastest growing, most lucrative segments of the Caribbean tourism market are those which reflect the low-density style in which St. Lucia has already demonstrated significant comparative advantage.

- *Social acceptability*. A tourism product based on high-density tourist enclaves, such as that seen in Jamaica or Haiti, is vulnerable to political pressures in both the host country and in reactions from the visitor-exporting countries.

- *Environmental sustainability*. Low-density tourism is intrinsically less stressful to both the human and the natural environment. Further, low-density tourism tends to require resource management policies which preserve options for future development. High density tourism requires such large infrastructure investments that alternative development choices are often foreclosed.

4.1.4 Directions for the Future and Policy Recommendations

If St. Lucia is to preserve and enhance its distinctive tourism style, specific environmental, economic, and infrastructural policy issues need to be addressed.

Environmental. Immediate consideration should be given to the development of a coastal zone management policy for the country, including enactment of coastal zone management legislation, perhaps along the lines of the decade-old CZM programme in the U.S. Virgin Islands. To help ensure the long-term sustainability of the coastal dependent tourism industry, development of a national CZM policy must:

(1) ensure coastal resources are devoted to water-dependent uses exclusively;

(2) institutionalise a permitting process for development activities in the coastal zone; and

(3) devise a protection and management strategy for common property resources and amenities in the coastal zone.

Many so-called amenities or attractions which serve as underpinning for the industry require special management strategies, in part because they often have special carrying capacity limits. This is particularly true of natural areas, historic sites, scenic landscape panoramas, marine (underwater) habitats, anchorages, and vernacular architecture in coastal towns. Unfortunately, all of these, in the normal course of setting development and resource management priorities, seldom rank very high, seldom have management plans, seldom are assigned to any single ministry or government unit with a budget and with clear lines of responsibility, and seldom are seen as the prime target of public sector investment strategies -- whether initiated by the country or by external lending banks or donor institutions. For example, in St. Lucia, the Tourist Industry Development Board has powers to develop and manage tourism amenities, including natural and historic sites, but has not done so, even as joint ventures with the National Trust, other government units, or private industry groups.

Under these conditions, the tourism industry itself should seek to mobilise "compensatory" private sector strategies to develop, protect and manage a broader spectrum of amenities

so important to the industry. When government fails to assert its "custodial role," especially in managing coastal resources (for example, all types of amenities), it is especially tragic because most of the resources and amenities in question could and should be developed and protected *for resident as well as visitor use*.

Economic. Long-term tourism planning needs to emphasise how to raise the value of the tourism multiplier -- as opposed to more short-term policies which are usually directed at raising the volume of visitors. For example, instead of a policy of import restrictions, emphasis needs to be on long-term import replacement strategies such as expanded credit access, improved marketing information and facilities, and tax benefits particularly for smallholder producers of local foodstuffs and artisanal fishermen.

The Government may also wish to consider the feasibility of imposing a nominal surcharge on all stayover tourists -- in addition to hotel occupancy and departures taxes -- as a "general user fee" or "environmental depletion allowance," designed both to emphasise the country's commitment to long-term preservation of environmental quality and to defray the costs of maintaining primary tourist infrastructure, including parks, museums, nature trails, and visitor centres.

Infrastructure. Large-scale projects need to be carefully reviewed by Government (ideally via a formal Environmental Impact Assessment procedure) not only because of their potential to alter the island's low-density tourism style, but also because of their propensity to place stress on the natural environment and overload available infrastructure. Impacts on infrastructure can be minimised by policies requiring large tourism developments to be energy and potable water self-sufficient and to have self-contained sewage treatment plants. Tippage fees should be charged for all solid waste, and yardage extraction fees charged for construction sand.

Additionally, the geographic distribution of infrastructure and large-scale tourist facilities needs to be carefully evaluated, particularly consideration of "agglomeration versus dispersal" policy alternatives. Recent Caribbean experience with urban sprawl, with attendant health, social, and quality-of-life problems, suggests in general that a spread or dispersed approach is less intrusive and distorting and in the case of St. Lucia would be more socially appropriate for maintaining the country's low-density ambience.

Conclusion. Ongoing expansion of tourism facility construction in St. Lucia, coupled with increasing international recognition of the country as a prime Caribbean destination (CTRC, 1987b, December), suggest market momentum may be carrying St. Lucia forward along the continuum from low-density to high-density tourism. If this movement is sustained over the near-term, it will alter the country's present tourism style and leave open to question the long-term economic viability and environmental sustainability of this key economic sector.

ANNEX A
[To Section 4.1]

Methodology:
Calculating Tourism Share of GDP

Step One. According to local government sources (*Annual Migration and Tourism Statistics*, 1986), in 1986 the number of tourists to St. Lucia included:

- 111,685 stayover visitors
- 58,756 cruise passengers
- 3,777 yacht excursionists.

The figure for yacht excursionists is very low, given Customs report of 5,515 yacht entrances and clearances in 1986. Assuming each yacht entered and cleared once and an average of five people were on board each yacht (passengers and crew), a revised estimate for yacht excursionists is 13,787.

Step Two. The per capita daily expenditures corresponding to these three separate categories are determined as follows.

1. The average daily expenditure for cruise and yacht excursionists is estimated to be EC$ 119 and EC$ 32 (US $44 and $12) respectively. These figures are based on the original values of US$ 22 and US$ 6 determined in Spinrad's 1982 IDRC study (based on 1978 data), and updated to account for the estimated doubling of island prices that has occurred between 1978 and 1986 (see World Bank, 1985).

2. The daily per capita expenditure per stayover visitor is determined from updated data taken from a recent (1983/1984) CTRC visitor expenditure study in St. Lucia (CTRC, 1987b, September). This survey found that average spending for winter versus summer tourists varied between EC$ 211 and $146 (US $78 and $54), respectively. By adjusting these seasonal expenditure patterns with seasonal weighting of visitor flows, an all-season, year-round weighted average of EC$ 177 (US$ 65) per stayover visitor is determined (see Table Annex A-1).

3. This per capita annual average expenditure of US $65 for 1983/84 is updated to a value of US $68 for 1986 by adjusting for island inflation. This adjustment assumes a continuation of the 2.5 percent rate recorded in St. Lucia between 1982-1984 (World Bank, 1985).

These procedures together yield the following estimates of average daily visitor expenditures:

stayovers	EC$183 (US$ 68)
cruise	EC$119 (US$ 44)
yacht excursionists	EC$32 (US$ 12).

Table Annex A-1. Average stayover visitor expenditure.

Type of Visitor	Average Spending(1) 1983/1984	Seasonal(2) Weights	Weighted Average
Winter	EC$211	.48	$101
Summer	$146	.52	$ 76
Total or year-round weighted ave.	$177 (US$ 65)		

(1) Source: CTRC, 1987b (September).

(2) These ratios represent the percentage of tourists who visited December-April (48%0) and May-November (52%) during 1983.

Step Three. Annual gross tourist expenditures are simply estimated for cruise day-trippers by multiplying the number of visitors in 1986 times the average daily spending rates. This yields total 1986 expenditures of EC$ 7 million (US$ 2.6 million).

Visitor Type	No.		Average Daily Expenditure		Total Expenditures (EC Millions)
Cruise ship	58,756	x	EC$ 119	=	$7.0 (US$ 2.6)

Estimating stayover expenditures requires:

(1) factoring in the average length of stay per visitor. Here conservatively assumed to be 9 days for land-based stayovers and 3 days for yachtsmen;

(2) estimating the percentage of "hotel visitors" in total stayovers -- i.e., those who use commercial accommodations. Following standard historical practice in St. Lucia, this proportion is assumed to be 92 percent. These adjustments yield gross tourist expenditures for stayover visitors of EC$ 171.1 million in 1986.

Type	No.		Average Stay		Percent "Hotel"		Average Daily Expenditures	Total Expenditures (EC Millions)
Stayover	111,685	X	9.0	X	92%	X	$183	= $169.2
Yacht	13,787	X	3.0	X	100%	X	$ 32	=$ 1.3
							TOTAL	EC$170.5 (US$63.1)

[This calculation underestimates the impact of yacht-based tourism, as it allows no sum for yachts chartered from St. Lucia. At present it is estimated there are about 68 bareboats and a comparable number of crewed charter boats based in St. Lucia for four months or more per year. Adequate information does not exist to permit a full analysis of the economic impact of yachting at this time.]

As a result of the above calculations, estimated gross tourist expenditures in 1986 for visitor categories combined is $EC 177.5 million (US $66 million) of which over 95 percent is contributed by overnighters because of their long island stay and high per capita daily spending. These gross receipts from tourism represent 36 percent of the EC$ 494 million in GDP estimated for 1986.

Step Four. To determine the GDP or local economic contribution of this spending, it is necessary to subtract direct and indirect import leakages due to the highly open, dependent structure of the economy. Direct imports represent those immediate off-island purchases by tourists during their vacation stay: food, luxury gifts, fuel, transport and other services, and the like. Indirect imports represent those off-island purchase by islanders and resident businesses generated from the income, wages, taxes and investment deriving from the original tourist expenditure impulses.

In the export-propelled model, these import streams are netted out by the tourist income multiplier (TIM or Kt), which calculates exclusively the local economic content or GDP created by a dollar of visitor expenditure. Spinrad's estimate (1982) of the tourist income multiplier for St. Lucia (based on 1977/78 data) is 0.55. This value is at the lower end of the range of Caribbean multipliers reported in a recent OAS study (1984). They vary roughly between 0.50 and 0.90: for example, Antigua (0.88), Bahamas (0.78), British Virgin Islands (0.58), Caymans (0.65), and the U.S. Virgin Islands (0.89). (N.B. The 0.80 value the OAS reports for St. Lucia, and supposedly taken from Spinrad, is obviously a misquote.)

However, given the maturation of the industry in St. Lucia since 1978, this multiplier seems too low for measuring contemporary impacts. In fact, a 1984 CTRC survey discovered that over two-thirds of all seafood, fresh fruits, vegetables and other staples consumed in hotels were supplied locally. Thirty-two percent of beverages (mainly beer) were also produced locally.

Other factors arguing for a higher multiplier are the balanced, predictable, and long-staying character of the visitor base, and the relatively large contingent (25%) of West Indians who are assumed to spend heavily in the local sector. In addition, the number of hotels, apartments, and guest house/villa properties with local ownership or participation has increased from 42 percent in 1961 to 70 percent in 1983 and includes two-thirds of all room capacity (CTRC, 1984).

Consequently, a higher TIM of .60 is used in this analysis. This figure is more in line with the overall (average) export income multiplier of 1.0 used in Section 1.5. Yet it is plausibly lower given the high import content characteristic of the visitor industry. This value signifies that the average tourist dollar spent in St. Lucia generates 60 cents in local island activity.

Tourism's macroeconomic impact is thus determined by employing the following formulation of the export-propelled model:

$$GDPt = T \times Kt$$

where GDPt signifies the amount of domestic product due to tourism, T represents gross tourist expenditures for 1986, and Kt represents gross tourist expenditures for 1986, and Kt represents the TIM value of 0.60.

The equation reveals a total tourism impact of EC$106.5 million ($177.5 x 0.60) in island GDP. This contribution represents roughly 22 percent of St. Lucia's total GDP of $494 million. Assuming an estimated 1986 population of 139,529, this $106.5 million in tourist GDP is equivalent to $763 in annual income for every island resident.

As expected, this impact is higher than Spinrad's calculation of 18 percent for 1978 largely because of the observed ongoing maturation of the industry since that time. These are best-guess estimates, however, highly sensitive to the underlying multiplier assumptions, and thus must be interpreted with caution. If in fact local linkages are stronger than assumed in this analysis, such that the actual TIM approaches 0.70, then tourism's 1986 GDP contribution is $124 million and accounts for a full quarter of all island production.

Step Five. The breakdown of this tourist GDP is calculated in Table 4.1(4) following the categories developed in Spinrad's (1982) IDRC study, which used 1978 data. The percentage of GDP attributed to tourism for each individual sector is based on Spinrad's estimates but adjusted upwards in most cases to account for the increasing local linkages and import substitution discussed previously.

ANNEX B
[To Section 4.1]

Methodology:
Calculating Foreign Exchange Earnings of Tourism

One method for estimating the foreign exchange contribution of tourism activity is to measure the percentage of merchandise imports that visitor spending finances. This estimation requires three basic calculations:

(1) estimating the net foreign exchange flowing from gross tourist expenditures, that is, gross visitor receipts minus immediate income leakages for off-island tourist beverages, etc.;

(2) adjusting merchandise imports for the same import leakages to avoid double-counting;

(3) and calculating the ratio of the two.

These procedures yield the following foreign exchange impact model:

$$Ft = \frac{T - Mt}{Mm - Mt}$$

Where Ft = the proportion of merchandise imports financed by tourism
T = total gross tourist expenditures
Mt = import leakages from first-round gross tourist expenditures
Mm = total merchandise imports.

Using the data for 1986 of gross tourist expenditures of US$ 65.7 million (see Annex A), total merchandise imports of US$ 154.8 million, and an estimated first round import leakage ratio of 0.45 from Seward and Spinrad (1982), the equation produces a foreign exchange contribution of approximately 29 percent.

$$= \frac{65.7 - (0.45 \times 65.7)}{154.8 - 29.6}$$

$$= \frac{36.1}{125.2}$$

$$= 28.8\%$$

4.2 INDUSTRY AND ENVIRONMENTAL IMPACTS

4.2.1 Overview

St. Lucia's Gross Domestic Product (GDP) increased to EC$ 426.6 million in 1986 from EC$ 156.7 million in 1977 (CDB, 1987). Allowing for inflation, these figures demonstrate an extraordinary fifty percent growth rate in ten years. Such remarkable expansion of the economy has been achieved while the country maintained a relative balance of growth among the contributing economic sectors. Figure 4.2(1) illustrates the proportional input of eight major sectors of the St. Lucian economy over the past decade.

The subtle implication of this balanced growth scenario is that economic expansion in general may have a more profound *aggregate* effect on the environment than might be anticipated by only evaluating the effects of any single sector or any two or three major industries. Since growth is incremental and spread among the economic sectors, impacts are usually additive rather than discrete. In other words, in terms of environmental pressures, the whole really may be greater than the sum of the parts.

4.2.2 Environmental Issues and Problems Associated with Eight Economic/Industrial Sectors

(1) GOVERNMENT

"Government Services" is the largest sector of the eight identified in Figure 4.2(1). As the chief resource management, protection, and development authority in the country, GOSL is responsible for setting and implementing the environmental agenda and for establishing policies which support sustainable development (see also Section 5.3).

Public sector activities are theoretically held to a higher standard of information sharing and accountability than is generally encountered in the private sector. On the other hand, governments in the Eastern Caribbean (and St. Lucia is no exception) tend to assume that, in their role as "the voice of the people," they are above environmental review processes. Thus, while other industries, particularly large land-altering development projects, are gradually being required to provide some assessment of potential environmental impacts during project planning phases, similarly large-scale, land-altering infrastructure projects of Government are not required to do so -- unless the requirement is imposed by an external funding agency.

(2) AGRICULTURE AND MINING

Agriculture and fisheries development are discussed in Sections 3. and 2.5, respectively. One environmental issue not mentioned in the Agriculture Chapter is the increasing concern about solid waste disposal problems associated with the banana industry. The St. Lucia Banana Growers Association, a government statutory body, has been taken to task in the local press as the country's "worst litterbug," with its packing boxes and rotting bananas lining the roadways and countryside throughout the island. In light of the Ministry of Health's renewed emphasis on better enforcement of the country's Litter Act, questions have been raised about the ability of the Ministry to take appropriate action against another quasi-governmental body, namely, the Banana Growers Association.

Agro-processing Industries. Until the mid-1970's, agro-processing in St. Lucia was primarily limited to the manufacture of oil, soap, and coconut meal by Copra Manufacturers Ltd., which operates a factory in Soufriere for the processing of copra into oil and other products. The industry was hit hard by hurricane Allen in 1980, and production dropped sharply (see Table 4.2(1)). Since then, the coconut industry has been afflicted by the spread of "coconut mite" disease which primarily affects the size of the nut, thus requiring more nuts for processing. A further reason for the slump has been a growing

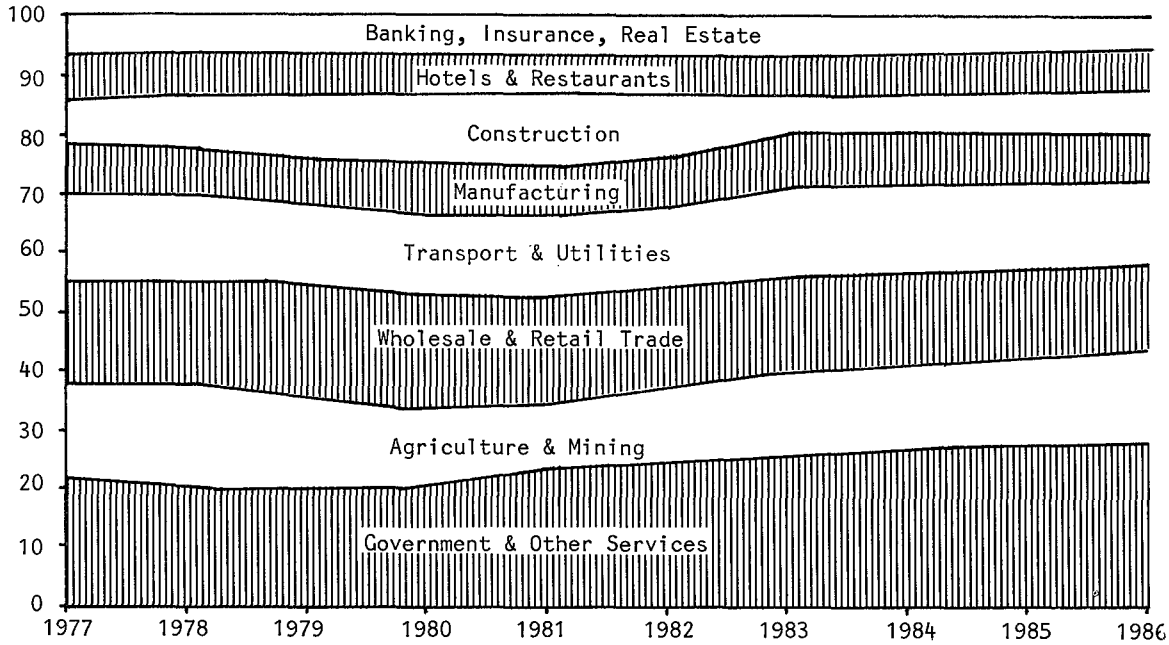


Figure 4.2(1). Gross domestic product (GDP) contribution of eight major sectors of the St. Lucian economy, 1977-1986 (source: CDB, 1987).

consumer preference for cholesterol-free edible oil.

The edible oil and soap production industry discharges untreated waste with a high level of organic content and oil (Archer, 1984). Coconut shell residues, however, can be recycled, for example, husks may be burned for cooking fuel or for smoking fish. Products made from coconut fibre like mats, rope, and twine are not manufactured, nor is fibre dust used for products such as hardboard (Dodd and Jackson, 1982).

St. Lucia has several food and beverage processing industries which discharge waste into the sea. The Vieux Fort area with its large livestock farms is the highest annual producer of BOD and suspended solids in animal waste (141 and 963 tons/year, respectively, as reported in Archer's 1984 study), a large percentage of which is washed into the nearby coastal waters by storm run-off or leached into the marine environment by normal hydrological flow.

The country's brewery, also located in Vieux Fort, pretreats its waste by an oxidation ditch before discharge. The high BOD effect on benthic communities may be reduced by treatment, although the nutrient levels probably increase with the increased algal growth in shallow areas. The country's distillery in Cul de Sac Bay is also a heavy polluter. High BOD (126 tons/year), high temperature, and low pH of the waste can adversely affect marine benthic life near the point of discharge (Archer, 1984).

Mining. St. Lucia has only limited mineral resources, the primary being: quarry stone, sand (riverine and beach), pumice and clays. Accessible veins of quality quarry stone exist particularly in the north of the island, although these tend to be in proximity of expanding residential areas. Tomblin (1964) estimated that at least three cubic miles of pyroclastic material (pumice) fell in the area of Soufriere on the southwest of the island. Other deposits have since been identified by

Table 4.2(1). Copra production and processing in St. Lucia.

YEAR	COPRA Ton	COPRA 000 $	COCONUT OIL RAW 000 Gals.	COCONUT OIL RAW 000 $	COCONUT OIL REFINED 000 Gals.	COCONUT OIL REFINED 000 $	LAUNDRY SOAP 000 lbs.	LAUNDRY SOAP 000 $	COCONUT MEAL 000 lbs.	COCONUT MEAL 000 $
1980	6,395	7,674	845	7,474	408	4,270	982	1,246	4,171	459
1981	2,433	3,248	399	4,045	242	2,662	905	1,376	1,911	232
1982	3,693	4,930	615	5,587	370	5,557	1,075	1,638	2,828	494
1983	4,703	6,278	732	6,701	535	6,660	1,218	1,475	3,343	508
1984	3,980	5,392	604	6,619	457	6,408	411	542	2,797	392
1985	3,939	5,338	601	6,581	284	4,117	267	346	2,791	392
1986	4,108	5,566	613	5,147	228	3,171	29	36	2,786	389

Source: GOSL, Annual Statistical Digest, 1986.

Newman (1969) in Vanard, Ravine Poisson, Durandeau, Morne d'Or, Millet, Sarot, and Roseau in the north central area. Deane (1973, Vol. IV) reports on the quality and quantity of pumice available from each of these sites.

As also discussed in Section 2.5.4 of the Profile, indiscriminate and often illegal sand mining from beaches in St. Lucia has caused serious coastal erosion, first extensively documented by Deane, *et al.*, 1972. Deane estimated the volume of sand mined at seven St. Lucia beaches for selected years from 1960-62 to 1969-70 and found that volume mined had increased 142 percent during that period (Table 4.2(2)). Full estimates are not available for the years since Deane's study; however, the CPU, using the amount of concrete building floorspace approved as an indicator, estimated an annual demand of 98,000 cubic yards for 1984, representing a stabilisation of demand at the level shown by Deane, *et al.* (1972) for the two years, 1969-70 (Williams, 1985a). Note that the CPU estimate is somewhat lower than the figure cited in Section 2.5.4 of the Profile (134,000 cubic yards of sand), where demand level is derived by applying a 6:1 sand to cement ratio when the amount of cement imported/year is known.

The Beach Protection Act of 1967 was designed to regulate removal of sand from beaches by requiring that a permit be issued by the Ministry of Communications and Works before extraction can occur; violators are subject to fines. Nevertheless, sand removal continues to a greater or lesser degree on all major beaches, although mining on key northwest beaches is at a comparatively low level due primarily to monitoring by the St. Lucia National Trust, the Parks and Beaches Commission, and other concerned citizens groups. Unfortunately, mining activity has shifted elsewhere: Comerette, Grande Anse, and Fond D'Or (Williams, 1985a).

Sand dredging activities are now largely confined to harbour and channel maintenance. Deane, *et al.*, 1972, carried out a preliminary evaluation of potential offshore sand sources and concluded the total amount available was not large enough to warrant further activity, particularly in light of serious environmental risks and high operational costs.

River sand mining is carried out by the Ministry of Communications and Works, allegedly to clear river mouths of large sand barriers (and trash) which build up during periods of low flow. This process has periodically produced serious environmental consequences

Table 4.2(2). Estimates of sand mined from beaches, 1960-1970.

LOCATION - SAND SOURCE	ESTIMATED VOLUME OF SAND MINED (cu yd) 1960-62	1963-65	1966-68	1969-70	Total
- Vigie Beach	70,000	35,000	3,000	2,000	110,000
- Choc Beach	13,000	47,000	3,000	5,000	68,000
- Gros Islet (north end of Reduit)	----	16,000	108,000	27,000	151,000
- Anse La Raye	3,000	5,000	27,000	61,000	96,000
- Dennery	2,000	2,000	2,000	18,000	24,000
- Black Bay	2,000	5,000	4,000	105,000	116,000
- Soufriere	1,000	1,000	3,000	2,000	7,000
TOTAL	91,000	111,000	150,000	220,000	572,000

Source: Deane, *et al.*, 1972.

(e.g., removal of the entire sand bar including adjoining beach and alteration of river profile causing accelerated back and stream head erosion), and the Ministry occasionally has been forced to halt mining at the Anse La Raye and Dennery River mouths (Williams, 1985a).

Serious coastal erosion -- the progressive loss of sand and of large stabilised berms which protect coastal areas from the effects of storms -- has been accelerated by sand mining activities in St. Lucia. On the island's windward beaches, this process contributes to seaborne flooding as the berms which protect low-lying coastal valleys disappear (for example, at Fond D'Or and Troumasse). The problem is more severe on the island's leeward beaches if only because the effects of beach mining are often delayed here. The low-energy character of these beaches can mask the effects of sand removal, and only after the beaches are subjected to the relatively infrequent southwest and northwest swells associated with hurricanes and North Atlantic winter storms does the accumulated damage become observable (DuBois, 1985).

Mining at the mouths of rivers (current Government policy) is a very unsatisfactory solution as it cuts off the principal source of beach sand replenishment which is required for stabilised beaches to compensate for the loss of sand occurring under normal cyclical patterns of shifts in wind and wave regimes (DuBois, 1985). Human-induced change in the pattern of replenishment can cause progressive sand volume losses and decline of beach quality.

Pumice deposits on the island have been studied and tested to determine their suitability as a substitute for sand in the construction industry. This alternative option for the manufacture of lightweight concrete blocks has been under discussion since the 1970's. A pilot project to test consumer acceptance of pumice, using material mined at Millet (north central area), was initiated early in 1983 as a joint effort of the CPU and the Ministry of Communications and Works. Unfortunately, the project was abandoned later in the year, and equipment provided by a donor was transferred to another unnamed GOSL agency (Williams, 1985a).

Efforts continue within Government to develop a cement manufacturing plant using pumice and to interest the private sector in investing in a pumice mining venture. Generally, pumice deposits in the north central area are regarded as priority sites because of their proximity to the urban areas of greatest de-

mand. Mining of pumice in parts of the southwestern section of the island needs to be more carefully evaluated because deposits are located in areas of high agricultural capability or within critical watersheds (Williams, 1985a).

While construction materials made from pumice are lighter in weight and easier to haul than concrete, greater care is required to mix cement when pumice is used. There is not as wide a range for error in the production process, and thus greater technical skills are required. This would seem to require that widespread use of pumice in construction will have to be introduced by Government or larger commercial firms with the required expertise before it becomes more widely available to residential homebuilders, for example.

Several quarry sites in St. Lucia offer fine aggregate of various grades. The volume of aggregate sold by the main quarry serving the Castries area, Northrock Ltd., fell from 22,090 cubic yards in 1979 to 11,788 cubic yards in 1984. Due to the hard basaltic nature of the parent material, this aggregate is not as well sorted as beach sand and therefore not as suited to some types of construction (Williams, 1985a). In addition to Northrock, there are six other quarry sites, four in the Castries-Gros Islet area and two in the Vieux Fort area.

(3) WHOLESALE AND RETAIL TRADE

It is customary to dismiss the environmental effects of wholesale and retail trade industries. In small islands like St. Lucia, however, one major environmental problem associated with solid waste disposal can be directly linked to the packaging practices of local businesses.

For example, twenty years ago marine biologists and naturalists in the Eastern Caribbean began to notice sea turtles were dying from intestinal blockages caused by eating light colored plastic bags. Turtle diets include jellyfish which floating plastic sheeting or bag material resemble when wet and being flexed by wave action. Although now in common use at department stores and supermarkets throughout the region, two decades ago four large supermarkets in Guadeloupe and Martinique were the primary, perhaps only, source of such bags. Concerted action to reduce the use of plastic bags or to reduce the number that escaped from trash piles and the open dumps to find their way to the sea could, at that time, have saved countless endangered turtles. St. Lucia's blue diothene banana protector bags may be having the same unfortunate effect on sea turtles today.

Similarly, planning for ways to reduce the quantity of durable plastic waste (a key ingredient of St. Lucia's even larger solid waste problem) may start with a careful collaboration between Government and the retail trade sector on ways to limit the indiscriminate distribution of plastic packaging products. Efforts to promote a variety of recycling options also need to be developed in close collaboration with the wholesale and retail trade sector, in order to assure that such schemes are organised on economically defensible grounds. (See also "Solid Waste Management" in next section.)

(4) UTILITIES, TRANSPORTATION, AND INFRASTRUCTURE

Electricity. Electricity is generated, transmitted and distributed by St. Lucia Electricity Services Ltd. (LUCELEC). The system consists of two separate networks: (1) the northern system, commissioned in 1971, extends from the Union Power Station to Cap Estate in the north and to Dennery in the east and Canaries in the west, with an installed capacity of 14.85 MW; (2) the southern system, commissioned in 1965, extends from the Vieux Fort Power Station to Praslin in the east and Soufriere in the west, with an installed capacity of 4.12 MW. Operating two separate grids has proven costly, and an interconnection to permit system exchange will be operational by the end of the decade (GOSL/CPU, 1986c).

Furthermore, a new power generating facility is under construction at Cul de Sac and will be linked by a new 11 kV transmission line to the existing distribution centres at Union, Castries, and Vieux Fort (see Figure 4.2(2)). It is assumed that the new 5 MW geothermal

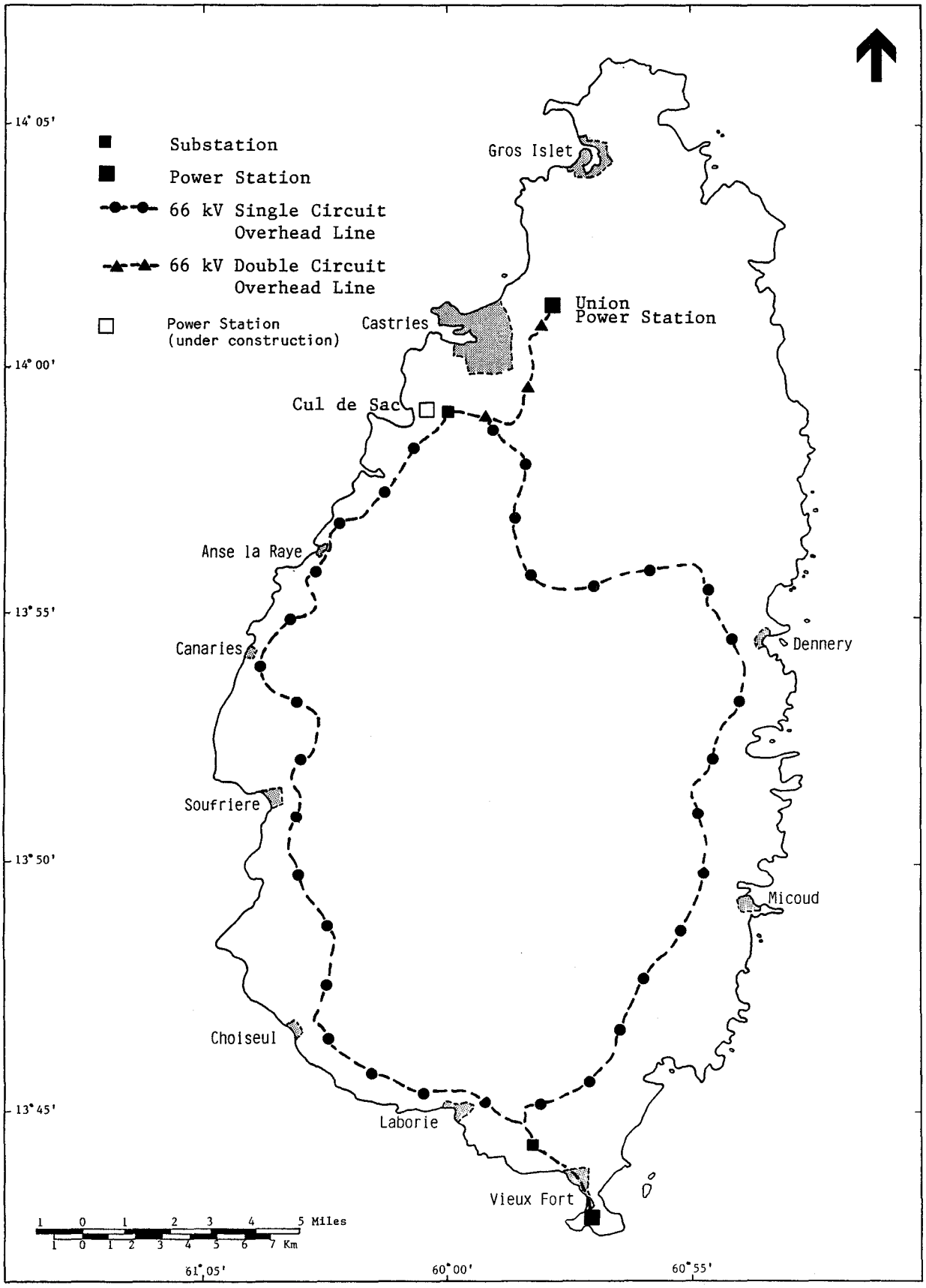


Figure 4.2(2). High voltage transmission lines.

power source at Soufriere, once a generator is installed, will be tied to the new "national" grid or network.

As pointed out in Section 4.3.1, electricity is a small piece of the energy picture in St. Lucia, but a costly and complex piece and one always at risk, whether from technical failures or natural hazard impacts. Geothermal power development has, therefore, been studied by Government for a number of years as an alternative for generating electricity from the Sulphur Springs at Soufriere. Despite advantages associated with broadening the country's energy options, the geothermal alternative has potentially serious environmental consequences which must be considered by project developers; these are also reviewed in Section 4.3.1.

Water Supply. Water collection and distribution throughout the island is the responsibility of the Water and Sewerage Authority (WASA). The Authority was created in 1984 by legislation which added sewage disposal responsibilities to those of the old Central Water Authority. According to WASA, the water supply network is fed by 38 supply systems which basically consist of a river intake structure, transmission mains, treatment works, and storage and distribution mains.

There are still communities which have no access to piped water supply or where existing supplies are inadequate. Water supply figures from WASA currently show about 50 percent of the population is covered by house connections; 38 percent served only by standpipes, and 12 percent of the population with no access to first time supply.

The absence of piped water in some areas of the island (resulting in use of contaminated water from streams and rivers), inadequate protection and treatment of public water supplies, and improper storage of previously treated water have been identified as primary factors contributing to the high prevalence of gastroenteritis (in particular) and other waterborne diseases in St. Lucia. As Table 4.2(3) indicates, gastroenteritis is by far the leading communicable disease in the country, especially among children under five years of age, and has been attributed to the effects of fecal and other pollution on streams and rivers used by rural populations for bathing, laundering, and drinking. Henry (1981) confirmed this in a study on the relationship between malnutrition and environmental sanitation in rural St. Lucia. Children in areas of poor sanitation had a slower growth rate which showed an observable improvement when pipe-borne water and latrine facilities were established in areas under study.

Table 4.2(3). Water-related diseases in St. Lucia for the period 1979-1987.

	1979	1980	1981	1982	1983	1984	1985	1986	1987 *
Gastroenteritis	895	376	377	606	300	1331	1000	440	684
Typhoid Fever	4	7	14	10	5	18	8	66	50
Dengue Fever	26	6	23	31	0	0	0	164	1
Dysentery	175	153	103	19	40	100	49	71	85
Schistosomiasis	24	39	32	27	18	59	4	10	7

* 1987: reported to 28 November, 1987

Source: Ministry of Health, Labour, and Housing, annual reports of the Health Division.

Water demand will continue to increase as a consequence of the combined effects of population growth, expanding urbanisation and industrialisation, and further development of the tourism industry. Present consumption by users of piped water systems require a water supply of approximately 21 Ml/day (CPU Issue Paper, 1985). Consumption has been growing at an average annual rate of 10 percent since 1977 (attributable in part to the rapid growth of tourism). If consumption continues to increase at present rates, one investigator predicts water supply requirements could reach as high as nearly 40 ML/day by 1990 (Stevenson, 1986). (The reader is also referred to Section 1.1.6 and Section 2.4 of the Profile.)

The cost of water supply increases disproportionately as the amount of total rainfall intercepted rises. For example, current supplies required the laying of pipes from central water catchment areas. To substantially increase this amount will require more capital-intensive impoundment systems, such as the proposed Roseau Dam, reservoirs, or expensive pumping systems from catchment basins in surplus to those in deficit (Stevenson, 1986).

Similarly, the most accessible consumers are supplied first. Costs rise steeply as the supply network is extended out of urban centres to more dispersed suburban and rural settlements. Furthermore, it is relatively easy to recover capital and operational costs for water supplied to concentrations of industry, commerce, and more prosperous urban consumers, but as the network is extended, it is targeted to meet the needs of more dispersed, poorer sectors (Stevenson, 1986).

While efforts aimed at consumer conservation should continue (for example, installation of self-closing taps at standpipes), such attempts to conserve water by constraining use will not substantially diminish demand. Nor is desalination -- an expensive, high-tech option demanding skilled operational and maintenance personnel -- a viable option for St. Lucia. As discussed in more detail in Section 2.4 on Water Resources and Section 2.2 on Forestry, St. Lucia's water supply is best secured by measures which protect key watershed catchment areas upon which the country's potable water supply is dependent.

Sewage Disposal.

(1) *Castries Harbour Area.* Sewage disposal is a responsibility of the Water and Sewerage Authority which was created in 1984 to replace the old Central Water Authority. At present the only sewerage system in the country for the disposal of domestic and industrial waste is the old and overloaded Castries municipal system, which until recently had been operated by the Castries City Council (with oversight provided by the Ministry of Health to ensure maintenance of public health standards). The system was built shortly after the Castries fire of 1948, but WASA only recently has taken over responsibility for management.

In a recent survey, approximately 64 percent of downtown Castries' almost 600 households and 16 percent of the 2,565 households in the suburbs are connected to the municipal system (GOSL, Statistical Unit, 1987). Untreated raw sewage from these households and an unknown number of commercial establishments is discharged directly into the inner harbour within 20 metres from the shoreline. According to an "issue paper" from the CPU in 1985, discharge is at a rate of 250,000 to 300,000 gallons of raw sewage per day. The result is an adjacent marine environment characterised by one investigator as "dangerously polluted with crude sewage, little benthic life, and [in need of] immediate clean-up" (Archer, 1984; see also "Coastal Water Pollution" of Section 2.5.4.). However, CEHI data, according to Shim (1988), does not support this assertion.

Nevertheless, several alternative sites for a longer, out-of-the-harbour marine outfall or discharge pipe are under consideration to replace the existing Castries sewer outfall which presently terminates in the harbour. Baseline investigations of physico-chemical and ecological factors at these sites and other locations around St. Lucia are being carried out by CEHI.

Grab sampling of benthic sediments at various locations in the vicinity of Castries Harbor was carried out by CEHI's Pollution Monitoring Project staff between March to May, 1983 (Ramsammy, *et al.*, 1985). Results demonstrated a general tendency towards decreased species diversity, richness, density and number of organisms from the harbour mouth to the inner reaches in the vicinity of the sewage outfall and the ship turning basin. This agrees with the expected pollution trend, except that the turning basin exhibited lower values than expected, perhaps due to disturbance by propeller wash.

Various ecological indices were calculated from the sampling data and compared to values from the literature. When compared to criteria used in a pollution study of Kingston Harbour, Jamaica, all stations in Castries Harbour would be deemed "semi-healthy" to "healthy" (Wade, 1976), and CEHI (Ramsammy, *et al.*, 1985) concludes that the inner harbour is in a "less healthy" condition than areas outside the harbour mouth. The authors recommend continued monitoring of the inner harbour to detect any further deterioration. However, there is reason to question the generality and appropriateness of Wade's study and criteria (now out of date).

In the meanwhile, Castries Harbour has other related waste loading problems, some from residential sewage and some from industrial waste. Limited chemical pollution data for the harbour, reported by Ramsammy, *et al*, in 1985, indicated very high levels of fungicide residues (Thiophanate-methyl) in water and fish (Mullet) compared to those recorded in the U.S. and other areas. Fortunately, repeated chemical pollution analyses done over the next year, 1986, showed lower concentrations of organochlorines's and PCB's (polychlorobiphenols) than previously reported (Singh, *et al.*, 1986). Obviously tidal flushing gradually diluted the harbour water over time.

Recent bacteriological sampling in Castries Harbor confirmed a declining gradient in species densities going from offshore stations to those in the inner harbour (Corbin, 1988) confirming high levels of bacterial pollution in the inner harbour and the *unsuitability of this area for recreational purposes*.

(2) *Outside Castries Harbour.* For domestic sewage disposal outside of Castries, most St. Lucian households remain dependent on septic tanks, draining to tile fields or soak-aways, or on pit latrines, which constitute the largest number (51%) of systems presently in use in the country. Almost 60 percent of pit latrines are concentrated in rural areas. Latrines are rarely disinfected, too often provide easy access to flies, rodents, mosquitoes and other disease-carrying vectors, and may be located too near to ground water supplies to prevent contamination. (See also Table 4.2(4).)

Health officials have encouraged the construction of septic tanks and soak-away systems as an alternative to the pit latrine, but a constraining element is the fact that over 60 percent of the country's approximate 25,000 households do not have a water supply on the premise. Even so, the number of applications approved for septic tanks increased from 96 in 1983 to 333 in 1986 (Record Section, Environmental Health Branch, MOH).

The Ministry of Health also experimented with the manufacture and sale of latrine units in rural areas, but the high costs of production and transportation caused GOSL to discontinue this subsidised community service in 1987. The programme was developed in response to the fact that a large percentage of houses in the country are without even this form of waste disposal, due not only to the natural features of the island (i.e., high water table, rocky soil), but also because of the high cost of installation. A concrete slab and riser for a pit latrine can cost approximately EC$ 60.00, which is a sizable sum for a rural family.

Private sewerage systems are used primarily by hotels. Most larger hotels in St. Lucia tend to rely on under-sized, ill-managed, and sometimes inoperative package treatment plants, which often create a false sense of security. In a recent report on land-based pollution in CARICOM countries, Archer (1984) confirmed that with few exceptions package treatment plants in the region were poorly operated and maintained. It was common to

Table 4.2(4). Distribution of households and type of waste disposal system, by major urban areas, in 1987.

	TYPE OF DISPOSAL SYSTEM			
	Municipal	Septic Tank	Pit Latrine	Other*
Castries:				
- Town	383			
- Suburban	428			
- Rural		743		
Anse La Raye		12	535	
Canaries		42	25	44
Soufriere		38	612	141
Choiseul		12	703	40
Laborie		24	692	13
Vieux Fort		36	1,367	24
Micoud		66	1,241	124
Dennery		47	775	246
Gros Islet		43	1,310	56
TOTAL	811	1,063	7,260	688

* pail latrines, chemical toilets, treatment plants, public facilities

Source: GOSL Statistical Unit.

find that plants inadequately "break down" sewage so that floating solids were discharged in effluents used as irrigation water for gardens and golf courses or into the sea via mangroves, salt ponds or within close reach of coral and other marine ecosystems. Under general public health legislation, the Ministry of Health can exercise its authority to monitor and regulate effluent discharge from privately-operated sewerage treatment systems.

(3) *Vigie-Choc Bay Area.* This is one of the sites being considered as an alternative sewage outfall location. Presently the area is already affected by hotel development. In addition to hotel treatment system effluents, there is some stormwater run-off as well as a solid-waste dump to the north. In the past, Vigie beach suffered extensive sand mining, and the bay was dredged in 1980 to rebuild the beach. The marine ecology of the area has been considerably affected by all these impacts, as indicated by sampling in 1985 (Shim, 1988). Some areas are now being recolonised by seagrasses and algae, but coral reefs appear to be on the decline as a result of probable leaching of nutrients from the solid waste dump and surface run-off. Nutrient levels need to be evaluated (Singh, *et al.*, 1986).

In view of the importance of Vigie/Choc Bay to tourism, careful consideration needs to be given to the possible effects of siting the Castries sewer outfall offshore, especially because the area already appears to be under stress. Coastal current studies have not yet been done but are of critical importance in site evaluation.

Despite distinct evidence of human fecal pollution found at some sampling points immediately adjacent to hotels, the present level of bacterial contamination at Vigie/Choc Bay is

not alarming (Corbin, 1988)). The main source of bacterial pollution appears to be stormwater run-off.

(4) *Rodney Bay Lagoon*. A recent water quality and sewerage study of Rodney Bay (Archer, 1985) found that liquid waste (sewage) disposal problems, caused by the inability of the soil to absorb waste effluents from water-borne, on-site sewage disposal systems, pose a serious health threat and were obstructing the pace and scope of physical development planned for this important residential/tourism area. The immediate construction of a sewerage system for the Rodney Bay and Gros Islet areas was recommended.

Rodney Bay Lagoon was originally a mangrove swamp which has been the site of considerable development -- hotels, restaurants, marina facilities and housing -- following clearing of the mangroves and dredging of the area in the early 1970's. The inner lagoon receives wastes from surface run-off, yachts anchored in the lagoon and small amounts of hotel effluents. Most hotel effluents are treated in a central sewage treatment facility, discharging via a long outfall into outer Rodney Bay (Shim, 1988).

Overall, the inner lagoon appears to be in a less healthy condition relative to the outer stations sampled by CEHI, based on the results of benthic sampling. Compared to Castries Harbour which has similar mud-type sediments, the limited data on benthic organisms in Rodney Bay Lagoon suggest that conditions are similar, i.e., "semi-healthy to healthy." The area adjacent to the Ravine Castagne drain appears to be under the greatest stress at present.

Currently, most of the fecal pollution seems to come from upstream housing developments, e.g., Bonne Terre, as shown by the analysis of spot samples taken from drainage ravines where they enter the Lagoon. The sample results are indicative of human as well as animal fecal pollution, which in the case of Ravine Castagne is dangerously high and a threat to health (Archer, 1984).

Bacteriological sampling within the Lagoon, carried out by CEHI on an approximately monthly schedule since June 1985, indicates that all sampling stations conform to EEC requirements for recreational activity as far as bacterial densities are concerned. However, the data on fecal streptococci strongly imply that stormwater is the major pollution source in the area, probably contaminated by both animal and human fecal material (Singh, *et al.*, 1986).

(5) *National Planning*. In a new 10-year development plan prepared by the Water and Sewerage Authority, priorities are: (1) the need to expand and modernise the Castries municipal system, including relocation of the sewage outfall and extension of the discharge point; (2) development of sewerage systems for rural communities, including Anse la Raye, Micoud, Vieux Fort, Dennery, and Soufriere; and (3) development of Rodney Bay and Gros Islet sewerage systems, possibly linked to Castries. With technical consultants provided to WASA by the French Government, various options for the kind of sewage treatment, prior to disposal, are also being examined. A primary problem for development of a land-based collection system to filter and treat sewage is lack of a suitable site of sufficient size.

Solid Waste Disposal. Management of solid waste disposal in St. Lucia is split between national and local levels of government. The Ministry of Health has responsibility for operation of waste disposal sites and for ensuring that disposal systems meet general health standards, while local city and village governments are responsible for refuse collection, storage and transportation. Approximately 34 percent of the population (Archer, 1984) is served by formal solid waste collection services and public disposal. Commercial businesses and industries generally transport their own refuse via private collectors to public disposal sites.

Given the inadequacy of public sector financing for solid waste disposal, combined with modernising life styles generating ever-expanding volumes of refuse in both urban centres and rural settlements (see Table 4.2(5)), divided responsibility for solid waste management has not generally proven conducive to an efficiently run system, even in

Table 4.2(5). Waste generation by administrative districts and estimates of anticipated solid waste levels by 1990.

POPULATION CENTRE	DISTRICT POPULATION	CURRENT AS OF 1983 STUDY URBAN POPULATION IN DISTRICT	% URBAN POPULATION	WASTE GENERATED (METRIC TONS/YR)
Castries	48,000	26,300	55%	10,560
Gros Islet	10,600	3,690	35%	1,480
Dennery	9,970	2,500	25%	750
Micoud	12,300	2,750	22%	825
Vieux Fort	11,130	4,870	44%	1,960
Laborie	6,960	2,650	38%	800
Choiseul	6,450	1,040	16%	320
Soufriere	7,400	4,500	61%	1,810
Canaries	2,100	1,220	58%	370
Anse-la-Raye	5,010	1,750	35%	530

POPULATION CENTRE	DISTRICT POPULATION	PROJECTIONS FOR 1990 URBAN POPULATION IN DISTRICT	% URBAN POPULATION	WASTE GENERATED (METRIC TONS/YR)
Castries	52,140	39,100	75%	15,700
Gros Islet	14,020	10,520	75%	4,220
Dennery	11,050	5,330	50%	1,676
Micoud	14,230	7,120	50%	2,140
Vieux Fort	13,470	8,080	60%	3,240
Laborie	8,000	4,800	60%	1,930
Choiseul	6,720	1,680	25%	500
Soufriere	7,620	5,720	75%	2,300
Canaries	2,140	1,610	75%	500
Anse-la-Raye	5,380	2,690	50%	810

Source: Hippolyte, 1983.

larger urban areas like Castries and Vieux Fort. Effective solid waste management is further impeded by lack of national legislation which sets standards, defines responsibilities, and regulates practices, e.g., licencing of private waste collectors.

Solid waste management is a serious environmental problem which St. Lucia shares with its neighbours in the Caribbean. Sanitary land-filling is not widely practiced; rather, the accepted solid waste disposal method is open dumping, periodic burning of combustibles, and occasional covering of putrescible material. In St. Lucia, disposal is generally by open dumping with periodic burning or by dumping into rivers and the sea (Archer, 1984).

St. Lucia's major landfill site at Choc Bay, which serves the Castries urban area, is already over-loaded, and current waste disposal practices at the site are quite primitive, casual, and unacceptable. Establishment of more effective management suffers from a lack of

adequate data about the level of use and amount of material disposed of at the site. There are no weighing facilities, and only refuse collection vehicles from the Castries City Council are recorded (Hippolyte, 1983). Little has changed since the 1983 survey.

Disposal sites in districts outside of Castries are located at Vieux Fort (also serves Laborie), Soufriere, Anse La Raye, Canaries, Dennery, Micoud, and Choiseul. In some villages, collection is by wheelbarrow, a low-tech, mostly fail safe system!

Aside from management problems, St. Lucia's solid waste disposal system suffers because of the following:

- Scarcity of public land suitable for sanitary landfill siting, with the following characteristics: (1) accessibility, (2) relative remoteness so fumes, smell, and smoke will not intrude on nearby communities, (3) hydrologic isolation to protect water supply, (4) close to suitable cover material, (5) reasonably well-drained (not flood-prone) where deposited materials will not be disturbed.

- Change from traditional combustible and biodegradable packaging materials used for consumer products to non-combustible/biodegradable materials which persist for longer periods in the environment and are more difficult to dispose of.

- Inadequate number and method of storage/collection facilities, further contributing to problems of litter, proliferation of disease-carrying vectors, and pollution of water systems.

- Aging equipment experiencing frequent breakdowns and unable -- because of terrain -- to service many areas.

High priority has been given by St. Lucian planners and health officials to relocation of the Choc landfill site, first established in 1973 and now severely overstressed in its capacity to handle solid waste for Castries and the northern area of St. Lucia. Equipment breakdowns result in stockpiling of waste materials, a situation compounded by poor compaction practices. Cover material generally has to be trucked to the site, and, when not available, incineration is a frequent occurrence.

Hippolyte (1983) further recommends the formation of a separate Northern Solid Waste Management Unit (to serve Castries and the rapidly growing northern corridor of St. Lucia) and the enactment of appropriate legislation to strengthen local town and village governments to allow them, in co-operation with the Ministry of Health, to improve solid waste management within their jurisdictions. A major requirement, this report emphasises, is enactment of a "solid waste tax" to provide the revenues necessary to improve operations. Alternatives include various types of collection charges, privatising the operation, licencing haulers, and imposing tippage fees.

The need to relocate disposal sites in Dennery and Soufriere was noted by a 1984 French Mission sent to St. Lucia to make recommendations for sanitation improvement. Also noted was the need for better site management in Vieux Fort, Dennery and Choiseul.

A new litter law was enacted in 1983 in an attempt to reduce indiscriminate dumping of garbage and litter along streets and highways. In late 1987, the Ministry of Health launched a "get tough" anti-litter drive, publicising its intention to vigorously prosecute violators. The Ministry has also indicated its intention to fine owners of derelict vehicles abandoned on public roadsides, while noting at the same time the need to strengthen the law concerning removal of such vehicles.

In co-operation with the Ministry of Health and NDC, a coalition of community groups and the town council in Vieux Fort launched a grassroots-based solid waste management programme for this area in 1988. One focus of the campaign is to improve waste collection and disposal practices of Vieux Fort's residential, commercial and industrial establishments, which are responsible for the waste

generated on or near their place of business or site of operations.

Air and Sea Ports. St. Lucia is served by two airports, both operated by the Air and Sea Ports Authority. The largest is the Hewanorra International Airport situated at Vieux Fort, some 40 miles (64 km) south of Castries. It has a 9,000 foot (2,743 m) runway and accommodates long-range, international jet traffic from Europe and North America. The airstrip at the smaller Vigie airport, just two miles north of Castries, is 5,700 feet (1,754 m) long and can accommodate only medium-range, regional traffic. A sizable portion of St. Lucia's flat land area was utilised for construction of the two runways.

There has been some consideration given to increasing the size of the Vigie Airport runway; planners need to carefully consider the following factors:

- increased noise and air pollution in residential and commercial areas in adjacent Castries;
- dangerous approach routings intersecting Castries Harbour approaches by cruise liners, freighters and yachts;
- costly relocation of roads and taxiways, and the construction of new terminals, customs areas and other airport infrastructure requirements;
- diminished economic viability of Hewanorra Airport because of diversion of flights to Vigie.

While the goal of accommodating larger jets to bring tourists more easily to northern resorts is one that many in the country support, in the end, the cumulative negative effects -- both environmental and economic -- may weigh against such a proposal.

Castries on the northwest coast is the country's major port facility, with minor ports located at Vieux Fort and, mostly for yachts, at Soufriere, Marigot Bay, and Rodney Bay (see also Section 2.5). Port Castries is a small but well-protected facility which combines standard cargo-handling operations with tourism. The latter is accommodated at the two year-old waterfront Pointe Seraphine duty-free, self-contained tourist shopping complex, which includes berthing facilities for two small cruise ships.

The Pointe Seraphine touristic commercial project, which involved dredge and fill operations and changes in shoreline and harbour geometry, has created some alarm in that it has affected the wave and swell patterns in Castries Harbour, impacting significantly on the yacht moorings and shoreline facilities in Vielle Ville Bay. The changed wave and swell regime and modified in-harbour refraction patterns have been confirmed by Professor Compton Deane of the University of the West Indies, who was employed as a consultant by the Central Planning Unit to investigate the matter. The consensus is that the design was faulty, and some remedial action may be required. Given these circumstances, the Port Authority now takes the position that it is committed to a thorough examination of the environmental implications of all port development proposals.

Vieux Fort in the south provides a deep-water anchorage and facilities to accommodate cargo and container-carrying vessels. The western port in Soufriere, although small, has deep water and can accommodate medium-sized vessels. The nearby harbour at Marigot Bay is favoured as a hurricane shelter due to its well-protected location, but it is very small. The harbour at Rodney Bay on the northwest coast is artificial, having been formed by the opening to the sea of a former fresh-water swamp.

The Ministry of Communications and Works recently designated Rodney Bay, Marigot Harbour and Soufriere as "sport and leisure ports," a special designation which emphasises that they are preferred ports of entry for visiting yachts. This action represents an attempt to better serve yacht-based industries, while separating such activities from the commercial operations of the Air and Sea Ports Authority, which manages all ports in the country. Harbours at Soufriere, Marigot, La Toc Bay, Choc Bay, and Rodney Bay are

particularly attractive to visiting yachtsmen, and marinas have been developed at Marigot, Castries, and Rodney Bay.

Further development of Marigot Bay needs to incorporate protective strategies for surviving mangrove habitats, while development of the harbour at Soufriere clearly must include consideration for the aesthetic amenities of this site and the role it will play in tourism expansion in the area.

Hess Oil St. Lucia, Ltd. In terms of capitalisation and the value of materials handled, Hess Oil St. Lucia, Ltd. (a subsidiary of the U.S. corporation Amerada Hess) is the largest non-governmental industrial enterprise in St. Lucia. By virtue of an agreement struck in the late 1970's between Hess and the Government of St. Lucia (confirmed by the Oil Refinery Act of 1977), Amerada Hess received permission to locate a deepwater oil transshipment terminal near Castries in Cul de Sac Bay on a 700 acre (283 ha) site. That facility, which has storage capacity for five million barrels of oil, has been operational since 1982. Although the enabling legislation stipulated that once the transshipment terminal was completed Hess would begin construction of a refinery, no such work has yet been undertaken by Hess.

As a result of the Hess agreement, St. Lucia gained a deepwater oil terminal, a potential -- but thus far undeveloped -- deepwater freight port, and two cents a barrel for each barrel of oil passing through the terminal. Current employment levels (post the construction period) are relatively low, approximately 40 people, half of whom are St. Lucians. There is no public record indicating Hess will provide fuel to St. Lucia in the event of regional or worldwide oil shortages, although this might have been a logical extension of the terms by which St. Lucia granted authorisation for the facility.

Costs to St. Lucia of the Hess development include:

- the loss of 600 acres of prime agricultural land;
- the destruction of a small village (Tu Bres) and the relocation of its inhabitants;
- the loss of fishing resources in the shallows of Cul de Sac Bay for 30 to 40 local fishermen;
- the loss of productive nearshore fish hatching and nursery areas for a variety of local food and bait fish (Koester, 1986).

St. Lucia also appears to have lost the right to insist on additional economic or environmental protections in the event that Hess chooses to exercise its right to build the authorised 150,000 barrel-per-day oil refinery.

Currently Hess Oil St. Lucia Ltd. (HOSLL) is a transshipment terminal serving the purposes of Amerada Hess. It has been assumed that the purpose of the terminal is simply to receive crude in supertankers and to ship it on to the Hess refinery in St. Croix, U.S. Virgin Islands in smaller tankers (or barges). There is nothing to prevent HOSLL from using the terminal to transship crude to other destinations (such as European or mainland U.S. oil refineries), or to use it to transship oil products from St. Croix to European markets. (In spite of the major concessions it receives from the Governments of both the Virgin Islands and the United States, there is no known prohibition on the Hess Oil Virgin Islands Corporation (HOVIC) shipping refinery products to non-US ports.)

There are also major health, safety and environmental risks associated with the storage and transshipment of millions of barrels of oil every month through the Hess facility in St. Lucia. It is not clear whether GOSL has taken steps, in the form of contingency planning, to protect the public from these potential dangers. To do this Government needs full and reliable operational data from Hess regarding its St. Lucia facility. For example, major oil spills or even chronic high levels of dissolved/dispersed petroleum hydrocarbons (DDPH) on surface waters or adjacent beaches are a direct function of:

- the volume of crude oil and refined products being shipped through the terminal (e.g., millions of barrels per month);

- the number of shipments (e.g., landings);

- the type and registry of the vessel;

- the origination point of the shipment; and

- the type of crude or product involved, to predict the degree of toxicity and persistence of a potential spill.

Concerns about oil spills and marine pollution are especially important because St. Lucia is dependent on a high quality shoreline and marine environment for further growth of its tourism industry. Although the HOVIC plant in St. Croix is known to have an excellent record in preventing and cleaning up oil spills, this is not a risk-free activity, and it is not known if the Hess facility in St. Lucia shares the same degree of preparedness as the St. Croix refinery. The very small size of the HOSLL work force suggests that they are incapable of responding quickly to a major spill.

Recent summaries of studies of petroleum pollution in the Caribbean (Atwood, 1988) indicate that half of the beach tar, floating oil and dissolved/dispersed petroleum hydrocarbons are directly related to nearby tanker operations. This suggests a possible need for closer monitoring of tanker operations by GOSL -- at least in territorial waters.

Oil Spill Contingency Planning. Lack of adequate information about the health, safety and environmental risks posed by the operations of the HOSLL terminal is important in part because Cul de Sac Bay is excluded from St. Lucia's Oil Spill Contingency Plan. While it may be true that Government resources would never be adequate by themselves to cope with a major spill from the terminal or from tankers or barges serving the terminal, nevertheless, GOSL should have a plan which includes the exclusive use of HOSLL and other Hess resources to cope with disasters at the terminal. Government might also want to be able to count on HOSLL resources as backup in the event of other major disasters in the country -- such as assistance provided by HOVIC to the Virgin Islands Government in 1977 when a cruise ship caught fire at the West Indian Company's docks in St. Thomas.

In general, the subject of oil spill contingency planning is new in St. Lucia, and specific arrangements are still being worked out. The country does have a basic plan which was developed on a generalised regional model, with technical assistance from the International Maritime Organisation (IMO). At present the operating responsibility for the plan resides with the Ministry of Foreign Affairs -- largely by default. In order to assure prompt, accountable, and responsible action in the event of an oil spill emergency, it is essential that a Government agency with substantial resources for spill response be directly involved in the management of the plan. For all practical purposes, this means the Ministry of Communications and Works.

Roads. St. Lucia has 500 miles (800 km) of roadway, of which approximately 300 miles are paved and the rest gravel and earth roads. For a mountainous country, St. Lucia is well-served by its road network. The principal highway provides major road access for the full length of the island from the tourism/residential hub at Rodney Bay in the north, via Castries, then to the east coast across Barre de L'Isle down the Fond D'Or river valley and south to the industrial development centre at Vieux Fort in the south. The road continues past Vieux Fort on the west coast back to Castries, but from Soufriere, it is much narrower and steeper than the east coast highway.

There are approximately 10,000 motor vehicles in St. Lucia, with 1,000 vehicles being imported per annum (Stevenson, 1986). Public transport is provided by mini-buses. Motor vehicle exhaust pollution is not a serious problem. However, traffic congestion problems in Castries and the area surrounding the capital are rapidly increasing, a pattern

which will continue given the present level of vehicular imports.

In building roads in St. Lucia, particularly rural roads up steep hillsides, serious erosion problems have occurred following construction, especially where adequate drain and culvert systems were not provided for. Environmental impacts can be considerably diminished if, in the design/construction phases of road projects, sufficient time and effort is spent on assessing potential impacts, for example, identifying road routings which destroy a minimal amount of vegetation and leave normal, natural drainage patterns intact. There are also lesser environmental concerns associated with road maintenance activities, but most of these can be minimalised if enough attention is paid to environmental impacts during road design and construction phases.

Consideration must also be given to the unintentional impacts of feeder roads which provide greater public access to areas which should be protected from human interference, such as feeder roads which have increased the accessibility of the forest reserves. More specifically, planning analysis of environmental impacts should routinely include important secondary effects, such as contribution to deforestation by enabling extension of steep slope farming and fuelwood harvesting in critical areas.

(5) MANUFACTURING

In the 1960's there were only a few simple industries in St. Lucia engaged primarily in the processing of local raw materials for the manufacture of copra products, bay rum, beverages, garments and wood products. Today, as a result of a conscious public policy to encourage industrial production, the sector includes a wide range of small-scale industries producing both for the local market and export. While manufacturing is still in an early stage of development (contributing about nine percent of GDP in 1985, according to World Bank figures), its potential for employment creation and export expansion are ranked highly by GOSL economic planners.

The industrial sector began to expand in the 1970's with the establishment of a carton manufacturing plant, a joint venture among the four Windward Islands and a Venezuelan paper firm. By the early 1980's 70 manufacturing operations produced a variety of products including garments, plastic goods, and soft drinks. A survey of manufacturing establishments carried out in 1983 reported that, of those firms responding, 23% were engaged in the manufacture of food products, 15.5% in textiles, 14% in wood and wood products, 12% in paper and paper products, 12% in fabricated metal products, 9.5% in beverages, 8% in industrial chemicals, and 6% in metallic mineral products. Out of the total, over 70% were locally-owned, with the foreign-owned firms dominant in textiles and fabricated metal products (World Bank, 1985). The directory of St. Lucian manufacturers maintained by the Ministry of Trade lists (March 1988) 177 firms, many of which are predominantly commercial or service organisations.

Among the factors contributing to St. Lucia's expanding manufacturing base is the relatively high quality of the country's infrastructure, fiscal incentives (e.g., tax holidays, exemptions from import duties), GOSL provision of industrial estates and subsidised factory shells, and low industrial wages. Industrial parks are owned and managed by the National Development Corporation (NDC) and include at present: Bissee Industrial Estate (near Castries), Hewanorra Airport Free Zone, Dennery Industrial Estate, Vieux Fort Industrial Estate, and Vieux Fort Industrial Free Zone. The emergence of enclave-type export manufacturing is an important goal of the country's industrialisation strategy, which has also targeted the Vieux Fort area for major manufacturing expansion.

According to NDC, it follows a deliberate policy of only encouraging and promoting non-polluting industrial development (personal communication, Cromwell Goodridge, March 1988). NDC cites specific examples of this policy: negotiations with a potential outside investor terminated when the investor proved unwilling to employ standard pollution control practices; investigation of reports concerning pollution of coastal wa-

ters by firms operating from NDC's Vieux Fort industrial complex.

Nonetheless, the environmental impacts of manufacturing operations are visible in St. Lucia, in particular the threat to specific coastal and marine environments posed by the discharge of industrial wastes. The areas most directly affected by industrial waste are Castries harbour, Cul de Sac Bay, Vieux Fort Bay and perhaps Choc Bay and Rodney Bay Lagoon.

Pollution sources in Castries harbour are not limited to industrial wastes; as identified by CEHI and others, they include:

- domestic wastes and storm-water from residential districts;
- untreated sewage from pumping stations;
- waste-water, storm-water and solid wastes from Castries River;
- animal wastes from the city abattoir;
- bilge water and other wastes associated with maritime traffic;
- feces and other wastes dumped by individuals and institutions/enterprises around the periphery of the harbour;
- pesticides and chemicals from occasionally damaged containers in the port cargo handling areas;
- perchlorethelene from dry cleaning establishments;
- chemicals from film and photo processing establishments.

This informal listing, however, is no substitute for a formal, quantitative inventory of industrial/commercial waste streams, expanding the Archer 1984 and 1988 overviews with a detailed profile of point-source pollution discharges for which mitigation and management strategies can be developed.

The environmental impacts of manufacturers in St. Lucia are usually minor. The exceptions are generally well known and obvious -- for example, the brewery, the distillery and the box making plant. Each of these has had problems with controlling noxious discharges in the past, and each claims to have solved their problems in response to complaints by private or public parties. The need for a regular programme to continually monitor the discharge of large generators of waste water is an obvious GOSL responsibility which should be enhanced with the operation of the Caribbean Environmental Health Institute. Failure to keep these discharges under control can drastically affect the productivity of the few remaining coastal areas still available as spawning and nursery grounds for St. Lucia's marine fauna.

The island's fledgling electronics industry represents another industrial group which should be monitored. In this case the problem is the disposal of potentially hazardous wastes. The chlorinated hydrocarbons used in electronic PC board manufacturing and the by-products of the battery manufacturing businesses are especially worrisome if they are allowed to contaminate groundwater resources. (Chlorinated hydrocarbon discharges are also a problem for some dry cleaning facilities.)

The furniture manufacturers of St. Lucia have a special interest in improved management of the country's forest resources, in order to assure a supply of high quality woods. The continued use of local hardwoods will be especially important as the furniture manufacturing industry matures and begins to develop export markets. Finished fabrication of high quality furniture built from tropical hardwoods can be a very high-value-added business, with major foreign exchange earning potential for St. Lucia. (See Section 2.2.)

Industrial pollution from manufacturing activities can stem from two different kinds of investment situations. The first is the investor with a major plant who might shortcut proper procedures for whatever purpose, resulting in environmental damage. The second results from small discharges of hazardous or environmentally dangerous substances by small local entrepreneurs who either do not know or cannot afford proper controls. In St. Lucia's case, the first kind of situation is well on the way to being controlled. Periodic review of the terms of concessions granted under the Fiscal Incentives Act (1974) can provide meaningful sanctions for recalcitrant investors. In general, standards are un-

derstood and expectations of compliance are clear. The second situation will require more work.

Occupational Health and Safety Act of 1985. While St. Lucia has had occupational health and safety legislation for several years, there are at present no regulations in effect, nor have standards specific to St. Lucia been formulated. Officers of the National Insurance Scheme, the Environmental Health Branch of the Ministry of Health, and the Labour Department are responsible for providing inspection services, but only the inspectors from Labour are empowered under the law. Site inspection is limited and is further impeded by lack of proper testing equipment.

A survey of manufacturing establishments by the Caribbean Epidemiology Centre (Trinidad) and the Ministry of Health (Keenlyside, 1987) classified major occupational hazards in this sector resulting from:

- poor housekeeping practices
- inadequate safety measures for work involving machinery
- excessive noise
- poor lighting
- faulty electrical systems
- poor ventilation
- heavy exposure to lead and possibly asbestos
- inadequate storage and labelling of chemicals.

As St. Lucia continues to expand its manufacturing base, health and safety risks to the work force will also increase. It is important that GOSL (1) provide adequate support for improved inspection services (increased numbers, training for personnel, adequate equipment), (2) strengthen the existing legislation through provision of regulations and standards, and (3) establish a programme of education for employers and employees regarding environmental and safety hazards in the work place.

(6) CONSTRUCTION

The construction industry in St. Lucia is highly cyclical and is especially sensitive to large projects such as the construction of the Hess Oil St. Lucia Ltd. terminal in Cul de Sac Bay. For major construction activities, contractors, engineers and even architects may be imported from overseas -- sometimes with no prior experience in the Eastern Caribbean or even working with tropical, insular environments. This suggests the need for exacting standards and controls for development projects utilising foreign-owned or foreign-based construction contractors, particularly when such firms have few assets or expectations of remaining in the country beyond the term of the project activity.

The project review and approval functions of the Development Control Authority (DCA) provide one means to avoid or mitigate major environmental impacts from construction activities. The limitations of this process as currently exercised in St. Lucia are reviewed in more detail in Chapter 5. It should be noted also that major infrastructure construction is the responsibility of Government, which should not be exempted from the environmental and building control standards established by the DCA. A new "developer's handbook" with guidelines and standards is scheduled to be issued shortly by the DCA. A similar internal GOSL document should be prepared for all Government facilities and development project planners, designers, and managers.

(7) HOTELS AND RESTAURANTS

The hotel/restaurant sector of the St. Lucian economy is primarily related to the country's tourism industry, which is discussed fully in Section 4.1 of the Profile.

Food Sanitation. An additional environmental health issue involving industries, like restaurants, which handle food is that of food sanitation. Responsibility for ensuring the quality of food is primarily provided by the Ministry of Health through the site inspections carried out by its 20 Environmental Health Officers (EHO). In addition to hotels

and restaurants, grocery shops, supermarkets, slaughter houses and food processing plants are inspected at least twice per year.

However, because the Public Health (Food) Regulations are very general and since there are no administrative procedures for taking legal action against offenders, the EHOs are limited to providing information or making suggestions during their on-site inspections, even when unhealthy conditions have been identified. Furthermore, the Environmental Health Branch has limited technical capability for dealing with food quality testing, and what analysis might be provided by the Ministry of Agriculture's Food Laboratory at Union is not available because of poor co-ordination between the two agencies. Under normal circumstances, a public health agency would contract for the required testing services with an existing laboratory rather than develop a new special purpose facility.

Consumers in St. Lucia, whether residents or tourists, need to have confidence in the quality and safety of foods available. This can only be ensured if the Government addresses the inadequacy of its present food inspection and restaurant/food service licencing procedures. Fast food outlets, mobile restaurants, and snack bar services are often overlooked in monitoring programmes, as are temporary food service booths at carnivals and other community fetes.

(8) BANKING, INSURANCE AND REAL ESTATE

By controlling access to and the conditions for the development of land, the institutions represented by this economic sector define how market forces are translated into development projects. As such, they exert considerable influence over the development process, including the extent to which environmental impact considerations are made a part of that process.

In recent years external lending agencies (World Bank, 1985, 1986; CDB, 1987) have commented on the need to improve the project design and project monitoring criteria employed by public and commercial banking institutions in St. Lucia. A principal purpose of this overall recommendation is to increase the diversity, and return, of viable development projects supported by development banks and private lending agencies. From an environmental perspective, it should be added that improving the ability of private and public financial institutions to evaluate the short and long-term environmental consequences of major projects can only improve overall rates of return, protect important amenities to serve future social and economic development needs, and decrease overall risk of public and private loan portfolios in St. Lucia.

These suggested reforms in lending and project monitoring practices are plainly part of a worldwide trend -- best exemplified by recent reforms at the World Bank designed to strengthen the Bank's long-term environmental policies and to assure environmental quality on a project-by-project, loan-by-loan basis. In St. Lucia, it is interesting to note that *as long ago as 1941, a Cooperative Bank was making loans to farmers subject to a number of conditions, one of which was that adequate measures be taken against soil erosion* (Westermann, 1952). The more recent policies of the St. Lucia Development Bank are not as specific. For its agricultural loans, there are no provisions to require environmentally sound cultivation practices, and for industrial and housing loans, the Bank defers to the Development Control Authority, requiring its approval before a loan is granted (D. Girard, personal communication, March 1988). This is probably less than effective.

It should be emphasised that calls to reform lending policies and project assessment criteria are not necessarily negative -- that is, the objective is not simply to keep banks from funding environmentally damaging projects. Rather, the objective is an alternative approach to project assessment, one which ultimately will create a greater variety of potential funding options because a wider range of costs and benefits have been considered.

4.2.3 Directions for the Future and Policy Recommendations

SAND MINING

St. Lucia must immediately take steps to confront the issue of beach sand mining and its destructive impacts on coastal environments. Recommendations include the following:

(1) *Systematic evaluation of sand resources.* St. Lucia resource managers need to assess available sand deposits in the country and make some judgments as to where continued sand removal will have the least detrimental impacts on natural systems and is more compatible with current site utilisation. Until a substitute (for sand) has been not only identified but has demonstrated technical and monetary capability for widespread use, sand will continue to be removed from the beaches, with or without permit. To better manage and control this inevitable resource exploitation in the near-term, GOSL must make hard decisions to earmark priority areas where sand removal will be absolutely protected and areas of lesser concern and stress where regulated sand removal will continue.

(2) *Monitoring and enforcement.* Having made these choices, GOSL must improve its enforcement capabilities for dealing with violators. Publication of regulations governing the "off-limits" beaches as well as the "exploitation" beaches must be available to the public, and thereafter protected areas must be rigorously monitored and patrolled by the Ministry for illegal extraction.

(3) *Fee for sand extraction.* As long as sand is a "free" commodity, it will continue to be viewed by the general public as a common property resource. The permitting system established under the Beach Protection Act of 1967 should be amended to attach a charge for sand removal to each permit issued. In the U.S. Virgin Islands, similar charges have been in effect for a decade, with each permit holder charged US$ 3.00/yard for sand dredged offshore (beach sand removal is not permitted at all under law). Removal of sand by GOSL agencies should also be regulated by permit, with fees paid by extracting parties or agencies into the general treasury. Fees should be based on the potential replacement cost of beach sand or, better yet, at or slightly above the market value of equivalent quarry sand and pumice sand. Permits should be required to carry sand since most sand extraction and sale is handled by small-scale truck owners/entrepreneurs.

(4) *Incentives for sand substitution.* If sand removal is more tightly controlled and if the resource itself no longer is treated as a "free" construction material, incentives for exploiting alternative sources will increase (as a function of the increased costs associated with sand). Quarries producing fine aggregate as a by-product of rock-crushing will find their product more competitive, and the feasibility for larger-scale commercial development of pumice (beyond the small pumice quarries now in operation) should be viewed more optimistically.

(5) *Long-term solutions.* The solution for the longer term will revolve around the following:

(a) Using seabed sand as a major source for domestic purposes, dredged from nearshore but outside the 60 foot contour;

(b) Use of pumice for block and commercial (concrete) purposes;

(c) Limited and licenced river sand harvesting for plastering purposes (i.e., fine finishes);

(d) Prohibition against all beach sand mining except perhaps for one beach, rotated and monitored (using the back beach area only);

(e) Establishment of a rigorously enforced fee schedule for all beach and marine sand; licencing and permits for all sand suppliers, truckers, and contractors/builders.

ENVIRONMENTAL HEALTH ISSUES

The lack of adequate environmental sanitation systems in St. Lucia contributes to a high incidence of gastroenteritis and other water-related enteric diseases. Problems associated with solid waste management, human waste disposal, and vector proliferation are interrelated in contributing to national environmental health issues. Sub-standard garbage and human waste disposal creates ideal habitats for disease-carrying flies, rodents, and mosquitoes. Unsanitary excreta disposal acts as a medium of contamination for further dissemination of disease by vectors. Waterborne illnesses such as schistosomiasis, typhoid fever and dysentery are readily transmitted through waters contaminated with human waste.

A number of recent studies point to a series of priority recommendations for an action agenda for the country.

(1) *Sewage Disposal*:

- Upgrading or replacement of the 40-year old Castries municipal sewerage works, a system no longer capable of coping with the population growth and industrial development demands under which it is now operating; the present system has no treatment capability and the discharge of crude sewage into Castries harbour is a continuing biological threat;

- Development of sewerage systems for other growing urban areas, such as Vieux Fort and Dennery and eventually for all coastal towns;

- Development by WASA of regulations which establish water quality standards for effluent discharge from public sewers;

- Development by WASA of regulations and standards for privately-operated package treatment plants which are generally poorly maintained and add to growing concern about coastal pollution;

- Reactivation by the Ministry of Health of its programme to assist rural residents in acquisition of pit latrines which, if adequate standards are employed in their construction and use, constitute a safe method of waste disposal until water-borne sewage systems are more generally available.

N.B. All of the above activities should be incorporated within a policy framework which helps to guide action agendas (such as the new 10-year development plan). A "sewage management policy" will, among other things, help to resolve (1) internal conflicts (for example, expanding sewage treatment vs. avoiding high-tech solutions with high life cycle costs) and (2) external conflicts (e.g., water for domestic sewage processing vs. water for irrigation).

(2) *Solid Waste Disposal*:

- Alternative refuse dump sites are needed for Castries, Dennery, Micoud, Choiseul, Soufriere, Canaries and Anse-la-Raye. Improvement in the management of the Vieux Fort dump site is needed;

- Enactment of Solid Waste Management legislation to define national and local government responsibilities, establish standards for waste disposal, and regulate waste collection practices; legislation should include a prohibition against all refuse disposal in the sea or adjacent to streams and rivers;

- Assistance to local government units charged with solid waste collection and disposal, possibly through enactment of a solid waste tax, to allow them to upgrade the services presently provided;

- Replacement of out-dated refuse collection equipment and storage/collection facilities.

TOXIC MATERIAL AND OIL SPILL CONTINGENCY PLANNING

St. Lucia should consider assigning the central GOSL role in oil spill contingency planning and emergency response to the Ministry of Communications and Works, an agency with the operational capacity to deal with these issues. Under that broad mandate, a major component should be development of a specific contingency plan for the Air and Sea Ports Authority, whose plan of action would be particular to its own facilities and resources, in much the same way as a specific plan for the Hess Oil terminal and service fleet should also be incorporated in the country's broader plan.

This contingency planning effort needs also to incorporate all toxic and hazardous materials and should include an impact reduction and mitigation plan (i.e., risk reduction action plan) along with the "response capability" plan. It should address all tanks on shore and warehouse storage facilities for chemical drums, explosives, pesticides, industrial chemicals, and waste materials, including pathogenic/toxic hospital waste and low level radioactive material.

INDUSTRIAL/URBAN POLLUTION MONITORING PROBLEMS

Current microbiological techniques used in monitoring point-source and non-point-source riverine and marine pollution, as currently carried out by Ministry of Health officials under supervision of the Caribbean Environmental Health Institute, demonstrate four important deficiencies which need to be addressed.

(1) Current standards designed to protect humans against microbiological agents in marine waters may be too lenient and should be upgraded.

(2) Monitoring protocols are inadequate to detect intermittent or periodic violation of existing standards and need to be more stringent.

(3) Standards based on use of fecal coliform indicators may not adequately measure pathogen survival. Alternatives should be selected.

(4) The Jamaican Kingston Harbour model should be discarded as a "standard". It was perhaps the most polluted, large city harbour of its time in the region and is hardly a suitable standard for St. Lucia.

Current techniques used to measure marine water quality are probably significantly underestimating the true number of viable pathogens that are entering the marine environment for at least four reasons:

(1) Coliforms, the most widely used indicators, are not generally pathogenic and do not survive as well in salt water as other pathogenic bacteria or viruses. Recent studies suggest that enteric bacteria may be a more suitable indicator although the debate continues as to the most appropriate indicator of fecal pollution.

(2) Existing standards use bacteria as indicators of contamination, while viruses appear to be the major cause of diseases transmitted through the environment.

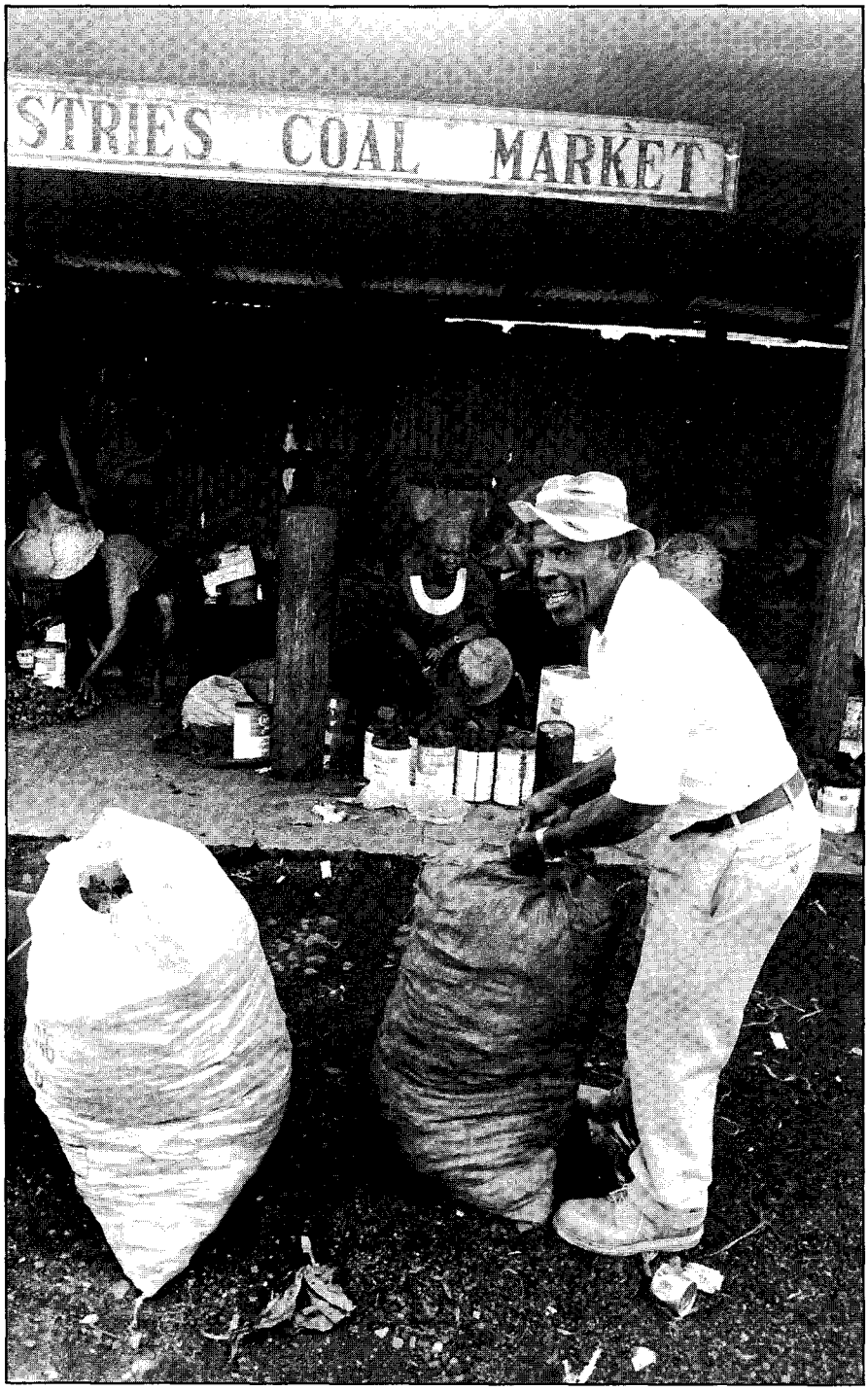
(3) Current standards are based solely on water quality, while levels in sediment and shell fish are neither regulated nor routinely monitored.

(4) Bacteria, including certain pathogens, may remain viable for long periods of time in the marine environment while being non-culturable using available methods.

In terms of the local environment, the absence of local standards or at least standards applicable to a tropical environment has meant that comparison with international standards more suited to temperate regions may be of limited significance. It is thus necessary for MOH, CEHI, and possibly PAHO to try to establish such local standards, especially since, even in relation to the varying international standards, controversy exists as to the true relationship between bacterial densities and incidence of disease. These institutions should each gradually revise their standards, but St. Lucia should remember that the regional minimums do not have to be accepted by the country which may elect to impose more stringent, more precise and more customised standards.

Finally, most of the work on bacterial pollution has been concentrated on the north and northwestern coasts of St. Lucia (e.g., Castries Harbour, Rodney Bay, Vigie/Choc Bay, Reduit Beach and Smuggler's Cove). In order to obtain an overview picture of the status of bacterial pollution throughout the island, it may be necessary to carry out rapid assessment type monitoring at selected points around the entire coast. At the very least baseline assessment surveys should be done for a year, on perhaps a monthly or quarterly basis, for all village waterfront areas, rivers, river mouths, anchorages, swimming beaches and significant sewer or drain point source discharge locations.

Point-source waste discharge volumes, rates, and content also need to be monitored to establish a systems loading baseline. This could and probably should be done under the aegis of MOH on contract by a private sector engineering firm. Only after the dimensions of the problem are established would MOH be in a position to design a proper national monitoring programme and supporting laboratory system. CEHI would undoubtedly assist with counsel on quality control and the task of setting new, practical, and appropriate national standards. These new standards will be very important once the country launches its proposed Environmental Impact Assessment programme for development projects because they constitute bench marks against which to measure the degree or percent or quantity of induced environmental degradation or change.



Energy by the bag: charcoal exchange at the Castries Market.

4.3 ENERGY RESOURCES

As a non-oil-producing, developing country with limited land and high population density, St. Lucia's energy sector suffers the negative consequences of several trends:

- Rising population and incomes increase the demand for energy disproportionately (i.e., energy demand is highly elastic with respect to income -- a 10 percent increase in per capita incomes results in more than a 10 percent increase in energy consumption);

- The pattern of energy demand is shifting toward more petroleum sources, principally to satisfy transportation needs;

- Energy prices have been and are expected to continue to increase faster than the prices of St. Lucia's exports.

In confronting these problems, St. Lucia enjoys some advantages. Current energy consumption levels are relatively low. The country is already providing about one-fifth of its own domestic energy needs from renewable fuelwood resources. Geothermal resources appear to be a viable alternative to diesel fuel for a large portion of the country's electrical power generation needs, and steps are underway to exploit this potential. Finally, Government has recognised the importance of developing a long-term strategy in response to the country's energy needs, and the Central Planning Unit has devoted considerable effort to mapping a reasonable plan.

4.3.1 Overview of Energy Resources and Utilisation

Figure 4.3(1) summarises the Central Planning Unit's (1986c) data on recent primary

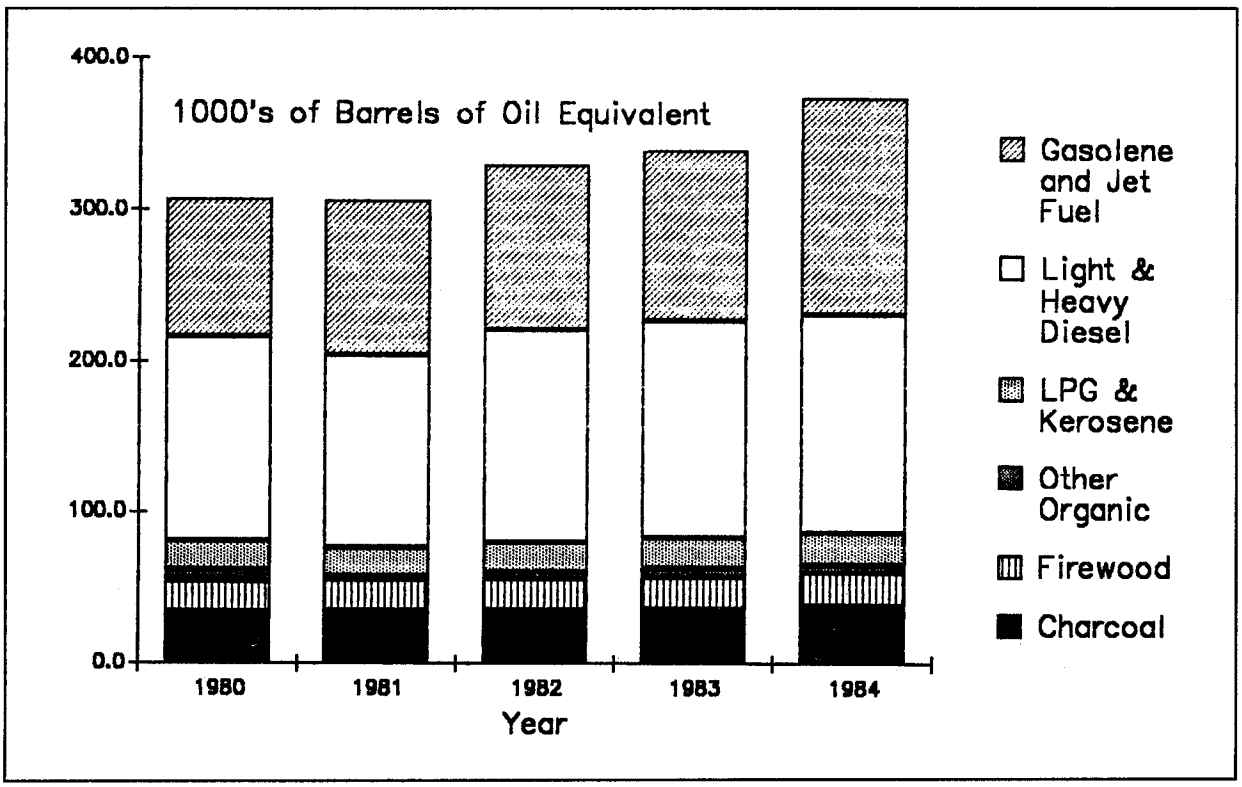


Figure 4.3(1). Total primary energy consumption by fuel type (data from GOSL/CPU, 1986c).

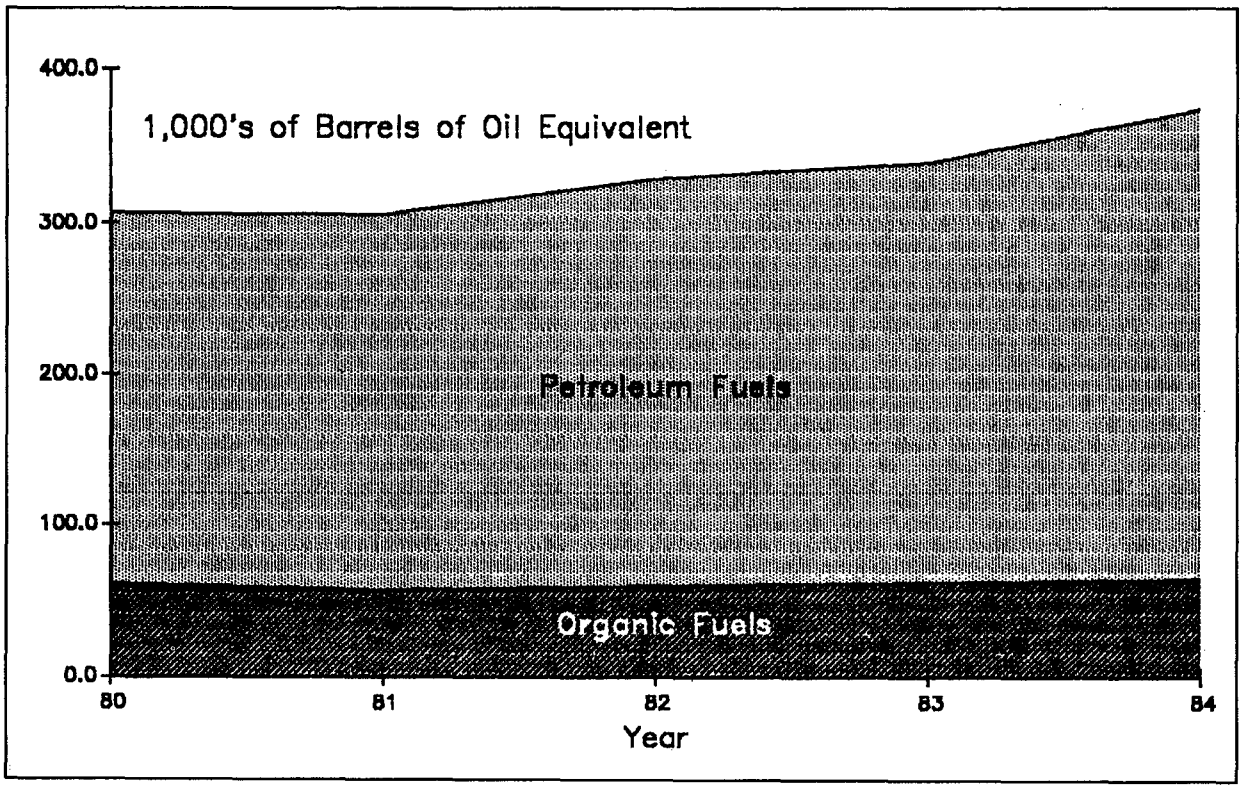


Figure 4.3(2). Energy consumption trends by type (data from GOSL/CPU, 1986c).

energy consumption in St. Lucia. As displayed in Figure 4.3(2), the fastest growing energy sources are those which use petroleum products, while locally grown firewood, charcoal and coconut husks (organic fuels) are not seen to be growing at all. Within the petroleum sector (Figure 4.3(3)), the fastest growing areas are diesel oils (dominated by light diesel which is used both for motor transport and electrical generation), and gasoline and jet fuel, used for on-island and international transport.

Based on 1984 estimates by the Central Planning Unit, Figure 4.3(4) demonstrates the patterns of energy use by the final consumers of energy in St. Lucia, both in terms of the energy mix and by the sectors of the economy which are major consumers. The picture of end-use consumption patterns carries some interesting implications for St. Lucian energy policy makers. Electricity consumption is such a small piece of the whole picture that major public benefits are unlikely to accrue from marginal increases in the efficiency of electrical appliances.

Diesel fuel consumption, however, will be very sensitive to increased efficiency in the operation of power plants and distribution systems. A recent UNDP/World Bank (1984) study highlights the problems faced by St. Lucia Electricity Services (LUCELEC) as a result of high generating system losses. These losses are both technical (e.g., the need to integrate the northern and southern grids and to replace undersize power cable) and administrative (the presence of power users without meters).

The high proportion of energy that goes to transportation systems is very significant for St. Lucia. As there are no practical substitutes for petroleum to support transport systems, it becomes extremely important for the country to maintain access to relatively large quantities of petroleum products to sustain domestic and international transport systems. Efforts to increase the fuel efficiency of the local vehicle fleet (GOSL/CPU, 1986c) and to decrease demand by improving commercial passenger transport systems are important

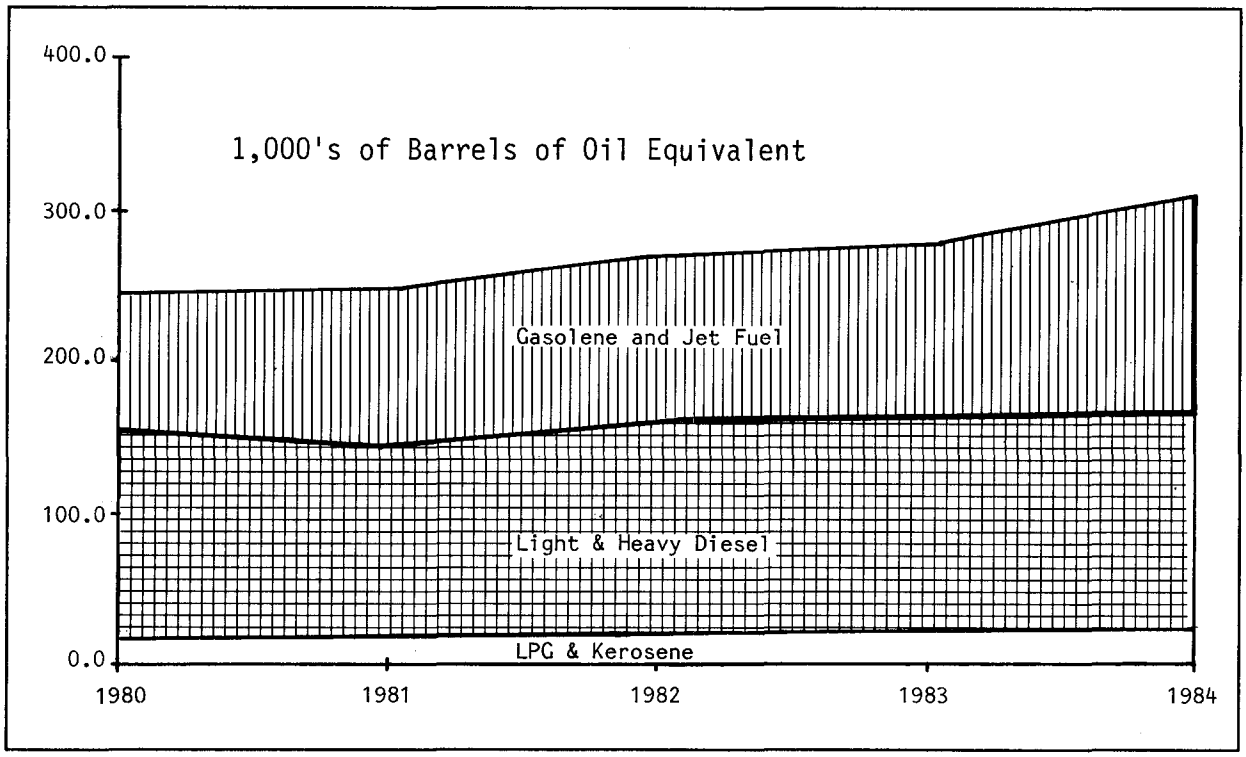


Figure 4.3(3). Petroleum consumption trends by fuel (data from GOSL/CPU, 1986c).

initiatives, but they are no substitute for guaranteed access to supplies.

In addition, the 1984 UNDP/World Bank energy sector study pointed out that St. Lucia -- and other OECS states -- pay very high transport costs for imported petroleum products, especially liquefied petroleum gas (LPG). High LPG costs (and fears of supply interruptions repeating the oil crisis experience of the mid-1970's and early 1980's) may explain the slow growth of LPG usage. LPG is used exclusively for cooking fuel, and greater LPG use would probably relieve some pressure on local fuelwood production.

HYDRO-POWER DEVELOPMENT

Surveys of hydro potential for St. Lucia are agreed that, except for the occasional micro-hydro project in isolated parts of the island, hydro-power development is not feasible because of wide fluctuations in river flow over the course of a year and because of extensive siltation in most rivers. Watershed disturbances have eliminated this option for the foreseeable future. (See also Section 2.4 on Water Resources.)

Improved soil conservation efforts -- leading to lowered siltation and better water retention -- may in the long-term permit exploitation of the country's hydro-power potential.

SOLAR AND ALTERNATIVE ENERGY DEVELOPMENT

In general, solar and other alternative energy technologies have seldom demonstrated technical and economic gains in keeping with early optimism. Incentives to improve their viability as an energy source have diminished with the fall in energy costs since 1982.

An additional problem specific to St. Lucia is the country's general lack of expertise about or access to new technologies as they are developed in the metropolitan centres of Europe and North America. Both factors limit the possibilities for extensive exploitation of solar, wind and wave energy systems.

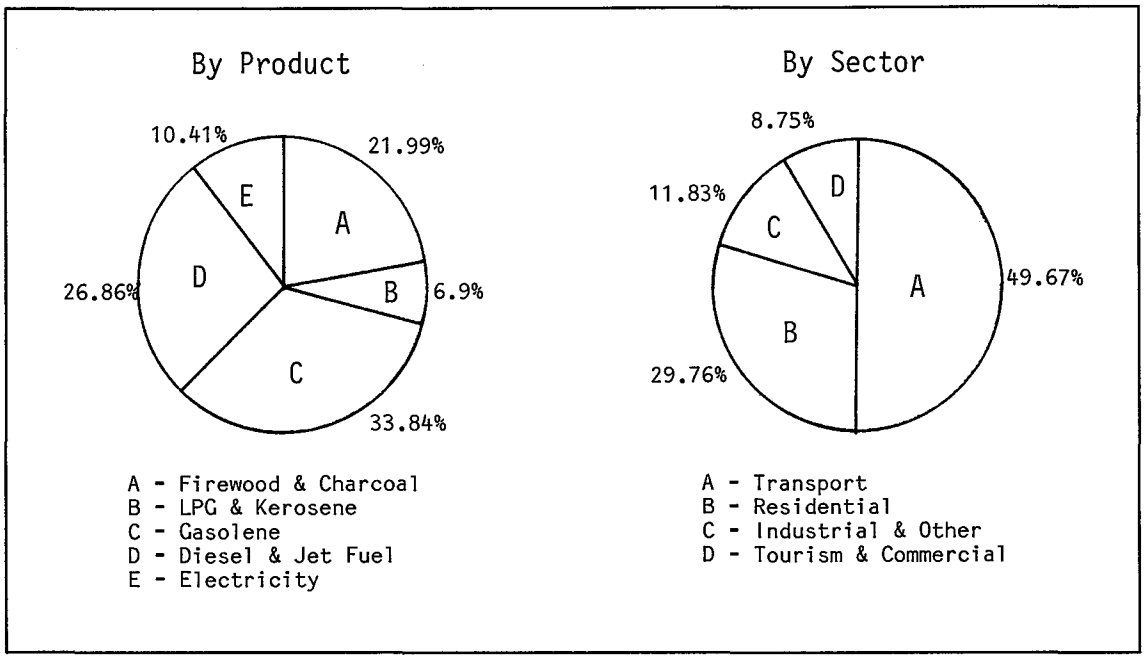


Figure 4.3(4). Final energy consumption by product and by sector (data from GOSL/CPU, 1986c).

The Central Planning Unit has identified a limited number of opportunities for applying specific techniques, such as wind or solar-powered water pumping systems, to special, small-scale conditions, but applications of these alternatives to meet large-scale energy production requirements is not considered an option at present.

GEOTHERMAL POWER DEVELOPMENT

The leading element of Government's energy development strategy is "to accelerate in every way possible Geothermal Exploration and Development" (GOSL/CPU, 1986c). According to the CPU, the goal of Government policy is to secure 60 percent of total electrical generation from geothermal sources by 1990.

St. Lucia has high geothermal energy potential which has been studied since 1952. The British carried out a preliminary exploratory programme of seven drill holes in 1975-76, at the very site later to prove successful (the British findings were undoubtedly a positive contributing factor in the later, 1987-88, site selection and drilling strategy). A new exploration and development plan was established in 1984. According to this plan, development of the country's geothermal potential would be co-ordinated with integration of the country's two existing power grids. This would permit the gradual phasing in of three (projected) five megawatt geothermal powered generators as the country's smaller diesel generating units required replacement.

In March of 1988, GOSL and its geothermal consultant (Aquater, an Italian company) announced completion of the country's first successful production well, near the Soufriere steam vents. (The first well in this current series was a dry hole at Belfond.) The Soufriere well is rated at a five megawatt capacity, although long-term production tests have not been carried out. Government hopes to install a temporary, skid mounted generating unit at the well site to permit immediate exploitation of electrical power from the well.

Several serious questions need to be carefully studied and reviewed as the country moves to exploit its geothermal potential.

(1) The viability of geothermal electrical power generation is not assured. Studies by the U.S.-based Los Alamos National Laboratories in 1984 indicated only a 30 per-

cent cost advantage for geothermal power over the 30-year project life. Given the level of uncertainty associated with this estimate, the possibility for unforeseen developmental, maintenance and environmental costs and the need for heavy front-end investments to build the wells and associated generating stations, this is not a very wide margin.

The following are some of the economic risk factors associated with geothermal development which should be weighed by St. Lucia against the obvious advantages of reducing the country's dependency on foreign oil:

- Extremely expensive drilling and pipe costs, with no assurance that installed wells and pipelines will last for the 30 year project lifespan;

- Heavy dependence on specialised foreign technology and equipment (this can run the gamut from exploration technology to special generating stations sited in earthquake-prone areas);

- Unique and costly maintenance requirements, including exotic materials to withstand the corrosive effects of superheated brine;

- The variable quality of support from outside contractors and consultants.

(2) There are a wide range of largely unforeseeable negative environmental effects associated with development of geothermal generating facilities. Some of these impacts might include:

- Chemical and thermal pollution from the geothermal steam discharge;

- Possible loss of or diminishing the attractiveness of the sulfur springs as a tourist attraction;

- The siting of incompatible industries in the area to use the waste heat from the wells.

(3) If successful, the project risks overdependence on a very fragile producing system. A small geologic shift could sever all of the country's geothermal wells at the same time. If this destroys 30 percent or more of the electrical system's capacity, this could have severe consequences.

St. Lucia has been living with hopes for the development of its geothermal potential for a long time. The cautionary notes stated above should not slow the rapid development of the resource now proven. They do, however, highlight the need for on-going study of the long-term economic and environmental impacts of the geothermal power option.

FUELWOOD AS AN ENERGY SOURCE

As reviewed in more detail in Section 2.2.4, fuelwood production figures for St. Lucia are not reliable or consistent. What can be stated with some degree of confidence is that total fuelwood consumption is probably over 80,000 tons per year (for both charcoal and firewood). Recent data from the CPU (1986c) indicate that fuelwood represents approximately 22 percent of all secondary (end-use) energy consumed in St. Lucia.

The major use of fuelwood is in the production of charcoal which is favoured for its higher heat value and transportability. It is produced in earth pits which give a very low yield but do not require a high capital investment. Charcoal production is a traditional industry carried on by approximately 2,000 households for personal consumption and sale; for some 400 to 500 households, the primary income is derived from charcoal production (CDB, 1983). Most is produced on private land.

On average, it takes 8.6 pounds of wood to produce a pound of charcoal; at the same time, the heat value of 8.6 pounds of wood is five times greater than a pound of charcoal. The energy efficiency of the traditional processes of converting wood to charcoal is only

about 20 percent. In other words, 80 percent of the wood that is harvested for charcoal production simply goes up in smoke. *Increasing the efficiency of charcoal production may very well be the most important single step which St. Lucia can take to safeguard its fuelwood resources.* It is unfortunate that the experimental use of charcoal kilns (which elsewhere in the developing world have a demonstrated track record of providing more charcoal with less wood) has been abandoned in St. Lucia. Four such kilns provided by donor agencies to the Department of Forest and Lands lie abandoned in the bush, and GOSL policy makers would be wise to pursue why this experiment failed and determine how a renewed effort could lead to a viable option of improved production efficiencies. It is not an insoluable problem.

Defining how best to meet the country's fuelwood needs on a sustainable basis from existing resources is a management problem of considerable complexity, involving careful monitoring and research, regulation and controls, incentives and market support. As suggested above, one important focus of management strategies should be on improving the efficiency of the production system. There is little evidence from other countries that a redesign of coalpots used for cooking will improve energy use efficiency. Allegations of such were virtually all theory and prospective proposals. On a broad scale, there have been few stove/coalpot improvement projects which have paid off. It has already been proven difficult to introduce such changes in St. Lucia.

More information is needed about the domestic (i.e., residential) energy economy -- especially about how households weigh the tradeoffs among the various cooking fuels, including wood, coal, LPG, kerosene and electricity. This information should provide valuable insights into the incentives which can be used to promote a faster (or slower) rate of conversion from traditional fuels to modern, commercial fuels.

4.3.2 Institutional Responsibilities and Linkages

Institutional responsibilities for the energy sector are broadly dispersed through St. Lucian society. The "commercial" energy sector is split between public and private interests, including all of the following: petroleum product distributors; St. Lucia Electricity Services Ltd. (LUCELEC); the Development Control Authority; the Air and Sea Ports Authority; the Water and Sewerage Authority (the largest public consumer of energy); and even the Customs Bureau, which collects differential duties on cars based on fuel efficiency.

The Central Planning Unit of the Ministry of Finance (through its Energy, Science and Technology Unit) has assumed a key role as diagnostician and prescriber of solutions for the country's energy affairs. In mapping the broad concerns of public policy and setting forth the priorities and strategies which will guide Government and its public investment choices, the CPU helps to integrate public and private actions in the energy sector.

In the artisanal (i.e., fuelwood) energy sector, supply is controlled by individual wood cutters running unregulated charcoal kilns. Management is exercised by the Department of Forest and Lands, which polices forest reserves and other protected Crown Lands in an effort to eliminate illegal cutting of fuelwood. Forestry officers have no jurisdiction over private woodlands.

4.3.3 Problems and Issues

From an economic and political point of view, St. Lucia would benefit from a decrease in dependency on imported petroleum. Roughly seventeen percent of the country's foreign exchange goes to pay for fuel. There are, however, several factors which conspire to frustrate this goal:

- Total energy consumption is so low (less than 2.5 barrels of oil equivalent [BOE] per capita in

1984) that there is not much margin for cutting back;

- The transportation sector accounts for half of total energy consumed, and there is no realistic alternative to petroleum to fuel this sector;

- Electricity accounts for only about 10 percent of total energy; therefore, even if all electrical generation were shifted to indigenous geothermal sources, it would not have a major impact on the total petroleum import bill;

- Indigenous fuelwood counts for a large share of total energy (22 percent), but it cannot be substituted for imported petroleum products because consumers using commercial fuels are unlikely to switch. Moreover, because fuelwood-based cooking systems are much less efficient than LPG, kerosene or electricity, any expanded demand for this fuel source could contribute to increased pressure on forest resources.

For St. Lucia and the OECS states generally, a petroleum crisis is likely within five to eight years, and unless GOSL has made arrangements to guarantee supply (e.g., from HOSLL), interruptions, rationing, and shortages are fairly predictable. Shortages of LPG (Liquid Petroleum Gas) and kerosene will then probably result in significant increases in fuelwood harvesting, contributing to substantial degradation and pressure not only on the overall economy but on the country's fuelwood reserves as well.

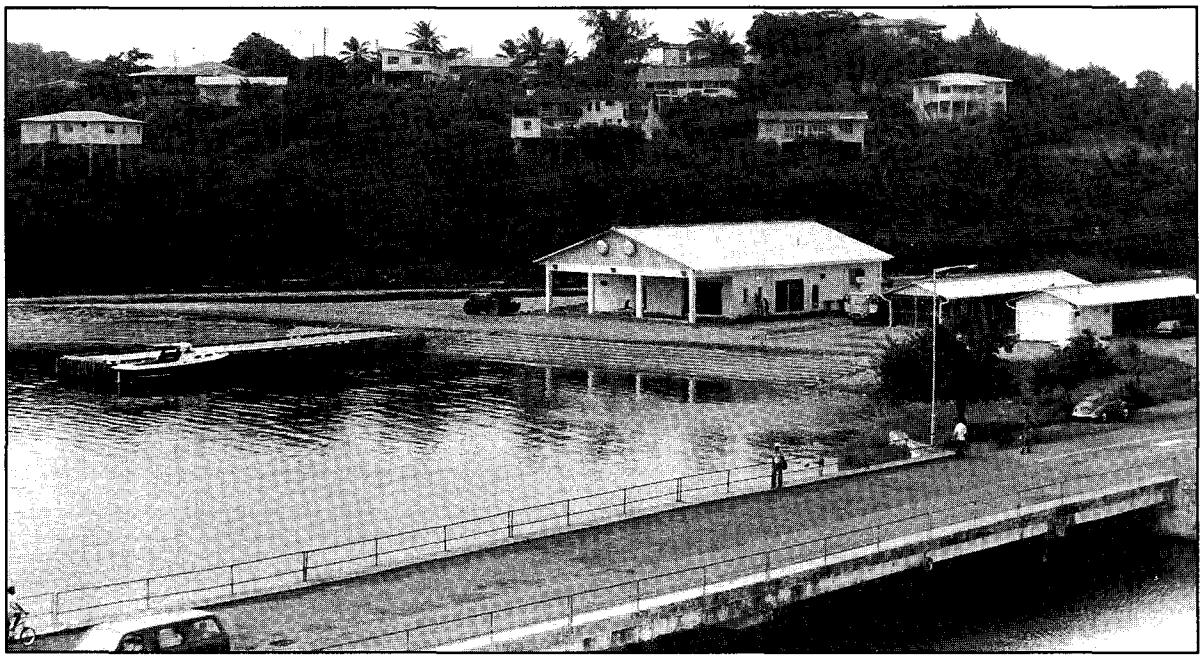
4.3.4 Directions for the Future and Policy Recommendations

As host country for one of the major petroleum transshipment centres in the Caribbean (the Hess Oil Terminal at Cul de Sac Bay), St. Lucia is in a uniquely favourable position to work with the owners of the Hess facility to assure the country ample supplies of necessary petroleum products in the event of shortages in the future. (St. Lucia's total petroleum needs are an extremely small fraction of the volume of shipments through the Terminal.) By eliminating the possibility of major supply reductions, GOSL can guarantee an adequate "window" of time in which to explore future options in the energy sector and provide for a more gradual transition to alternative energy sources. Implications of this action for the environment include:

- A more secure supply of petroleum fuels for domestic use (i.e., kerosene and LPG) will ease pressure on charcoal as an energy source for cooking and will enable policy makers to 1)continue study of the impact of fuelwood harvesting on forest resources, 2) increase efforts to improve the efficiency of charcoal production, and 3) promote appropriate plantation and extension forestry strategies for fuelwood renewal;

- A slower paced development of the country's geothermal potential will increase the possibility that hidden economic and environmental costs are revealed before the country has made a massive and irreversible commitment to this energy source;

- Fuelwood plantations of fast growing species have proven successful in other developing countries. St. Lucia's efforts in this regard are about a decade old. With a little retrospection on "lessons learned", it is now time for St. Lucia to scale up with several larger format social forestry fuelwood projects.



Fisheries complex, north of Castries, adjacent to Pointe Seraphine.

5. INSTITUTIONAL FRAMEWORK FOR ENVIRONMENTAL MANAGEMENT

5.1 GOVERNMENT STRUCTURE

St. Lucia is a parliamentary democracy and an independent member of the British Commonwealth of Nations, having gained its independence from Great Britain in 1979. The Head of State is the British sovereign who is represented in St. Lucia by the Governor-General, appointed on the advice of the Prime Minister.

Government is based on the Westminster Parliamentary model, with a popularly elected House of Assembly, whose 17 members are elected for five-year terms, and an 11 member Senate, whose members are appointed by the Governor-General on the advice of the Prime Minister and the Leader of the Opposition. Parliament exercises legislative authority, and the Cabinet, chaired by the Prime Minister, exercises executive authority. Departments of the central government are:

- Attorney-General's Office
- Ministry of Agriculture, Lands, Fisheries and Co-operatives (hereinafter referred to as Ministry of Agriculture)
- Ministry of Communications, Works and Transport (hereinafter referred to as Ministry of Communications and Works)
- Ministry of Education and Culture
- Ministry of Finance
- Ministry of Foreign Affairs
- Ministry of Health, Housing, Labour, Information, and Broadcasting (hereinafter referred to as Ministry of Health)
- Ministry of Home Affairs
- Ministry of Planning, Personnel, Establishment, and Training (hereinafter referred to as Ministry of Planning); formerly Ministry of Finance and Planning
- Ministry of Trade, Industry and Tourism
- Ministry of Youth, Community Development, Social Affairs and Sports.

[N.B. The reader should note that after the basic text of the CEP was completed in 1988, the environment was added to the portfolio of the Minister of Health. The chapter which follows does not reflect this new institutional arrangement.]

The country is divided into eight regions as part of a new decentralisation scheme which went into effect in 1987 (see also Figure 5.1):

Region 1	Gros Islet
Region 2	Babonneau
Region 3	Dennery
Region 4	Micoud
Region 5	Vieux Fort
Region 6	Soufriere
Region 7	Anse La Raye
Region 8	Castries.

Decentralisation represents an attempt by the Government to improve service delivery to the outlying areas. To facilitate local implementation of public programmes, regional councils were established in each of the eight regions, comprised of representatives of community organisations and members of town, village and rural councils. Additionally, technical co-ordinating committees, consisting of officials of national ministries working in each region, were created for the purpose of co-ordinating government programmes locally. A co-ordinator in each region is to assist the regional councils and technical co-ordinating committees to establish more unified service delivery systems and to improve development planning procedures by providing for local input. The regional co-ordinators are responsible to the Ministry of Home Affairs.

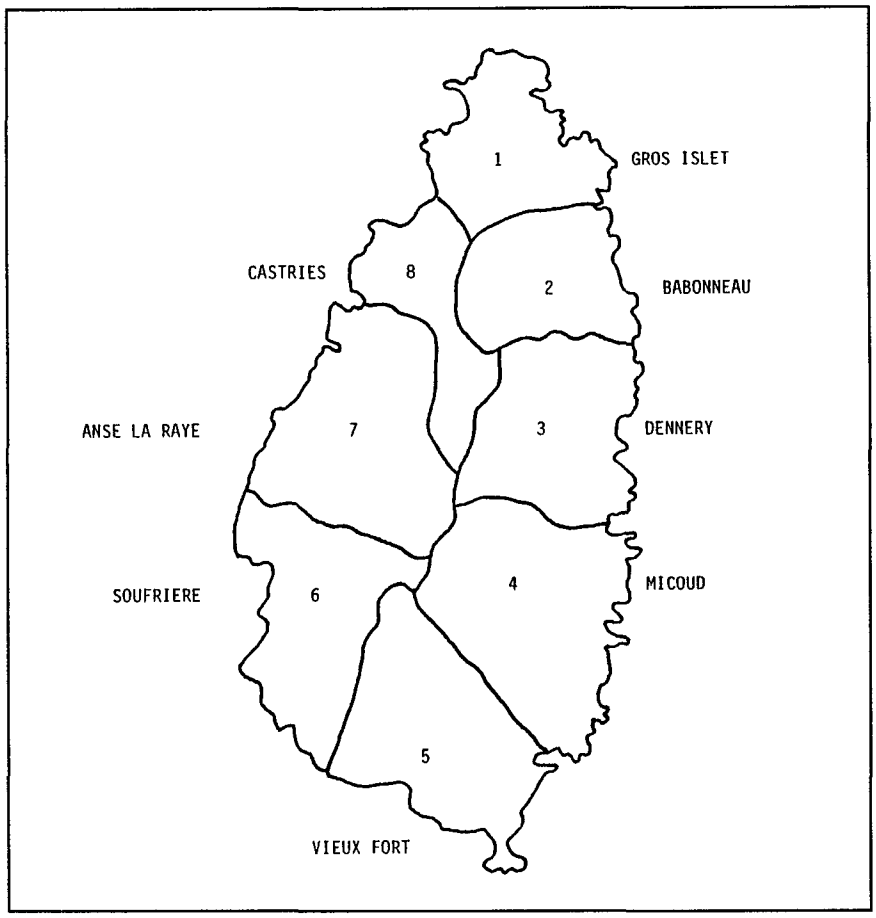


Figure 5.1. Eight decentralisation regions in St. Lucia.

5.2 HISTORICAL DEVELOPMENT OF ENVIRONMENTAL MANAGEMENT

Although the St. Lucia National Trust, in a broad interpretation of the word "environment," has documented environmental legislation in St. Lucia dating to the mid-nineteenth century, serious consideration of the institutional requirements for natural resource management, physical planning, and conservation objectives did not become a part of the administrative fabric of government until the mid-1940's, about a century later. Since 1946, a primarily sector-specific body of legislation related to environmental management has been put in place, including, according to a recent OECS survey of natural resources management legislation (Lausche, 1986), the following:

- Town and Country Planning Act, 1946
- Forest, Soil and Water Conservation Act, 1946 (revised 1957, 1983)
- Crown Lands Act, 1946
- Beach Protection Act, 1967
- Land Development (Interim Control) Act, 1971
- Pesticides Control Act, 1975
- St. Lucia National Trust Act, 1975
- Public Health Act, 1975
- Wildlife Protection Act, 1980
- Parks and Beaches Commission Act, 1983
- Litter Act, 1983
- Water and Sewerage Authority Act, 1984
- Fisheries Act, 1984.

(The reader is also referred to the sector analyses in Chapters 2, 3 and 4, for more in-

formation about legislative controls and institutional responsibilities.)

Furthermore, as pointed out by Lausche (1986), almost all ministries of Government now have some legal responsibility relating to or affecting management of the nation's natural and historic resources. Nevertheless, despite the range of legislation and extent of institutional responsibilities, environmental management at the national level in St. Lucia remains fragmented and unco-ordinated. There is no central or single agency of Government responsible for environmental affairs, including monitoring and enforcement, and no statutory mechanism available to integrate environmental considerations in the national planning process.

How the existing legislative and institutional framework for environmental management in St. Lucia has evolved during the last 40 years is reviewed in the sections which follow.

EARLY PLANNING AND REGULATORY INITIATIVES

In the mid-1940's, new legislation was enacted which signaled the first steps in development of modern environmental management policies for the country. Key initiatives at that time focused on the urban environment and the city of Castries, the main population area, including the Town and Country Planning Ordinance (1946) and the Slum Clearance and Housing Ordinance (1946).

The Town and Country Planning Ordinance introduced urban and land use planning to St. Lucia. Patterned after similar legislation in the region, the law established the basis for planning through the preparation of "regional schemes". The Castries Regional Scheme became the model for redevelopment of the town following a devastating fire which destroyed the capital in 1948. In it, perceptions about the "environment" were dominated by human settlement and public health concerns. The Town and Country Planning Ordinance also established procedures for the regulation of building construction and general development control through a permitting process and is today implemented by the Development Control Authority.

Legislation focusing on non-urban land use -- the Forest, Soil and Water Conservation Ordinance -- was also enacted in 1946, but only covered limited aspects of natural resource conservation. It provides for the management of forests on Crown (government) Lands, for the declaration of forest reserves and protected forests, for government oversight of the timber industry, and addresses some aspects of soil and water conservation (those related to forest management). Today the personnel of the Department of Forest and Lands (created by this statute in 1946 as the Forestry Division) are regarded as strong environmental advocates within Government.

PRE-INDEPENDENCE: NATIONAL PLANNING AND DEVELOPMENT CONTROL

With the achievement of statehood in 1967, St. Lucia was able to exercise more control over its internal governmental affairs. Such authority gave the public sector the opportunity to manage and develop the nation's resources more directly. Furthermore, with the growth of tourism, beginning in the 1960's and expanding in the decades to follow, concerns about environmental degradation affecting touristic assets -- coastal environs, historic sites, natural areas -- gradually gained more attention within the central government.

The Beach Protection Ordinance of 1967 provided some legislative protection for this important natural resource. The act, however, is narrow in scope and contains no provisions for the integrated management or protection of the larger coastal ecosystem upon which much of the country's tourism and recreational needs depend.

Economic growth in the late sixties and into the seventies centred increasingly on tourism development and construction which, in turn, sparked the growth of the Castries northwest corridor through infrastructure expansion and suburbanization. Increasing demands for improved management of urban areas and for long-term planning created a need for new in-

stitutions and legislation during the growth period, 1969-1975.

In 1971, the Central Housing and Planning Authority (first established under the Town and Country Planning Act of 1946) was dissolved with enactment of the Housing and Urban Development Corporation Act and the Land Development (Interim Control) Act, which established the Development Control Authority (DCA). The National Development Corporation (NDC) was also established in 1971 for the promotion of economic growth. The Public Health Act of 1975 provided general regulations for sewage disposal and prevention of unsanitary health conditions.

Of the legislation enacted during this time, the most important for environmental planning purposes was the Land Development Act. Its purpose was to extend planning control to the entire island without the requirement of a physical plan. It was enacted in 1971 as an interim measure while full planning legislation was considered by the House of Assembly. However, despite the fact that a "Land Planning and Development Act" has been in draft for several years, no new planning legislation has been passed.

The 1971 law specifies that a planning permit must be issued for land development activities falling under the DCA's authority. Amendments expanded the options available to the Authority to deal with non-approved "illegal" development, while any applicant not satisfied with a DCA decision may appeal to the Minister of Planning. Permitting procedures allow multi-sectoral inputs into the decision making process on large projects, but there is no explicit requirement that "environmental issues" be taken into account.

By the late 1970's, administrative problems associated with the dispersal of "planning and development" functions throughout the Government, coupled with external donor pressure for improved project design and management, provided Government with an incentive to create a new centralised planning agency. The Central Planning Unit (CPU), the revamped core of the former (until 1987) Ministry of Finance and Planning, was formed in 1977 by (1) annexing the Architectural Section of the Ministry of Works, by (2) redefining the role of the old Town and Country [Physical] Planning Department as a new Environmental Planning section, and by (3) establishing closer co-ordination links between physical and economic planning within the Ministry. The 1977 reorganisation represents an attempt by GOSL to centralise the planning and project design and oversight functions of Government within a single agency. It was a formidable agenda -- perhaps too extensive for effective implementation.

Environmental management considerations in the national planning process are largely determined by the level of awareness and sensitivity of technical personnel located within the Central Planning Unit. Concern about resource management planning issues was strengthened by the presence of a UNDP-sponsored Physical Planning Programme in St. Lucia during the years 1973-1977. During that time a St. Lucia National Plan was prepared by the Central Planning Unit (1977), but the Plan was never formally accepted by Government. Nevertheless, the Physical Development Strategy and Technical Supplement to the National Plan remain the most comprehensive attempt at national physical planning in St. Lucia.

A more recent (1985) attempt at defining sectoral issues in a five year plan never was completed but generated some very useful issue-focused documentation. Some of these papers have informed the CEP discussion contained in this document, and the original undertaking should be revived.

The St. Lucia National Trust Act, another important addition to the legal framework for resource conservation during the pre-independence period, was enacted in 1975. However, the absence of a comprehensive national planning agenda or a National Physical Development Plan limited the immediate potential of the Trust Act to serve the long-term conservation needs of the country. From time to time, the Government has designated the Trust as the authority to manage and control specified areas such as national parks and nature reserves.

POST-INDEPENDENCE: ATTEMPTS TO CO-ORDINATE PLANNING FUNCTIONS

The problems of inter-agency co-ordination and the need for coherent government action in confronting development issues resulted in the formation of a Project Appraisal Committee in 1979, located within the Ministry of Trade, Industry and Tourism and headed by the Chairman of the National Development Corporation's Board. This committee attempted to formalise and strengthen horizontal inter-agency collaboration and to broaden the number and scope of issues reviewed by government agencies prior to Cabinet consideration of major development projects. Central to the purpose of the committee was the need to eliminate duplication of responsibility and effort and to ensure that adequate attention was given to all sectors affected by development projects, including environmental considerations. The Project Appraisal Committee was short-lived, however, a victim perhaps of its perceived usurping of Cabinet prerogatives.

A not dissimilar attempt at horizontal co-ordination, this time in the specific area of resource management, was the formation of the Environmental Commission in 1981. The Commission was comprised of representatives from GOSL agencies and private groups directly involved in environmental management. Its mandate was to facilitate inter-departmental co-operation, to infuse the process of project development and project evaluation within Government with sound environmental impact assessment procedures, to ensure that adequate environmental data are available to development agencies, to assist in the identification of priorities for conservation action, and to promote conservation education in the country. Although the Commission was sanctioned by a Cabinet Conclusion in 1981, its formation was not gazetted, nor was it given specific terms of reference to guide its operations. As such, its recommendations or actions are not binding, it has met only infrequently, and it lacks both a secretariat and enforcement procedures.

Both the Project Appraisal Committee and the Environmental Commission appear to have been undertaken as an alternative to increasing the capability of the DCA. However, one unresolved problem has been that it was never clarified how either would operate along side the DCA.

In the early 1980s, with assistance from the OAS, the Central Planning Unit underwent yet another reorganisation and also produced a series of issue papers on 13 major physical development topics. The "issue papers" were, for a short period of time, vetted in the press and at a series of formal public meetings. A new (draft) physical development strategy for the years 1986-1991 was prepared, but this document also has not been officially endorsed by Government. At the present time, another planning effort is underway by the CPU to produce a national planning agenda and another National Physical Development Plan.

The management of lands is an area which has received much attention in recent years (see also Section 1.2). Primary responsibility for the management of Crown Lands rests with the Commissioner of Crown Lands, who is the Permanent Secretary in the Ministry of Agriculture and whose functions are delegated to the Chief Forest and Lands Officer. Following the completion (1987) of a cadastral survey -- USAID's Land Registration and Titling Project (LRTP) -- a Land Registry has been established under the Ministry of Planning. Specific responsibilities for public land management are also vested to the National Development Corporation (see Section 5.3).

To summarise, in the post-independence years, Government emphasis on sustaining the economic growth of the early seventies period, as centred primarily in the Castries area, gave way to new concern for infrastructure improvement for the nascent industrial/manufacturing sectors and planning for village-level expansion and rural development. At the same time, expectations about the benefits of long-range planning and recognition of the complexities of cross-sectoral co-ordination influenced the re-organisation of the Ministry of Finance and Planning and later contributed to the emergence of its Central Planning Unit as the primary project planning and co-ordination unit within Government.

RESOURCE PROTECTION AND RESEARCH STRATEGIES FOR THE 1980's

In recent years, GOSL has undertaken several actions which directly promote the conservation and management of parks and other protected areas and which address specific conservation and resource management issues in the country. In 1983 a Parks and Beaches Commission was formed. This statutory body is responsible to the Ministry of Trade, Industry and Tourism and, as such, its functions are presently focused on the maintenance of park and beach facilities for recreation and tourism and the licencing of businesses in these areas.

As part of an overall fisheries management and development programme, a Fisheries Act was passed in 1984. Nineteen marine reserves and five fishing priority areas were declared in 1986 under the provisions of this legislation. Fisheries Regulations (incorporating the protection of selected marine species) were gazetted in December of 1987, providing, among other things, for a ban on the white sea urchin (sea egg) and for a closed season and size limits on conchs, turtles and lobsters.

The Wildlife Protection Act of 1980 up-dated and expanded upon the century-old Wild Bird Protection Ordinance and provided new authority for Government to protect endangered or threatened wildlife species. Under provisions of the legislation, a Parrot Sanctuary has been established, and through a combination of research, education and protection programmes, the country has turned around the near extinct status of the endemic St. Lucia Parrot.

The Pigeon Island National Park was established in 1982 and is managed by the St. Lucia National Trust. The Trust also manages the Maria Islands Nature Reserve which was declared under the provisions of the Wildlife Protection Act (1980).

At the end of 1987, the Ministry of Health launched a tough new anti-litter drive, announcing that litter had become a serious social and health problem. The programme was first implemented in the City of Castries, with strict enforcement of the Litter Law by litter wardens and authorized officers. A prototype solid waste management programme was also initiated in early 1988 in the town of Vieux Fort as part of a nation-wide educational effort directed at businesses, schools and the general public. Both of these initiatives will require sustained leadership and support, creative implementation, and increased funding if they are to work and be institutionalised as policy and practice in all relevant ministries and statutory bodies, especially the Ministries of Communications and Works, Agriculture, and Trade, Industry and Tourism, as well as the St. Lucia Banana Growers Association and the National Development Corporation.

REGIONAL AND INTERNATIONAL PROGRAMMES

St. Lucia is a key actor in and beneficiary of regional programmes in the field of resource management and development (see also Section 5.5 below). Particularly important to the strengthening of environmental management capabilities in the country has been the siting in St. Lucia of two regional programmes: the Caribbean Environmental Health Institute and OECS's Natural Resources Management Project.

The Government of St. Lucia is a member of the Caribbean Conservation Association and is a party to the UNEP-sponsored Cartagena Convention (Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region). At the international level, St. Lucia is a party to CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), the Law of the Sea Treaty, and the London Dumping Convention (Convention on the Prevention of Marine Pollution by Dumping of Wastes). It is also a member of the International Whaling Commission.

5.3 ENVIRONMENTAL MANAGEMENT MACHINERY OF GOSL

Environmental management in St. Lucia is currently dependent on the co-ordinated ac-

tion of many agencies with varying responsibilities for key resource sectors and for resource management, resource protection, or resource development activities. These are summarised by function in Tables 5.1 - 5.6 and are also reviewed below. Specific agency activities are described, as appropriate, in the sector analyses found in Chapters 2, 3, and 4.

PLANNING AND DEVELOPMENT CONTROL AGENCIES (Table 5.1)

The central planning agency in St. Lucia, responsible for co-ordinating project development and project review functions within Government, is the **Central Planning Unit** (CPU) located within the Ministry of Planning, Personnel, Establishment and Training. Given its central planning and co-ordinating role, the CPU exercises considerable influence over the Government bureaucracy in St. Lucia. The **Physical Planning Unit** (PPU), within the CPU, is responsible for the formulation of land use development plans and policies, and, as the executing agency for the Development Control Authority, it establishes architectural design and construction standards and administers building regulations. This section is also charged with responsibility for co-ordinating multi-sector inputs into the project approval process, including preparation of Environmental Impact Assessments (EIAs). At present, the EIA process has not been mandated or standardised by legislative authority or by administrative procedure.

It should be noted that while the strategic planning capabilities of the CPU are generally highly regarded, at least one donor agency (World Bank, 1985 and 1986) has also called attention to the need for GOSL to strengthen the planning capabilities of implementing ministries and institutions throughout Government.

The **Development Control Authority** (DCA), created in 1971, is responsible for approval of development plans and projects. As established under the Land Development (Interim Control) Act, the Authority is a seven person board which includes the Technical Officer in charge of Housing, Public Works, and Health Services, with the Chief Technical Officer in charge of Town and Country Planning acting as Executive Secretary. The authority of DCA is constrained by:

- a provision in the enabling legislation which excludes agricultural development (thus focusing the Authority's attention on mostly urbanised development);
- the authority of Cabinet to override its decisions;
- the fact that the enabling legislation did not provide a framework for growth and development by requiring a national physical development plan; and
- lack of regulations with enforcement procedures to support the legislative authority.

Under these circumstances, the DCA has primarily confined its terms of reference to those matters conventionally falling under town planning and building control. Furthermore, its overall effectiveness has been affected by lack of legislative provision for public input and participation in the planning process, thus reducing the information available to the DCA from the non-government sector and diminishing potential public support for its decisions.

RESOURCE MANAGEMENT AGENCIES (Table 5.2)

Resource management activities in the country are primarily carried out by sector, with few attempts to date at integrating resource management programmes or expertise across sectors, except as noted in Table 5.5. For example, the **Department of Forest and Lands** and the **Fisheries Management Unit** (FMU) of the Ministry of Agriculture are responsible for management of forest and fishery resources, respectively. The **Works Division** of the Ministry of Communications, Works and Transport is responsible for management of the nation's "seashores" through a permitting system which prevents sand removal without permission of the Chief

Table. 5.1. GOSL agencies with **PLANNING AND DEVELOPMENT CONTROL** functions.

AGENCY	ENABLING LEGISLATION	KEY RESPONSIBILITIES
Central Government Agencies		
(1) Ministry of Planning, Personnel, Establishment and Training		
- CENTRAL PLANNING UNIT (CPU)	Town and Country Planning Ordinance, 1946 Land Development (Interim Control) Act, 1971	Central agency for land use and project planning and development
(i) PHYSICAL PLANNING UNIT (PPU)		Preparation of national, regional, urban development policies and plans; administration of planning and building regulations (as executive arm of DCA); technical input on environmental standards for development projects
(ii) ECONOMIC PLANNING UNIT (EPU)		Preparation of economic development plans and policies for the country
(iii) ENERGY, SCIENCE AND TECHNOLOGY UNIT		Monitoring of energy consumption; formulation of energy policies; management of energy sector projects; technical input for science and technology policy development
(iv) LAND SURVEY, REGISTRY AND MAPPING UNIT		Central depository of maps and land surveys; execution of land surveys for land subdivision and development
(v) ARCHITECTURAL SECTION		
(vi) SOCIAL PLANNING SECTION		
(2) Ministry of Agriculture, Lands, Fisheries and Co-Operatives - ENGINEERING SERVICES DIVISION		
(i) WATER RESOURCES AND IRRIGATION UNIT (formerly Land and Water Use Unit)		Centralisation of hydrological/hydrometeorological information
Statutory Bodies		
(1) DEVELOPMENT CONTROL AUTHORITY (DCA) (responsible to Ministry of Planning)	Land Development (Interim Control) Act, 1971 (created DCA)	Approval of development activities
(2) HOUSING AND URBAN DEVELOPMENT CORPORATION (responsible to Cabinet)	Housing and Urban Development Corporation Act, 1971	Planning and development of housing projects
(3) AIR AND SEA PORT AUTHORITY (responsible to Ministry of Communications, Works and Transport)	Air and Sea Port Act of 1981	Development and management of St. Lucia's air and sea port facilities

Table 5.2. GOSL agencies with **RESOURCE MANAGEMENT** functions.

AGENCY	ENABLING LEGISLATION	KEY RESPONSIBILITIES
Central Government Agencies		
(1) Ministry of Agriculture, Lands, Fisheries and Co-Operatives		
(i) DEPARTMENT OF LANDS	Crown Lands Ordinance, 1946	PS is Commissioner of Crown Lands; Crown Land Policy of 1988 establishes Crown Land Committee to review and make recommendations on the allocation/use of Crown Land, with the Commissioner of Crown Lands as Chairman
(ii) DEPARTMENT OF FOREST AND LANDS	Forest, Soil and Water Conservation Ordinance, 1946 (principal legislation for regulation of forest production and conservation)	Management of state forests; oversight of timber industry
(iii) FISHERIES MANAGEMENT UNIT (FMU)	Fisheries Act, 1984	Fisheries management programmes including stock assessments and monitoring of the resource base; extension services to fishermen
(iv) EXTENSION DIVISION		Advice to farmers on land use and sound agricultural practices
(2) Ministry of Communications, Works and Transport		
(i) WORKS DIVISION	Beach Protection Act, 1967	Control of sand mining
Statutory Bodies		
(1) WATER AND SEWERAGE AUTHORITY (WASA) (responsible to Ministry of Health and Housing)	Water and Sewerage Authority Act, 1984 (transfers the functions of old Central Water Authority)	Management of water supply for domestic and industrial uses; development and control of sewerage systems
(2) NATIONAL TRUST	National Trust Act, 1975	Management of parks and other protected areas and sites entrusted to its control by GOSL
(3) PARKS AND BEACHES COMMISSION (responsible to Ministry of Trade, Industry and Tourism)	Parks and Beaches Commission Act, 1983	Management of parks and beaches
Local Governments		
(1) CITY AND VILLAGE COUNCILS		Operation of local solid waste management systems

Engineer. The **Water and Sewerage Authority** (WASA) is responsible for development and management of the water supply.

Additional resource management functions are assigned to the **Ministry of Agriculture's Lands Department** for the control and registry of Crown Lands, with the Permanent Secretary serving as the Commissioner of Crown Lands. The **Crown Land Committee** was created under a new Crown Land Policy recently approved by Cabinet (1988). That policy, which provides for the more orderly development, distribution, and management of Crown Lands, establishes procedures for identifying, acquiring, surveying, mapping, gazetting and registering Crown Land, including the assignment of appropriate land use categories or zoning classifications (e.g., agricultural, residential or industrial lands, lands needed for Government services or lands requiring protection). Decisions regarding land use designations will be made by the inter-agency Crown Land Committee, with the Department of Lands serving as the Committee's secretariat.

Resource management responsibilities are not always clear-cut, and several agencies may have overlapping responsibilities. For example, both WASA and the Department of Forest and Lands have responsibilities for water conservation and protection of watersheds. The Ministry of Communications and Works has responsibility for issuing sand mining permits, but village councils are traditionally responsible for control of the beaches within their territorial boundaries, while the Parks and Beaches Commission is charged with beach management and maintenance functions. WASA is charged with management of water intakes, while management of water catchment areas within the forest reserves is the responsibility of the Department of Forest and Lands. Solid waste management is the responsibility of local authorities, but general oversight, to prevent unsanitary health conditions, is the task of the Ministry of Health.

Public land management is also an area of overlapping authority, with the Department of Forest and Lands maintaining overall control of Crown Land and forest reserves, including the lease and sale of Crown Lands, under the Crown Lands Ordinance of 1946 and the Forest, Soil and Water Conservation Ordinance (1946, revised 1957 and 1983). Additionally, the National Development Corporation is responsible for the management of industrial estates and other public lands to which it holds title. And lastly, certain public lands (most notably Pigeon Island and Maria Islands) have been vested to the St. Lucia National Trust for management and development.

St. Lucia's decidedly sector-specific approach to resource management has prevented serious attempts at integrated resource management or protection strategies, a deficiency particularly detrimental to management of the country's coastal resources.

On the more positive side, the technical expertise of personnel located within several of the Government's resource management units is highly regarded both in the country and in the Eastern Caribbean. For example, Forestry and FMU staff members have over time developed relatively strong natural resource management capabilities, including data collection and environmental monitoring. But the lack of strong cross-sectoral co-ordination between resource management agencies in Government weakens the ability of any single unit to share information or for country-level assessments of cumulative environmental impacts. This is why the role of the DCA and CPU are so important and why Environmental Impact Assessments are so valuable as a planning tool, encouraging all parties -- government and private sector -- to take a longer view and broader look at the environmental implications, impacts, and foreclosures of any given development plan or project.

REGULATORY AGENCIES (Table 5.3)

The Ministry of Health, Housing and Labour, through its **Environmental Health Branch**, is the agency responsible for monitoring and enforcing the health and sanitation provisions of the Public Health Act (1975) and the Public Health (Water Quality Control) Regulations (1978). It performs these functions directly through its central and regional offices and

Table 5.3. GOSL agencies with **REGULATORY** functions.

AGENCY	ENABLING LEGISLATION	KEY RESPONSIBILITIES
Central Government Agencies		
(1) Ministry of Health, Housing and Labour	Public Health Act, 1975 Litter Act, 1983 Employers Occupational Health and Safety Act, 1985	Regulatory oversight for sewage, industrial and solid waste disposal; monitoring of water quality; enforcement of the Litter Act; providing inspections under the Occupational Health and Safety Act; inspections of food handling premises
(2) Ministry of Agriculture, Lands, Fisheries and Co-Operatives		
(i) DEPARTMENT OF FOREST AND LANDS (formerly Forestry Division)	Forest, Soil and Water Conservation Ordinance, 1946	Enforcement of the Act's provisions prohibiting squatting, illegal cutting, clearing, cultivation, grazing, setting of fires in forest areas under the Department's control; issue permits for purchase of saws for timber extraction
	Wildlife Protection Act, 1980	Enforcement of hunting regulations; imposition of fines for violations
(ii) FISHERIES MANAGEMENT UNIT (FMU)	Fisheries Act, 1984	Enforcement of 1987 Regulations which protect sea turtles, spiny lobsters, conch, sea eggs
(iii) CHIEF AGRICULTURAL OFFICER	Agricultural Small Tenancies Act, 1983	Enforcement of regulations (not yet available) requiring sound soil and water conservation practices on small land holdings used for agriculture
Statutory Bodies		
(1) WATER AND SEWERAGE AUTHORITY (WASA) (responsible to Ministry of Health)	Water and Sewerage Authority Act, 1984	Establishment of the regulatory structure (not yet in place) to implement legislation, i.e., protection of surface water supply intakes, set water quality standards
(2) PESTICIDES CONTROL BOARD	Pesticides Control Act, 1975	Enforcement of 1987 Regulations related to pesticide control, including licencing, packaging, import, use, labelling, and storage

also through technical input provided at the local government level. Environmental Health is responsible for monitoring water quality (potable) and sewage and industrial waste disposal. At present, MOH personnel carry out these functions through a co-operative working relationship with CEHI. Solid waste collection is the responsibility of local

authorities; oversight is provided by the Ministry of Health which also manages the solid waste disposal sites. The **Ministry of Health** is also responsible for enforcement of the Litter Act (1983), as amended (1985).

The **Water and Sewerage Authority** (WASA) has power to make regulations governing effluent discharge from public sewers and to set water quality standards, but at present no regulations have been enacted. The only operational municipal sewerage system is in Castries which has been managed since the 1950s by the **Castries City Council** but which is now being transferred to WASA. At present, WASA does not have testing facilities to effectively monitor effluent from either public or private sewerage systems.

Other regulatory agencies in St. Lucia concerned with enforcement of natural resource legislation include the **Department of Forest and Lands** (enforcement of the Forest, Soil and Water Conservation Ordinance, 1946, as amended in 1983, and the Wildlife Protection Act, 1980), **Fisheries Management Unit** (enforcement of regulations to the Fisheries Act), and the **Pesticides Control Board** (enforcement of the Pesticides Control Act, 1975). Regulations for the Fisheries Act and the Pesticides Control Act were recently approved, in December of 1987.

The lack of regulations governing the enforcement of a number of key natural resource management laws and the non-clarification of overlapping responsibilities for others (i.e., water quality and waste disposal) have limited the effectiveness of legislation intended to improve resource management and protection programmes in the country.

RESOURCE CONSERVATION AND PROTECTION AGENCIES (Table 5.4)

The National Trust Act of 1975 created the **St. Lucia National Trust** with authority to protect and manage sites of historical and cultural interest or areas of biological importance. The Trust Act legislation gives this statutory body the authority to act in an advisory or an executive capacity, to raise funds, to acquire property and to make necessary bylaws to control the conservation and use of the property it holds.

Under these provisions, the Trust currently exercises control over several properties, the most significant of which are the Pigeon Island National Park and the Maria Islands Nature Reserve. The Trust also executes programmes of research, conservation, education, and publication which have attracted national support and international funding.

Additional responsibility for parks, reserves, and other protected areas in St. Lucia is shared by: the **Department of Forest and Lands** (forest reserves and wildlife sanctuaries), the **FMU** (marine reserves), the **St. Lucia Tourist Board** (tourism attractions), and the **Parks and Beaches Commission** (parks and beaches). Resource protection programmes are also the responsibility of the **Soil Conservation and Drainage Unit** in the Ministry of Agriculture (for soil conservation) and **WASA** (water conservation and protection of watersheds).

While the creation of forest reserves was authorised by legislation as early as the 1940's, the establishment of national parks, nature reserves, wildlife sanctuaries, and marine reserves is a conservation approach only utilised in the 1980's. GOSL agencies are presently building their institutional capacities for managing protected areas. One of the main problems affecting the establishment and management of parks and protected areas in the country is the absence of a formal mechanism for co-ordinating the programmes and activities of the several agencies which share these responsibilities, e.g., the National Trust, the FMU, the Department of Forest and Lands, and the Parks and Beaches Commission. (See also Section 2.6.)

INTER-SECTORAL CO-ORDINATION (Table 5.5)

During this decade the **Central Planning Unit** of the Ministry of Planning has emerged as the primary project planning and co-ordination unit within Government, with policy formulation, programme development and project monitoring/evaluation responsibilities

Table 5.4. GOSL agencies with **RESOURCE CONSERVATION AND PROTECTION** functions.

AGENCY	ENABLING LEGISLATION	KEY RESPONSIBILITIES
Central Government Agencies		
(1) Ministry of Agriculture, Lands, Fisheries and Co-Operatives		
(i) DEPARTMENT OF FOREST AND LANDS	Forest, Soil and Water Conservation Ordinance, 1946	Establishment of forest reserves and protected forests; soil and water conservation programmes to protect forested areas
	Wildlife Protection Act, 1980	Conservation of wildlife and recommendations for designation of wildlife reserves; environmental education
	Water and Sewerage Authority Act, 1984	Assistance to WASA in protection of watersheds threatened by deforestation
(ii) FISHERIES MANAGEMENT UNIT (FMU)	Fisheries Act, 1984	Recommendations for designation of marine reserves; management of marine protected areas
(iii) ENGINEERING SERVICES DIVISION/SOIL CONSERVATION AND DRAINAGE UNIT		Promotion of soil conservation
(2) Ministry of Communications, Works and Transport		
(i) WORKS DIVISION	Beach Protection Act, 1967	Protection of beaches through permitting system for beach sand mining
Statutory Bodies		
(1) NATIONAL TRUST	National Trust Act, 1975	Preservation of buildings and objects of historic and architectural value and areas of natural or scenic importance
(2) ENVIRONMENTAL COMMISSION	Cabinet Conclusion, 1981 (not gazetted)	Environmental education
(3) WATER AND SEWERAGE AUTHORITY (WASA) (responsible to Ministry of Health and Housing)	Water and Sewerage Authority Act, 1984	Water conservation and protection of watersheds
(4) PARKS AND BEACHES COMMISSION (responsible to Ministry of Trade, Industry and Tourism)	Parks and Beaches Commission Act, 1983	Beach management; advisory body on matters related to coastal erosion

Table 5.5. GOSL agencies with **RESOURCE CO-ORDINATION** functions.

AGENCY	ENABLING LEGISLATION	KEY RESPONSIBILITIES
Central Government Agencies		
(1) Ministry of Planning, Personnel, Establishment and Training		
- CENTRAL PLANNING UNIT (CPU)	Land Development (Interim Control) Act, 1971	Policy formulation across sector lines; project design, review and co-ordination on behalf of line ministries
(2) Ministry of Agriculture, Lands, Fisheries and Co-Operatives		
- CROWN LAND COMMITTEE (chaired by Commissioner of Crown Lands)	Crown Land Policy, 1988	Multi-agency body charged with review and counsel regarding the allocation and use of Crown Lands
(3) NATIONAL EMERGENCY ORGANISATION (Office of the Prime Minister)		Ensure state of preparedness for national disaster; co-ordinate activities of GOSL agencies and NGOs in event of disaster
Statutory Bodies		
(1) ENVIRONMENTAL COMMISSION	Cabinet Conclusion, 1981 (not gazetted)	Facilitate inter-departmental co-operation regarding environmental impact review procedures for development projects, assist in identification of priorities for for conservation action, promote environmental education

which cut across line ministries. Its key centralising role in Government gives the CPU considerable leverage to influence co-ordination of environmental policy and resource enhancement programmes which cannot easily be assigned to a single sector agency.

The formation of the **Environmental Commission** in the early 1980's represents one effort by GOSL to co-ordinate resource management interests in a single, broadly-based, multi-agency body, which includes representation from both key GOSL agencies and from non-government organisations with environmental expertise and interests. This statutory body was approved by a Cabinet Conclusion in 1981 that unfortunately has never been officially gazetted. The Commission has continued to meet informally and has drafted a policy document which proposes draft terms of reference. It has also periodically brought to public attention development activities which have potentially negative environmental impacts. The Commission has, to say the least, been controversial, but perhaps usefully so as a transition vehicle. Only time will tell.

The most recent attempt at inter-sectoral co-ordination is the formation (1988) of a **Crown Land Committee** under the authority of the new Cabinet-approved Crown Land Policy. The Committee, with responsibilities to review and make recommendations to the Min-

ister of Agriculture on the allocation and utilisation of Crown Lands, is comprised of representatives from several ministries and departments of Government with responsibilities which impact on the management of public lands.

The **National Emergency Organisation**, under the general direction and control of the Prime Minister, is responsible for co-ordinating activities of government and non-government agencies in the event of a national disaster. Its ten standing sub-committees are comprised of representatives of Government departments which reasonably need to be involved in planning for GOSL action in the event of natural or man-made emergencies and disasters.

RESOURCE DEVELOPMENT AGENCIES
(Table 5.6)

In addition to the resource development responsibilities of the Ministry of Agriculture, Lands, Fisheries and Co-operatives (fisheries, agriculture, forests), the industrial development responsibilities of the Ministry of Trade, Industry and Tourism, and the infrastructure development tasks of the Ministry of Communications, Works and Transport, several St. Lucian statutory bodies are charged with specific resource development mandates. Collectively, these parastatals have been recognised by at least one development agency (USAID, 1985) as among the most developed in the Commonwealth Caribbean in terms of organisation, defined objectives and strategy, personnel and corresponding performance.

- **National Development Corporation**: charged with the promotion of investment and industrial development in St. Lucia.

The original capital of the Corporation consisted of the land comprising the former U.S. Army/Air Base at Vieux Fort, most of which the Corporation still owns and manages. NDC's current industrial development programme has grown to include five industrial estates located throughout the island; factory "shells" have been constructed at such complexes and are leased to investors. Additionally, NDC holds all of GOSL's shares in Pointe Seraphine (a duty free, totally self-contained tourist shopping complex with berthing facilities for cruise ships in Castries Harbour), the St. Lucia Fish Marketing Corporation, the St. Lucia Livestock Company, and the Dennery Farmco Estate. NDC owns one-third of the former Geest Estate at Roseau (St. Lucia Model Farms, Ltd.) and minority shares of the Boxing Plant and the Rodney Bay Development Corporation.

- **Housing and Urban Development Corporation**: charged with the implementation of urban housing projects which are now undertaken through joint-venture projects with private housing developers.

- **Air and Sea Port Authority**: responsible for development and management of the nation's air and sea ports, including St. Lucia's two airports (Hewanorra International Airport in the south and Vigie Airport near the capital) and the island's two seaports (Port Castries and Vieux Fort Port). Recent re-organisation moved airport management, previously housed within the Ministry of Communications and Works, to the Authority's jurisdiction. It is now responsible for construction and management of buildings and structures located on the property it administers and for the provision of navigational aids.

- **Tourist Board** (formerly Tourist Industry Development Board): promotion and development of the tourism industry in conjunction with St. Lucia hotels. The Board also has powers to develop and manage tourism amenities, including natural sites, and can derive income from such ventures.

- **Timber Industry Development Board**: responsible for development, preservation, and maintenance of the timber industry. It operates a government-owned sawmill and lumber yard, with supervision provided by personnel from the Department of Forest and Lands.

- **Parks and Beaches Commission**: responsible for the development and maintenance of facilities in public parks, gardens and beaches and licencing of businesses operating on beaches or in public parks. The

Table 5.6. GOSL agencies with **RESOURCE DEVELOPMENT** functions.

AGENCY	ENABLING LEGISLATION	KEY RESPONSIBILITIES
Central Government Agencies		
(1) Ministry of Communications, Works and Transport		
(i) WORKS DIVISION		Planning, development, and maintenance of major infrastructure, including roads and and coastal construction
(2) Ministry of Agriculture, Lands, Fisheries and Co-Operatives		
(i) ENGINEERING SERVICES DIVISION/WATER RESOURCES AND IRRIGATION UNIT (formerly Land and Water Use Unit)		Planning and development of irrigation projects
Statutory Bodies		
(1) NATIONAL DEVELOPMENT CORPORATION (NDC) (responsible to Ministry of Planning)	National Development Corporation Act, 1971	Promotion of economic growth/industrial development; specifically charged with infrastructure development in Vieux Fort
(2) TOURIST BOARD (responsible to Ministry of Trade, Industry and Tourism)	Formerly Tourist Industry Development Board, established under 1981 Act of the same name	Promotion and development of tourist industry, including amenities development
(3) PARKS and BEACHES COMMISSION (responsible to Ministry of Trade, Industry and Tourism)	Parks and Beaches Commission Act, 1983	Development and maintenance of parks and beaches facilities and licencing of businesses for the same
(4) TIMBER INDUSTRY DEVELOPMENT BOARD (responsible to Ministry of Agriculture and Lands)	Timber Industry Development Ordinance, 1963	Development of timber industry; promotion of timber production
(5) AIR AND SEA PORT AUTHORITY (responsible to Ministry of Communications, Works and Transport)	Air and Sea Port Act of 1981	Development and management of St. Lucia's air and sea port facilities
(6) HOUSING AND URBAN DEVELOPMENT CORPORATION (responsible to Cabinet)	Housing and Urban Development Corporation Act, 1971	Planning and development of housing projects

Table 5.6 (continued). GOSL agencies with **RESOURCE DEVELOPMENT** functions.

AGENCY	ENABLING LEGISLATION	KEY RESPONSIBILITIES
(7) ST. LUCIA MARKETING BOARD (responsible to Ministry of Agriculture and Lands)		Marketing of agricultural commodities
(8) COMMODITY ASSOCIATIONS		Marketing of agricultural commodities; land use advice; credit
(i) St. Lucia Banana Growers Association	Banana Growers Association Ordinance	
(ii) St. Lucia Coconut Growers Association	Coconut Growers Association Ordinance	
(9) ST. LUCIA FISH MARKETING CORPORATION		Marketing of fish; development and operation of Castries Fisheries Complex

Commission also has authority to advise the Minister on matters related to coral removal and protection of coastal areas from erosion.

- **St. Lucia Marketing Board:** provides assistance to farmers for marketing and exporting crops and also controls imports of selected products. It attempts to deal in agricultural commodities other than bananas or coconuts.

- **St. Lucia Banana Growers Association** and **St. Lucia Coconut Growers Association:** parastatal growers associations formed to centralise the production and marketing of bananas and coconuts. The Banana Growers Association organises the harvesting, packing, and transporting of fruit to dockside for export to the United Kingdom; it imports the fertilisers and pesticides needed by banana growers. The Coconut Growers Association serves as intermediary in making financial and other arrangements for the purchase of members' copra for processing into oil, imports supplies needed for coconut production, and advises members on proven agricultural practices.

- **St. Lucia Fish Marketing Corporation:** a totally Government-owned corporation (with NDC as the sole shareholder) organised to market fish; it also controls imports of selected products. The Corporation's primary outlet is the direct retail sales of fish to local hotels, restaurants and others buying from its processing plant in Castries. It buys fish on the open market, and there are no requirements for local fishermen to sell to the Corporation.

- **National Commercial Bank of St. Lucia:** limited liability company wholly owned by the Government and run as a commercial bank (incorporated in 1980). Credits for agriculture and fisheries run approximately EC$ eight to ten million per year.

- **St. Lucia Development Bank:** established in 1981 by combining the resources and programmes of the Housing Bank, the Agricultural and Industrial Bank, and the loan activities of the Student Loan Fund and the Small Industries Credit Programme of the NDC. As a quasi-government institution, the Bank concentrates on providing long-term investment credits which facilitate the overall

public policy objectives of GOSL for economic development.

5.4 THE NON-GOVERNMENT SECTOR IN ENVIRONMENTAL MANAGEMENT

A number of non-government organisations (NGOs) have played an important role in influencing the level of environmental awareness in the country. Taken in the aggregate, these private sector groups have helped create an environmental advocacy climate in St. Lucia which is above that of most other Eastern Caribbean islands.

This is not to suggest that NGOs in St. Lucia function as "pressure groups." Rather, alternative education, research, training, and support strategies have been employed by NGOs to heighten public awareness about environmental issues and to provide private sector input for the achievement of environmental goals.

Several development-oriented NGOs have also begun to integrate environmental issues and concerns into their programme agendas, and others have the potential to do likewise. At the local level, several interest groups have been formed to address community development issues and often respond to resource management and environmental concerns. Extant community groups have shown a growing interest in such issues as well. A summary discussion of these and the more traditional environmental NGOs follows.

NGOs WITH CONSERVATION PROGRAMMES

The **St. Lucia Naturalists Society** was founded in 1978 to meet the need for private sector support of conservation/protection programmes related to the island's fauna and flora. With a membership exceeding 130, its programmes focus primarily on lectures, field trips and related conservation education activities. The Society is not, however, merely a special interest group of natural history enthusiasts, for its programme agenda includes discussion of public policy issues related to development and the environment, and the group was in the forefront of support for establishment of the Environmental Commission.

The **St. Lucia Archaeological and Historical Society**, founded in 1954, is custodian of the country's archaeological collections and maintains the state archives in space leased by Government and shared with the St. Lucia National Trust. In addition to joint facilities and common programme interests, the Trust and Society are linked in the person of the executive director of the Trust, who acts as general secretary of the Archaeological and Historical Society and is the secretary of the Archives Advisory Committee.

The **National Research and Development Foundation** (NRDF) is the primary non-governmental development agency in the country. In addition to more traditional small business development programmes, the Foundation also manages integrated rural development projects and has executed programmes with environmental objectives.

For example, it recently surveyed self-help organisations in OECS countries, including St. Lucia, to assess their potential for implementing resource conservation and utilisation projects (carried out under the aegis of OECS/NRMP). NRDF also works co-operatively with ECNAMP and other community groups in carrying out projects to raise the level of environmental awareness in the country, such as co-ordination of the 1987 "environmental retreat" for community leaders. An environmental reference section is maintained in its research library, and the Foundation is currently the executing NGO in St. Lucia for implementation of CCA's Country Environmental Profile project.

The **Folk Research Centre**, founded in 1973, is a non-profit NGO involved in "action research" and education programmes. It seeks to preserve and promote the cultural heritage of the country and has sponsored folk medicine research programmes and appropriate technology projects at the village level. More recently, the Centre has co-operated with the Caribbean Conservation Association

in developing a cultural policy for CCA and has organised several "popular theatre" productions with GOSL's Department of Forest and Lands. These performances, focusing on the environment, were designed to reach local farming communities.

OTHER NGOs

In the business sector, two NGOs -- the **Small Business Association** and the **Manufacturers Association** -- have recently joined forces to strengthen their respective organisations. At the same time, environmental topics have been added to newsletter coverage and in other information services provided for members. An institutional development grant (1987) from Island Resources Foundation, under its NGO support programme, will assist the two associations in expanding resource management programme objectives.

The co-operative sector in St. Lucia is significant, comprising over 20 percent of the island's labour force and 15 percent of the adult population (Finisterre and Renard, 1987). Although primarily preoccupied with economic issues, co-operatives have some potential for the mobilisation of community-level resource management activities. This is particularly true with reference to two secondary cooperatives: NAFCO-OP and STAFCO-OP.

The **National Association of Fisheries Co-Operatives** (NAFCO-OP) is a federation of nine fisheries co-operatives. While its focus is on marketing, the potential for involvement of co-operatives in marine resource management activities has been noted by the FMU and ECNAMP, and both have explored opportunities for better co-operation between fishing co-operatives and resource management programmes.

Less direct involvement with environmental issues has been demonstrated by the **St. Lucia Association of Farmers Co-Operatives** (STAFCO-OP). This co-op, comprising five farm producer co-operatives, is primarily concerned with joint marketing ventures and representing the interests of members in dealing with Government on import restrictions and pricing policies. It is emerging as the marketing and service agency for small farmers and could provide another outlet for encouraging better land management practices by small agricultural producers.

Another non-government agricultural group is the **St. Lucia Agriculturists Association**, organised in 1950 to promote the production and marketing of agricultural products. A 1982 study (Dodd and Jackson) found the Association to be well managed and financially sound with a membership of approximately 1,200.

The larger farmers associations (St. Lucia Bananas Growers Association and Coconut Growers Association) are quasi-government bodies since each was created by an Act of Government. Although they might also be considered NGOs, they appear for purposes of this report in Section 5.1.3.

In addition to co-operatives, the most significant community-level, non-government structure in the country is the network of **Mothers and Fathers Clubs**. The **National Mothers and Fathers League** links Mothers and Fathers Clubs across the island and has a membership of over 2,000 individuals dispersed in 40 clubs based in almost every community on the island. Several of the local clubs are involved in natural resource management activities (Finisterre and Renard, 1987), while the larger network of local clubs represents an important potential resource for promoting environmental objectives and transferring conservation information at the village level.

At the community level, several organisations are already active in the field of resource management. In certain localities, "development committees" have been formed to provide infrastructure and services and to promote socio-economic development. The most active of these is the Soufriere Development Committee, which is spearheading an ambitious programme with several environmental management components, such as solid waste disposal, urban beautification. and a tourism and national park development plan for the Pitons area.

In recent years, service clubs, community organisations and other local groups have displayed increasing interest in environmental issues and have been conducting many small-scale programmes (for example, anti-litter campaigns, health education programmes, and beautification). In some areas, development-oriented activities, such as integrated rural development projects (GOSL/NRDF) and the southeast coast conservation and development project (GOSL/ECNAMP), have strengthened community structures and expanded opportunities for direct involvement in resource management initiatives.

Traditional Resource Management. Non-government involvement in resource management also takes place at the community level within the framework of traditional systems. The best example of traditional resource management is offered by the small farming sector, which has developed rather sophisticated, but low-tech, crop cultivation techniques and agricultural systems in response to locally-perceived ecological, political and economic conditions. Traditional users of coastal and marine resources have also developed more traditional systems of common property resource management, as is the case with the white sea urchin fishery.

Several research and development programmes in St. Lucia are designed to increase understanding about, respect for, and enhancement of popular and traditional resource use systems, notably CARDI's research project on farming systems, the Ministry of Agriculture's Training, Research, Extension and Development Unit, and GOSL/ECNAMP's project for the conservation and development of the southeast coast.

5.5 DONOR-SUPPORTED ENVIRONMENTAL RESEARCH AND RESOURCE MANAGEMENT PROGRAMMES AND PROJECTS

REGIONAL CONSERVATION PROGRAMMES

In 1981, the **Eastern Caribbean Natural Area Management Programme** (ECNAMP), then a programme of the Caribbean Conservation Association (CCA), initiated a long-term project for the southeast coast of the country which was designed to identify both conservation and development requirements for the area. In the intervening years, ECNAMP has worked with GOSL, with other NGOs, with the National Trust, and with local residents from the study area (for example fishermen and charcoal makers) in implementing the programme's coastal resource management objectives. The emphasis of ECNAMP's efforts in St. Lucia has been on people as agents of change, on community participation, and on improving communication between resource users and managers at the local level and central government planners and executing agencies at the national level.

Since 1980, the **Organisation of American States, Department of Regional Development** (OAS/DRD) has carried out a series of "natural resources and agricultural development" projects in co-operation with GOSL, including sponsorship of a model land registration project, implementation of specific land development projects, and preparation of technical reports dealing with natural resource conservation, natural hazards, land use zoning, and land redistribution policies. Other OAS activities in St. Lucia include a series of tourism-related studies (e.g., tourism attractions, development plan for Soufriere and the Sulphur Springs), and museum and marketing studies on behalf of the National Trust. OAS/DRD maintains an office and full-time representative in St. Lucia.

The **Organisation of Eastern Caribbean States' Natural Resources Management Project** (OECS-NRMP), a co-operative programme of OECS with OAS and GTZ (the German Agency for Technical Co-operation),

was launched in 1986; although it is regionally focused, the project is based in St. Lucia. Its overall objective is to improve the capacity of OECS member countries to plan and manage natural resource management programmes. To date, there have been no major OECS-NRMP project activities focused specifically on St. Lucia, but the country has been included in regional surveys sponsored by OECS-NRMP (e.g., environmental legislation, self-help organisations). Furthermore, the presence of the programme in the country serves to focus attention on the resource management sector and to expand the pool of technical expertise available to Government.

RESEARCH AND TRAINING PROGRAMMES

Based in St. Lucia since 1982, CARICOM's **Caribbean Environmental Health Institute** (CEHI) provides technical and scientific advisory services to CARICOM governments on environmental health issues (e.g., water supply, waste disposal, pollution control, pesticide disposal). It was established as a sub-regional institutional base for implementation of CARICOM's Environmental Health Strategy. CEHI acts as a regional reference centre for the collection and dissemination of technical and scientific information in the area of environmental management and carries out applied research programmes relevant to its mandate. It also is a water quality training centre to assist regional governments in the establishment of local environmental monitoring programmes. Coastal pollution monitoring activities have been carried out by CEHI in St. Lucia since 1982, and GOSL currently has an attachment training programme for Environmental Health personnel at CEHI.

The **Caribbean Agricultural Research and Development Institute** (CARDI) is the agricultural research arm of CARICOM. With primary laboratories in Trinidad, CARDI also maintains representatives and a full programme in each member island, including St. Lucia. The St. Lucia unit was established in 1977 where its programmes have included research on cereals, root crops, livestock, tree crops, multiple-cropping systems for small farms, soil and water conservation, agricultural engineering and integrated pest management. A CARDI representative serves on St. Lucia's Pesticides Control Board.

The **Windward Islands Banana Growers Association** (WINBAN) provides assistance to the respective growers associations on the islands of St. Lucia, Dominica, St. Vincent and Grenada through co-ordination of shipping and marketing for banana exports and the conducting of research on banana production. WINBAN established a research centre at Roseau in the mid-1960's that has become the largest agricultural research unit in the Eastern Caribbean. Research is conducted there on all aspects of banana production, including pest control, fruit quality, and intercropping. The centre also provides training for banana extension officers from all the Windward Islands.

According to one researcher (N. Singh, CEHI, personal communication, May 1988), the research programmes of CEHI, CARDI, and WINBAN, plus that under the aegis of the Ministry of Agriculture at Union, complement one another rather than overlap, with each testing facility exhibiting a slightly different area of expertise. CEHI's programmes in St. Lucia have emphasised water quality monitoring and baseline pollution control studies; the Institute also responds from time to time to requests from both Government and private sector industries for assistance in devising appropriate pollution mitigation strategies. Both CARDI and WINBAN are concerned with agricultural research efforts, but CARDI's focus is multi-crop while WINBAN's is single-crop. Furthermore, much of WINBAN's programme has been directed specifically at pest control research. Lastly, MOA's laboratory at Union is the only facility on the island carrying out food quality control testing.

The **Inter-American Institute for Co-operation on Agriculture** (IICA), an international agricultural research and technical assistance organisation, is a specialized agency of the OAS. In St. Lucia, IICA has supported research activities, institutional assessments, and training exercises related to regional goals for agricultural diversification. Current project activities include coconut mite research, pesti-

cide safety seminars, marketing feasibility studies, and efforts to improve cultivation of fruit tree crops. IICA also contributed funding for the 1986 Agricultural Census (along with FAO and USAID), and a representative from IICA is a member of St. Lucia's Pesticides Control Board.

INTERNATIONAL DEVELOPMENT ASSISTANCE SUPPORT

The **Canadian International Development Agency** (CIDA) has provided substantial support for natural resource management programmes in St. Lucia, in particular for fisheries and forestry development. CIDA has assisted both the FMU and Department of Forest and Lands in the planning and design of long-term sector development plans. In the case of forestry, CIDA support began in 1981 when it undertook a joint Forest Management Project with GOSL, which was extended in the fall of 1987 for a five year period as a Forest Management and Conservation Project (see Section 2.2). CIDA's full-time, on-site forestry team is currently housed at the Department's headquarters in Castries. CIDA also provided funding for the establishment of the Fisheries Complex in Castries Harbour, managed and operated by St. Lucia's Fish Marketing Corporation. Additional funding for the hydrological, feasibility, and design studies for construction of the Roseau dam is being provided by CIDA.

Key resource management and related assistance programmes supported by the **United States Agency for International Development** (USAID) in St. Lucia include: execution of an island-wide Land Registration and Titling Project, which was completed in 1987; implementation of an Agricultural Structural Adjustment Project; support for geothermal energy development; and assistance for the 1986 Agricultural Census. USAID's HIAMP (High Impact Agricultural Marketing and Production) Project is just getting off the ground in St. Lucia. Overall, HIAMP aims at improving the investment climate for agricultural (including fisheries) enterprises in targeted countries. In early 1988, USAID announced funding support for a parks and protected area programme, including formulation of an overall planning document and site-specific development activities at six protected areas. Funding for this latter project is made possible under USAID's Biodiversity Programme.

British Development Division (BDD) has focused its support on a series of agricultural and integrated water development projects. Specifically, Britain continues to help St. Lucia develop its infrastructure of water supply. A longstanding arrangement between WASA and the Wessex Water Authority will soon be extended. Britain also provides funding for the Castries Drainage Project designed to prevent seasonal flooding, a common occurrence in the capital. The UK's **Commonwealth Development Corporation** (a statutory body charged with the task of assisting the economic development of Commonwealth countries) has supported the St. Lucia Model Farms project (see Section 3).

The **French Government** has provided technical counsel and assistance to the St. Lucia Government for development of improved municipal solid waste and sewerage disposal systems. The **Government of China** currently provides funding for an aquaculture development project at Beausejour.

Other important multilateral assistance for resource management has been provided by the European Communities through the **European Development Fund** (EDF), most significantly, support for MOA's Land Conservation and Drainage Programme focused on drainage projects for the Dennery, Roseau and Cul de Sac watersheds. Major assistance for St. Lucia's Model Farms project (see Chapter 3) was also provided through EDF as well as support for an aquaculture development project at Union.

The regional **Caribbean Development Bank** (CDB) has furnished significant development assistance to St. Lucia in recent years. CDB largely financed (through a EC$ 7.5 million loan) development of the Pointe Seraphine cruise ship/tourism complex, has assisted with other infrastructure projects (roads, water system), and -- with the Commonwealth Fund for Technical Co-operation (CFTC) -- supported a mineral resource study to assess the

availability and feasibility of pumice as a sand substitute. CDB also provides substantial support for the agricultural sector.

TECHNICAL ASSISTANCE AND OTHER DONOR-SUPPORTED ACTIVITIES

Significant support for protected area and environmental education programmes in St. Lucia has been provided by the **World Wildlife Fund-US.** Project-specific funding since the early 1980s has been targeted for development of the parrot sanctuary in the Central Forest Reserve and the Maria Islands Nature Reserve, implementation of environmental education activities and publications, surveys of endangered species, design and execution of a training programme for coral reef monitoring, and support for ECNAMP's Southeast Coast Resource Management Programme.

Several Canadian development assistance organisations have provided support for marine sector resource management projects, including sea moss cultivation (International Development Research Centre, IDRC, and the Canadian High Commission), survey of sea moss market potential (International Centre for Ocean Development, ICOD), and a training project for marine mechanics (Co-operative Development Foundation of Canada).

5.6 OVERVIEW ASSESSMENT OF THE INSTITUTIONAL FRAMEWORK FOR ENVIRONMENTAL MANAGEMENT

CENTRAL GOVERNMENT CONSIDERATIONS

A key element in facilitating public policy decision-making in St. Lucia in the last decade has been the concentration of planning and project co-ordination authority within the Central Planning Unit (CPU) of the Ministry of Planning, Personnel, Establishment and Training. In recent years, the CPU has developed strong institutional capabilities for addressing economic, physical and social planning issues, has strengthened its expertise in project management, and has identified for itself a role in performing certain co-ordinating functions within Government.

At the same time, the technical competence of Government agencies specifically charged with resource management responsibilities has been steadily improving. Within the Eastern Caribbean context, GOSL resource management personnel are generally acknowledged as technically skilled and environmentally aware persons, thoughtful proponents of serious programmes for research, training, and resource development.

Nevertheless, the institutional framework for environmental management in St. Lucia has significant weaknesses, which can generally be characterised as:

1) an inadequate data base;

2) shortage of sufficient numbers of well-trained staff;

3) poor links between physical planning and the budgeting process;

4) conflicting development "plans," often imposed by different external donor agencies;

5) frequent overlap of responsibility between government agencies; and

6) absence of a formal mechanism for inter-sectoral co-operation and co-ordination.

Of these issues, that of co-ordination is the most critical, in the first place, because many of the other institutional problems identified can be linked directly or indirectly to this systemic weakness. The need to utilise an inter-sectoral co-ordinating approach is particularly important when overall monitoring and enforcement functions are spread among several departments, as is the case with environmental management in St. Lucia.

An inter-sectoral co-ordinating mechanism should not weaken but rather should com-

plement existing units of government, for example, by identifying opportunities for a more comprehensive, integrated approach to the complexities of resource planning and development. Without adequate co-ordination, capable of cutting across departmental lines, the present fragmentation of institutional responsibility and programme effort will continue.

The extant Environmental Commission represents one institutional opportunity for overcoming this recognised weakness in the GOSL institutional framework. However, since it has not been formally established or granted official recognition by Government, it is not an immediately viable option.

The year 1989 was proclaimed the Year of the Environment in St. Lucia, and a co-ordinating committee, chaired by the Minister of Health, has been established. This body might over time extend its immediate mandate and provide broader co-ordination functions for environmental management in the country. However, before this occurs, an opportunity for assessment and consultation should be provided, during which time appropriate public and private sector representatives should, in collaboration, define the structure, composition, functions, accountability, and operating procedures of this new body.

Furthermore, the CEP National Committee will continue to function as a body to co-ordinate the development of a National Strategy for Environmental Management, providing another opportunity for public/private sector environmental leadership and co-ordination in the country.

PROCEDURAL AND LEGISLATIVE ELEMENTS

Seven recommendations for procedural changes, some requiring legislative action, are provided in this section to facilitate the ability of GOSL to integrate environmental considerations into the decision-making process and to facilitate the resource management responsibilities of Government.

(1) *Provide legislation for and require standardisation of Environmental Impact Assessments for development projects.* There is at present no legal basis for EIAs in the country, although examples of its ad hoc application exist, dating from the first formal assessment carried out on a proposed hotel development at Marigot Bay in 1980. Furthermore, across-the-board procedures which ensure that the process will be applied on a systematic -- rather than case-by-case -- basis have not been established.

At present, DCA generally requires EIAs for large projects undertaken by the private sector. However, specific standards or procedures for EIAs have not been established with the result that some major projects -- such as the Hess oil transhipment terminal -- are not subjected to the process. Additionally, this requirement does not generally apply to the public sector.

A "developer's handbook" of guidelines and procedures has been completed by the CPU, with assistance provided by the OAS. While this is a useful and necessary document to ensure more orderly development control in St. Lucia, its availability will not lessen the need for mandatory EIA requirements.

In a country where environmental management functions are spread among many government departments and quasi-government institutions -- each of which tends to view "the environment" from its own perspective or area of interest -- the EIA process forces a more holistic integration of technical data. Potential impacts are not viewed in isolation by department "x" or ministry "y". Instead information is collected and assessed in an orderly, logical manner and then made available to decision-makers.

(2) *Preparation and approval of a National Land Use Plan, augmented by local development and land use plans where appropriate.* Land use planning provides a framework for assessing the physical and natural features of an area and for suggesting its long-term sustainable uses. The land use plan serves as another guideline to inform the decision-making process regarding potential development choices within the larger context of acceptable social, economic, and environmental goals.

St. Lucia has experimented with national planning, including physical land use planning, since the mid-1970's. With the assistance of UNDP, a draft National Plan was first prepared in 1977, but this attempt at comprehensive planning, and those which followed, were never formally accepted by Government. Perhaps in response to the absence of an officially recognised national plan, several resource or area-specific plans have been prepared in recent years, often with the assistance of donor agencies, for example, the CIDA-funded Forest Management Plan, the ECNAMP-sponsored Southeast Coast Conservation and Development Plan, and the OAS-supported Soufriere Tourism Development Plan.

A draft land planning and development act which attempts to resolve some of the weakness of the existing Land Development (Interim Control) Act has been under consideration by Government for several years. This proposed new legislation should specifically mandate preparation of a comprehensive "National Land Use Plan" and specify procedures for its adoption by Government.

Additionally, Government has under consideration a Land Conservation and Improvement Act, drafted by the Ministry of Agriculture. This legislation calls for regulation of land use on agricultural lands where conservation strategies are considered essential for the preservation of land capability. The proposed statute would provide mechanisms for better Government control over rural lands where the integrity of the resource base is presently at risk.

Land use planning efforts in St. Lucia which attempt to bring privately held lands under the control of conservation or land protection regulations -- such as management regulations for privately-held forests -- must provide appropriate incentives or disincentives to influence the behaviour of private landowners. Lausche (1986) and Devaux (1987) suggest several possibilities such as direct purchase or exchange of private forest land for non-forested Crown Land. Such compensatory strategies, designed to accelerate nationally accepted conservation objectives, should be a part of the Government's land use policy planning.

(3) *Formalisation of procedures for environmental input at all phases of project planning, implementation and assessment.* There are presently no formal or standard procedures which guarantee that GOSL environmental units, now housed within several ministries, will provide co-ordinated technical input prior to the approval of development projects or will systematically monitor potential environmental impacts after project implementation.

As pointed out in a recent OECS study (Lausche, 1986), although almost all ministries of Government have some legal responsibility related to or affecting management of natural resources, there is no statutory mechanism for co-ordinated action with respect to resource planning or regulatory oversight. Each agency addresses only a partial or specific aspect of environmental management, resulting in an underutilisation of available human resources and a fragmented, sector-specific approach to solving complex resource management problems.

One option for correcting this deficiency would be creation of a comprehensive "Ministry of the Environment" to serve as the central focus of GOSL resource management activities by locating key "resource agencies" within one unit of Government. While such a step would substantially lessen the problems now associated with the overlapping responsibilities (or gaps in the authority) of key resource sectors, it represents a very fundamental and broad reorganisation of Government structure. There are no indications that GOSL has given such an approach any consideration.

As indicated in the previous section, another possible strategy for improving cross-sectoral dialogue and co-operation between those agencies responsible for environmental management is formal establishment of the Environmental Commission. Representatives from GOSL departments with environmental management responsibilities or expertise should be members of the Commission so that the concerns and input of all such units of

Government are reflected in the Commission's deliberations. Operating procedures, yet to be established, should include provisions for the Commission to review, assess, and comment upon proposed development projects, to identify potential sector-specific as well as the cumulative environmental impacts of development activities, to review and monitor ongoing development projects, and to make such information available to decision-makers on a timely basis.

(4) *Harmonisation and rationalisation of environmental law and avoidance of unnecessary overlaps in institutional responsibilities.* Critical to improving the resource management responsibilities of Government is the need to clarify institutional roles and authority. The objective is not to eliminate overlap per se but to capitalize on opportunities for shared monitoring, identification of common goals, and provision of greater control, oversight and enforcement.

As identified throughout this Profile, there are many areas of overlapping institutional responsibility in the resource management sectors of Government, most of which have been authorised by statute. Key among these are:

- management of public lands
- management of parks and other protected areas
- conservation and protection of watersheds
- development and management of coastal/marine resources
- solid waste management
- pollution control and maintenance of water quality.

What is required at this point is a more detailed, tightly defined analysis of extant environmental law than that provided in the recent OECS overview (Lausche, 1986). Such an analysis needs to update and build upon the Lausche study by more specifically identifying those areas of (1) existing or potential conflict in institutional responsibilities and (2) shared or overlapping legislated authority. Recommendations for how to harmonise or bring about a rational agreement of the legal base for environmental management needs to be included in this review/assessment effort, with recommendations forwarded to the Attorney General for implementation. The most expedient method to accomplish this task would be for GOSL to approach an appropriate donor agency for assistance.

(5) *Provision for public consultation and participation in national and local planning.* For a period of time in 1982-83, the CPU experimented with a short-lived public consultation strategy with a series of issue-oriented sector papers appearing in the local press and a limited number of formal public meetings held to focus on the sector papers. This brief attempt at providing an opportunity for public input in the planning process has not been repeated since.

Nevertheless, in St. Lucia, there are increasing examples of a decided bias in favour of expanded public participation in local and national planning efforts which involve the utilisation and management of natural, historical, and cultural resources. A number of the non-government organisations discussed in Section 5.4 actively solicit public input and support in the design and implementation of their own conservation and resource-focused programme activities. At the same time, GOSL needs to provide a like opportunity for public consultation in its planning process and in its deliberations about resource development and environmental management issues.

While efforts to facilitate or accommodate public participation can make the task of the government planner or resource manager more complex and time consuming, such efforts also provide important advantages by:

- facilitating Government access to a larger information base and providing for the assimilation of such information (e.g., public perceptions and preferences, NGO technical expertise) into the planning, review and evaluation functions of Government;

- providing an opportunity for Government to build coalitions or support on behalf of its projects or decisions;

- allowing for discussion and possible resolution of conflicts prior to an extensive commitment of resources to a potentially controversial activity or project;

- enhancing the likelihood of success by expanding the base of information, expertise, public opinion, and potential support available to decision-makers in Government.

(6) *Creation of a public information and documentation centre*. In recent years, the CPU has increasingly taken on the responsibilities of a primary information centre within Government, a position which complements the co-ordination functions performed by the Planning Unit and is equally important in enhancing CPU capabilities for policy and plan formulation. There are also plans underway for creation of a National Information System with the Chief Librarian as the primary organiser.

The problem with these and other information centralisation attempts has been a lack of access to government data and documents, both within and among GOSL units and departments and by the general public. In the area of natural resource planning and management, this lack of access impedes appropriate public participation in the formulation of government policies and proposals which affect the environment.

Access to information has traditionally been hampered by public administration practices inherited from the Colonial Civil Service, specifically the requirement that all information within Government be kept confidential unless explicitly determined to be suitable for dissemination. This policy, over time, has been compounded by the absence of standardised procedures and guidelines for the regular review and subsequent determination of what information may pass into the public domain.

Present plans to establish a National Information System, comprising, *inter alia*, a Government Documentation Centre, provide an opportunity for Government, at the same time, to create a process for public access to the following kinds of information relative to environmental management:

- data on the status of natural resources as collected by GOSL agencies with resource management functions (i.e., pollution levels, endangered species habitat requirements, erosion/deforestation rates);

- information on Government-sponsored projects and development proposals, from an early stage of conceptualisation, in order to facilitate public assessment of potential environmental impacts;

- development proposals presented to Government by the private sector which may have long-term implications for the sustainable use or continued availability of specific natural resources.

(7) *Establishment of monitoring programmes as an integral part of resource management activities*. As discussed in Section 2.5 relative to the marine sector, optimum resource management depends on the availability of a continuous flow of information about the status of the resource base and its response to the impacts of development activities. Data collection and monitoring regimes are essential elements in a continual process of assessment and evaluation which, in turn, feeds back to inform and direct the process of planning and management.

Data collection and monitoring programmes for natural resource management are weak in St. Lucia. One identified problem is the lack of long-term consistency in providing for and carrying out monitoring tasks. Monitoring is not broadly perceived as an important resource management tool and thus is generally overlooked in the design and implementation of resource management programmes. When it has been integrated within a programme, the lack of systematic follow-through and regularity in carrying out these tasks has subse-

quently placed the data collection process at risk.

There does not appear to be a clear understanding about the utility of monitoring, and therefore when staff assigned such responsibilities fail to perceive results or benefits in the short-term, they become slack in executing the assignment and moreover remain unconvinced of its usefulness -- it may *appear* to them they are measuring for measuring's sake alone.

Therefore, in order to encourage a more rigorous pursuit of data collection and full implementation of monitoring tasks, by increasing the visibility of the task and the incentive for the data collector, it is recommended that a new "environmental data" section be added to the Annual Statistical Digest maintained and published by GOSL. It is important that there be a central clearinghouse to collect and assemble environmental data and to provide a degree of accountability to ensure that monitoring and data collection activities are carried out.

Furthermore, at present, "institutional memory" for environmental data is scattered among the files of several departments of Government and within the reports of numerous consulting firms and agencies. By providing a central repository for environmentally-focused statistical data, a "value" is added to the data gathering task, and a method of verification is provided to ensure that data is collected and reported to the Government's Statistics Office.

Over time, the Environmental Commission, in co-operation with the appropriate executing agencies of Government, could review current monitoring regimes, identify deficiencies (particularly resource areas at high risk for which little or no data is currently collected), and provide recommendations to improve overall monitoring activities. The Commission could also give consideration to a systematic assembly and standardisation of environmental data contained in the relatively large number of externally funded consulting reports found in St. Lucia.

It will be important to find ways to link data collection to normal organisational operations. The degree of risk that data collection will not be pursued on a systematic and consistent basis is a function of the degree to which that task is isolated from the more routine functions of the department. To the extent that monitoring is not linked to the normal activities of the agency, the greater is the risk that it will not happen.

LOCAL INSTITUTIONAL DEVELOPMENT FOR NATURAL RESOURCE MANAGEMENT

St. Lucia's decentralisation strategy, an attempt to promote local institutional involvement in the development and implementation of public sector projects, is too new to fully evaluate its effectiveness. Nevertheless, this GOSL effort to regionalise service delivery from the central government to local communities and to increase opportunities for public participation in government-initiated project planning does represent an opportunity for local institutions to become more involved in resource issues.

For example, the decentralisation structure is well suited as a dissemination and public discussion framework for the follow-up phases of the Country Environmental Profile project. The Regional Councils should be used as a vehicle for transferring information generated by the CEP and for public meetings about the policy issues raised by the Environmental Profile.

The concept of "user management," as applied to natural resources, should also be considered as an option for mobilising local efforts and responsibility for natural resource management. User management strategies can be carried out whereever there is a shared consensus or mutual understanding of the limits and possibilities of resource exploitation. Such approaches complement more formal resource management institutions.

There are indeed opportunities available for the promotion of community-based resource management strategies in St. Lucia. A number of existing structures, notably the pro-

ducer co-operatives in agriculture and fisheries, have the potential to incorporate resource management issues within their programme agendas. New approaches can also be explored, principally in the marine resource sector, where the Fisheries Act (1984) includes a provision for the establishment of "local management authorities." A systematic programme designed to identify and promote community-based structures for resource management in other appropriate sectors should be pursued.

The conservation and resource development programmes of ECNAMP demonstrate how this option can be employed. ECNAMP has based much of its work on the southeast coast on the premise that local residents have both the most stake in and often the most information about marine and coastal resources and should therefore be directly involved in making and carrying out resource management policy.

Some national NGOs in St. Lucia also have a role to play at the local level. The Naturalists Society, which has already expressed a willingness to expand its educational and public awareness programmes outside of the Castries area, should be encouraged to broaden the scope and range of its activities. The National Research and Development Foundation, as the country's leading development NGO, is already broadening its mandate to incorporate environmental concerns within its programmatic goals.

CONCLUSION

In the last analysis, effective implementation of resource management programmes in St. Lucia will require the following:

(1) public sector consensus on general resource management objectives;

(2) sufficient political will to support those objectives; and

(3) sharing of programme goals and development objectives among central government agencies, interest groups and local communities.

There is little point in shaping new resource management policies or environmental protection standards unless the political and social means are available to carry these out. This will require close liaison among Government leaders at the Cabinet level, coordination of environmental activities at the technical level, and interaction with non-government "user" groups impacted by both government regulation and damage to the resource.

6. SYNTHESIS OF ENVIRONMENTAL ISSUES AND RECOMMENDATIONS

6.1 ESTABLISHING DIRECTIONS

More than a decade ago, as it readied the country for independence, the Government of St. Lucia carefully laid out a ten-year "development strategy" in the form of a St. Lucia National Plan. Published in 1977 under the signature of the Prime Minister, this widely-circulated document proudly drew attention to the existence in St. Lucia of " ... a national awareness of the island's critical resources -- the foundations upon which to build a Nation."

The Plan went on to emphasise the importance of " ... managing these resources ... so that economic development takes place, not in isolation, but hand in hand with social progress, conservation of national resources and enhancement of the environment."

This was a promising, forward-looking statement for its time, calling for integrated development, resource conservation, and environmental enhancement as equally vital components in managing national growth.

This was easier said than done. Within a decade, the emphasis shifted and became more reactive as pressing environmental issues began to surface. By 1986, a draft GOSL Physical Development Strategy document reflected these changing circumstances by placing new emphasis on emerging pollution, land use, flooding, and water quality problems. It highlighted the need " ... to anticipate and detect newly emerging resource use conflicts, and to prepare for dealing with these conflicts."

By timely happenstance, this St. Lucia Environmental Profile effort has served as a "catchment" device for identifying exactly those kinds of environmental issues within the country. It has helped to identify which of these "emerging resource use conflicts" are being handled effectively, how they relate one to another, which ones persist and inhibit national development, and what kind of environmental policy framework is needed to reduce pollution loads, lower environmental risks, protect the resource base, and enhance the development process -- all at the same time.

Each of the preceding chapters and sub-sections of the Environmental Profile has reviewed the current status of St. Lucia's natural resource base, as well as the effects of recent growth and development initiatives on the full spectrum (but often limited) inventory of such resources. The word "environment" has been interpreted broadly, and, as a consequence, the "profiling" exercise has produced a rather long list of environmental problems and issues, most with accompanying recommendations. But this is not surprising, nor is it necessarily cause for alarm at this point.

It is quite normal for any small developing country, especially one like St. Lucia with an active growth agenda, to experience a shortfall or lag in the development of new public sector management institutions. It is equally routine to encounter difficulty in staffing new or expanding governmental management, research and monitoring units with competent, experienced persons. The environmental sector is no exception. And it is almost inevitable that persons with new and often exotic academic specialties and professional skills (as in pollution control or marine ecology) will be in short supply, usually lagging behind recruitment needs. This is a problem endemic to the wider Caribbean region, especially with the smaller islands where out-migration of young professionals is common.

Furthermore, in St. Lucia as elsewhere in the region, both donor-driven and external investor-funded development tend to proceed very unevenly along a broad economic, geographic and environmental front. Project coordination is difficult, and the unpredictability of the funding/start-up process makes it ex-

tremely hard to carry out proper anticipatory environmental planning.

In retrospect, the rather large number and diverse nature of the sector-specific issues that have been brought to the attention of the St. Lucia Environmental Profile team suggest not so much an environmental catastrophe in the making as a delayed start in developing national environmental programs and a national environmental strategy or framework aimed at sustainable resource use. It also suggests that perhaps it would not be wise to delay much longer (see also Section 6.4 below).

6.2 IDENTIFYING AN AGENDA: ISSUES AND RECOMMENDATIONS

6.2.1 Environmental Issues and Sustainable Development: The First Imperative

The various recommendations made within this document, when taken together, constitute a national environmental agenda for which some modicum of consensus has been established. Under the best of circumstances this Profile could and should lead directly into the design and implementation of a St. Lucia "national conservation strategy" or its equivalent. At the very least, the document stands as an agenda of tasks, an array of policy options, environmental conservation needs, and resource conservation procedures and projects, even including some public sector investment strategies dealing with vital environmental systems and renewable resources. The overall objective is to help ensure the sustainability of St. Lucia's national development initiatives by properly maintaining the resource base.

But, despite the progress made at identifying an agenda for an action programme, three very important tasks still lie ahead: setting public priorities; shaping a workable government-wide, environmental policy framework; and establishing a schedule for implementation.

6.2.2 Sector Level Issues and Recommendations

There are two major classes of issues addressed within this Profile. The first was derived from the sector review activities which generated the eleven major sub-sections of the preceding five chapters of this document. For the convenience of the reader, sector-specific issues and recommendation summaries accompany each sub-sector statement, with the recommendations always appearing as the concluding sub-section.

Most sector-specific issue statements that have survived the Profile screening process (there are over one hundred) are accompanied by action recommendations. Others, fortunately only a few, are simply presented as technically documented problems needing further definition and attention beyond the scope of this Profile.

Index to Sector Recommendations:

6.2.3 The Larger Issues: Establishing Priorities

A second, more policy-based group of larger issues, mostly national and often interdisciplinary in scope, has been separated out and is presented in this concluding chapter within a topical framework. This entire summary review exercise, while convenient for the busy reader, presents all users with the risk of various distortions for which there is no easy solution or alternative. For example:

- Complex environmental issues are usually dynamic, even volatile, with interacting driving variables, which means that static descriptions and suggested, specific intervention strategies tend to become rapidly outdated and should only be used as a guide to further review and refinement of an action strategy.

- Suggested remedial measures generally should be seen as experimental rather than curative or prescriptive.

- Any scheduled regime of interventions should be applied separately and sequentially over time, rather than simultaneously, if only to identify by observation which presumed remedy for a specific ill or problem may have made things worse. This requires the patience to monitor the impacts of each successive step and each kind of intervention as far as possible.

- There is also some danger that any attempted simplification or compartmentation of a complicated issue or cluster of related issues may so distort the intrinsic nature of the problem that the reader is mislead by the artificial separation of the problem from its context, including its human setting and local perceptions.

- Most suggested solutions are seldom as neat and orderly as their presentation in an abbreviated summary such as this would suggest.

- Finally, the connectedness of many environmental issues raises the possibility and even the likelihood that some combinations of simultaneous problem-solving solutions may be quite contradictory, or even exacerbate other issues.

Lastly, the reader is advised that a few fairly major issues are, by design, not featured in this final chapter of the CEP (although they are addressed in the Profile itself). Examples are the proposed Roseau dam, the new electric power plant at Cul de Sac, the hydrothermal exploration project at Soufriere, and the Rural Development Plan for the Fond d'Or River Basin. Detailed impact assessments and impact mitigation planning exercises have already been completed in one form or another for each of these initiatives. References, however, are listed in the CEP Bibliography which follows this chapter.

6.2.4 Basic Resource Concerns: Putting First Things First

Some basic natural resources, like soils, water, plants, trees, and wildlife, are often seen as a vital life support system, critical to human survival and growth. These generally shared resources are, in fact, often taken for granted as readily available common property. McHenry and Gane (1988) refer to them as "imperatives" because they should command our attention as the very building blocks of sustainable development.

The status of these so-called critical resources may be used as a yardstick by which to measure the success of previous policies and as a basis for comparing the merits of alternative strategies for the future. They are naturally linked together by various ecological processes (the water cycle, for example) and by human use patterns derived from basic human needs. Sometimes they collectively bear the burden of pollution loading from ill-conceived waste disposal practices or accidental toxic spills. Therefore, any national development strategy, which assumes continuing inputs of these critical resources, should incorporate protection policies sufficient to provide the following guarantees to the people of St. Lucia:

(1) *WATER* -- maintaining and improving the island's capacity to collect, store, and provide high-quality water for domestic, industrial and agricultural use, and safeguarding water quality by proper management of the forested watersheds and by proper pollution control, waste management, water treatment and waste water disposal.

(2) *SOIL* -- preventing the loss of soil from unnecessary erosion and maintaining and improving soil fertility by managing the natural and agricultural vegetation in accordance with sound land use practices.

(3) *PLANTS (flora) and WILDLIFE (fauna)* -- safeguarding the natural heritage of St. Lucia for present and future generations, protecting endangered or threatened species, controlling the rate of exploitation of economically useful species, preserving examples of various ecosystems (large and small), and maintaining the habitat of plants and animals in designated, formally protected areas, such as water-producing forest reserves.

(4) *LAND AND LANDSCAPE* -- maintaining features of the landscape throughout the island, with a view to also protecting and enhancing natural vistas and providing citizens with pleasing and healthy living space, as well as functionally appropriate recreational and occupational opportunities.

In addition to these four common resource categories, some St. Lucians point to the emerging need for focusing additional attention on the unusual cluster of resources and ocean-dependent uses in the coastal zone:

(5) *COASTAL AND MARINE RESOURCES* -- including marine vistas, anchorages, marina sites, mangroves, beaches, coral reefs, seagrass beds, and marine wildlife. These resources are increasingly in great demand by an ever larger proportion of the population. The coastal plain itself is an increasingly preferred location in which to work, live and play. Therefore, exploring the range of choices and procedures for maintaining coastal resource quality and sustainable long-term use may be seen as an additional "environmental imperative" of a more comprehensive nature.

But identifying key resources warranting improved protection and more aggressive management is not enough by itself; there must also be a mechanism to permit those concerned to deal directly with the intricate and interacting linkages among natural resource elements within the system or systems. Despite the relatively small size of St. Lucia, its network of closely-coupled resources is more complex and important to natural system production and processing efficiencies than is generally realized. Furthermore, several institutional obstacles quite often stand in the way of would-be resource managers.

For example, the absence of established structures and procedures for inter-sectoral co-operation among various branches of Government and statutory bodies remains one of the main obstacles for achieving integrated approaches to environmental management. The Government of St. Lucia has at its disposal several fairly strong, visibly competent, public sector agencies dealing with selected facets of the resource base (fisheries, forestry, water, wildlife), and some development-focused governmental units and statutory bodies have begun to place environmental matters on their agendas. But there is no procedural mechanism for ensuring systematic liaison, consultation, and coordination among governmental units; nor is there an efficient, uniform, multi-disciplinary vetting process for all major development projects and plans -- whether public or private.

6.3 SELECTED KEY ISSUES AND RECOMMENDATIONS

(1) ISSUE: DEFORESTATION AND HILLSIDE FARMING

Pressure to increase banana cultivation for export has necessitated the clearing of more and more new land which impinges upon steeper slopes highly susceptible to erosion. Small farmers are also being forced into more mountainous areas by expanding plantation agriculture. Soil erosion and excessive downstream siltation are the common result of such deforestation. While erosion has serious implications for reduced agricultural productivity, it can also raise the risk of landslides and diminish the value of valley land by contributing to excessive flooding and sediment deposition.

Meanwhile, the rate of reforestation and afforestation in St. Lucia continues to fall behind the rate of forest loss. Reforestation figures since the beginning of the decade show that reforested acreage totals per annum have been fairly consistent since 1983-1984, with 61

hectares (150 acres) being reforested in the period 1985-1986. While this trend may be encouraging (only ten acres were reported in 1972), the actual cumulative totals are not large. Forest cover loss -- whether due to illegal felling of trees for timber, land clearance for cultivation, or removal of wood for fuel -- continues to be of concern in St. Lucia.

Recommendation. Illegal banana production, land clearing, and farming in general on very steep upland slopes, Crown Lands, water catchment reserves, forest reserves, and Government-managed estates should be reduced and phased out. This will require both improved monitoring and regulatory control initiatives, as well as a variety of positive, even economic, incentives that present alternatives to illegal squatting or illegal land clearing.

Recommendation. Future conservation and resource development policies should be designed to:

- prevent agricultural and residential encroachment and the informal harvesting of trees in designated "protected" forest areas;

- provide for carefully supervised harvesting on the basis of sustained yield management in the "protection/production" and "exploitation" forest areas, as defined under the Forest Management Plan;

- implement an experimental pilot project in agroforestry in order to test its feasibility for future plantation maintenance involving farmers as part of the management team.

(2) ISSUE: EROSION AND DOWNSTREAM SEDIMENT POLLUTION AND FLOODING

Perhaps the most visibly dramatic conservation issue in St. Lucia at present involves soil erosion from privately-owned, excessively-steep hillsides which have been cleared and planted in bananas or root crops. While few measurements or even estimates of the affected hillside areas are available, circumstantial evidence suggests the scope of the problem is enormous and growing. Thousands of tons of silt and sediment are being eroded in the rainy season from carelessly, often illegally, devegetated upland areas and carried away by excessively rapid run-off. Much of this soil material, when it reaches the larger valleys, is deposited in the miles of drainage ditches designed to make low-lying, flat land arable. Costly drainage ditch cleaning is now required four to five times as often as it was only ten years ago.

The economic consequences of this kind of erosion are profound but unquantified in the absence of suitable evaluation and monitoring by any Government agency or unit. The additional costs of damages to roads, bridges, and other croplands, and of good soil lost forever -- to say nothing of reduced agricultural production -- appear to be escalating annually but are seldom discussed publicly as an officially recognised land use management problem.

Erosion is not the only problem linked to excessive clearing of steep slopes for expanded banana production. In combination with road building, illegal logging, squatting, and fuelwood harvesting on elevated ridges and upland slopes, devegetated areas soak up less water, and paved and cleared areas permit more direct sheet run-off. This results in less water infiltrating the soil to underground storage and instead produces immediate, more rapid run-off downslope. As a result, areas normally immune from floods, like Castries for example, are increasingly subject to inundation following heavy rains.

Recommendation. Documentation is needed of the costs of erosion-induced sediment damage to culverts, drains, and cropland; of reduced land values from soil losses; and of the systems cost of reduced agricultural production.

Recommendation. Documentation is also required to assess the dimensions of flood damage; and the costs to roads, culverts,

bridges, houses, farms, crops, and urban areas needs to be evaluated as a regular exercise in order to properly justify expenses for watershed protection and other flood control measures.

(3) *ISSUE: WATERSHED MANAGEMENT AND WATER SUPPLY*

Upper catchment and forest reserve areas are not being adequately protected against deforestation and other illegal uses, and these important, protected areas are not, unfortunately, being expanded by land acquisition to guarantee a continuing water supply for future generations. Present legislative measures and land use controls, where private land is involved, have proven insufficient to enable Government to deal with this problem.

Government ownership of land at higher elevations in the mountainous interior areas of St. Lucia should, in theory, enable most of the catchments above water supply intake points to be kept unoccupied and free of cultivation, agricultural chemicals, and all settlement, save for wardens and an occasional researcher. Unfortunately, GOSL has found it difficult to exercise its authority, and some areas of Crown Land are occupied illegally by squatters, roads have been cut, and deforestation for agriculture and fuelwood is accelerating the erosion process. Lower down, most land is privately owned, and there is no effective control of its use. Cultivation on precipitous slopes affects stream flow, causes serious erosion and siltation, and may endanger lives due to increased landslide risk.

Recommendation. A comprehensive national watershed management policy and upland land acquisition programme to protect and maintain water supplies, wildlife habitats, soils, forested areas, and optimum biodiversity should be developed by GOSL.

Recommendation. Water catchment areas should be rigorously defended against encroachment, and no land use other than controlled forestry, research, warden residency, and possibly telecommunication facilities should be permitted.

Recommendation. Water catchment areas should be increased in size by at least 2,000 hectares in anticipation of future requirements and, more immediately, for essential protection above existing intakes that are outside the protected areas. Investigations should be undertaken into the feasibility and cost of increasing pumping and storage capacity as a supplement to conserving and enlarging catchment areas.

Recommendation. Hydro-meteorological recording capability should be continually improved and updated, especially with a view to quantifying changes in run-off resulting from changes in land use.

Recommendation. Public awareness of water conservation needs (both for water consumption practices and regarding the importance of catchment areas) should be promoted.

Recommendation. WASA, the CPU, and the Department of Forest and Lands should work closely on planning issues related to water catchments, impoundment, and distribution, particularly as these relate to settlement planning and critical environmental impacts.

Recommendation. Serious consideration should be given to enacting the recommendation of the Department of Forest and Lands to protect 20 metres of forest along each side of rivers for the protection of stream flow water quality, reduction of bank erosion, and enhancement of wildlife habitat.

Recommendation. Water resource legislation should be reviewed and revised to declare water a nationally-owned commodity (like sand), requiring that usage rights be acquired by the private sector. Legislation should define watercourse and utilisation rights and the use of overspills and right-of-ways for infrastructure, as well as provide the legal means to resolve conflicts between individual ownership rights and the water protection requirements of the state.

(4) *ISSUE: LAND TENURE AND THE ENVIRONMENT*

With the recent completion of the USAID-funded Land Registration and Titling Project, an important barrier to improved agricultural development in St. Lucia has been removed. A larger number of landholders now have clear title to their agricultural lands and -- it might be speculated -- will in the future have better access to credit and greater personal incentive for investing in more long-term conservation practices, such as tree crop planting, drainage system improvements, and terracing. While land tenure security is helpful in strengthening the agricultural sector, more than this is needed -- in part, because completion of the Land Registration and Titling Project has not resolved the problem of jointly held "family lands," a systemic problem which will continue to perpetuate patterns of insecure land tenure and over-exploitation of small farms under temporal control.

Recommendation. GOSL should expand agricultural extension services to farmers, emphasising education and training programmes in soil conservation techniques.

Recommendation. GOSL should consider more innovative and near-term rewards, incentives, and subsidies to encourage the practice of environmentally-sound land management by small farmers -- many of whom will continue to lack a long-term claim to their land. Also needed are low-cost loans for farmers or even public sector grant and project funds for the construction of bench terraces, grass and stone barriers, contour drains, stepped waterways, windbreaks and similar soil conservation techniques which are often very labour intensive.

(5) *ISSUE: LAND USE AND LAND MANAGEMENT*

St. Lucia's remaining prime lands must satisfy the nation's needs for food, housing, recreation, waste disposal and many other human activities. And they must provide these things on a continuing basis for an expanding population of residents and visitors if the country is to remain both ecologically and economically viable and competitive within the region. In a small island with limited physical space, planning for the allocation and use of available land for various national purposes is critical to orderly, efficient, and truly sustainable development.

Although OAS has recently developed a "Land Use and Vegetation" map for St. Lucia, it is at a 1:50,000 scale which, while suitable for strategic planning purposes, is quite inadequate for parcel-level planning, infrastructure and subdivision siting, and land use decision-making generally.

Furthermore, in the last two decades, prime, highly productive agricultural land has been placed at risk in the face of alternative usages which tend to produce a greater economic return. According to OAS (Rojas, *et al.*, 1988), slightly over 1,000 acres of good agricultural land have been taken out of production to accommodate road construction, urban activities, and village expansion. Most of the loss was sustained by three watershed areas -- Dennery, Roseau, and Cul de Sac -- precisely those areas with the largest concentrations of top quality productive land. More integrative kinds of agricultural land use planning cannot be postponed much longer without greatly increasing the risk of reduced productivity, lower farm income and declining export earnings for the state.

There is a similar risk of misallocation in coastal land use decision-making -- with an even greater prospect of tax revenue and foreign exchange loss (see also Issue Six below).

Recommendation. A high priority should be given to carrying out a full-scale "national land utilisation survey" at an appropriate map scale, i.e., 1:2,500 or 1:5,000 or perhaps 1:10,000.

Recommendation. A National Land Use Plan needs to be prepared, incorporating and updating some or all of the many sectoral plans which have been written in the past. It should focus on the best means of achieving sustainable development over the long-term and should attempt to guide future development into areas which are best suited for particular kinds and densities of land use,

based on physical and ecological constraints. The watershed should be evaluated as the appropriate unit for land use planning in rural areas.

Recommendation. St. Lucia needs to identify an appropriate method to reserve its remaining agricultural lands for agricultural pursuits, particularly those with the highest land capabilities. If present trends continue, further fragmentation and subdivision of these lands -- for housing, infrastructure, tourism, urban and commercial development -- will not lessen. A plan for island-wide zoning, which classifies and protects certain categories of land (for agriculture, recreation, forestry, water catchment, wildlife, etc.), is increasingly important. It is particularly critical in the rural sector to prevent further displacement of small farmers to urban areas and to ensure the availability of suitable lands for ecologically-sound and profitable agricultural production.

(6) ISSUE: COASTAL ZONE DEGRADATION AND SAND MINING

Five related problems impinge upon the quality of St. Lucia's coastal ecosystems. These are: (1) inadequate or badly managed solid and liquid waste disposal facilities and practices; (2) excessive beach sand mining; (3) coastal erosion accelerated by reef, mangrove and seagrass destruction; (4) improper coastal engineering and construction practices; and (5) a general zoning, permitting and planning failure regarding land use along the coastline.

Recommendation. GOSL needs to develop a strategy and carry out a comprehensive coastal resource assessment of the country.

Recommendation. A permitting process for development activities in the coastal zone needs to be developed and institutionalised. Coastal permitting procedures need to be put in place, allowing water-dependent uses only and gradually introducing more stringent pollutant discharge controls (probably with a discharge fee schedule).

Recommendation. GOSL should design and implement a national Coastal Zone Management Programme, designed with serious input from all resource users and with experimental participatory coastal resource management activities modeled on the ECNAMP Southeast Coast Project. A protection and management plan for common property resources and amenities in the coastal zone should be developed.

Recommendation. St. Lucia cannot delay much longer the need to confront the issue of beach sand mining and its destructive impacts on coastal environments. Recommendations include the following:

- St. Lucia resource managers need to assess available sand deposits in the country and make judgments as to where continued sand removal will have the least detrimental impacts on natural systems and is more compatible with current site utilisation, and where continued sand mining will be absolutely prohibited because of resource management considerations.

- Having made such choices, GOSL must improve its enforcement capabilities for dealing with violators; publication of regulations governing the "off-limits" beaches as well as the "exploitation" beaches must be available to the public, and protected areas must be rigorously monitored.

- The present permitting system should be amended to attach a charge for sand removal to each permit issued. Fees should be based, as a minimum, on the potential replacement cost of beach sand.

- Pumice sand use should be encouraged and its commercial development supported.

(7) *ISSUE: MANAGING POLLUTION*

Waste disposal is a difficult problem for most small island societies, and St. Lucia is no exception. All urban areas lack adequate treatment facilities for domestic sewage and waste water. Ocean outfalls for effluents unsuitable as gray water are conspicuous by their absence. The waters of Castries Harbour, and to a degree other smaller embayments and inshore coastal areas, are receiving effluents from a variety of land-based sources of pollution, including agro-chemicals, sediments, and other waste materials from upland areas delivered to coastal waters by rivers, streams and underground seepage. Many package treatment plants serving hotels are badly maintained and inadequately supervised, and seldom function properly, which further adds to coastal nutrient loads.

At the same time, the management of solid waste remains a problem for most rural communities and all urban areas. An even more serious problem exists as a consequence of the increasing risks posed by various toxic materials such as many industrial wastes, biocides used in agriculture, cleaning solvents, hospital wastes, and by the ever-present threat of oil spills in the coastal zone. Management planning and spill contingency planning have not kept up with the potential threats to expanding communities and tourism facilities, particularly those in the coastal zone.

Recommendation. The quantitative and systemic aspects of environmental pollution in St. Lucia are not sufficiently well-documented to permit comprehensive development of remedial or regulatory measures. A national pollution assessment is needed to establish the basic dimensions of each waste stream and to identify and quantify sources, causative agents, volumes, flow rates, destinations, impacts and projections. Additionally, a long-term water quality and marine biological monitoring programme should be designed and implemented, independent of the studies currently carried out for GOSL by CEHI.

Recommendation. WASA should undertake the development of improved regulations and operating standards for privately-owned and operated sewage treatment plants, which, because of generally poor maintenance and operating procedures, are adding to nutrient loading.

Recommendation. A solid waste management plan should be prepared for all urban areas and industrial/commercial facilities. Enactment of solid waste management legislation to define national and local government responsibilities, establish standards for waste disposal, and regulate waste collection is needed. Legislation should include a prohibition against all refuse disposal in the sea or adjacent to streams and rivers. Assistance to local government units charged with solid waste collection and disposal, possibly through enactment of solid waste collection fees, is needed to allow local governments to upgrade the services presently provided.

Recommendation. Improved refuse dump sites are needed for Castries, Dennery, Micoud, Choiseul, Soufriere, Canaries and Anse la Raye. Improvement in the management of all dump sites is also needed, and a tippage fee system should be put in place.

Recommendation. GOSL should assign responsibility for oil and other toxic spill contingency planning and emergency response efforts to a single agency with the operational capacity to deal with these issues. Contingency planning for the country needs to incorporate all toxic and hazardous materials and should include an impact reduction and mitigation plan (i.e., risk reduction action plan), along with a response plan.

(8) *ISSUE: LEVEL OF ENVIRONMENTAL AWARENESS*

Since much of the environmental damage taking place in St. Lucia occurs at the grassroots or local community level, an expanded environmental education strategy focusing on both rural and urban populations warrants attention. This will be a longer term process which is currently hindered by the absence of any clearly articulated official environmental policy.

Recommendation. Non-governmental organisations and the more formal educa-

tional institutions at all levels should be enlisted in a national effort to upgrade environmental literacy. This will permit the expansion of the direct involvement of local communities and their institutional representatives in the planning and implementation of development activities which directly and indirectly affect natural resources and local environments.

6.4 MOBILISING GOVERNMENT

The notion that the "environment," broadly speaking, is government business is not new. The people of St. Lucia generally welcome the fact that their Government controls Crown Lands, public health, and some aspects of forestry, fishing, ports, harbours, and airports, among other activities. But, in St. Lucia, the self-defined environmental role for the Government is traditionally a narrow one, more regulatory than developmental and seldom incentive-driven. In this regard, St. Lucia, like most of its Eastern Caribbean neighbours, has until very recently opted for a hands-off, laissez-faire environmental stance, clinging mostly to an environmental non-intervention policy.

But while the idea of government as guardian of selected environmental resources is not new, what is new and still in experimental stages (in St. Lucia as well as elsewhere in the region) is the idea of trying to choreograph various ministries, government units and even statutory bodies into a coordinated resource management system -- one designed to improve efficiencies, reduce risks, and minimise adverse impacts.

What is also new is the rapid growth and acceptance of the citizen-based environmental movement which, in country after country in the Caribbean region, has seen community groups, from labour unions to churches, civic organisations and NGOs, begin to put pressure on the public sector to do something about environmental abuses, to protect communities from environmental hazards, and to guarantee the conservation and survival of certain environmental amenities.

EARLY WARNING SIGNS OF CONCERN

One simple way to gauge the level of public concern about the environment is to establish what "environmental" issues regularly make news in the local press. The following list of St. Lucia headlines or feature story news items was assembled during the Profile project:

- the "dreadful" landslides at Trois Seis, Marc (South Castries), and Myers Bridge, near Soufriere (among many others);
- repeated instances of extraordinarily high storm flooding in downtown Castries;
- unprecedented potable water shortages during the dry season in urban areas;
- fish kills in Castries Harbour, apparently from carelessly handled pesticides;
- coastal erosion at Vigie Beach, Pigeon Island, Reduit Beach and Choc Beach;
- a wave refraction problem at Vielle Ville, apparently caused by the design of Pointe Seraphine;
- sewage pollution and algal blooms at Rodney Bay;
- unacceptable levels of gastroenteritis, normally attributable to polluted drinking water;
- worsening trash, garbage and solid waste problems, including roadside litter, derelict cars, discarded left-back bananas and packing boxes, fruit processing wastes, and distillery and brewery slops;
- accelerated siltation of banana plantation irrigation drains in the Roseau and Cul de Sac alluvial valleys.

These are not simply accidents of nature that occur at random to make life uncomfortable for St. Lucians. They are all man-made or man-caused events. They constitute, in the aggregate, an early warning system. Events like these need to be more closely monitored, tabulated and evaluated, to provide a better idea of the seriousness of each of the problems.

An example is the first event on the list above. On 11 September, 1988, the mammoth landslide at Trois Seis (only a few miles from Ravine Poisson where nearly 100 persons died in a 1938 slide) was explained by a forestry officer as being the result of deforestation by banana farmers on steep slopes. "The disaster," he said, "is the consequence of the absence of land use policy in the country. ... what we need is a policy saying on which slopes we can grow what crops, and which crops should be grown in which areas, depending on the soil type" (*Voice*, 17 September, 1988). The explanation for the 1938 landslide was almost identical (see page 175).

6.5 MOBILISING PEOPLE

PUBLIC INVOLVEMENT AND PARTICIPATION

The challenges of environmental management and sustainable development in smaller island systems have proven to be quite amenable to the broad application of the principles of participatory planning and public involvement. In St. Lucia's case, there is now a need for procedures to facilitate both formal and informal involvement of communities and private sector groups in resource management activities, ensuring that their concerns are properly taken into account. In this regard, it is especially important to pay serious attention to groups and whole communities that rely heavily on natural resources.

In effect, the days of passive conservation for many natural resources in St. Lucia are fast disappearing. Any new national conservation programme for the country in the decade of the nineties will inevitably require expanding levels of more direct kinds of governmental intervention. In turn, this presumes an antecedent national strategy and plan for ecosystem restoration and management.

But since most environmental intervention and all resource management involves people -- whether as land owners, constituents or resource users -- it follows that a national programme for ensuring public participation is equally important. Evidence from around the region in this regard is compelling. Public involvement enhances the planning process, minimises conflict between government regulators and traditional resource users, and enlists the cooperation of the latter group, thereby reducing system maintenance costs in the longer term. This will, of course, be politically difficult, but St. Lucia needs to find a way or it will be overwhelmed by its own growth and by external forces such as tourism, pollution, and competition from within the region.

This is a classic case where open, imaginative leadership is just as important as public funding because an enlightened independent sector, properly encouraged, will develop its own institutions (NGOs), its own funding, and its own cadre of paid professionals and volunteers who can be of great assistance to Government. Although most Government leaders appreciate the value of natural resources, as having great national significance, some have difficulty in seeing local institutional resources, especially non-governmental organisations, in the same light -- namely, as a national resource.

Enlisting people in any longer range endeavor takes persuasion. It takes someone or some group with a sense of vision to inculcate a believable image of something worth doing and worth working for because it will have merit in the end. Recruiting a team of supporters for a national environmental management strategy will require, among other things, a visionary kind of "persuasion model," one that conveys the beauty, intricacy, vitality and even the complexity of St. Lucia's ecosystem but does not drive people away with trivia, detail, and controversy. It must engender a spirit of cooperation, not confrontation. And most of all, it must be achievable.

6.6 THE ENVIRONMENT AND HUMAN RESOURCE DEVELOPMENT

People are the key to sustainable development. To ensure that their enthusiasm, commitment, energies and ingenuity are harnessed, it is important to make certain that sector plans, and in fact all aspects of environmental planning, capitalise on St. Lucia's healthy regionalism and be sensitive to local priorities and resources. Environmental initiatives at the national level, if they are to be truly sustainable, must have a dimension that strengthens local communities and optimises human resource potential at the grassroots level, the true environmental frontier. The effort required to mount this top *and* bottom level strategy is clearly greater than that required to issue a few national guidelines. But the ultimate return on the investment of time and energy will not only be much greater, but it is the only way truly sustainable development can be achieved in a democratic society.

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CARIBBEAN CONSERVATION ASSOCIATION

The *Caribbean Conservation Association (CCA)* is a regional, non-governmental, non-profit organization dedicated to promoting policies and practices which contribute to the conservation, protection and wise use of natural and cultural resources in order to enhance the quality of life for present and future generations. In fulfilling its mission, the Association establishes partnerships with organizations and groups which share common objectives; it focuses attention on activities designed to anticipate and prevent, rather than react and cure.

Established in 1967, CCA's membership comprises Governments (currently 19), Caribbean-based non-governmental organizations, and non-Caribbean institutions, as well as Associate (individual), Sponsoring and Student members. CCA's activities span five major program areas: (1) the formulation and promotion of environmental policies and strategies; (2) information collection and dissemination services; (3) promotion of public awareness through environmental education activities; (4) research about, support for, and implementation of natural resource management projects to foster sustainable development; and (5) assistance for cultural patrimony programs.

CCA's support is derived from Caribbean Governments, membership contributions, international donor agencies, private corporations and concerned individuals. It is managed by a Board of Directors, while its day-to-day activities are supervised by a Secretariat comprising a small core of dedicated staff. For more information, write: Caribbean Conservation Association, Savannah Lodge, The Garrison, St. Michael, Barbados. Telephone: (809) 426-9635/5373; Fax: (809) 429-8483.

ISLAND RESOURCES FOUNDATION

The *Island Resources Foundation (IRF)* is a non-governmental, non-profit research and technical assistance organization dedicated to the improvement of resource management in offshore oceanic islands. Established in 1970, its programs focus on providing workable development strategies appropriate for small island resource utilization through the application of ecological principles and systems management approaches that preserve the special qualities of island life.

Key program implementation areas include coastal and marine resource utilization, land use planning, environmental impact assessment, national park and tourism planning, cultural resource development, and resource sector policy studies. In 1986 the Foundation launched a program of assistance to non-governmental organizations in the Eastern Caribbean designed to improve the capabilities of such groups to provide private sector leadership for achieving environmental goals in the region.

Foundation funding is derived from private foundations, government agencies, international organizations, and through donations and contributions. IRF publishes research and technical reports and maintains a publications office for distribution of these documents. Its reference libraries in the Virgin Islands and Washington, D.C. are widely recognized as a unique collection of over 10,000 documents on insular systems and resource management, with a primary emphasis on the Caribbean. The Foundation is based in the U.S. Virgin Islands, with a branch office in Washington, D.C. and a program office in Antigua. For additional information, write: Island Resources Foundation, Red Hook Center Box 33, St. Thomas, U.S. Virgin Islands 00802. Telephone: (809) 775-6225; Fax: (809) 779-2022.