Initial National Communication on Climate Change

St. Vincent and the Grenadines

Prepared by
National Environmental Advisory Board and
Ministry of Health and the Environment

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November 2000

General Secretariat,
Organization of American States
Washington D.C.

St. Vincent and the Grenadines
Initial National Communication

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Convention on Climate Change

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Caribbean: Planning for Adaptation to Global Climate Change
A Joint Regional Project of:
University of West Indies Centre for Environment and Development (UWICED)
Caribbean Community (CARICOM)
Organization of American States (OAS)
World Bank
Global Environment Facility (GEF)

PREFACE

Minister of Health and the Environment,
St. Vincent and the Grenadines

St. Vincent and the Grenadines acceded to the United Nations Framework Convention on Climate Change on September 5th 1996. This was not by accident. We in St. Vincent and the Grenadines are painfully aware of the consequences of the massive injection of greenhouse gases into the atmosphere. Being a tiny island state with most of our infrastructural development on the coast, sea-level rise will have a devastating impact on our ability to remain a proud independent nation. It was against this background that we declared the l990s as ***the decade of the Environment***. Even before the Rio and SIDS conferences, St. Vincent was on the march.

Recognizing our ecological fragility and our dependence on agriculture and tourism, we cannot afford to be spectators on issues as important as Climate Change. For this reason, St. Vincent and the Grenadines has taken its obligation seriously. We have conducted our greenhouse gas inventory and assessed our vulnerability to sea-level rise occasioned by global warming. We have felt the impact of El Niño and the storm surges associated with intense tropical storms. These are acid reminders of the reality of global climate change.

St. Vincent and the Grenadines is pleased to join other conscious members of the world community in the effort to reduce anthropogenic interference with the global climate system. We appreciate the work done by the scientific community in providing us with the information. Now, we must find creative ways to make sure that the most vulnerable countries of the world are protected from the scourges of climate change. This requires the dissemination of knowledge, transfer of technology and the provision of financial support for implementation. In this regard, St. Vincent and the Grenadines wishes to thank the Global Environment Facility, the World Bank and the Organization of American States for supporting us in the preparation of our first national report.

St. Vincent and the Grenadines takes pleasure in presenting its initial national communication as fulfillment of its commitment as a Party to the Convention.

Hon. Joseph Burns Bonadie
Minister of Health and the Environment

THE NATIONAL ENVIRONMENTAL ADVISORY COUNCIL

Environmental Services Coordinator	Dr. R. Murray
Solicitor General	Mr. D. Browne
The Town Planner	Mrs. E. Mwakosya
Director of community services	Mrs. R. Snagg
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Although conducted through the Ministry of Health and the Environment, the Initial National Communication of St. Vincent and the Grenadines involved input from a number of government and private sector interests relating to energy, agriculture, forestry, industry, tourism, and community organizations. Particular recognition is given to the National Environmental Advisory Board that oversaw development of this report.

Technical support to the Initial National Communication was provided by the Unit for Sustainable Development and Environment of the Organization of American States with support from the Global Environment Facility through the World Bank. This initiative was part of the 12 country Caribbean Planning for Adaptation to Climate Change (CPACC) project.

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CONVERSIONS

Gg	Gigagramme (10^9 gramme)
Kton	Kiloton (1 kiloton = 1,000 metric ton = 1 Gg)
ha	hectare (1 ha = 2.471 acres)
m	meter (1 m = 3.280 feet)
EC$	Eastern Caribbean dollar (EC$2.7 = US$1)
US$	U.S. dollar (approximately EC$ 0.37)

LIST OF ACRONYMS AND ABBREVIATIONS

CCA	Caribbean Conservation Association
CCCM	Canadian Climate Centre Model
CDM	Canadian Development Ministry
CFCs	Chloroflurocarbons
CH_4	Methane
CO; CO_2	Carbon Monoxide; Carbon Dioxide
COP	Conference of Parties
CPACC	Caribbean Planning for Adaptation to Climate Change
EC$	Eastern Caribbean Dollars
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization, United Nations
GATT	General Agreement on Trade and Tariffs
GCMs	General Circulation Models
GDP; GNP	Gross Domestic Product; Gross National Product
GEF	Global Environment Facility
GFDL	Geophysical Fluid Dynamics Model
Gg	Gigagramme
GHG	Greenhouse Gas Inventory
GISS	Goddard Institute for Space Studies
IBSNAT	International Benchmark Sites Network for Agrotechnology
ICASA	International Consortium for Application of System Approaches to Agriculture
IPCC	Intergovernmental Panel on Climate Change
JEMS	Jems Environmental Management Services
kW; kWh	kilowatt; kilowatt-hours
LPG	Light Petroleum Gas
MSW	Municipal Solid Waste
N_2O	Nitrous Oxide
NAFTA	North American Free Trade Agreement
NAS	U.S. National Academy of Sciences
NASA	U.S. National Aeronautics and Space Administration
NEAB	National Environmental Advisory Board
NEAP	National Environmental Action Plan
NGO	Non-governmental Organization
NMVOC	Non-Methane Volatile Organic Compounds
NOAA	National Oceanic and Atmospheric Administration
NO_X	Oxides of Nitrogen
OAS	Organization of American States
OSU	Oregon State University
SIDS	Small Island Developing States
SO_2	Sulfur Dioxide
SVG	St Vincent and the Grenadines
UKMO	United Kingdom Meteorological Office
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USCSP	United States Country Studies Program
UWI	University of the West Indies
VINLEC	St. Vincent Electricity Services, Ltd.
YES	Youth Environment Service Clubs

EXECUTIVE SUMMARY

St. Vincent and the Grenadines (SVG) signed the United Nations Framework Convention on Climate Change on September 6, 1996, and is now one of over 160 signatories. One of the primary objectives of the Convention is to establish a data-management system for the collection, review, and reporting of national data. This report constitutes the Initial National Communication on Climate Change for St. Vincent and the Grenadines.

National Circumstances

St. Vincent and the Grenadines is a small Eastern Caribbean island state consisting of 30 islands, inlets, and cays with a total land area of 345 Km^2. These islands are part of the Windward Island chain of the Lesser Antilles. Most of the land area and 91 percent of the country's population of 111,105 are on the main island, St. Vincent. The Grenadine's extend south for 45 miles.

The island of St. Vincent has a rugged terrain rising to an elevation of 1,234 m at the cone of the volcano Soufriere. Five major eruptions have occurred since European settlement began, the most recent was in 1979. The black sandy beaches on most of the island reflect their volcanic origin. The soils of the island are fertile, with ample rainfall supporting a wide variety of crops.

The Grenadines are much smaller and as a rule less rugged than St. Vincent. Their white sandy beaches are influenced more by near-shore coral-reef formations. In the lower Grenadines, above Grenada, is an underwater volcano named Kick 'em Jenny.

The GDP of SVG in 1994 was EC$554 million with a per capita GDP of EC$5046 (US$205 million and US$1,869 respectively). Agriculture has historically been the country's primary economic base, with bananas as the principal export commodity. Recent international trade agreements have seriously affected exports. Revenues from banana exports fell from EC$170 million in 1990 to EC$20 million in 1995, producing significant ramifications on the national economy.

This National Communication was completed in conjunction with the regional programme Caribbean: Planning for Adaptation to Global Climate Change (CPACC). As part of this initiative, a climate-monitoring station was established off the southwest coast of St. Vincent to compile a historical record. The country also participated in a series of regional efforts to establish database and information systems, inventory coastal resources and uses, and formulate a policy framework for integrated coastal and marine management. Pilot studies were done on coral-reef monitoring for climate change, coastal vulnerability and risk assessment, economic valuation of coastal and marine resources, and formulation of economic/regulatory proposals.

Greenhouse Gas Inventory

A major focus of the work in SVG was to compile a Greenhouse Gas Inventory (GHG) as a pilot project under CPACC. Inventories were completed for the baseline years 1990 and 1994 as well as for 1997, to show change over time. The methodology developed by the Intergovernmental Panel on Climate Change (IPCC) was employed, using both reference and sectoral approaches.

The findings indicate that gas/diesel accounts for 46 percent of fuel consumption, diesel being the primary power source for electricity generation. Gasoline, used primarily for transport, accounts for 37 percent of fuel consumption. In terms of GHG emissions, the energy sector accounts for 42 percent of total CO_2 emissions, while transport accounts for 36 percent of the total using 1994 figures as indicated in Figure ES-1.

Figure ES-1: CO_2 Emissions by Sector for 1994

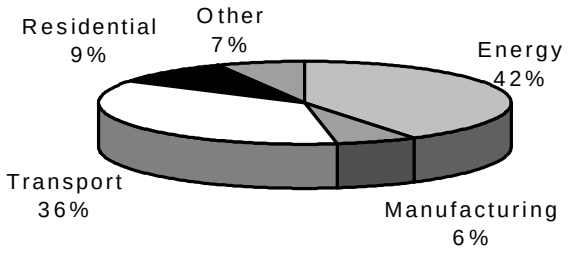


Table ES-1 shows GHG emissions by type and sector for the year 1994. Carbon dioxide emissions from fossil fuel combustion account for 95.1 gigagrams (Gg) of emissions. The majority of these emissions are generated from the energy and transport sectors as indicated above with smaller contributions from the residential and manufacturing sectors. For SVG, CO_2 emissions are offset by 133.7 Gg of net CO_2 removals from forestry and land use change. Carbon sequestration on the 12,689 hectares of forestland exceeds emissions from to the loss of 0.25 hectares per year in land conversion by threefold.

Figure ES-2 depicts non-CO_2 emissions for the year 1994. Methane emissions (CH_4) amount to 3 Gg per year with the bulk of emissions generated from agricultural operations and waste. Nitrous oxide (N_2O), nitrogen oxides (NO_x), and carbon monoxide emissions (CO) are derived primarily from agricultural practices which account for between 83 to 99 percent of total emissions. Sulfur dioxide emissions are more of a local or regional problem than the other constituents listed. Annual sulfer dioxide (SO_2) emissions amount to 0.3 Gg. Non-methane volatile organic compounds (NMVOC) are generated primarily from industrial and construction practices with road paving being the dominant source of emissions.

Figure ES-2: Non-CO_2 Emissions for the Year 1994

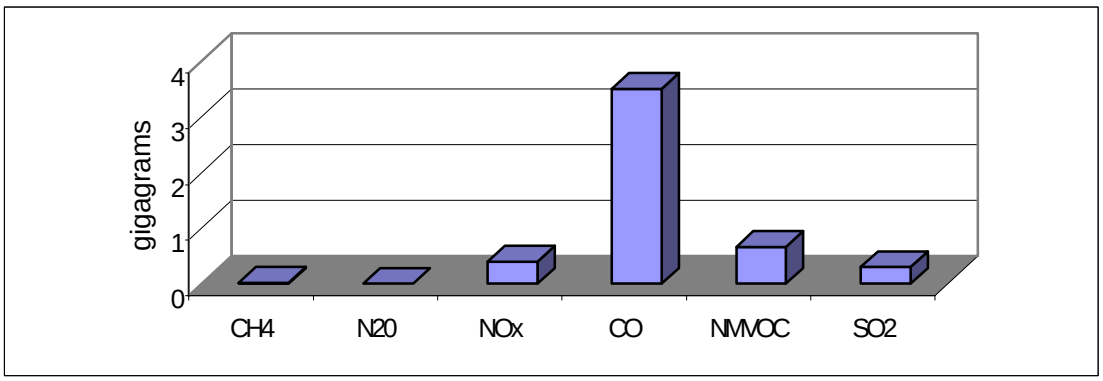


Table ES-1: Summary Report for National Greenhouse Gas Inventory for 1994 (gigagrams)

Greenhouse Gas Source And Sink Categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total emissions and removals	95.07	133.7*	3.035	0.712	25.82	19.02	53.05	0.295
Energy	95.07		0.011	0.0006	0.39	3.50	0.65	0.295
Industrial processes	0	0	0	0	0	0	52.39	0
Solvent and other product use	0	0	0	0	0	0	0	0
Agriculture	0	0	1.186	0.711	25.40	14.91	0	0
Land-use change and forestry	0*	133.7*	0.069	0.0005	0.01	0.59	0	0
Waste	0	0	1.769	0.005	0	0	0	0
Other	0	0	0	0	0	0	0	0
International bunkers:								
Aviation	1.58		1.418E-05	5.672E-05	0.0085	0.0028	0.0014	
Marine	0		0	5.672E-05				

* Net CO_2 removals based on forestry and land use practices. Annual CO_2 removal from forestlands (233.5 Gg) minus annual CO_2 emissions from land conversion (89.1Gg).

In terms of greenhouse gas emissions, carbon dioxide emissions increased by 31 percent from 82 Gg (gigagrams) in 1990 to 107 Gg in 1997 as indicated in Table ES-2. Still the contribution of SVG in terms of carbon dioxide emissions remains comparatively small. Given global estimates of 583,852 Gg of CO_2 emissions in 1994, SVG accounts for 0.016 percent of total global emissions. Yet those emissions continue to be offset by CO_2 sinks.

Methane, nitrous oxide, nitrogen oxides, and carbon monoxide have remained fairly constant over the study period. Emissions related to energy use and waste have increased, but the bulk of emissions for all four of these constituents are generated from agricultural activity. Agriculture remains an important part of the economic base, but its relative importance has decreased along with some shift in crop production due in large part to the downturn in the banana market.

Table ES-2: Total Greenhouse Gas Emissions for the Years 1990, 1994, and 1997 (gigagrams)*

	Emissions							Sink
Year	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	CO_2**
1990	81.51	3.026	0.803	28.79	20.18	45.07	0.254	133.7
1994	95.07	3.035	0.712	25.82	19.02	53.05	0.295	133.7
1997	106.83	3.135	0.772	27.87	20.55	62.44	0.322	133.7

* 1 gigagram = 1,000,000,000 grams = 1,000 tonnes.

** Net CO_2 removals from land conversion and uptake from forestlands. No differentiation is given between study years as the figure is based on a 1993 forest inventory and long term land conversion trends.

Vulnerability to Climate Change

Although their relative contributions to global warming are low, Small Island Developing States (SIDS) are the most vulnerable group in the international community (IPCC, 1995). Island states like St. Vincent are particularly susceptible to accelerated sea-level rise due to global warming. A coastal vulnerability pilot project under the CPACC programme projected an average sea-level rise for the region of 5.0 mm/year with an uncertainty range of 2.0-9.0 mm/year. Although these figures are more conservative than IPCC's mid-range projection of 6.5 mm/year, they are still two to five times greater than the rate experienced over the last 100 years. Measurements along sections of the windward side of St. Vincent show erosion rates of 1.6 m/year over the past three years, with a total loss at Orange Hill along this stretch of 15 m over the same period.

To address immediate needs, a vulnerability screening assessment was conducted as part of this project. In St. Vincent and the Grenadines, the principal findings were as follows:

- The main population centres, housing 85 percent of the population, lie on a narrow coastal strip less than 5 m above sea level and less than 5 km from the high-water mark.

- The infrastructure supporting these population centres--e.g. roads, telephone and electricity lines, transmission centres, water lines, airports, and marine centres, accounting for more than 80 percent of the island's total infrastructure base--fall within this area.

- The built-up area accounting for 90 percent of the country's economic investment is situated in this narrow coastal band.

Accelerated sea-level rise will therefore prove to be costly for the island of St. Vincent. Significant problems also exist for the Grenadines, where the white sandy beaches, coral reefs, and marine fishery support the greater part of the local economic base. Physical retreat from the shoreline will prove difficult, given the steep slopes in the interior of both St. Vincent and the Grenadines.

For agriculture, accelerated global warming will affect CO_2 concentrations, temperature, solar radiation, and precipitation patterns. Particularly important will be precipitation patterns that could change relatively wet areas to dry areas, with substantial impacts on agriculture. Also contributing to agricultural vulnerability are land-tenure practices that are cultivating steep slopes and international trade agreements that have significantly affected the banana industry. Given the importance of agriculture to the country's economic base, further work is warranted to assess climate-change-related impacts in agriculture and to identify appropriate adaptation measures.

The island of St. Vincent is relatively wet, with an abundance of surface water in rivers and streams, while the Grenadines experience severe shortages of both surface water and groundwater. Still, even on St. Vincent, competing uses, including domestic water use, hydroelectric demand, and irrigation, have substantially decreased stream flow. So has building in marginal areas, including steep slopes and floodplains, which has also increased vulnerability to tropical storms.

Policy Responses

Accelerated climate change will have a substantial impact on St. Vincent and the Grenadines. Vulnerabilities associated with climate change are already in evidence, and adaptive and mitigative measures appear to offer positive net benefits even under moderate climate-change scenarios. It is imperative, therefore, that St. Vincent and the Grenadines begins immediately to develop a broad based National Environmental Policy Reform Project.

To address this issue, the Government authorized the National Environmental Advisory Board to fill the role of national climate committee. This Board, under the auspices of the Ministry of Health and the Environment, is charged with reviewing all documents relating to climate change and providing a synopsis to the Minister of Health and the Environment, who takes environmental matters to Cabinet.

A high priority is to update and strengthen the National Environmental Action Plan (NEAP) of 1994. The plan should establish the legal authority of the National Environmental Advisory Board. The Board must take on the roles of coordination, long-range planning, and environmental oversight.

To date, the Board has produced the framework for a strategic plan, the objectives of which include:

- The development of a proactive approach to climate-change issues taking into account and complementary to national economic policies and plans, land-use plans, and sustainable use of natural resources;

- The identification and strengthening of complementary linkages between climate-change responses and current sectoral policies;

- The identification of barriers to climate responses and the development of appropriate strategies to remove these barriers; and

- The development of educational programmes to strengthen public involvement and institutional response to climate-change issues.

A dominant theme in the final national workshop for this project was the need for effective land-use planning with the enforcement of existing laws along with the expansion of authority, particularly along the coast. Those land-use controls must include a stronger regulatory framework but also incentives that send the right signals to individuals and discourage development in high-hazard areas.

A foundation for this approach is the further development of a good spatially based natural-resource inventory system. A start toward that system is in place, but further development of personnel and

information technology will be necessary to develop a thorough vulnerability assessment and mapping system as a basis for sound climate-change response programme.

The programme should include the following elements:

- An effective, ongoing information management system to provide a basis for decision-making on resource management;

- The compilation of a thorough vulnerability assessment with sustainability indicators to serve as a basis for hazard and suitability mapping;

- Land-use controls for both interior and coastal regions, with both regulatory and incentive-based components to address development trends and dynamic natural conditions;

- A more stringent programme of building permits and builder certification to assure that adequate standards are being met, so as to prevent loss of life and property;

- The promotion of energy conservation measures and the development of alternative energy options to reduce emissions and dependency on fuel imports;

- A disaster-management plan that addresses the training of local disaster committees, the preparation of disaster plans at the national and community levels, the development of mitigation plans, and the establishment of early warning systems; and

- An expansion of the public awareness programme on climate change that has become a model programme for the region.

Projects developed by SVG under climate change will seek to integrate environmental issues, providing an effective way to bring pollution and natural-resource management into the mainstream across sectoral activities. The approach also allows for an understanding of the contribution of environmental activities to the overall economic development agenda.

Impediments to the development of a sound climate-change response programme include financial and technical constraints. To overcome these, SVG should seek linkages with regional and international initiatives such as the Small Island Developing States (SIDS) Programme of Action and continue working relationships with CPACC, including the establishment of a Regional Climate Center

This project has increased general awareness of and knowledge on climate-change related issues, where St. Vincent and the Grenadines has been a leader within the region. Further development of the public-awareness program is expected to strengthen the dialogue, information exchange, and cooperation among all the relevant stakeholders, including government, non-government, academic, and private-sector entities.

INTRODUCTION

All signatories to the United Nations Framework Convention on Climate Change (UNFCCC) have agreed to prepare and update periodically a National Communication report on Climate Change (Articles 4 and 12). The report that follows is the Initial National Communication on Climate Change for St. Vincent and the Grenadines.

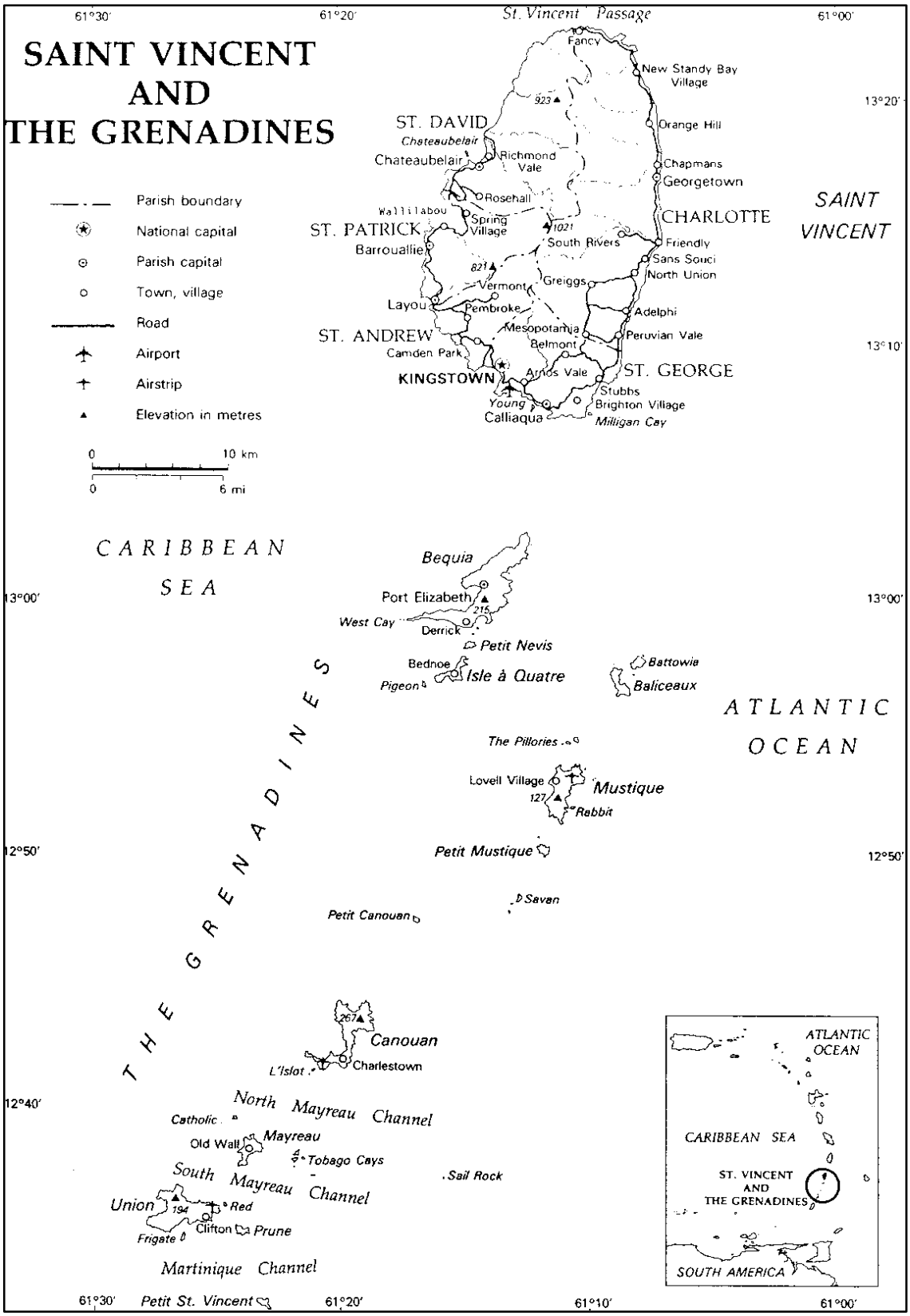
Although St. Vincent and the Grenadines is a small island nation with a comparatively small contribution to global climate change, its vulnerabilities are high. Many of these, including sea-level rise, tropical storms, inland flooding, landslides, and precipitation variability, are already evident. The information base and policy framework that is generated in this report, therefore has short-term as well as long-term benefit for both the environmental quality and the economic viability of St. Vincent and the Grenadines.

This report was prepared within a regional initiative: Caribbean Planning for Adaptation to Global Climate Change (CPACC). Each of the 12 participating countries was involved in one or more pilot projects. For St. Vincent, the primary responsibility was to develop a greenhouse gas (GHG) inventory. In addition, this report contains an overview of agricultural and water-resource vulnerability to complement the CPACC focus on coastal vulnerability.

This Communication contains the following components: national circumstances, greenhouse-gas inventory, vulnerability assessment, and policy response mechanisms.

It is expected that this report will be part of an ongoing effort to address impacts associated with climate change through responsible resource management.

Map 2-1: Country Map for St. Vincent and the Grenadines



Source: GSVG, 1986b. In CCA, 1990

NATIONAL CIRCUMSTANCES

Country Information

St. Vincent and the Grenadines consists of over 30 islands, inlets, and cays. The largest island, St. Vincent, located at latitude13^{o}15' N, longitude 61^{o}12' W. The other islands extend south for 75 km. St. Vincent and the Grenadines is part of the Windward Island chain in the Lesser Antilles. Neighboring islands include Grenada to the south, St. Lucia to the north, and Barbados to the east.

The climate of St. Vincent and the Grenadines is tropical, with temperatures ranging from 18 to 33^{o}C at E.T. Joshua Airport on St. Vincent. Temperatures in the interior of St. Vincent tend to be cooler at higher elevations. Annual precipitation varies from 150 cm in the extreme south to 381 cm in the interior of St. Vincent, resulting in a number of microclimates, especially on the main island.

Geography

The islands of St. Vincent and the Grenadines encompass 345 Km^{2}, with approximately 84 km of coastline (see Map 2-1). The mountainous main island of St. Vincent rises 1,234 m to the volcanic cone of Soufriere. Structurally, St. Vincent has a central north-south mountain chain with numerous valleys that drain to the narrow coastal belt. The mountains consist primarily of pyroclastics dating back to two major volcanic eruptions during the Pleistocene Era. St. Vincent, one of the youngest of the Antillean volcanic islands, is perched on the edge of the Caribbean and North American tectonic plates. Over time, magma formed along this subduction zone has been extruded by volcanoes as lava, giving rise to the Antillean arc. St. Vincent is one of the few places where the extrusion is still occurring. Soufriere has had five major eruptions since European settlement began--in 1718, 1812, 1902, 1971, and 1979. Most of these have been violent and accompanied by ash falls, mudflows, and avalanches of incandescent gases. The black sand beaches of the island reflect their volcanic origin (CCA, 1990).

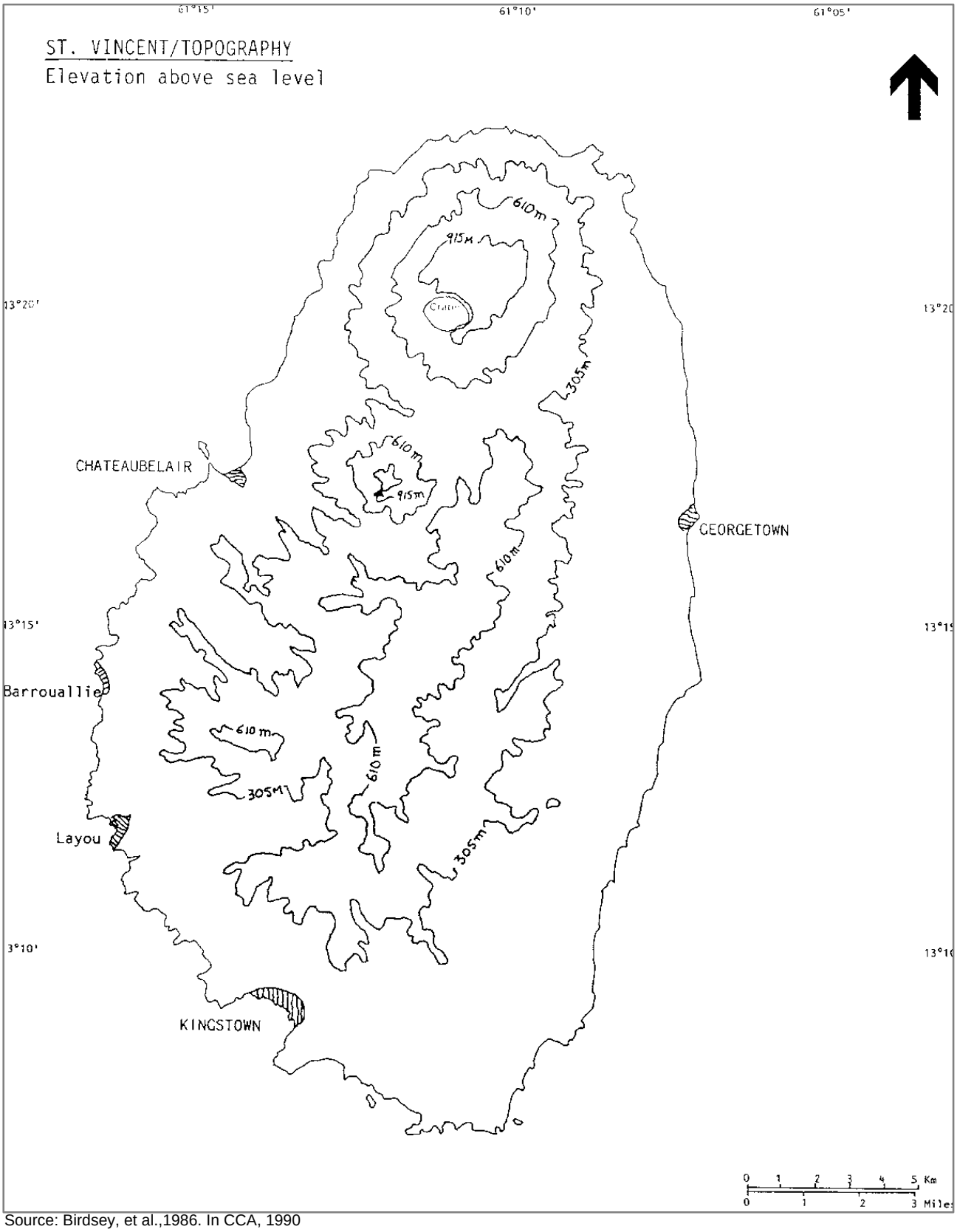
St. Vincent is characterized by rugged terrain with wet upland forests and numerous rivers. The soils of the island are fertile, with ample rainfall supporting a wide variety of agricultural commodities, of which bananas are the most important cash crop. Yet because of a scarcity of prime agricultural land, encroachment onto steep slopes at higher elevations is contributing to landslides and increased sediment transport. At the same time, building patterns along the immediate coast are increasing vulnerabilities in coastal villages and resort communities.

It is estimated that 50 percent of the island consists of slopes over 30 percent and only 20 percent of slopes less than 20 percent. Soufriere occupies most of the northern fifth of the island and is separated from the central mountain chain by a deep trough (Map 2-2). Two rivers run through this trough -- the Rabacca, which drains to the east, and the Walliabou, which drains to the west. The major peaks in the central ridge are Richmond, Mt. Brisbane, Grand and Petite Bonhomme, and Mt. St. Andrews.

From Soufriere, the rugged hills slope to the sea and then give way to several little islets and cays that form the Grenadines. Some of these cays appear as reefs cresting at low tide. The Grenadines are much smaller and as a rule less rugged than St. Vincent. They are more likely to have white sandy beaches due to coral-reef deposition. The protected waters of Tobago Cay are designated as a marine sanctuary. More intensive tourism development is affecting water quality and placing stress on near-shore coral reefs in both the Grenadines and St. Vincent.

Located in the lower Grenadines above Grenada is an underwater volcano named Kick ‘em Jenny. This is the only known submarine volcano in the Lesser Antilles and appears to be the most active volcano in the region at this time. Its summit lies at a depth of 160 m below sea level (CCA, 1990). An eruption of Kick 'em Jenny could generate a significant tidal wave (tsunami) affecting much of the Eastern Caribbean and particularly the Grenadines, Grenada, and St. Vincent.

Map 2-2: Topography of St. Vincent



Source: Birdsey, et al.,1986. In CCA, 1990

Population

The population of St. Vincent and the Grenadines grew by 33.2 percent between 1960 and 1991, as is indicated in Figure and Table 2-1. The most rapid rate of growth occurred during the 1970s, when the population grew by 13.4 percent. The current population is estimated at 111,105 (Table 2-2). Of that population, 102,375 residents, totaling 91.4 percent, live on mainland St. Vincent. The remaining 8,730, 8.6 percent, live on the Grenadines (SVGG, 1997). The population is predominantly Afro-West Indian with some remnants of indigenous Carib Amerindian assimilated into the majority population. Whites of European descent and East Indians comprise the majority of the remaining population.

Table 2-1: Population Trends in Census Years 1960-91

	1960	1970	1980	1991
Population	79,948	86,314	97,845	106,499
Rate of Change		7.96%	13.36%	8.84%

Source: St. Vincent and the Grenadines Statistical Office.

Figure 2-1: Population in Census Years 1960-91

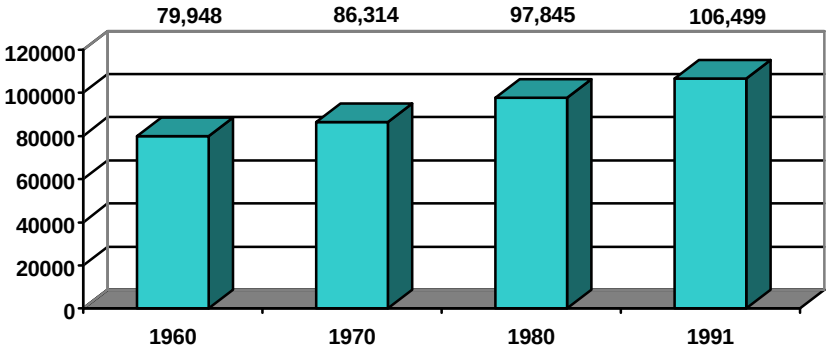


Table 2-2: National Circumstances for 1990, 1994, and 1997

Criteria	1990	1994	1997
Population	105,715	109,534	111,224
Relevant Areas (Km²)	340	340	340
GDP(1994 MEC$)	$ 453.0	$ 552.7	$ 666.6
GDP per capita (1994 US$)	$ 1587	$ 1869	$ 2220
Estimated % of the informal sector in GDP		10%	
% of industry in GDP	8.5	9.2	7.9
% of services in GDP	19.5	22.0	22.1
% of agriculture in GDP	21.2	11.1	10.1
Land area used for agricultural purposes (Km²)		10,675	12,368
Urban population as % of total population		43.7%	
Livestock population			
Hoofed	38,580	36,950	40,150
Poultry	222,000	270,000	315,000
Forest area (Km²)		12,689	
Population in absolute poverty[a]		37.9	
Life expectancy at birth (males/females)	68/73	68/73	68/73
Literacy rate	80%	80%	80%

[a] Central Statistics Department, Ministry of Finance and Planning.

The population is young, with 48.7 percent under 20 years of age (Figure 2-2). Another 30.3 percent of the population is in the prime childbearing years of 20-39. The average life expectancy is 68 years for males and 73 years for females. Since 1960, the infant mortality rate has fallen substantially, from 145.0 to 13.7 per thousand births, while the rate of natural increase has been more than halved, from 34.1 to 16.6 percent. The population is projected to reach 130,765 by the year 2021, an increase by 19.9 above the 1991 census figure and 17.7 percent above the current population as indicated in Figure 2-3 and Table 2-3.

Figure 2-2: Population by Age Cohort for 1991

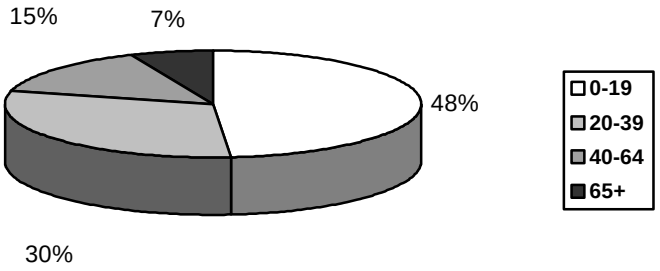


Figure 2-3: Population Projections to the Year 2021

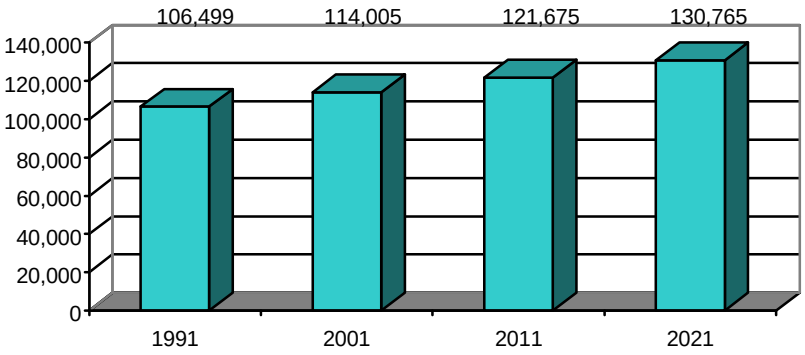


Table 2-3: Population Projections for the Years 1991-2021

	1991	2001	2011	2021
Population	106,499	114,005	121,675	130,765
Rate of change		7.05%	6.73%	7.47%

Source: St. Vincent and the Grenadines Statistical Office.

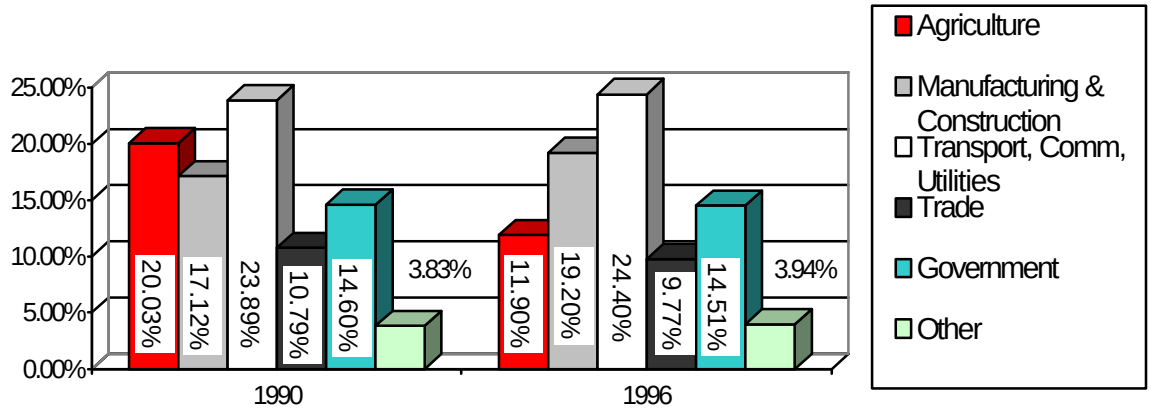
Photograph 2-1: Young Island Resort

Photograph 2-2: Port of Kingstown

Economy

St. Vincent and the Grenadines remains heavily dependent on agriculture for its economic base. The relative proportion of gross domestic product (GDP) accounted for by agriculture has declined in recent years (Figure 2-4). As late as 1990, agriculture still accounted for about 20.0 percent of GDP but by 1996 its share declined to 11.9 percent. Still, in 1996 it continued to employ nearly 60 percent of the workforce.

Figure 2-4: Gross Domestic Product by Sector, 1990 and 1996



The economy has prospered in the recent past, with annual growth rates from the late 1970s through the early 1990s averaging 13.3 percent (SVGG, 1997). A favorable external environment, concessionary aid, and preferential market access that led to high banana prices were the primary impetus to economic expansion. A fall in banana prices beginning in 1992 followed by unfavorable weather conditions caused a substantial decline in the value of agricultural output. Revenues from banana exports fell from EC$170.3 million in 1990 to EC$20.2 million in 1995.

In 1996, the Gross Domestic Product (GDP) amounted to EC$631.0 million (Table 2.4). Of that figure, 11.9 percent is derived from agriculture, 8.0 percent is from manufacturing, 14.5 percent is from trade, and 16.3 percent is from government services (SVGG, 1997). The average annual per capita income is currently EC$5673. The unemployment rate is estimated to be 22 percent, and underemployment is high with the decline in banana revenues. Inflation rate is modest, currently running at 3.6 percent. The value of imports has remained fairly constant in recent years, now totaling EC$355.9 million, but the value of exports has fallen from EC$210.9 million in 1992 to EC$125.3 million in 1996 (SVGG, 1997). Consequently, the trade deficit has increased by 58 percent during this time period (SVGG, 1998).

Table 2-4: Gross Domestic Product by Sector for 1980, 1990, and 1996 in Current Prices (EC$ Million)

	Gross domestic product			Percentage of total		
Sector	**1980**	**1990**	**1996**	**1980**	**1990**	**1996**
Agriculture	23.20	95.98	79.68	14.6%	20.0%	11.9%
Manufacturing	14.49	38.51	53.77	9.1%	8.0%	8.0%
Construction and Mining	18.86	43.50	74.77	11.9%	9.1%	11.2%
Transportation	18.30	61.91	84.99	11.5%	12.9%	12.7%
Communication and Utilities	21.72	52.58	78.41	13.7%	11.0%	11.7%
Finance, Ins., Real Estate	14.89	46.67	65.39	9.4%	9.7%	9.8%
Trade	17.66	51.70	97.17	11.1%	10.8%	14.5%
Services	7.25	18.35	26.36	4.6%	3.8%	3.9%
Government	22.6	69.97	109.07	14.2%	14.6%	16.3%
Sub-Total	158.97	479.17	669.61	100%	100%	100%
Less Imputed Service Charge[a]	7.41	26.19	38.66			
Total GDP	138.67	452.98	630.95			

[a] Not deducted in calculating relative shares by sector.
Source: St. Vincent and the Grenadines Statistical Office\ECCB.

Long-term trade prospects are threatened by the potential loss of preferential access for key export commodities due to international trade agreements including GATT, the integration of the European Common Market, and NAFTA. Particularly damaging is the possible loss of European preference for Caribbean bananas after the year 2001.

Transportation

St. Vincent and the Grenadines has 1,000 km of roadways, of which 400 km are improved and 300 km are paved. The number of automobiles in use has increased substantially over the past two decades owing both to relative prosperity and to a flood of used vehicles, particularly from Japan, that has reduced the price of vehicles for both private and commercial purposes.

The country has six airfields, of which four have permanent-surface runways. The E.T. Joshua Airport at Arnos Vale on St. Vincent is the largest, and the only one of the six to have a runway longer than 1,200 m. No rail lines exist on either St. Vincent or the Grenadines.

The primary port is at Kingstown (Photograph 2-2), which handles container cargo and passenger traffic. A new passenger terminal is under construction along the south side of Kingstown harbor.

Energy Sector

Electric power for St. Vincent and the Grenadines is provided by St. Vincent Electricity Services, Ltd. (VINLEC). VINLEC operates diesel power stations on St. Vincent, Bequia, Canouan, and Union Island along with five hydropower stations on St. Vincent. Generating capacity is 16,600 kW. According to 1997 figures, annual power generation is 62,738,735 kWh. Of this total, 69.2 percent is derived from diesel generating plants and 30.8 percent from hydropower plants (VINLEC, 1994). Per capita power consumption was 555 kWh in 1992.

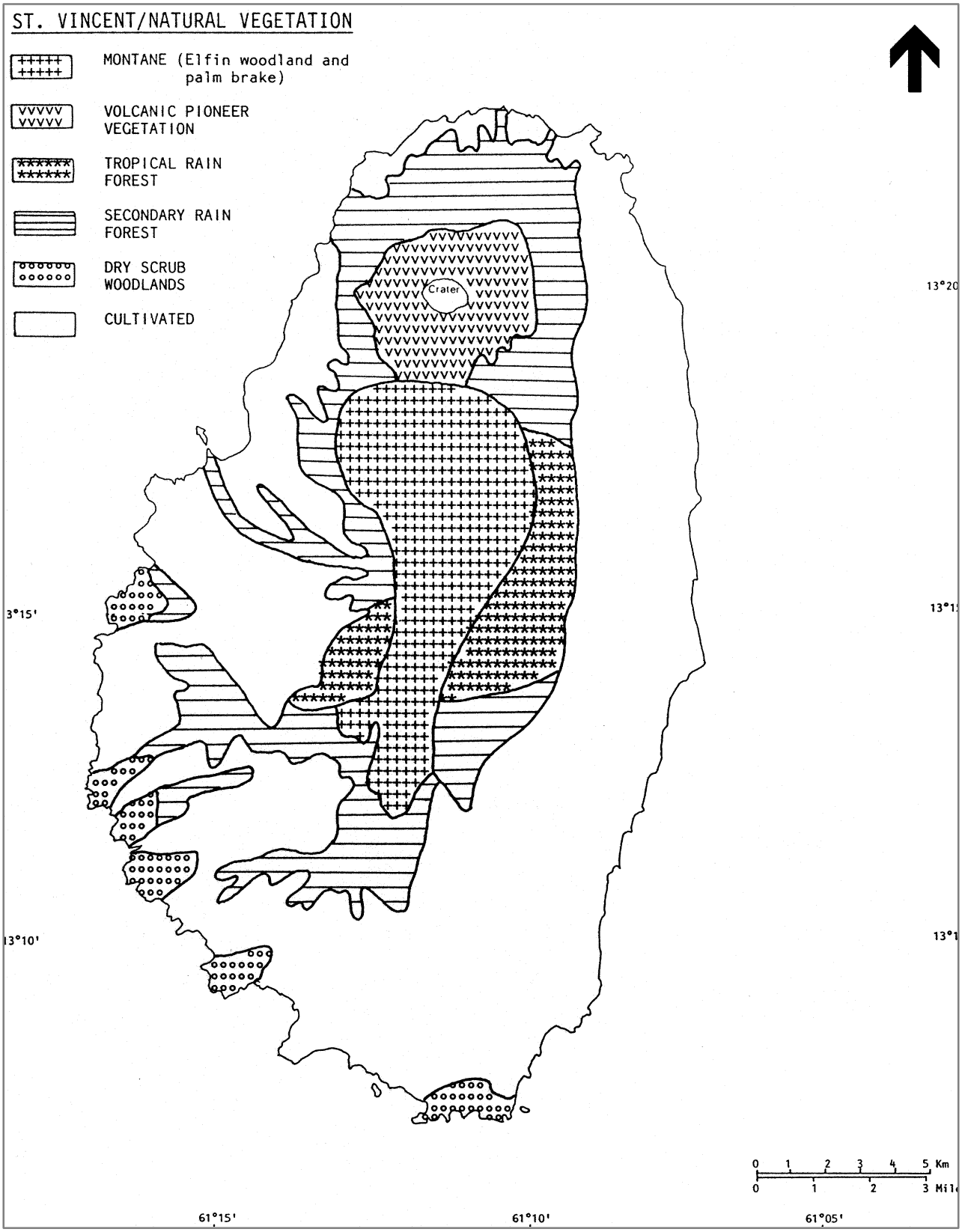
Since there are no domestic sources of fossil fuels, imports are necessary to meet the bulk of current energy requirements. Petroleum products are distributed through private means. Alternative fuels have been considered, with some potential identified for solar collection, geothermal power generation, and wind power.

Land Use

The land area of St. Vincent and the Grenadines consists of 345 Km^2. Of that total 139 km^2 (40.3 percent) are allocated to agricultural use and 121 km^2 (35 percent) are forestland (Map 2-3). The remaining land uses include natural vegetation (14.1 percent) and built area (10.1 percent). All figures are based on 1992 land-use patterns (SVGG, 1998).

Prime agricultural lands are located predominantly along the windward side of the island below the 1000-foot contour designated for agricultural use (Map 2-4). Built-up areas are primarily along the coast at lower elevations. The heaviest concentration of development is on the southern leeward side of the island in and around the capital, Kingstown. Recent development patterns are shown on Map 2.5, which indicates the change in built-up areas between 1981 and 1992. The heaviest concentration of new development is occurring around the capital city of Kingstown between Camden Park and Calliaqua.

Map 2-3: Natural Vegetation of St. Vincent



Distribution of natural vegetation in St. Vincent, circa 1983 (source: Talbot, 1983. In: CCA, 1990)

Agriculture, Industry, and Tourism

Primary agricultural products include bananas, mangos, coconuts, citrus fruit, and root crops including arrowroot, dasheen, eddoes, yams, and sweet potatoes. Bananas continue to be the most important agricultural commodity, with 8,000 acres allocated to fresh banana production. They account for 65.7 percent of agricultural exports, down from 92.6 percent in 1990, when fresh banana exports were valued at EC$170 million.

St. Vincent is the world's largest producer of arrowroot, which is used for flour, meal, and starch. Collectively, root crops are important domestically and for export to neighboring Caribbean islands. Industrial activity consists of food processing, metals fabrication, furniture, clothing, and starch production.

Tourism activity in St. Vincent and the Grenadines has lagged behind than in other Caribbean destinations. Inaccessibility and a lack of white sandy beaches, particularly on St. Vincent, have proved to be problematic. Still, visitor arrivals have increased by 37.1 percent since 1990. The greatest increases have occurred in Bequia and Canouan in the Grenadines, where visitation is up two- and three-fold, respectively.

Projects Related to Climate Change

Several recent projects have set the stage for this project. A thorough environmental profile of St. Vincent and the Grenadines was compiled in 1990 by the Caribbean Conservation Association (CCA) with funding from the U.S. Agency for International Development (USAID). This project was one of six environmental profiles compiled for Eastern Caribbean countries to provide a basis for sustainable development. In addition, a vulnerability study supported by the Organization of OAS identified and mapped areas of particular concern. That study provides an initial foundation for the vulnerability assessment within this project.

In 1994, a National Environmental Action Plan (NEAP), which examined legal instruments and institutions, was prepared. The plan establishes environmental priorities including solid-waste management, land-use planning, coastal and marine resources management, water pollution, noise pollution, and national parks and protected areas. The plan also provides a strategy for environmental action.

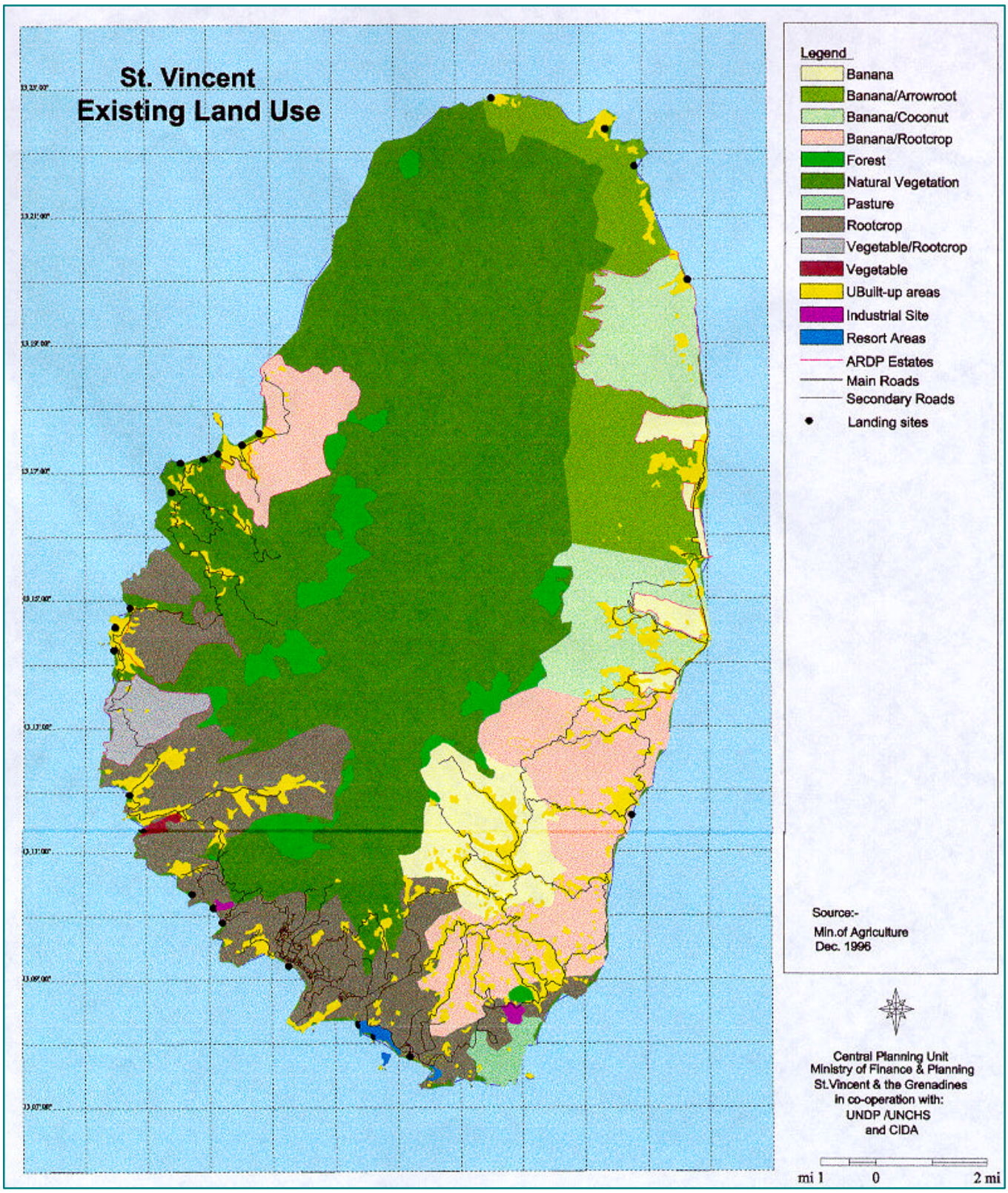
A recent assessment of distillate-fuel generating options for St. Vincent and the Grenadines concluded that in terms of energy alternatives, geothermal energy might be useful for meeting new power requirements based on physical capacity and economic feasibility. Still, geothermal energy is a long way from commercial reality. Solar collectors have been used for some time for localized power generation and hot-water heating. Alternative energy options will be explored still further as a means of meeting long-term energy needs in the country.

National Institutions Dealing with Climate-Change-Related Issues

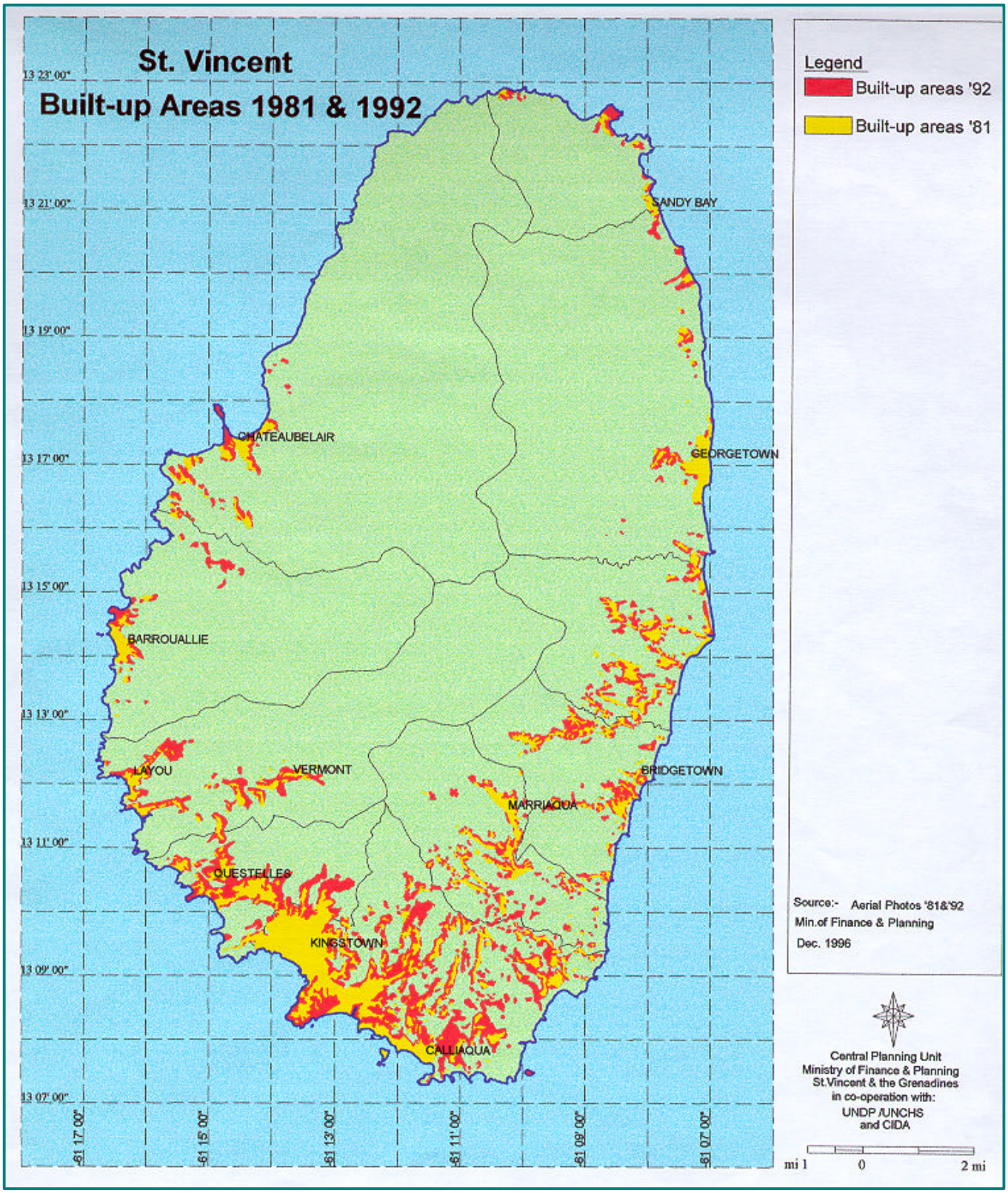
St. Vincent and the Grenadines has assigned staff and resources from the Ministry of Health and the Environment to implement the Climate Change Work Programme. A National Environmental Advisory Council has been established. The Council members and their affiliations are listed below and at the beginning of this document.

Environmental Services Coordinator, Dr. R. Murray; Solicitor General, Mr. D. Browne; The Town Planner, Mrs. E. Mwakosya; Director of community services, Mrs. R. Snagg; Director of Fisheries, Ms. R. Kirby; The Chief Agriculture Officer, Mr. P. Isaacs; Director of Forestry, Mr. N. Weekes; Representative of the National Trust, Mr. M. Baisden; President of National Youth Council, Mr. I. Bruce; Representative of the National NGO, (position rotated).

Map 2-4: Land Use by Type



Map 2-5: Built Up Areas 1981 and 1992



GREENHOUSE-GAS INVENTORY

The signatories to the UN Framework Convention on Climate Change have agreed to:

- To develop, update periodically, publish, and make available to the UNFCCC Conference of Parties (COP) their national inventories of anthropogenic emissions by sources and removals by sinks of all GHG not controlled by the Montreal Protocol; and

- To use comparable methodologies for inventories of GHG emissions and removals, to be agreed upon by the COP (UNFCCC, 1992).

To fulfil this requirement, St. Vincent and the Grenadines compiled a greenhouse-gas inventory based on the Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories. The objectives of the IPCC GHG inventory programme are:

- To develop and refine an internationally agreed methodology and software for the calculation and reporting of national GHG emissions;

- To encourage widespread use of the methodology by countries participating in the IPCC and the Parties to the UNFCCC; and

- To establish a data management system for the collection, review, and reporting of national data (IPCC, 1996).

Because St. Vincent and the Grenadines served as a pilot project under CPACC for GHG emissions, the inventory process began earlier there than in the other CPACC participating countries except The Bahamas. Some additional effort was expended on interviews with individual sectors about their energy use and technology. Emissions were estimated for the baseline years of 1990 and 1994 as well as for 1997, to track change over time.

An initial workshop was conducted from 2 to 4 November 1998 in St. Vincent to describe the development of the National Communication on Climate Change. Particular attention was given to the development of the GHG inventory. The first day of the workshop provided a general overview for participants from government, industry, and the national press. The second and third days were hands-on technical sessions targeted toward domestic consultants and ministry personnel actively committed to gathering inventory information. Representatives from Trinidad and Tobago and Barbados participated in the workshop as observers.

Site visits began following the workshop, on 5 and 6 November, beginning with energy suppliers, larger industrial plants, and agricultural operations. Interviews continued into early 1999, with data entry and analysis conducted through the middle of the year.

IPCC workbooks and the accompanying spreadsheet computer files were used for data entry and emissions calculation. The approach used two basic methodologies. The first is the reference approach, which calculates both CO_2 and non-CO_2 emissions on the basis of energy consumption by fuel type. The sectoral approach calculates emissions by industrial sector. The sectors for which emissions are calculated are:

- Energy,
- Industrial processes,
- Agriculture,
- Land-use change and forestry, and
- Waste.

The procedure is iterative: cells in individual sectoral tables are cross-referenced to summary tables by sector and emission type.

Energy Utilization

St. Vincent and the Grenadines has no fossil fuel stocks; the country is entirely dependent on imported supplies. Electricity is generated by St. Vincent Electricity Services Limited (VINLEC). As indicated in Table 3-1, the sources for electricity generation are diesel fuel and hydropower. In 1990, the mix between diesel- and hydro-generated electricity was split 53 to 47 percent. By 1997, the mix had shifted toward a greater dependence on diesel generation, with a split of 73 to 27 percent. While hydropower generation has decreased, partly because of water constraints, diesel power generation has more than doubled during this period. Overall, total electricity consumption increased by 56.3 percent between 1990 and 1997.

Table 3-1: Electricity Generation by Power Source for 1990, 1994, and 1997 (kilowatt hours)

	Diesel Fuel		Hydropower	
Year	Consumption	% of total	Consumption	% of Total
1990	27,110,442	52.8%	24,221,370	47.2%
1994	43,435,020	67.5%	20,939,201	32.5%
1997	58,549,117	73.0%	21,669,350	27.0%

Source: VINLEC, 1999.

Figures 3.1–3.3 indicate fuel consumption by type for the years 1990, 1994, and 1997. Gas/diesel oil accounts for roughly half of fuel consumption, ranging from a high of 46.4 percent in 1990 to 45.4 percent in 1997. Although the relative share of diesel oil decreased in the fuel mix, the absolute level of consumption increased by 27.0 percent from 1990 to 1997. The bulk of diesel fuel is used for power generation. Gasoline accounts for slightly over a third of fuel consumption, ranging from 35.6 percent in 1990 to 36.1 percent in 1997. In absolute terms, gasoline consumption increased by 34.0 percent during this time. Most of the increase in gasoline consumption continues to be generated by transportation demand. LPG accounts for most of the remainder of fuel imports, ranging from 9.6 to 12.0 percent . LPG consumption increased by 60.3 percent from 1990 to 1997, with use concentrated in the residential and commercial sectors (Tables 3-2 and 3-3).

Figure 3.1: Fuel Consumption in 1990

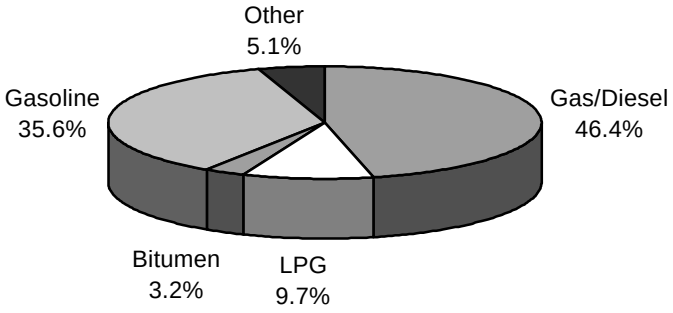


Figure 3.2: Fuel Consumption in 1994

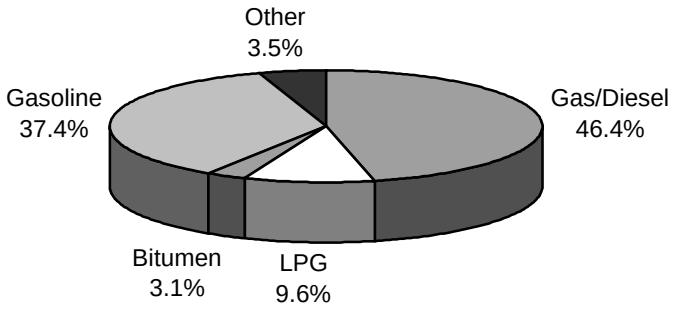


Figure 3.3: Fuel Consumption in 1997

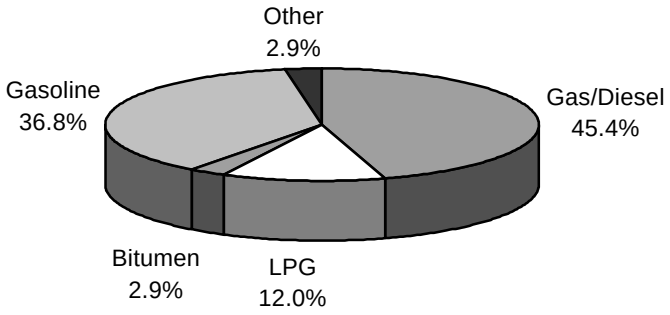


Table 3-2: Fuel Consumption by Type in 1990,1994, and 1997 (kilotonnes)

Fuel Type	1990	1994	1997	Change 1990-94	Change 1990-97
Gas	9.91	12.07	13.29	21.7%	34.0%
Jet kerosene	0.43	0.62	0.89	44.5%	1.0%
Other kerosene	0.55	0.40	0.26	-26.6%	-52.3%
Gas/diesel	12.91	14.99	16.39	16.2%	27.0%
LPG	2.71	3.11	4.34	14.9%	60.3%
Bitumen	0.88	0.99	1.02	12.6%	16.4%
Lubricants	0.41	0.57	0.52	39.7%	26.3%
Total	27.82	32.79	36.73	17.9%	32.0%

Table 3-3: Relative Share of Fuel Consumption by Type in 1990,1994, and 1997

Fuel Type	1990	1994	1997
Gas	35.7%	36.8%	36.2%
Jet kerosene	1.6%	1.9%	2.4%
Other kerosene	2.0%	1.2%	0.7%
Gas/diesel	46.4%	45.7%	44.6%
LPG	9.7%	9.5%	11.8%
Bitumen	3.2%	3.0%	2.8%
Lubricants	1.5%	1.8%	1.4%
Total	100.0%	100.0%	100.0%

Carbon Dioxide Emissions

Carbon-dioxide emissions from the energy sector were estimated using the reference approach that converts fuel consumption to heat energy (terra joules) and carbon content. CO_2 emissions are indicated in absolute and relative terms in tables 3-4 and 3-5, respectively. The proportion of emissions by fuel type for 1990, 1994, and 1997 is indicated in Figures 3.4-3.6.

Total CO_2 emissions increased by 32.0 percent from 82.1 to 108.3 gigagrams (Gg) between 1990 and 1997. In terms of relative contributions, diesel fuel accounted for half of CO_2 emissions, ranging from 50.0 percent in 1990 to 48.1 percent in 1997. Gasoline accounted for between 37.2 and 37.7 percent of CO_2 emissions over this period. LPG was the only other significant contributor, with proportions ranging from 9.8 to 11.9 percent between 1990 and 1997.

Table 3-4: Carbon Dioxide Emissions by Fuel Type for 1990,1994, and 1997 (gigagrams)

Fuel Type	1990	1994	1997	Change 1990-94	Change 1990-97
Gas	30.49	37.11	40.86	21.7%	34.0%
Jet kerosene	0.23	0.44	0.81	96.7%	257.8%
Other kerosene	1.77	1.30	0.84	-26.6%	-52.3%
Gas/diesel	41.02	47.65	52.08	16.2%	27.0%
LPG	8.05	9.25	12.90	14.9%	60.3%
Lubricants	0.60	0.84	0.76	39.7%	26.3%
Total	82.15	96.60	108.25	17.6%	31.8%

Table 3-5: Proportion of CO_2 Emissions by Fuel Type for the Years 1990,1994, and 1997

Fuel Type	1990	1994	1997
Gas	37.1%	38.4%	37.8%
Jet kerosene	0.3%	0.5%	0.8%
Other kerosene	2.2%	1.3%	0.8%
Gas/diesel	49.9%	49.3%	48.1%
LPG	9.8%	9.6%	11.9%
Lubricants	0.7%	0.9%	0.7%
Total	100.0%	100.0%	100.0%

Figure 3.4: CO2 Emissions for 1990

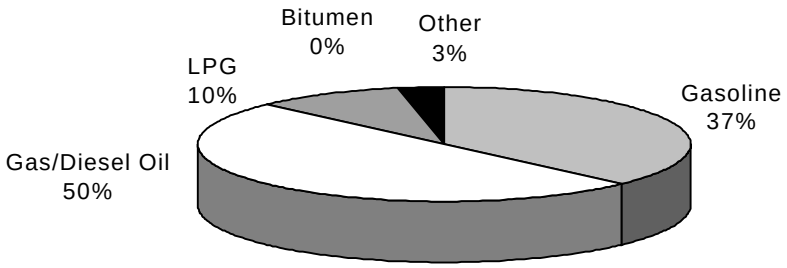


Figure 3.5: CO_2 Emissions in 1994

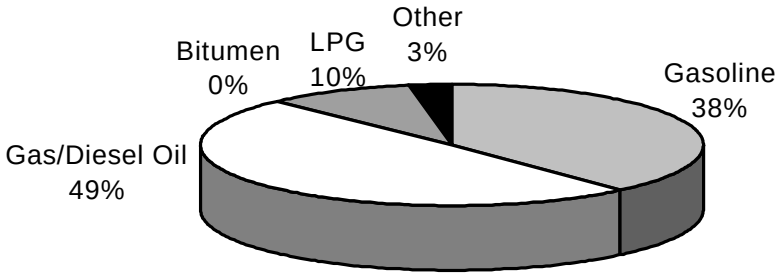
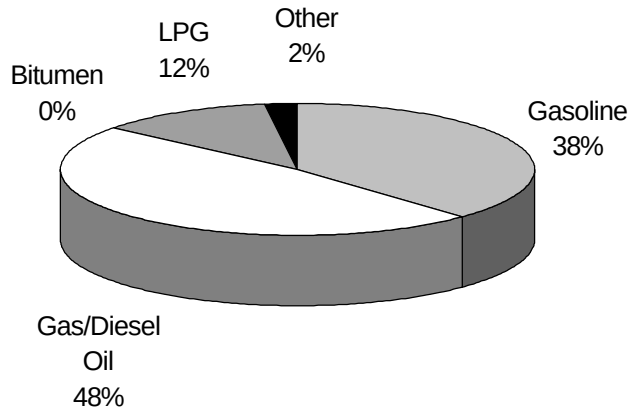


Figure 3.6 CO_2 Emissions for 1997



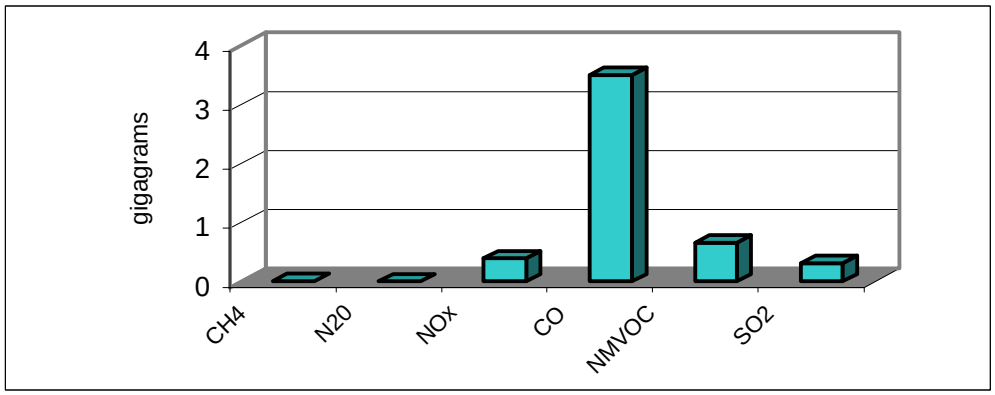
Non-CO_2 Emissions

Energy-derived non-CO_2 emissions for the years 1990, 1994, and 1997 are indicated in Table 3-6. Between 1990 and 1997, emission increases ranged from 26.7 percent for sulfur dioxide (SO_2) to 34.5 percent for methane (CH_4). Figure 3-7 compares the emission levels of each of these five greenhouse gases for the year 1994. Emissions range from 0.0006 Gg for nitrous oxide (N_2O) to 3.5088 Gg for carbon monoxide (CO) using 1994 figures.

Table 3-6: Non-CO_2 Emissions for 1990, 1994 and 1997 (gigagrams)

Emission	1990	1994	1997	Change 1990-94	Change 1990-97
CH_4	0.0093	0.0112	0.0125	20.3%	34.5%
N_20	0.0005	0.0006	0.0007	18.4%	30.6%
NO_X	0.3316	0.3981	0.4340	19.6%	31.9%
CO	2.8835	3.5088	3.8608	21.3%	34.0%
NMVOC	0.5414	0.6588	0.7246	21.6%	33.9%
SO_2	0.2538	0.2949	0.3216	16.2%	26.7%

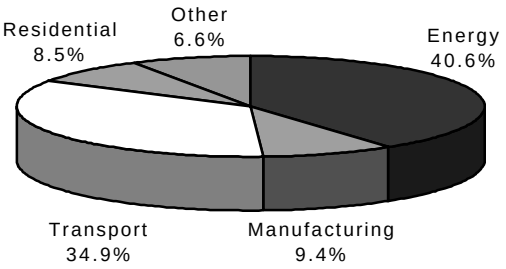
Figure 3-7: Non-CO_2 Emissions for the Year 1994



Energy Use by Sector

Figure 3.8 depicts energy use by sector for the year 1994. The primary sectors in terms of fuel consumption were energy and transportation sectors. Energy accounted for 40.6 percent of fuel use. Transportation accounts for most of the remaining fuel consumption, accounting for 34.9 percent of total use in 1994.

Figure 3-8 Fuel Consumption by Sector for the Year 1994



As indicated in Tables 3.7 - 3.9, the energy sector depends heavily on diesel fuel for power generation. Although its relative share has dropped slightly during this period, the consumption of diesel fuel was up by 26.9 percent from 1990 to 1997.

The transport sector is heavily dependent on gasoline and to a lesser extent on diesel fuel. Gasoline consumption in the transport sector increased by 34.0 percent over the seven years from 1990 to 1997. Of the remaining sectors, manufacturing and residential are the next highest energy users, each at or just below 10 percent of the energy mix. The manufacturing, residential, commercial and agriculture sectors are more dispersed in terms of fuel use, although LPG accounts for the bulk of residential consumption.

CO_2 Emissions by Sector

Using the sectoral approach, CO_2 emissions are up from 83.7 Gg in 1990 to 110.4 Gg in 1997. CO_2 emissions by sector are indicated in Figure 3.9 for the year 1994. Using 1994 figures, the energy sector is the largest contributor of CO_2 emissions with a relative share of 42.8 percent. Transportation contributes just over a third of CO_2 emissions accounting for 35.7 percent of the total. Other sectoral shares in order of CO_2 emissions include residential (9.3 percent), manufacturing (6.4 percent), commercial (3.9 percent) and agriculture, forestry and fisheries (3.0 percent). A detailed breakdown of CO_2 emissions by sector is provided in Tables 3.10- 3.12.

Table 3-7: Fuel Consumption by Sector for the Year 1990

Fuel	Energy	Mfg.	Transp.	Comm	Resid'l	Agric./ Forest./ Fish.	Bunkers	Total
Gasoline		0.174	8.732	0.343	0.058	0.581	0.032	9.919
Jet Kerosene			0.124				0.311	0.435
Other Kerosene		0.297		0.097	0.160	0.000		0.554
Gas/Diesel Oil	10.974	1.156	0.257	0.119		0.064	0.341	12.911
LPG		0.136		0.407	2.169			2.712
Bitumen		0.884						0.884
Lubricants	0.096	0.044	0.071	0.058		0.102	0.043	0.413
Other					0.014			0.014
Total	11.070	2.690	9.184	1.024	2.387	0.746	0.726	27.828

Table 3-8: Fuel Consumption by Sector for the Year 1994

Fuel	Energy	Mfg.	Transp.	Comm	Resid'l	Agric./ Forest./ Fish.	Bunkers	Total
Gasoline		0.212	10.629	0.418	0.071	0.707	0.039	12.074
Jet Kerosene			0.040				0.101	0.141
Other Kerosene		0.218		0.071	0.118	0.000		0.407
Gas/Diesel Oil	12.750	1.343	0.299	0.138		0.074	0.396	15.000
LPG		0.156		0.467	2.493			3.117
Bitumen		0.995						0.995
Lubricants	0.134	0.061	0.099	0.081		0.142	0.060	0.577
Other					0.009			0.009
Total	12.884	2.985	11.066	1.176	2.681	0.923	0.595	32.311

Table 3-9: Fuel Consumption by Sector for the Year 1997

Fuel	Energy	Mfg.	Transp.	Comm	Resid'l	Agric./ Forest./ Fish.	Bunkers	Total
Gasoline		0.233	11.704	0.460	0.078	0.778	0.042	13.295
Jet Kerosene			0.254				0.636	0.890
Other Kerosene		0.142		0.046	0.076	0.000		0.265
Gas/Diesel Oil	13.932	1.468	0.326	0.151		0.081	0.433	16.391
LPG		0.217		0.652	3.477			4.346
Bitumen		1.028						1.028
Lubricants	0.122	0.056	0.089	0.073		0.128	0.054	0.522
Other					0.016			0.016
Total	14.054	3.143	12.373	1.382	3.631	0.988	1.165	36.736

Table 3-10: CO_2 Emissions by Sector for the Year 1990 (gigagrams)

Fuel	Energy	Mfg.	Transp.	Comm	Resid'l	Agric./ Forest./ Fish	Bunkers	Total
Gasoline		0.534	26.839	1.058	0.178	1.785	0.097	30.491
Jet Kerosene			0.392				0.982	1.374
Other Kerosene		0.946		0.309	0.492	0.175		1.922
Gas/Diesel Oil	34.867	3.673	0.816	0.378		0.203	1.083	41.020
LPG		0.403		1.208	6.440			8.051
Bitumen								0.00
Lubricants	0.140	0.064	0.337	0.084		0.148	0.063	0.836
Other					0.043			0.043
Total	35.007	5.620	28.384	3.034	7.154	2.311	2.224	83.737
Percentage	42.95%	6.89%	34.82%	3.72%	8.78%	2.84%		100.00%

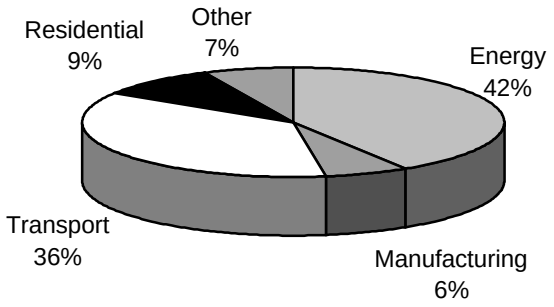
Table 3-11: CO_2 Emissions by Sector for the Year 1994 (gigagrams)

Fuel	Energy	Mfg.	Transp.	Comm	Resid'l	Agric./ Forest./ Fish.	Bunkers	Total
Gasoline		0.650	32.669	1.285	0.217	2.172	0.118	37.111
Jet Kerosene			0.183				1.265	1.448
Other Kerosene		0.695		0.227	0.361	0.175		1.458
Gas/Diesel Oil	40.508	4.267	0.948	0.439		0.236	1.258	47.656
LPG		0.463		1.388	7.402			9.253
Bitumen								0.00
Lubricants	0.196	0.090	0.144	0.118		0.207	0.087	0.842
Other					0.028			0.028
Total	40.704	6.164	33.945	3.457	8.008	2.791	2.728	97.796
Percentage	42.82%	6.48%	35.71%	3.64%	8.42%	2.94%		100.00%

Table 3-12: CO2 Emissions by Sector for the Year 1997 (gigagrams)

Fuel	Energy	Mfg.	Transp.	Comm	Resid'l	Agric./ Forest./ Fish.	Bunkers	Total
Gasoline		0.716	35.973	1.414	0.240	2.391	0.129	40.863
Jet Kerosene			0.802				2.007	2.809
Other Kerosene		0.452		0.146	0.233	0.175		1.006
Gas/Diesel Oil	44.265	4.664	1.036	0.480		0.257	1.376	52.078
LPG		0.644		1.936	10.322			12.902
Bitumen								0.00
Lubricants	0.177	0.082	0.083	0.106		0.187	0.079	0.714
Other					0.049			0.049
Total	44.441	6.558	37.894	4.082	10.845	3.010	3.590	110.421
Percentage	40.25%	5.94%	34.32%	3.70%	9.82%	2.73%		100.00%

Figure 3-9: CO_2 Emissions by Sector for the Year 1994



Industrial Processes and Construction

St. Vincent and the Grenadines has a relatively small industrial base. Although it has metals fabrication, the country produces no primary metals. Chemicals and building materials are imported as well. The primary sources of greenhouse gases from the industrial and construction sectors are food and beverage manufacturing and road paving.

Table 3.13 indicates non-methane volatile organic compounds (NMVOCs) from the food and beverage sector. NMVOCs are produced as part of the fermentation process in the production of alcoholic beverages. Among alcoholic beverages, rum production accounts for nearly all these emissions. Beer production on the island, by comparison, accounts for less than two percent of NMVOCs from the beverage industry. In food production, bread production provides the bulk of NMVOC generation. Still, the emissions from food processing are relatively small. A much larger proportion of NMVOCs is emitted by road paving (Table 3.14), which accounted for between 44.4 and 61.5 Gg of NMVOCS for the study years.

Table 3-13: NMVOC Emissions for Food and Beverages for 1990,1994, and 1997 (gigagrams)

	1990	1994	1997
Alcoholic beverages	0.082	0.105	0.119
Food production	0.057	0.070	0.069
Total	0.140	0.174	0.188

Table 3-14: NMVOC Emissions for Road Paving

	1990	1994	1997
Road paving	44.39	52.22	61.53
Total industrial and construction	44.53	52.40	61.72

Agriculture

Agriculture is an important part of the economic base for St. Vincent and the Grenadines. The primary sources of greenhouse gases from the agricultural sector are:

- Emissions from grazing animals,
- Prescribed burning of savannas,
- Emissions from agricultural residues, and
- Emissions form agricultural soils.

Table 3.15 shows methane emissions from enteric fermentation from domestic livestock for the year 1994. Given its geographic size, the country maintains a fairly large population of sheep, pigs, non-dairy cattle, and goats and a very large poultry population. Total methane emissions from livestock are estimated to be 0.62 Gg per year, more than half of which are generated by cattle.

Table 3-16 indicates methane and nitrous oxide emissions from domestic animals for the years 1990, 1994, and 1997. Annual methane emissions range from 0.62 to 0.67 Gg. Nitrous oxide emissions are comparatively small as most of the non-poultry livestock are kept in paddocks and pastures rather than confined spaces. N_2O emissions are estimated to range from 513 to 728 grams a year.

Table 3-15: Methane Emissions from Enteric Fermentation from Domestic Livestock for the Year 1994

Livestock Type	Population	Enteric Fermentation	Manure Management	Total (Gg)
Non-dairy cattle	6,300	308.7	6.3	0.315
Sheep	1,500	75	3.15	0.078
Goats	5,500	27.5	1.21	0.029
Swine	9,300	9.3	18.6	0.028
Poultry	270,000	0	6.21	0.168
Totals			36.49	0.618

Table 3-16: Methane and Nitrogen Emissions from Grazing Animals (gigagrams)

	1990	1994	1997
CH_4	0.629	0.618	0.669
N_20	5.128*10(-7)	6.237*10(-7)	7.277*10(-7)

Table 3.17 indicates emissions from field burning of savannas. This practice is not used extensively; only an estimated 10 to 20 hectares a year were burned in the years 1997 and 1990, respectively. As a result, total emissions are relatively small. Carbon monoxide emissions range from 0.0023 to 0.0044 Gg per year, and methane emissions from 86 to 169 Kg per year.

Table 3-17: Emissions from Prescribed Burning of Savannas (gigagrams)

	1990	1994	1997
CH_4	0.000169	0.000163	8.581*(-5)
N_2O	2.09*10(-6)	2.018*10(-6)	1.062*10(-6)
NO_X	7.676*10(-5)	7.292*10(-5)	3.838*10(-5)
CO	0.00443	0.00428	0.00225

Emissions from agricultural residues are shown in Table 3.18. Little field burning occurs; most crop residue, particularly from banana fields, is left as ground cover and nutrient supply. Some variation

occurs between years as a result of restructuring and shifts in crop varieties. Emissions from nitrogen oxides range from 25.4 to 28.5 Gg, and carbon monoxide emissions from 14.9 to 16.7 Gg per year.

Table 3-18: Emissions from Field Burning of Agricultural Residues (gigagrams)

	1990	1994	1997
CH_4	0.636	0.568	0.613
N_2O	0.787	0.703	0.759
NO_X	28.451	25.407	27.424
CO	16.698	14.911	16.095

Nitrous oxide emissions from soils are influenced principally by synthetic fertilizer, animal manure, nitrogen-fixing crops, and crop residue. Overall, nitrous oxide emissions from agricultural soils have decreased from 0.0094 to 0.0067 Gg primarily because of a decrease in the application of synthetic fertilizer (Table 3-19).

Table 3-19: Nitrous Oxide Emissions from Agricultural Soils (gigagrams)

	1990	1994	1997
N_20	0.0094	0.0080	0.0067

Land Use Change and Forestry

St. Vincent and the Grenadines has extensive forestlands estimated at 12,689 ha based on a reinterpretation of 1982 photo images and spot sampling, which is down slightly from earlier estimates by Birdsey, et al. (1984) (SVG Forestry Division, 1993). An estimated 7,759 ha are classified as rainforest; the remaining forestland consists primarily of dry scrub woodland and regeneration areas, with elfin woodland and palm brake primarily in the central mountain range. Using conservative annual growth rates as indicated in Table 3.20, it is estimated that total carbon uptake for forestlands amounts to 60.9 kt carbon per year. That uptake results in an annual carbon dioxide sink of 223.5 Gg. Due to lack of information at this time, no estimates were made for carbon uptake from non-forest trees.

Table 3-20: Annual CO_2 Removal from Forestlands (gigagrams)

Species	Forest Area (ha)	Annual Growth Rate (t dm/ha)	Change in Biomass (kt dm)	Total Carbon Uptake (kt C)	Total CO_2 Removal (Gg CO_2)
Primary Rainforest	4,308	12.5	53.85	26.93	98.74
Mixed Softwoods	3,451	10.0	34.51	17.26	63.29
Mixed Hardwoods	4,930	6.8	33.52	16.76	61.45
Total	12,689			60.94	223.45

It is estimated that 250 ha are converted from forests to development annually (FAO, 1993). Because these figures are annual rates over the past 20 years, individual figures are not provided for each of the study years. Total annual carbon release from land clearing is estimated at 24.5 kt, as indicated in Table 3.21. Annual carbon dioxide emissions are estimated to be 89.7 Gg. Net removals from forestry and land-use practices are estimated to be 133.7 Gg annually (233.5-89.7 Gg).

Table 3-21: CO_2 Emissions from Land-Use Change and Forestry (gigagrams)

Vegetation Type	Annual Loss of Biomass (kt dm)	Total Annual Carbon Release (kt C)	Total Annual CO_2 Release ($GgCO_2$)
Wet/Very Moist	0.24	24.06	88.20
Moist, long dry season	0.01	0.41	1.51
Total	0.25	24.47	89.71

Based on that rate of land conversion, annual GHG emissions are estimated to include 0.60 Gg of carbon monoxide, 0.07 Gg of methane, and .02 Gg of nitrogen oxides, as indicated in Table 3.22.

Table 3-22: GHG Emissions from Land-Use Change and Forestry (gigagrams)

	Emissions
CH_4	0.0685
CO	0.5997
N_2O	0.0004
NO_X	0.0170

Waste

The two primary sources of emissions from waste products are municipal solid waste and human waste. There are currently seven solid-waste-disposal sites on St. Vincent. Four of them are managed; the largest at Arnos Vale. Three are unmanaged. Three managed sites are operating in the Grenadines at Bequia, Canouan, and Union Island. Methane emission estimates are shown in Table 3-23. Annual methane emissions from solid waste disposal range from 32.8 to 34.5 gigagrams, an increase of 5.2 percent over this period.

Table 3-23: Methane Emissions from Municipal Solid Waste for 1990, 1994, 1997 (gigagrams)

Emissions	1990	1994	1997	Change 1990-97
MSW Disposal	32.79	34.47	34.50	
Methane Emissions	1.683	1.769	1.771	5.22%

St. Vincent and the Grenadines does not have wastewater-treatment facilities for either municipal or industrial purposes. The largest remaining waste-generated emission is nitrous oxide from human sewage. Given annual protein intake of 18.47 kg per capita, it is estimated that nitrous oxide emissions from human sewage range from 0.00499 to 0.00526 Gg between 1990 and 1997, also a 5.2 percent increase reflecting population change over this period (Table 3.24).

Table 3-24: Nitrous Oxide Emissions for Human Sewerage for 1990, 1994, and 1997 (gigagrams)

Emission	1990	1994	1997	Change 1990-97
N_2O	0.0049	0.0052	0.0052	5.23%

Total GHG Emissions

A summary of greenhouse gas emissions for the years 1990, 1994, and 1997 is given in Table 3.25. Carbon dioxide from energy consumption actually increased by 31.1 percent from 81.5 to 106.8 Gg between 1990 and 1997. Still, those figures represent a comparatively small fraction of CO_2 emissions worldwide. Given global estimates of 583,852 Gg of CO_2 emissions in 1994, SVG accounts for 0.016 percent of total emissions.

Summary inventories by sector for each of the three study years are shown in Tables 3.26-3.28. The overall level of CO_2 emissions is impacted by an estimated 133.7 Gg in net carbon dioxide removal from land clearing and uptake from forestlands. Because this figure is based on long-term trends, the same figure is used for each of the study years. On balance, when carbon sinks are included due to forestlands, St. Vincent has a negative contribution to global CO_2 emissions. No offsets are included for coral reefs that had been a part of earlier IPCC methodological discussions.

Methane, nitrous oxide, nitrogen oxides, and carbon monoxide have remained fairly constant over the study period. Emissions related to energy use and waste have increased, but the bulk of emissions for all four of these constituents are generated from agricultural activity. Agriculture remains an important part of the economic base, but its relative importance has decreased along with some shift in crop production due in large part to the downturn in the banana market.

The relative share of emissions from these four compounds attributed to agriculture range from 39.1 percent for methane to 98.4 percent for N_2O and 99.9 percent for NO_x. Sulfur dioxide emissions are more of a local or regional problem. SO_2 emissions range from 0.25 to 0.32 Gg.

Most industrial and construction emissions are non-methane volatile organic compounds from road paving. The figure for land-use change and forestry is again annualized, reflecting a long-term trend in land conversion. Waste from solid waste and untreated sewage continues to increase, reflecting an increase in population, and represents over half of all methane emissions.

Table 3-25: Total Greenhouse Gas Emissions for 1990, 1994, and 1997 (gigagrams)

	Emissions							Sink
Year	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2	CO_2**
1990	81.51	3.026	0.803	28.79	20.18	45.07	0.254	133.7
1994	95.07	3.035	0.712	25.82	19.02	53.05	0.295	133.7
1997	106.83	3.135	0.772	27.87	20.55	62.44	0.322	133.7

* * Net CO_2 removals from land conversion and uptake from forestlands. No differentiation is given between study years as the figure is based on a 1993 forest inventory and long term land conversion trends.

Table 3-26: Summary Report for National Greenhouse Gas Inventory for 1990 (Gg)

Greenhouse Gas Source And Sink Categories	CO_2 emissions	CO_2 removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total emissions and removals	81.51	133.7*	3.026	0.803	28.79	20.18	45.07	0.254
Energy	81.51		0.0093	0.0005	0.332	2.88	0.541	0.254
Industrial processes	0	0	0	0	0	0	44.53	0
Solvent and other product use	0	0	0	0	0	0	0	0
Agriculture	0	0	1.265	0.797	28.45	16.70	0	0
Land-use change and forestry	0	133.7*	0.069	0.0005	0.017	0.599	0	0
Waste	0	0	1.684	0.0049	0	0	0	0
Other	0	0	0	0	0	0	0	0
International bunkers								
Aviation	1.24		6.937E-06	2.775E-05	0.0042	0.0014	0.0007	0
Marine	0		0	2.775E-05				0

* Net removal due to forestry and land use practices including emissions from land conversion and removals from forestlands.

Table 3-27: Summary Report for National Greenhouse Gas Inventory for 1994 (Gg)

Greenhouse Gas Source And Sink Categories	CO_2 emissions	CO_2 removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total emissions and removals	95.07	133.7*	3.035	0.712	25.82	19.02	53.05	0.295
Energy	95.07		0.011	0.0006	0.39	3.50	0.65	0.295
Industrial processes	0	0	0	0	0	0	52.39	0
Solvent and other product use	0	0	0	0	0	0	0	0
Agriculture	0	0	1.186	0.711	25.40	14.91	0	0
Land-use change and forestry	0	133.7*	0.069	0.0005	0.01	0.59	0	0
Waste	0	0	1.769	0.005	0	0	0	0
Other	0	0	0	0	0	0	0	0
International bunkers								
Aviation	1.58		1.418E-05	5.672E-05	0.0085	0.0028	0.0014	0
Marine	0		0	5.672E-05				0

* Net removal due to forestry and land use practices including emissions from land conversion and removals from forestlands.

Table 3-28: Summary Report for National Greenhouse Gas Inventory for 1997 (Gg)

Greenhouse Gas Source And Sink Categories	CO_2 emissions	CO_2 removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total emissions and removals	106.83	133.7*	3.135	0.772	27.87	20.55	62.448	0.322
Energy	106.83		0.013	0.0007	0.43	3.86	0.725	0.322
Industrial processes	0	0	0	0	0	0	61.724	0
Solvent and other product use	0	0	0	0	0	0	0	0
Agriculture	0	0	1.282	0.765	27.42	16.09	0	0
Land-use change and forestry	0	133.7*	0.069	0.0005	0.017	0.59	0	0
Waste	0	0	1.771	0.005	0	0	0	0
Other	0	0	0	0	0	0	0	0
International bunkers								
Aviation	1.58		1.418E-05	5.672E-05	0.0085	0.0028	0.0014	0
Marine	0		0	5.672E-05				0

* Net removal due to forestry and land use practices including emissions from land conversion and removals from forestlands.

VULNERABILITY TO CLIMATE CHANGE

Prospects for Climate Change

Over the past two decades the consensus within the atmospheric science community has concluded that we are in fact in a period of accelerated global warming. This position was established in a report of the U.S. National Academy of Sciences (NAS, 1979) and recently confirmed in reports of the Intergovernmental Panel on Climate Change (IPCC, 1991, 1993, 1995).

The planet has been warming since the end of the Last Ice Age, approximately 15,000 B.C., when average surface temperatures were 9^{o}C colder than today. After a period of rapid global warming, temperatures stabilized to a moderate warming trend around 5,000 B.C. It is no coincidence that the rapid transformation of civilizations with stable agricultural conditions and the rise of city-states began shortly after this time.

The dawn of the Industrial Age brought about unprecedented social progress but also a substantial increase in the emission of greenhouse gases that increase the earth's capacity to trap infrared radiation. The single largest contributing factor has been the emission of carbon dioxide from the burning of fossil fuels. Other important greenhouse gases include methane, nitrous oxide, chlorofluorocarbons, hydrogenated chlorofluorocarbons, and ozone. Uncertainty exists as to the magnitude and timing of change, but the most often cited impact of an effective doubling of pre-industrial concentrations of CO_2 in the atmosphere is an average change in surface temperature of 3^{o}C +/- 1.5^{o}C (NAS, 1979, and NRC, Board of Atmospheric Sciences and Climate, 1991). IPCC's Scientific Panel is using 2-4^{o}C (IPCC, 1991, 1993), while the general circulation models (GCMs) have been using 1.9-5.2^{o}C (NAS, 1991).

To put these figures in context, surface temperatures have risen an average of 0.6^{o}C over the past hundred years and by 0.1^{o}C over the most recent decades. Since accurate and consistent records began in 1880, according to NASA Goddard Institute for Space Studies (GISS) surface-temperature readings, the 12 warmest years on record have come since 1981. The seven warmest years on record have been during the 1990s, with 1998 the hottest year to date and 1999 not far behind. It is hard to extrapolate long-term change from short-term observation, and the planet has over time experienced far greater variability. Still, it is likely that over the next century the earth will experience the most rapid warming event since the beginning of human civilization as we know it.

The climate-change scenarios indicated above are estimated using Global Circulation Models (GCMs). The most often cited GCMs are:

- Goddard Institute for Space Studies (GISS) (Hansen et al., 1983);
- Geophysical Fluid Dynamics Model (GFDL) (Mitchell et al., 1990);
- Canadian Climate Centre Model (CCCM) (Boer et al., 1992);
- United Kingdom Meteorological Office (UK89 and UKMO) (Mitchell et al., 1990 and Wilson and Mitchell, 1987);
- Geophysical Fluid Dynamics Laboratory (GF01) (Gates et al., 1992); and
- Oregon State University (OSU) (Schlesinger and Zhao, 1988).

Most GCMs have been run to estimate current climatic conditions ($1xCO_2$) and climate change resulting from an effective doubling of CO_2 in the atmosphere ($2xCO_2$). Regional models that are physically consistent with projected global temperature change can be and have been simulated. A significant problem with the use of GCMs for country or regional assessments is the level of resolution inherent in the models that ranges from $2.22^{o}x3.75^{o}$ to $7.83^{o}x10.0^{o}$ (USCSP, 1996). That level of resolution essentially lumps all or most of the Lesser Antilles together and may greatly misrepresent local conditions given the variability in precipitation patterns between the islands and the microclimates exist within them.

An alternative approach is to simulate incremental climate-change scenarios within feasible bounds. The most often used incremental change scenarios are + 2^{o} C temperature change and + 4^{o} C temperature

change, combined with rainfall scenarios of + 20 % change, + 10 % change, + 0 % change, - 10 % change, and - 20 % change.

Coastal Vulnerability

Although their contributions to greenhouse-gas emissions are relatively small, the Small Island Developing States (SIDS) are the most vulnerable group in the international community (IPCC, 1995). That grouping includes Pacific Ocean atolls as well as small Caribbean islands. SIDS are often low lying and depend heavily on coastal and marine resources. Even islands where changes in elevation are significant typically have a substantial share of their population and capital investment in nearshore areas. (CPACC, 1999)

There is a school of thought that the entire landmass of small island states constitutes the coastal zone. Acceptance of this definition requires an assessment of the entire island system in order to provide data on coastal resource vulnerability. This approach makes sense for St. Vincent and the Grenadines as it works toward the development of an integrated coastal management strategy. Still, for the purpose of this report, a cursory synopsis of SVG is presented followed by a more in-depth look at the immediate nearshore area -- the two miles landward and seaward of the high-water mark, referred to here as the coastal zone.

Coastal resources in this context fall into two categories: 1) natural resources, including fisheries, coral reefs, sand, mangroves and near-shore vegetation, and 2) built-up resources, including hotels, homes, jetties, roads, airports, and supporting infrastructure. For SIDS, the most significant coastal vulnerability is likely to be sea-level rise. Coastal systems are inherently dynamic, adapting both to long-term climatic change and to periodic events such as coastal storms, droughts, and shifts in energy flows. During the last Ice Age sea-level rise is estimated to have been up to 100 m lower than present elevations, while seas were 5 to 6 m higher during the last interglacial period. (Warrick et al., 1993). Following rapid sea-level rise from about 15,000 to 7,000 years ago, sea level has stabilized with a general tendency toward moderate erosion. Over the past 1,000 years, sea-level rise has been in the order of 0.1-0.2 cm/year (Warrick et al., 1993).

The IPCC projects sea-level rise by the year 2100 to be 65 cm, with an uncertainty range of 30 to 110 cm (IPCC, 1991, 1993a). The coastal vulnerability pilot project for Barbados, Grenada, and Guyana that was part of CPACC projected a rise of 5.0 mm/year (50 cm by the year 2100) with an uncertainty range of 2.0-9.0 mm/year. Although these figures are conservative relative to IPCC projections, they are still two to five times the rate experienced over the last 100 years (CPACC, 1999). Still, the confidence interval remains large and some regional variability will occur due to tectonic movement and land subsidence. For SVG, tectonic movement does not appear to be an issue, and therefore the long-term trend is one of shoreline retreat.

The most likely impacts of accelerated sea level rise are:

- Increased coastal erosion,
- Inundation of low-lying coastal areas,
- Increased flooding and storm damage,
- Wetland loss,
- Increased salinity of surface and ground water, and
- Higher water tables.

Records from coastal surveys conducted by the Sea Grant College Programme based at the University of Puerto Rico show that the Caribbean region has a background level of 0.3m/yr coastal erosion. In St. Vincent, the Programme interacts with the Seismic Unit in the Ministry of Agriculture. Their records show an average of 1.6 m/yr erosion on sections of the windward side of the island for the last three years. Over the same period, Orange Hill along this stretch of the eastern shoreline recorded a total of 15m coastal erosion. The loss of an entire playing field at Sandy Bay on the northern coast of the island, an

Photograph 4-1: Shoreline Erosion at Sandy Bay

Photograph 4-2: Coastal Erosion at Orange Hill

old cemetery at Campden Park on the southwestern tip of the island, and the undermining of the South Leeward Highway at Layou all speak of rapid rates of coastal erosion and the loss of land to the sea (Photographs 4-1 and 4-2).

To establish baseline conditions and to monitor change over time, a sea-level/climate monitor was installed along the southwest coast of St. Vincent near the Coast Guard Station on December 4, 1998. This monitoring system is part of SVG's involvement in Component 1 of the CPACC's regional initiative. Although the monitoring system will provide long-term benefit with real-time climate data, the ten months of data generated so far by this unit fall far short of the data set required for scientific modeling and assessment.

To address immediate needs, a vulnerability screening assessment was conducted between September 13 and 17, 1999. All areas below the 10-foot contour line were surveyed. In St. Vincent and the Grenadines, the principal findings were as follows:

- The main population centres, housing 85 percent of the population, lie on a narrow coastal strip less than 5 m above sea level and less than 5 km from the high-water mark.

- The infrastructure to support these population centres -- roads, telephone and electricity lines, transmission centres, water lines, airports, and marine centres accounting for more than 80 percent of the island's total infrastructure base -- fall within this area.

- The built-up area accounting for 90 percent of the country's economic investment is situated in this narrow coastal band.

Accelerated sea-level rise will prove costly for the main island of St. Vincent where 90 percent of the population resides and where the bulk of infrastructure and development activity has occurred. Portions of all four airports of St. Vincent and the Grenadines (Arnos Vale, Canouan, Union Island, and Bequia) occupy coastal reclaimed lands making them extremely vulnerable to sea-level rise and storm surge.

Accelerated sea-level rise could prove particularly devastating to the Grenadines, which are highly dependent on tourism for their economic base. The islands and cays of the Grenadines are surrounded by clear, shallow waters with offshore reefs. Holiday resorts and population centres are located along the shoreline, with significant limitations on inland retreat. A 50 cm sea-level rise with increased ocean temperatures would create an ecological system inhospitable to the current socioeconomic lifestyle.

The assessment of the existing situation in St. Vincent and the Grenadines revealed a compromise in the integrity and resilience of coastal and marine ecosystems. Ill-conceived development schemes and overexploitation of coastal and marine resources coupled with the impacts related to urbanization and tourism have altered the natural coastal armour. As a result, coastal resources and infrastructure have become still more vulnerable to possible impacts of sea-level rise. Additionally, St. Vincent and the Grenadines, with its limited resource base, is ill equipped to handle existing environmental problems, let alone the compounding impact of accelerated sea-level rise. The situation is expected to worsen with the passage of time unless adaptive measures are taken in the near term.

The geomorphologic changes exhibited by the Vincentian coastline over the last ten years have been significant. The agents that have contributed to these are:

- Tropical storms,
- Beach-front construction,
- Sand mining, and
- Pollution.

Tropical Storms: The geographical location of SVG (61° W longitude and 13.1°N latitude) falls in the path of hurricanes and tropical storms originating in the Atlantic. Two main meteorological systems, the subtropical anticyclones and the inter-tropical convergence zone, influence local climatic conditions

(Photographs 4-3 and 4-4). Fortunately, because of the islands low latitude, most tropical storms originating along the west coast of Africa have drifted further north by the time they hit the Caribbean Sea. Between 1980 and 1990, five tropical storm systems of varying intensity affected SVG (Table 4-1), but none storms were direct hits. In 1980, storm surge from Hurricane Allen forced the village of Gorse to relocate inland after the destruction of several homes. The same storm damaged the entire eastern coastline.

Table 4-1: Tropical Storms Affecting St. Vincent and the Grenadines Over the Last Two Decades

Storm	Year
Allen	1980
Danielle	1986
Emily	1987
Isaac	1998
Arthur	1990
Lenny	1999

Although SVG did not receive any direct impact of the triple storm systems of 1995--Iris, Luis, and Marilyn--coastal areas received considerable damage from storm surge associated with these systems. Tailwinds from Iris caused more than EC$1 million worth of damage to the port of Kingstown, including the deep-water pier.

Even though SVG did not receive a direct impact from the very unusual Hurricane Lenny, damages caused by the storm system were significant. Not only did hurricane Lenny originate in the Caribbean Basin, but it did so late in the season (November 15-19, 1999). It traveled from west to east at low latitude and impacted countries far from its track. The hurricane reached a strong category 4 Saffir-Simpson scale with winds of 240 km/h. It caused a total of 13 deaths on several Caribbean islands (NOAA, 1999). Particularly in SVG, the hurricane produced flooding in coastal areas of the city, damaged a total of five houses, and washed away three houses and one shop. The National Disaster Coordinator estimated that total damage to houses, beaches, and the road network system was close to EC$386,250.00. The major damage observed was to the newly built EC$48.5 million Cruise Ship Complex in the capital. More than EC$2.5 million would be required to carry out restorative work to the complex (UWI, 1999).

Beachfront Construction/Infrastructure Development: In recent years, a number of significant public investments have occurred along the coast. In 1965, Kingstown was extended by the addition of approximately 20 acres of reclaimed lands. The new cruise-ship berth was constructed using further reclaimed land. West of Kingstown is the Ottley Hall Marina, a project valued over EC$110 million. Other substantial public investments include the container port at Campden Park, the largest industrial park in the country; fisheries development projects in Kingstown and Calliaqua; and the Coast Guard Base, also at Calliaqua area. Over the past 10 years, these projects total in excess of EC$180 million in public investment.

At the same time, there has been substantial private investment along the shoreline, especially on the west and south coasts of St. Vincent.

Sand Mining: Many of these recent coastal projects are already experiencing shoreline retreat. The use of structural solutions, including groynes and seawalls, interferes with sediment transport along the coastline and, with that, the shoreline stability of adjacent properties. This situation is exacerbated by the use of beach sand for building material. Traditionally, beach sand has been the only source of sand for concrete works in SVG. Over the past two decades, an escalation in sand mining has occurred due to expansion in the construction industry. This activity led to the destruction of sand dunes and the removal of sand at the high-water mark. At Diamond, on the eastern side of the island, front-end loaders even reached into the sea to extract sand.

Photograph 4-3: Storm Surge over new Cruise Ship Terminal

Photograph 4-4: Storm Debris near new Cruise Ship Terminal

Photograph 4-5: Sandy Bay

Note: Open drain with waste from the Sandy Bay Clinic -- passing outside the Sandy Bay Primary School

Photograph 4-6: Seawall along Villa Beach

In an effort to alleviate this problem, government is encouraging the importation of quarry sand from Guyana. This initiative has gained very little support from the Vincentian public, which still obtains 95 percent of the sand used in the construction industry from beach mining.

Pollution: Natural systems are resilient and can adjust within reasonable bounds to changing climatic conditions. The ability of natural systems to adapt will be influenced in part by the level of stress placed on the system by water-quality conditions. For St. Vincent and the Grenadines, water-quality levels are being affected by solid-waste disposal, wastewater discharge, urban and agricultural run-off, and shipping activity (Photograph 4-5).

The absence of a national sanitary landfill has resulted in several open dumps located without good siting criteria. Leachate from disposal sites damages groundwater as well as surface-water quality. In addition, waste debris blocks rivers and streams, causing flooding in coastal areas. Offshore impacts occur as floodwaters take sediments and plastics out to sea depositing them on reefs. A regional solid waste management study recently has been completed in an attempt to deal with this issue.

St. Vincent and the Grenadines has no a wastewater treatment system, a fact that has implications for ground and offshore water quality. Adding to the problem is non-point pollution from urban and agricultural runoff. In earlier times when population densities and discharges were lower, the issue was much less serious, given the assimilative capacity of the system. With increased waste loads, water quality is now a serious issue.

Coastal waters are further affected by ship-generated waste. Oil-based bilge and other waste are frequently spotted in coastal waters. Collectively, these conditions are already contributing to stress on natural systems. That stress will affect the productivity of coral-reef and mangrove systems, both of which have very specific demands in terms of water quality, water depth, and temperature. Climatic variability as well as pollution could severely affect the fishing industry, the second major source of employment in the Grenadines. Mainland St. Vincent could suffer as well.

Agricultural Vulnerability

Considerable uncertainty remains as to the aggregate and region specific impacts of global warming on agricultural productivity. The principal variables affecting agriculture include the following:

- CO_2 concentrations,
- temperature,
- solar radiation, and
- precipitation patterns.

The major effects of elevated CO_2 levels will be on photosynthesis and respiration which will in turn affect water use, crop development, and product quality. Higher levels of CO_2 are expected to be positive, with higher levels of dry plant-matter production. Increased levels of CO_2 in the atmosphere are projected to reduce water requirements by decreasing evapotranspiration per unit leaf area. Nitrogen fixation may increase or decrease resulting in a change in fertilizer application rates.

Higher temperatures will affect plant production. Although the more extreme temperature change is likely to occur in the polar extremes rather than in equatorial regions, higher temperature gradients are expected in the region. Productivity increases are more likely to occur in C_3 plants rather than C_4 plants because of both temperature and radiation tolerance. Native vegetation is expected to migrate owing to temperature change, which may create problems in small island settings. The migration of insect pests and crop diseases may accelerate this change. With agricultural crops, some flexibility in terms of cultivation technique and seed variety will be needed to adjust to changing climatic conditions.

Perhaps a more significant factor affecting productivity will be precipitation patterns. Considerable variation in rainfall patterns exists currently in the Caribbean region. Minor shifts in rainfall patterns could

turn comparatively wet islands into dry ones, with devastating impacts on agricultural productivity, given the low use of irrigation in the region. Comparatively wet islands like Dominica, St. Lucia, and St. Vincent that have a significant agricultural base could be particularly hard hit.

The general approach to anticipating agricultural vulnerability to climate change is to develop simulation models. The International Benchmark Sites Network for Agrotechnology Transfer – International Consortium for Application of Systems Approaches to Agriculture (IBSNAT-ICASA) offers a framework evaluation system for estimating agricultural vulnerability. The IBSNAT-ICASA model predicts crop yield as a function of factors that include genetics, climatic variables (maximum and minimum temperature, solar radiation, and precipitation), soils, and management approach. Similarly, the SPUR2 model estimates grassland and livestock productivity from plant growth, soils/hydrology, domestic animals, wild animals, and grasshopper submodels (USCSP, 1996).

A climate change simulation was conducted for Antigua and Barbuda using the FAO computer model Crop Wat. It uses a simple water balance/climate model with temperature and precipitation as the key independent variables. Sensitivity tests were conducted for important crops including cotton, onions, and vegetables, and for pasturelands. All the crops were shown to undergo a significant decline in productivity with temperature increase and precipitation decrease. Substantial decreases in productivity also occurred when only precipitation was decreased, at levels up to 20 percent. Under dry weather conditions, planting dates become important and irrigation water becomes still more necessary to maintain adequate crop yields (Kentish and Lewis, 1997). Some parallels to the St. Vincent case exist, although agriculture is less important on Antigua and Barbuda, where no substantial export commodities are grown and current precipitation levels are lower than in St. Vincent and the Grenadines.

The agricultural sector in St. Vincent and the Grenadines is particularly vulnerable both to natural conditions and to international trade arrangements. The phasing out of preferential access to European markets due to international trade agreements, stiff competition particularly from Central American plantations, and poor weather conditions have led to a fall in export earnings. Particularly hard hit has been the banana industry, in which export revenues fell from EC$170.3 million in 1990 to EC$20.2 million in 1995. These recent events point to volatility of the country's export sector. Unfavorable climatic conditions could be devastating to the banana industry and the agricultural sector as a whole.

Although agriculture now contributes only about 10.8 percent of the national GDP, down from 22 percent ten years earlier, its importance to national development is significantly greater. It employs approximately 8,500 persons, 30 percent of the workforce, growing more than half of the food consumed locally. Linkages to trade and transport sectors, including the port, make bananas vital to the country's economic base.

St. Vincent is the world's largest producer of arrowroot used for flour, meal, and starch. A reduction in rainfall also could affect other agricultural crops, including root crops that are important domestically and for export to neighboring Caribbean islands.

Forests cover approximately 28 percent of the island but contribute only 0.74 percent to the national GDP. In economic terms this relative contribution might be considered insignificant. However, the true value of forests is difficult to calculate, for it is the forest that constitutes and/or supports 65 percent of the national biodiversity, protects the many steep slopes from erosion, and maintains the surface water flow on which the country depends. The greatest threat to the valuable forest reserve of SVG is poverty. Unemployed persons engaged in survival activities (charcoal burning, farming, hunting) have destroyed 10 percent of the forest cover in the last eight years. The situation could have been worse but for an aggressive reforestation effort of the forestry division. The current loss of forest cover can be accelerated by climate change unless immediate action is taken vis-à-vis adaptation and mitigation measures.

Climate change with associated changes in precipitation and atmospheric CO_2 will result in changes in altitudinal zonation, species type, and vegetation type and location. Unfortunately, SVG is a consumer of propagative seed material. It does not at this time have any organised long-term plan to address possible climate change impacts to either its forestry or agriculture. The current reasoning is that of the country

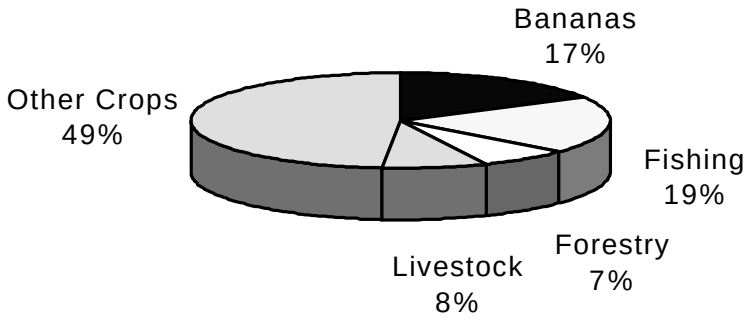
cannot afford research and development and therefore must buy its agricultural technology rather than develop it. This approach does not encourage the development of tissue culture or *in situ* seed banks; rather, it allows for plant germ-plasm exploitation and loss of native species.

There are no current circulation models appropriate for SVG, and the cost of developing such a model is beyond the financial scope of this project. Since, in addition, analogue scenarios are not appropriate for small island states, no climate-change scenario was used in this assessment. As a compensatory mechanism, some comparative analyses have been conducted pitting yields against rainfall for the past 15 years.

The Marine Areas Act (No. 15 of 1983) gives SVG an Exclusive Economic Zone (EEZ) of 200 nautical miles. The fisheries sector contributes 2 percent to the national GDP. Fisheries resources face serious threats from climate-change-associated impacts. Sea-level rise and increased ocean temperatures coupled with marine pollution will have substantial impact on the coral-reef system, mangroves, and sea-grass beds, which are the major nurseries of the fishing industry.

Figure 4-1 indicates relative shares of gross domestic product by sector for natural resource commodities. Agriculture accounts 74 percent of the total, followed by fisheries (19 percent) and forestry (7 percent).

Figure 4-1: Relative Share of Gross Domestic Product for Natural Resource Sectors, 1997



Biodiversity

A shift in altitudional zonation and land degradation occasioned by climate change is one of the major threats to biodiversity in St. Vincent and the Grenadines. Given the age of the island in geographic terms, it is easy to understand the fragility of its biological resources. For this reason, biodiversity conservation should be recognized as an integral aspect of environmental planning and management. Conservation in this sense refers to the management of human use of the biological resources in a manner that yields the greatest sustainable benefit to current and future generations. Conservation strategies should therefore address habitat loss and fragmentation, intensive monoculture agricultural system, loss of precipitation and fresh water resources, and atmospheric pollution by greenhouse gases. Proliferation of greenhouse gases leading to global warming will become a factor of increasing significance in the coming years. The projected temperature rise may result in displacement of the limits of tolerance of animal and plant species. Many species will be unable to redistribute themselves fast enough to keep up with projected changes. This change will mean extinction especially for species endemic to small island states (e.g the *Amazona guildingii*, the national bird of St. Vincent whose mode of distribution is still not understood).

Responsible action by the Department of Agriculture has lead to the development of a silviculture plan, which seeks to import new and more tolerant species of plants to protect the vital water catchment area. While such actions reflect human interference with biological diversity, it does take cognizance of the possible consequences of climate change. The condition also provides for addition of new genetic material to the rather small gene pool and the possible emergence of more resistance species.

In coastal waters, increase in temperature will lower the oxygen content and allow for growth of toxic algae and harmful bacteria that can destroy several species of fish. This scenario is currently being experienced in the southeastern Caribbean. The inundation of shallow reefs and mangroves will result in loss of breeding grounds and ultimately the loss of some species.

There is no exhaustive biodiversity study available for SVG. Several pieces of work exist and a National Biodiversity Strategy and Action Plan is now being developed. Habitat maps are unavailable and the lack of knowledge of the dynamics of these systems contribute to species vulnerability associated with climate change.

Water Resource Vulnerability

Hydrologic models exist at various levels of sophistication. Basic hydrologic models project streamflow using historical records. The independent variables most often used are temperature and precipitation applied by catchment basin. Other variables included in more detailed modelling include land cover, soils, and slope. Groundwater/surface water interface becomes important when projecting immediate streamflow under drought or floodwater conditions. Water-balance models relate water supply and demand conditions by basin, indicating areas of limited streamflow and potential stress. Among the more detailed models are the Stanford, Sacramento, and U.S. National Weather Service models (Todini, 1988).

Despite the level of sophistication of the current generation of hydrologic models, they may disguise temporal and spatial imbalances. Monthly reporting will substantially underestimate the immediate effects of short-term water shortages. Furthermore, despite disaggregation to basin-level reporting, the models still may mask stress in sub-basins subject to low flow or heavy water demand.

Mainland St. Vincent boasts an abundance of surface water in rivers and streams, while the Grenadines experience severe shortages due to the limited supply of surface or groundwater. Fresh water in the Grenadines is obtained mainly from rainwater runoff. Some water is imported, and the remainder is obtained from desalination plants.

Although there has been no significant decline in precipitation in SVG over the last ten years, normal flow volumes in streams and rivers have diminished. This situation is due largely to deforestation and construction activity that facilitates excessive runoff and little soil penetration. Additionally, competition for fresh water is increasing. Population growth, industrial development, irrigation, and electric power generation are all demanding an increasing quota of this limited resource.

Table 4-2 indicates primary water uses by watershed. Competing uses include domestic water use, hydroelectric demand, and irrigation. Any significant decrease in precipitation will severely affect development in SVG. The loss of hydropower-generating capacity will result in decreased productivity or greater reliance on diesel power. Diesel power translates into a loss of foreign exchange and an increase in CO_2 production, with ripple effects on agriculture and environmental quality.

Sea-level rise will push salt water inland along low-lying river valleys like the Buccamnet Valley, affecting agricultural activities and displacing the community dependent on them.

Table 4-2: Primary Water Use by Watershed

Major Watersheds	Water Use
Cumberland	Hydropower generation; domestic use
Buccament	Domestic; limited irrigation
Majorca	Domestic
Montreal	Domestic; limited irrigation
Colonarie	Hydropower generation; domestic use
Rabacca	Irrigation

CLIMATE CHANGE RESPONSE STRATEGY

Policy Response

Having signed the UNFCCC, recognizing the vulnerability of island states to the possible impacts of climate change and being desirous of safeguarding the livelihood and the way of life of St. Vincent and the Grenadines, the Government has authorized the National Environmental Advisory Board (NEAB) to fill the role of national climate committee. This Board, under the auspices of the Ministry of Health and the Environment, is charged with reviewing all documents relating to climate change and providing a synopsis to the Minister of Health and the Environment, who takes environmental matters to Cabinet.

The Advisory Board is a coordinating body that, by virtue of its composition, brings an interministerial-intersectoral perspective to the implementation of policies relating to the environment. In its review of environmental policies, the Board pointed to the many interactions between policy areas at the national and local level. Environmental laws typically are developed on a sectoral basis and often result in overlapping jurisdiction with differing layers of enforcement. Examples of overlapping jurisdiction include ministerial responsibilities under the Central Water and Sewage Authority and Forest Resource Conservation Acts and oversight responsibilities of the Beach Protection and Fisheries Acts.

Still, the NEAB, as an advisory board lacks legal authority to execute environmental initiatives. There remains a need for a programme of environmental policy review to include evaluation, implementation, and enforcement. Such a programme is necessary to address both long-term and short-term natural resource issues.

With regard to climate change, the Board noted the findings of the screening assessment conducted as part of this project. The assessment examined possible impacts associated with climate change by type and severity of impact. The information provided by the screening assessment highlighted the following points:

1. The greatest possible distance inland is only nine miles from high-water mark.
2. Most economic development and human activities take place less than two miles from high-water mark.
3. The topography limits inland movement.
4. Fishing and marine-related activities constitute a major socioeconomic attraction.
5. Climate-change issues are neither well understood nor articulated by most Vincentians.

The Board concluded that the entire island state and its inhabitants are ill-prepared for the consequences of climate change.

The problem is further exacerbated by the incompatibility of roles that the country's natural resources are required to fulfill. For example, mangroves and coral reefs are the bulwark against natural disasters like hurricanes. They offer coastal stability and are the basis of marine productivity, high biodiversity, and tourism. Yet insufficient management attention and limited public understanding and appreciation of these roles are leaving these resources unprotected from development pressure. The screening assessment also revealed the need for better modelling and predictive capacity as a basis for an informed policy response to climate change.

In the light of all this, the screening assessors identified the following resources as being most vulnerable:

- Coastal resources,
- Water resources,
- Agricultural resources, and
- Energy resources.

All of these vulnerabilities exist currently on St. Vincent and the Grenadines as well as other countries of the region. Small island developing states face significant problems in responding to climate change and sea-level rise. The orientation of the predominant economic activities to coastal waters makes island states particularly vulnerable to climatic change. In addition, the topography of volcanic islands such as St. Vincent often makes inland retreat almost impossible. Although these impacts are likely to become more severe over time as climatic conditions change, measures to address these vulnerabilities have immediate benefit, as physical and economic impacts are already being experienced.

Armed with the assessment report, the National Environmental Advisory Board (NEAB) formulated a strategic plan to address climate change issues over the next three years. The plan calls for the following:

- A national education programme (public awareness) to address climate change;
- Group consultations to involve diverse interest groups in the decision-making process;
- The preparation of a document on climate change specific to SVG;
- A review of national policies relating to climate change; and
- The implementation of adaptation and mitigation measures, to include a research and development component.

The plan of action laid out by the NEAB requires a participatory approach to the identification and implementation of adaptation and mitigation strategies. This approach will ensure ownership and acceptance of such strategies, thus making implementation more feasible.

The objectives of the plan are:

- To develop a proactive approach to climate-change issues, taking into account and complementary to national economic policies and plans, land-use plans, and sustainable use of natural resources;

- To identify and strengthen complementary linkages between climate-change responses and current sectoral policies;

- To identify barriers to climate responses and develop appropriate strategies to remove these barriers; and

- To develop education programmes and strengthen public involvement and institutional response to climate-change issues.

The fact that more than 80 percent of the island's economic activities take place along a narrow coastal strip makes it imperative that public officials and private developers perform the delicate balancing act of making the coast accessible to people while protecting them from the perils of the stormy sea. Policy makers are therefore caught in a dilemma. Should they restrict economic activities or protect the resource users? These issues are all too real in the Vincentian context.

Much of the problem is one of sending the right signals. Long-term solutions to address issues related to climate change must begin with a sound regulatory framework that establishes minimum performance standards. The approach also must include an incentive system that sends the right signals to individuals. Building in high hazard areas must be discouraged both by regulatory means and by appropriate risk bearing. People who build in flood plains, on steep slopes, or along erosional shorelines should be discouraged from doing so. A thorough vulnerability assessment with well-documented vulnerability maps should be developed to serve as a basis for this management framework. Yet ultimately, with basic information provided, individuals must bear the risk associated with building in high-hazard areas. A responsive insurance industry is part of the solution.

Incentives should also be employed to incorporate spillover costs associated with development into the decision-making process. Often individual actions have ramifications on adjacent properties. External costs must be internalized as part of an effective resource management approach. One of the components of the CPACC initiative is to explore still further means of incorporating economic incentives into resource-management decisions. Those instruments should be incorporated into land-use and coastal-management initiatives.

While there are no easy solutions to the foregoing problems, balance must be maintained between the objectives of economic development and environmental quality. Yet it is becoming more clear all the time that these objectives are inter-related. The economic base of SVG is closely tied to its resource endowment for agriculture, tourism, and fisheries. Sound resource management is basic to economic development potential.

At the final national workshop for this project, resource-management conflicts and high vulnerabilities were frequently mentioned. Participants stressed the need for effective land-use planning and the enforcement of existing laws, along with expansion of authority, particularly along the coast. The need to promote incentives for responsible development was also indicated as an important component of new land-use-planning initiatives.

The National Environmental Action Plan (NEAP) for St. Vincent and the Grenadines was implemented in 1994. But the policy matters included in it have not always been observed; hence its execution has often been sporadic and ineffective. A high priority must be to update NEAP to address coordination along with project review, information resources, and enforcement.

A policy review programme is only as good as the information on which decisions are based. The foundation of that information system is a good spatially based natural resource information system to establish current baseline conditions. A start on this information system is in place at the Department of Physical Planning although further development is needed. The second part of the information base requires a good monitoring system to track change over time. The climate-monitoring stations established under CPACC are a significant contribution in this regard, but better tracking of air and water quality and a change-detection system are necessary. The final piece of the information base is an assessment system to anticipate the impact of development as well as climatic change on natural systems.

Related to the issue of information systems is that of technology. Information technology is changing rapidly, and currency in hardware, software, and training is important in developing and maintaining a good information base. Technology is also important in promoting environmentally sensitive production processes. To achieve this end, research and development must be encouraged, applying appropriate technology to address both resource management and product development.

As was mentioned earlier, missing at this time is the legal authority for the execution of initiatives by the NEAB. A major limitation here is the constitutionality of the Board. Being an advisory body, the Board has neither the legal mandate nor the financial resources to facilitate project execution. The Board must take on the roles of coordination, long-range planning, and environmental oversight. Oversight responsibilities should relate to permitting of land development or modification, environmental impact assessment for large projects, and environmental audits, including the compilation of regular GHG inventories.

St. Vincent and the Grenadines has ratified several international environmental agreements and conventions. These agreements must be incorporated by legislation before becoming effective national laws. In some instances, the administrative procedures are more advanced than the legal arrangements that have been put in place to date. In other cases, there are several Acts of Parliament that seek to give some measure of protection to the environment but that lack enforcement.

The development of a compendium of environmental laws, acts, and regulations is a prerequisite for sound environmental management. Such a document will lend support to adaptation and mitigation

measures as they relate to climate change. The following agreements, singly or collectively, are supportive of adaptation measures for climate change and have all been signed by SVG:

The ***United Nations Framework Convention on Climate Change (UNFCCC 1992).*** This convention and its protocol seek to control the emission of greenhouse gases. The Government of SVG and the private sector are taking measures to reduce greenhouse-gas emissions.

The ***United Nations Convention on Biological Diversity (CBD 1992).*** This convention seeks to protect flora and fauna and their habitats from destruction by man. The Government of SVG is currently preparing its report on biological diversity as part of this convention.

The ***Basel Convention on the Control of Transboundary Movement of Hazardous Waste and their Disposal (1989).***

The ***Vienna Convention on the Protection of the Ozone Layer (1985).*** Protection of the ozone layer will reduce ultraviolet radiation. SVG has in place a programme to phase out the use of ozone-depleting substances under this convention.

The ***United Nations Convention on the Law of the Sea (UNCLOS 1982).*** This convention prescribes jurisdictional rule for the protection of the marine environment. UNCLOS obligates coastal member states to "protect and preserve the marine environment". This convention provides the framework for the Exclusive Economic Zone.

The ***International Convention for the Prevention of Pollution from Ships (MARPOL 1973).*** Enforcement of this convention will protect aspects of coastal resources against marine pollution.

The ***Town and Country Planning Act (45 of 1992).*** which makes provision to ensure orderly development of lands and the proper planning of town and country areas.

The ***Forest Resource Conservation Act of 1992***, which makes provision for the management and protection of forested areas.

The ***Fisheries Act of 1986***, which makes provision for the protection and management of fisheries and marine protected areas.

The ***Beach Protection Act of 1981***, which makes provision for the control of sand mining and the general protection of beach areas.

The ***Central Water and Sewage Authority Act of 1992***, which permits the protection of water resources related to water-supply needs.

Adaptation Measures

Before adaptation measures can be considered, a policy review must be initiated culminating in the reformulation of a National Environmental Policy Plan built on sound scientific principles and consistent with a viable long-range development agenda. The plan should incorporate a licensee system that binds developers to high environmental standards. Such an approach necessitates the existence of a sustainable development council or other monitoring agency with the necessary legal authority and administrative capability.

Specific adaptation measures to be pursued include:

- Revision and enforcement of the Town and Country Planning Act, establishing land use as a high priority with sound land-use controls along with flexibility to address the dynamic aspects of long-term shoreline retreat and climatic change.

- Strengthening of the building codes and the initiation of builder certification to assure that adequate construction standards are being met.

- The development of a thorough vulnerability assessment as a basis for land-suitability and hazard mapping.

- The formulation of a coastal management programme with permitting authority and incentive-based criteria for coastal development that sends the right signals to the development community.

- Agricultural reform that promotes a strong, viable agricultural base able to adapt to changing climatic conditions, including the development of *in situ* seed-bank and tissue-culture development centres for the preservation of plant genetic information.

- Protection of water-supply sources and improved harnessing and distribution systems to accommodate competing uses with increasing water demand and water supply variability.

- The enhancement of water quality, addressing municipal and industrial discharges and urban and agricultural runoff.

- An expansion of the country's environmental education programme that speaks to climate change, vulnerability, sustainability , human health, and safety.

- The provision of incentives for investment in renewable energy, including solar and wind energy and hydrogen-fuel-based transportation.

- The strengthening and equipping of the local vector-control unit to respond to expanding insect populations and the emergence or re-emergence of vector-borne diseases.

- Greater emphasis on heritage and eco-tourism to supplement beach tourism.

Mitigation Measures

GHG emissions in St. Vincent and the Grenadines are a comparatively small part of global emissions. However, any reduction in emissions is important in the global context. For this reason, SVG will seek to reduce emissions in individual economic sectors. This initiative would depend in large part on the development of appropriate technology to retrofit or replace existing operating systems.

Energy is the primary source of greenhouse-gas emissions in SVG. In recent years, a greater proportion of the energy mix has come from diesel power, and this trend is likely to continue, given increasing competition for water that may constrain hydroelectric capacity. Currently, diesel-powered electricity plants are being retrofitted through a bilateral arrangement with Canada. All existing plants are expected to achieve internationally accepted emission standards by the end of 1999.

In the transportation industry, the importation of used vehicles is a major concern, given their lower operating efficiencies. During the fiscal year 1998-99, government imposed a tax on aged vehicles to discourage importation. Still, the gap between import duties on new and used vehicles remains low and should be increased to reflect the full cost imposed by used vehicles. Used tyres also are imported. After their rather short life, they are burnt in the open air, inflating national emission levels. A total ban on the importation of used tyres is the most desirable corrective measure.

In addition to operating efficiencies in all sectors of the economy, energy conservation and alternative energy sources offer opportunity for emission reduction. Despite efforts to retrofit power plants, the demand for electricity has increased sharply in recent years owing in large part to air conditioning in hotels, public buildings, and individual residences. Many of these buildings were not designed, or not

adequately designed, for air-conditioning systems, and cooling efficiencies are low. Energy audits and design assistance appear to offer substantial long-run cost savings. Because of the country's dependence on and vulnerability to imported fossil fuels, alternative energy sources, including in particular solar and wind power, should be pursued in the energy sector along with hydrogen-based fuels in the transportation sector. Regional cooperation in research and development and public/private partnerships are essential.

In the area of carbon sequestration, the Forestry Division is aggressively pursuing the replanting of forests above the 1000-foot contour. However, this programme will only be as successful as economic development initiatives that seek to provide meaningful employment away from the hills. Additionally, hillside farmers are being encouraged to go the way of agro-forestry, planting fruit trees on slopes instead of root crops.

Constraints

Financial: Being a small island state with no mineral wealth, SVG has a rather weak and fragile economy. Many of the development needs of the island are therefore met through loans from international banking institutions. In many cases, loan conditions have proved to be counter-productive in the context of national-resource management because they fragment environment issues and initiatives.

Financial support provided under the UNFCCC and GEF is targeted to emissions reduction rather than climate-change vulnerability. As a consequence, small island states like St. Vincent and the Grenadines are eligible for a comparatively limited amount of assistance despite their very high degree of vulnerability.

Given the foregoing scenario and development pressures particularly along the coast, significant adaptation and mitigation measures are not likely to be initiated without targeted external funding.

Technical: Technical response to climate change and sea-level rise requires a cadre of skilled technicians, an accurate and extensive data-management system, adequate financial resources, the enthusiasm of an informed public, a private/public partnership, and the political will to marry and manage these resources.

At this time, SVG continues to lack many of the prerequisites for dealing effectively with climate-change issues, although some progress is being made. This project provided capacity building as domestic consultants, ministry officials, and private entities compiled an information base, greenhouse-gas inventory, and planning framework. Still, continued efforts to build local and regional capacity should be pursued. SVG will support the emergence of a Caribbean Climate Centre as an extension of CPACC. Such a centre would undertake modelling and facilitate technology adaptation for the entire sub-region.

Education, Training, Public Awareness

Under CPACC, SVG has initiated a public education programme targeting schools, NGOs, government departments and the private sector. As part of this initiative, the 1999 Secondary Schools Public Speaking Competition organised by the Ministry of Health and the Environment in conjunction with the Ministry of Education and the Lions Club South was built around climate change. In the finals, schools were asked to speak on The impact of Sea Level Rise on SVG. Approximately 400 persons attended the exercise while an estimated 60,000 followed it live on local television and radio. Since that event, service clubs, NGOs, and organised groups have been requesting information on climate change.
The NEAB plans to establish an education sub-committee to disseminate environmental information and develop a National Environmental Management Plan. However, this agency lacks at this time the legal and financial base to accomplish this task.

A number of secondary and tertiary institutions are including climate change in their options for research and class project development. Despite all these developments, the level of public awareness and public debates currently taking place is far from satisfactory, given the significance of climate change and sea level rise to sustainable development in SVG.

There are some training possibilities (short and long term) under CPACC, but these possibilities are too few at the present time to meet the needs of the island. The University of the West Indies (UWI) currently offers some courses in climate issues and hopes to improve its offerings in the next school year.

Climate issues are not formally included in the curriculum at the primary and secondary levels in SVG. However, the issues are articulated through programmes like the UNESCO Caribbean Sea Project, Vinci Nature Notes produced by the Forestry Department, beach clean-up activities for Youth Environment Service (YES) clubs sponsored by the Jems Environmental Management Services (JEMS), and various initiatives organised by the Ministry of Health and the Environment.

Project Development/Future Considerations

Accelerated climate change will have a substantial impact on small island states like St. Vincent and the Grenadines. It is imperative, therefore, that the country begins immediately to develop a National Environmental Policy Reform Project. Because vulnerabilities associated with climate change are already evidenced, adaptive and mitigative measures appear to offer positive net benefits even under moderate climate-change scenarios. The project should create and test innovative environmental policy initiatives and prepare a National Environmental Management Plan.

The project should include the following elements:

- An effective, ongoing information management system to provide a basis for decision making on resource management.

- The compilation of a thorough vulnerability assessment with sustainability indicators to serve as a basis for hazard and suitability mapping.

- Land-use controls for both interior and coastal regions, with both regulatory and incentive-based components to address development trends and dynamic natural conditions.

- A more stringent programme of building permit and builder certification programme to assure that adequate building standards are being met, so as to prevent loss of life and property.

- The promotion of energy conservation measures and the development of alternative energy options to reduce emissions and dependency on fuel imports.

- A disaster-management plan that addresses the training of local disaster committees, the preparation of disaster plans at the national and community levels, the development of mitigation plans, and the establishment of early warning systems.

- An expansion of the public-awareness programme on climate change that has become a model for the region.

Projects developed by SVG under climate change will seek to integrate environmental issues providing an effective way to bring pollution and natural resource management into the mainstream across sectoral activities. The approach also allows for an understanding of the contribution of environmental activities to the overall economic development agenda.

In developing these projects, SVG should seek linkages with regional and international initiatives such as the Small Island Development States (SIDS) Programme of Action, and continue working relationships

with CPACC and CDM. Indeed, Globalization is a reality not only from an economic perspective but in an environmental context as well.

In particular, the project is expected to increase general awareness and knowledge on climate-change-related issues in St. Vincent and the Grenadines and to strengthen the dialogue, information exchange, and cooperation among all the relevant stakeholders including government, non-government, academic and private-sector entities.

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