

Antigua and Barbuda's
Initial National Communication
on Climate Change

Office of the Prime Minister
St. John's
Antigua and Barbuda
May 2001

Prepared under UNDP Project ANT/97/GC2/99
Climate Change Project

ACKNOWLEDGEMENTS

The preparation of Antigua and Barbuda's Initial National Communications to the UNFCCC would not have been possible without the invaluable inputs and support of a number of individuals and agencies.

Appreciation is expressed to the consultants involved in preparing the technical documents, particularly Professor Bhawan Singh and Mr. Ernest Benjamin and Mr. Jerry Fernandez for the Vulnerability and Adaptation Study.

At the management and policy level, Mrs. Agnes James, Permanent Secretary in the Prime Minister's Office, has been consistently supportive of this effort and has used her good office to facilitate many of the contacts and linkages required. Mr. Eddison Nias, Administrative Assistant, provided logistical support.

Actual preparation of the document was undertaken by Mr. Colin Murdoch, supported by Miss Karen Cabral, who provided the secretarial support. Mrs. Annette Nias ably conducted final editing and publication of the document.

Appreciation is also extended to the participants of the UNFCCC National Workshop and Consultations held to prepare and review material for the enabling activity project and outputs.

Finally, appreciation also goes to Ambassador, Dr. John Ashe, who has provided steadfast encouragement and support to the National Communications from its inception.

Brian Challenger
Project Coordinator

April 2001

TABLE OF CONTENTS

Preface	v
Message from the Prime Minister	vi
Glossary of Acronyms	viii
Executive Summary	ix
Chapter 1. National Circumstances	2
1.1 Introduction	2
1.2 Socio-Economic Background	10
Chapter 2. National Greenhouse Gases Inventory	15
2.1 Introduction	15
2.2 Energy Sector	15
2.3 Industrial Sector	19
2.4 Agriculture Sector	20
2.5 Land Use and Forestry Sector	20
2.6 Waste Sector	22
2.7 Summary of Emissions/Removals	24
2.8 Sources of Uncertainty	25
2.9 Conclusions	27
Chapter 3. Mitigation Assessment	28
3.1 Introduction	28
3.2 Electricity	28
3.3 Renewable Energy	29
3.4 Transportation	30
3.5 Recommendations for Promoting GHG Mitigation	31

Chapter 4.	Climate Change Vulnerability and Adaptation	34
4.1	Introduction	34
4.2	Climate Change Scenarios	34
4.3	Baseline Socio-Economic Scenarios	36
4.4	Human Settlements and Tourism	37
4.5	Coastal Zones	39
4.6	Fisheries Sector	41
4.7	Agricultural Sector	44
4.8	Water Resources	45
4.9	Health Impacts	49
4.10	Conclusion	50
Chapter 5.	General Description of Steps Taken	51
5.1	Introduction	51
5.2	Research and Systematic Observation	51
5.3	Public Awareness	53
5.4	Capacity Building	54
5.5	Sustainable Development Initiatives	55
Chapter 6.	Financial and Technological Needs and Constraints	56
6.1	Integrating Climate Change into Development Planning	56
6.2	Climate Change, Public Awareness and Information	57
6.3	Promoting Sustainable Energy	57
6.4	Purpose-Built Storm Shelters	58
6.5	Prioritized Projects Requiring Financial Resources from the Global Environmental Facility	59
6.6	Establishment of a Caribbean Climate Change Centre	60

LIST OF FIGURES

1.1	Mean Maximum and Mean Minimum Temperatures (1969-2000)	6
1.2	Yearly Rainfall Totals (1960-2000)	7
1.3a	Annual Rainfall for V.C. Bird Airport (1960-1999)	8
1.3b	Annual Rainfall Averages for Antigua (V.C. Bird Airport, 1960-1999)	8
1.4	National Circumstances (1994)	11
1.5	Antigua and Barbuda Tourist Arrivals	11
1.6	Antigua and Barbuda GDP by Economic Sector	13
1.7	Select Economic and Social Statistics	14
1.8	Education Statistics	14
1.9	Vital Statistics	14
2.1	Supply (import) of Fuels for Antigua and Barbuda in 1990 and 1994	16
2.2	C02 Emissions from Energy Sources according to the Reference and Sectoral Approaches for Antigua and Barbuda (1990/1994)	17
2.3	C02 Emissions from Energy Sources and Fuel Combustion Categories	17
2.4	C02 Emissions from Energy Source and Fuel Combustion Categories	18
2.5	C02 Emissions from Memo Items (1990/1994)	18
2.6	Non-C02 Emissions from Fuel Combustion by Source Category (1990/1994)	19
2.7	Non-S02 Emissions from Fuel Combustion by Source/Category (1990/1994)	19
2.8	NM VOC Emissions from the Industrial Sector (1990)	20
2.9	CH4 Emissions from Animal Stocks in the Agricultural Sector (1990)	20
2.10	C02 Emissions and Removals and Net/Sink for Land Use/Forestry Sector	22
2.11	CH4 and N20 Emissions from the Waste Sector	23
2.12	C02 Emissions and Removals by Sector (1990)	24
2.13	Non-C02 Emissions and Removals by Sector (1990)	24
3.1	Electricity Sales (1995-1998)	29
4.1	Hurricane Scenarios for Antigua and Barbuda	35
4.2	Drought Scenarios for Antigua and Barbuda	35
4.3	Current Resources and Water Supply and Demand Situation	48

LIST OF TABLES

1.1	Location of Antigua and Barbuda in the Eastern Caribbean	1
1.2	Map of Main Infrastructure for Antigua and Barbuda	2
1.3	Annual Rainfall Distribution for Antigua and Barbuda	9
4.1a	Map Showing Locations of Main Reef Systems of Antigua	43
4.1b	Map Showing Locations of Main Reef Systems of Barbuda	43
4.2a	Location of Major Watersheds in Antigua	47
4.2b	Location of Major Watersheds in Barbuda	47

PREFACE

The Government of Antigua & Barbuda has undertaken the preparation of a programme of enabling activities aimed at supporting the fulfillment of certain obligations under the United Nations Framework Convention on Climate Change (UNFCCC). This Report constitutes the Initial National Communications in accordance with the Guidelines laid down by the UNFCCC Conference of Parties (COP) in decision 10/CP.2, and as required under Articles 4 and 12 of the UNFCCC.

The report constitutes one output of the programme of Enabling Activities being implemented by the Government of Antigua and Barbuda through the Office of the Prime Minister. This forms a part of project ANT/97/GC2/99 financed by the Global Environmental Facility (GEF) and implemented in conjunction with the United Nations Development Programme (UNDP).

In addition to its role in fulfilling Antigua and Barbuda's obligations under the UNFCCC the National Communications document is also intended as an information source to national stakeholders and other persons at regional and international levels interested in information pertaining to Antigua and Barbuda's fulfillment of its obligations under the UNFCCC.

MESSAGE FROM THE PRIME MINISTER

All concerned agree that climate change is a threat to mankind, and when it occurs its predicted effects will be severe. There is also agreement on the fact that responding to the adverse effects of climate change will be expensive, complicated, and difficult and that it is the most vulnerable countries that will suffer most. While there are those who doubt whether any problem exists at all, one thing is indeed certain: if the international community waits until the consequences and victims are clear, then it will certainly be too late to act.

As the ultimate arbiter of scientific information on climate change, the Intergovernmental Panel on Climate Change (IPCC) has presented evidence which has persuaded us that the global average sea level has risen by 10 to 25 cm over the past 100 years; and that it is likely that much of this rise is related to an increase in the lower atmosphere's global average temperature since 1860. Moreover, the IPCC's climate change models project that sea levels will rise another 15 to 95 cm by the year 2100.

Even with the most conservative of estimates, sea levels are expected to continue rising for hundreds of years after atmospheric temperatures stabilize, and coastal zones and small islands are extremely vulnerable. Since most are developing countries with weaker economies and institutions, they face the gravest risks, and would therefore be the most seriously affected.

As a small island developing State, Antigua and Barbuda stands to be devastated by sea level rise. Tourism is our dominant economic sector and accounts for more than 50 per cent of gross national product (GNP). This sector earns considerable foreign exchange that is used for imported food, fuel and a range of other vital goods and services; foreign exchange earnings from tourism also provides more than 50 per cent of our total revenues. Hence climate change and sea-level rise will affect our tourism directly and indirectly through the loss of beaches to erosion and inundation, salinization of freshwater aquifers, increasing stress on coastal ecosystems, damage to infrastructure from more frequent tropical storms, and an overall loss of amenities. This would undoubtedly jeopardize our economic viability and threaten the long-term sustainability of this important industry in our twin-island State. In short, our very survival as a nation and as a people would be threatened.

In keeping with our commitments under Articles 4.1 and 12.1 of the Convention, we have produced our First National Communications containing our efforts to address the adverse impacts of climate change, sea level rise and environmental degradation.

The Government and people of Antigua and Barbuda in their quest for sustainable development, understand

and appreciate that their natural resources, although finite, can still be productive if they are given proper care and wisely managed. We are prepared to do our part to limit even further our miniscule contributions to those activities which are linked to climate change and sea level rise. We therefore call on partners in the industrialized countries, who bear the brunt of the responsibility for the climate change problem, and who are legally bound to honour their legally binding commitments under the Convention, to undertake meaningful actions aimed at addressing the root causes of climate change, in particular through substantial domestic actions. Finally, we urge them to provide the necessary financial resources and to effect the transfer of environmentally sound technologies to countries such as my own, to enable us to fulfill our commitments under the Convention in a timely manner.

Lester Bird
Prime Minister

GLOSSARY OF ACRONYMS

UN	United Nations
IPCC	Inter-Governmental Panel on Climate Change
CPACC	Caribbean Planning for Adaptation to Climate Change
OECS	Organization of Eastern Caribbean States
AOSIS	Association of Small Island States
SIDS	Small Island Developing States
OAS	Organization of American States
CDM	Clean Development Mechanism
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
GEF	Global Environmental Facility
GHG	Greenhouse Gases
NODS	National Office of Disaster Services
DCA	Development Control Authority

EXECUTIVE SUMMARY

BACKGROUND

The archipelagic state of Antigua & Barbuda is located approximately midway in the Caribbean chain of islands at 17° N and 62°W. Geographically, the islands are low-lying with the primary environmental influence being the Atlantic Ocean and the Caribbean Sea. Climatic features include relatively high and uniform temperatures throughout the year and steady easterly trade winds. Both islands are among the driest in the eastern Caribbean. Recent years have seen a dramatic increase in the frequency of hurricane activity and impacts.

The marine and coastal environment is particularly important to Antigua and Barbuda. Mangroves, coral reefs and sea-grass beds are among the principal eco-systems in the country's coastal and marine areas. These eco-systems sustain Antigua & Barbuda's sandy beaches and fisheries resources and serve as protective barriers against tropical storm and hurricane activity.

With a population of approximately 70,000 people and a small, open economy, Antigua and Barbuda constitutes one of the smallest and most vulnerable States in the world. Over the past thirty years, tourism has become the dominant sector of the economy. Cruise tourism is an especially strong sub-sector, assuming an increasing share of the tourism market. At present, the tourism sector is estimated to constitute over 60% of GDP. Other principal economic sectors include construction, commercial activities, agriculture, transport and communications.

NATIONAL INVENTORY OF GREENHOUSE GASES

An Inventory was conducted of the following Greenhouse Gases – Carbon Dioxide (CO₂), Methane (CH₄), and Nitrous Oxide (N₂O), Non Methane Volatile Organic Compounds (NMVOC), Carbon Monoxide and Nitrogen Oxide. The Inventory utilized the IPCC 1996 Revised Guidelines. The GHG Inventory was done on an individual sector basis for the Energy, Industrial Processes, Agriculture, Land-use Change and Forestry, and Wastes sectors. The reference year was 1990, with data from 1994 also used for the Energy sector.

Data analyses show that CO₂ emissions in the energy sector totaled 288.3Gg for 1990 and 334.40 for 1994. Of these CO₂ emissions, the greatest proportions result from the combustion of Residual Fuel Oil (45.2 % in 1990 and 46.9 % in 1994), used exclusively for thermal electricity production, from Gas/Diesel Oil (29.2 % in 1990 and 27.6 % in 1994), used for electricity generation and road vehicular transport, from Gasoline (22.3 % in 1990 and 22.1 % in 1994), for vehicular road transport, mainly, and agriculture and fishing. Small amounts

of CO₂ emissions also result from LPG use (3.3 % in 1990 and 3.4 % in 1994) primarily in the residential sector.

CO₂ Emissions and Removals by Sector

For 1990, emissions from Memo Items, primarily international aviation bunkers, totaled 167.30Gg, rising to 230.79 Gg in 1994.

Methane is the only significant greenhouse gas emitted from the Agricultural sector and derives from enteric fermentation (1.06Gg) and manure management (0.5Gg).

Data analyzed for 1990 shows a reduction of 219.19 Gg due to growth changes in forest and woody biomass stocks and a further removal of 0.90 Gg of CO₂ due to re-growth by the abandonment of managed lands. On the other hand forest and grassland conversions account for 123.26 Gg of CO₂ emissions from burning and decay of biomass. This results in a net removal/sink of 96.83 Gg of CO₂ from the Land-Use Change and Forestry sector.

In the Wastes sector GHG emissions derive from methane from waste disposal sites and nitrous oxide from sewage. An overview summary of Antigua and Barbuda's national Greenhouse Gas Inventory is provided below.

As is typical of small-island developing States, Antigua and Barbuda therefore makes a miniscule contribution to global levels of greenhouse gas emissions.

VULNERABILITY AND ADAPTATION

Antigua and Barbuda are small islands where pressure to subdivide land for housing, tourism development, agriculture and quarrying, is mounting exponentially with increasing population and economic activity.

The country's natural climate is punctuated by the occurrence of a range of extreme climatic events such as tropical storms, hurricanes, sea surges, floods and droughts. Of these events, hurricanes, which recently have been occurring more frequently in the Caribbean, have caused the greatest impact, causing loss of life and damage to property, environment, and critical facilities; their dangers arise from a combination of factors that characterize hurricanes (high winds, heavy rainfall and storm surge).

Utilizing IPCC scenarios for sea-level rise, air and sea surface temperature increases, and rainfall variability, as well as projections for increased hurricane activity impact, the results of the Vulnerability and Adaptation assessment point to possible severe negative impacts on a number of key sectors and geographical areas.

In the coastal areas these include destruction of critical mangrove, sea grass and coral reef ecosystems from sea-level rise, hurricane activity and temperature changes. This will have important implications for the country's vital tourism industry. Experiences from recent hurricanes, notably Hurricane Luis in 1995 and Hurricane Lenny in 1999, point to their devastating economic effects. Areas particularly at risk to sea-level rise include sections of the capital city of St. Johns, Barbuda, Parham, and the northwest coast where significant tourism development exists. Additionally, these and a number of other areas are likely to be at increased risk of storm surge, including important coastal roads and other economic infrastructure.

Water supply is also another sector likely to be directly affected by climate change. Reductions in rainfall are likely to reduce surface and ground water availability. Increased rainfall, particularly if in the form of torrential downpours, is likely to produce landslides and soil erosion as well as damage water intakes and flood residential and commercial areas.

Water availability will be a critical factor affecting the viability of the agricultural sector. Experiences from hurricane activity and drought in the 1990's demonstrate the continuing vulnerability of agricultural production in Antigua and Barbuda to extreme weather events; conditions that would be expected to intensify with global climate change.

The health sector is also likely to be adversely affected by changes in the hydrological cycle. Likely impacts of the scenarios include increased opportunities for breeding of dengue- and malaria-carrying insect vectors, both diseases being endemic to the Caribbean. Other health risks associated with the scenarios include increased

incidences of cardiovascular diseases.

A wide range of adaptation measures are identified at the sectoral level for addressing projected climate change impacts. Importantly, these all target existing threats to sustainable development by seeking to reduce vulnerability and promoting sustainable development. Central to adaptation recommendations are measures for strengthening development control, improving disaster response capabilities, establishing an institutional base for climate change, and implementing an integrated water management plan.

GREENHOUSE GAS MITIGATION

Mitigation opportunities need to be pursued within the context of the country's efforts to attain sustainable development. Within the Antigua and Barbuda context the policy options for reducing emissions relate primarily to reductions in the energy sector through improvements in energy efficiency and conservation. Mitigation options for the energy sector should focus on attempts to promote improved efficiency in electricity end-use and production/distribution. This should involve a range of measures including energy audits, demand side management, and public awareness.

In relation to renewable energy, substantial resources exist for solar and wind power utilization. However, given the costs of these technologies, resources assessments and action plans are needed to guide further action and development. Nevertheless, given the commercial availability of solar water heaters, consideration should be given to measures for further stimulating demand.

The transport sector represents Antigua and Barbuda's second main source of GHG emissions after electricity production. However, this sector provides a difficult area for effecting significant reductions in emissions. A transportation master plan integrating concerns for energy efficiency and conservation with wider concerns for improving transportation flows and reducing traffic congestion is required.

CONCLUSION

Small island developing States such as Antigua & Barbuda possess innate capacity limitations. Developing and building national and regional capacity has been and remains a priority for Antigua & Barbuda in order to achieve the objectives of UNFCCC. A number of ongoing initiatives for strengthening capabilities in responding to climate change are already underway. These range from data collection and distribution by the national meteorological service to the strengthening of the Environment Division. The regional CPACC project has been a principal instrument for building capacity at the national and regional levels. The programme of enabling activities has helped to build national capacity: these activities have centred around developing and institutionalizing the country's initial greenhouse gas inventory; undertaking a vulnerability and adaptation assessment; identifying mitigation measures; promoting public awareness; and preparing the initial national communications document.

Priorities for future action include:

- capacity building for climate change
- increasing public awareness
- promoting sustainable energy
- construction of purpose built storm shelters, and
- establishment of a Caribbean Climate Change Centre.

Figure 1.1. Location of Antigua and Barbuda in the Eastern Caribbean



CHAPTER 1

NATIONAL CIRCUMSTANCES

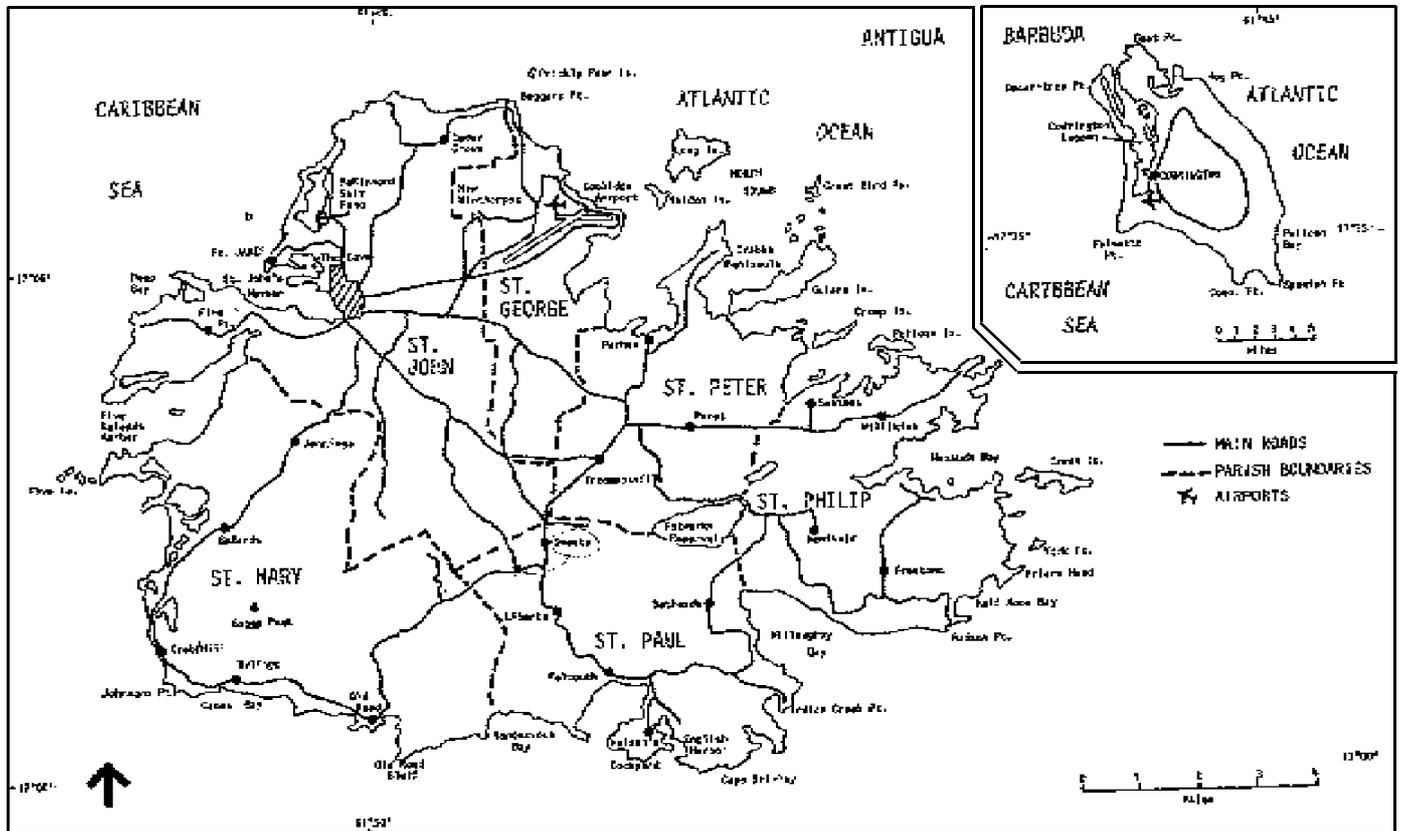


Figure 1.2 Map of main infrastructure for Antigua and Barbuda

I.1 INTRODUCTION

The archipelagic State of Antigua and Barbuda is located between latitudes 17 and 18 degrees north and longitudes 61 and 62 degrees west. In addition to the populated islands of Antigua and Barbuda, the territory also comprises a number of uninhabited isles and rocks. The country has a total land area of 440 square km. (Antigua 280 sq. km. and Barbuda 160 sq. km.), and an exclusive economic zone of 110,071 square km. Neighbouring countries include the twin island Federation of St. Kitts and Nevis, the French Department of Guadeloupe in the south, and the British Dependent territory of Montserrat to the southwest.

With its limited land area and a population of approximately 70,000 people, Antigua and Barbuda constitutes the second smallest State in the western hemisphere and one of the smallest in the world.

Geologically, Antigua is made up of rocks of the Middle and Late Oligocene period. At that time a volcano southwest of present-day Antigua erupted out of the sea. When sea levels fell Antigua emerged, the volcano itself having eroded away. This formed the base for corals and eventually limestone rock was formed. Barbuda is composed of comparatively recent limestone formed in the northern end of the Barbuda Bank on which Antigua also lies.

Both islands lie within an area of active seismic activity and are subject to periodic tremors. A number of neighbouring islands, notably Montserrat where the Soufriere volcano has been continuously active since 1995, are formed from the bases of volcanoes, some still geologically active.

Geographically, the islands are primarily flat and low lying, consisting of a volcanic base overlaid with coral deposits. Barbuda is particularly low lying rising to only approximately sixty metres, with a large coastal lagoon virtually enclosed by a sand spit on its western side. In the case of Antigua, gently undulating hills over most of the island give way to a hilly and more rugged landscape in the southwest. The islands possess no known commercially exploitable mineral resources although guano has been mined in the past on the uninhabited island of Redonda.

Located in the eastern Caribbean, the country's climatic features are fairly characteristic of small tropical islands and are primarily influenced by the presence of the Atlantic Ocean and the Caribbean Sea. Among the principal climatic features are relatively high and uniform temperatures throughout the year and steady easterly trade winds (which tend to have a cooling influence). As a result of their topography and geographical position both islands are among the driest in the eastern Caribbean. Temperatures average 29 degrees Centigrade during the summer and 24 degrees during the winter.

For both islands seasonal variation in rainfall is considerable. Typically there is a dry season that extends from January to March or April when less than 10% of annual rainfall occurs. May is a wetter month before the wet season in August to November when typically approximately 50% of annual rainfall can be expected to fall. Almost half of the country's rainfall is the product of tropical storms producing more than one inch of rain. Notwithstanding the seasonal patterns, the most significant feature of the rainfall regime is its variability. Variations in rainfall amounts (in some cases quite significant) also exist between parts of the islands. Relative humidity in both islands tends to be high.

Both islands also experience the annual Atlantic hurricane season. Following a thirty- year lull in direct hits from hurricanes, the country has experienced five major hurricanes since 1989. Tables 1.1 and 1.2 provide select climate statistics for Antigua. The islands are also influenced by changes in global oceanic circulation related to the El Nino/Southern Oscillation with evidence that recent ENSO events have had significant influences on sea surface surface temperatures, hurricanes and precipitation patterns.

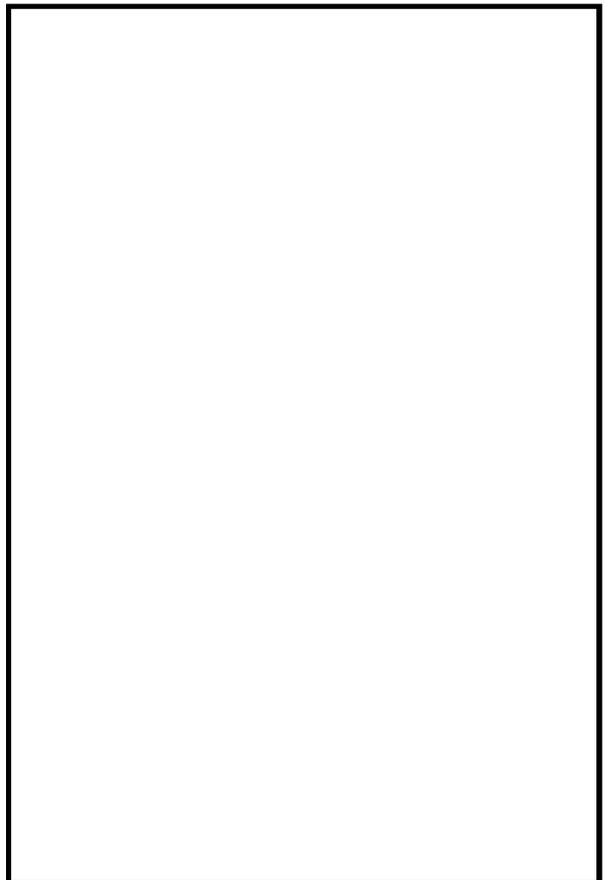


Photo courtesy Timothy Payne

As small islands the marine and coastal environment are particularly important to Antigua and Barbuda. Mangroves, coral reefs, and sea grass beds are among the principal ecosystems in coastal and marine areas. In particular these ecosystems form the basis for the country's sandy beaches and fisheries resources as well as serving as protective barriers against tropical storm and hurricane activity.

Antigua can be divided into three distinct topographical regions. These are the volcanic regions in the southwest, a central plain, and limestone regions in the north and east. The volcanic southwesterly areas contain several small alluvial valleys rising to Boggy Peak at 402 metres (1319 ft.) Orographic influences and fertile soils provide favourable conditions for various types of agricultural produce in this area.

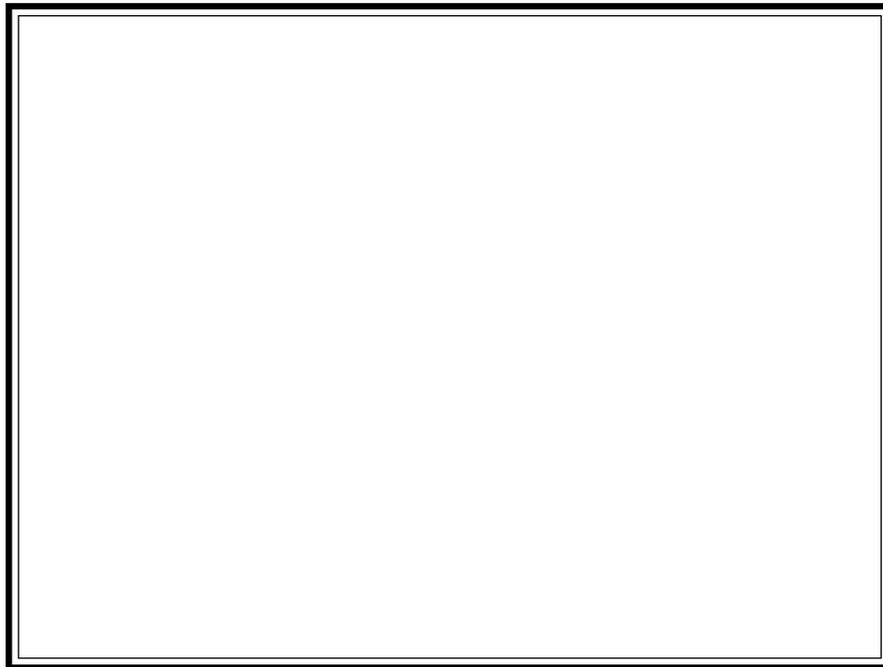


Photo courtesy EAG

In comparison to Antigua, Barbuda's topography is relatively uniform and lower in elevation. A principal feature of the Barbuda landscape is the presence of a large lagoon on the western side of the island, separated from the sea by a narrow spit of sand. The island is nearly completely surrounded by reefs. The eastern Highlands are the highest point on Barbuda, rising to 100 ft. Extensive sandy dunes are another distinguishing topographic feature. Much of the island's history has been influenced by its geographical nature.

Soil types range from volcanic to various grades of limestone. In general the soil is quite fertile although limited rainfall and drought have historically served as barriers to agriculture. For Antigua the vegetative cover consists primarily of secondary growth shrub and dry forest and grasslands with small pockets of tropical forest. These features are as a result of widespread burning of original forest-cover for agriculture during the colonial period. Vegetative cover in Barbuda consists essentially of dry shrub forests and grasslands while soil types are generally more sandy and saline, making them less attractive for agriculture.

Other vegetative types found in these islands include humid valley forests, slope forest, mangroves, succulent thorny scrub, and various savannah and grassland types. These ecosystems provide habitat for a range of threatened and endangered species of flora and fauna. One endemic reptile, the Racer Snake, found exclusively on certain offshore islands on Antigua's northeast coast, is the focus of international conservation efforts.

Despite its small size, Antigua and Barbuda enjoys relatively high levels of biodiversity, particularly in the coastal and marine environment.

While the islands do not appear to have commercially exploitable mineral resources they do have significant renewable energy resources particularly solar and wind.

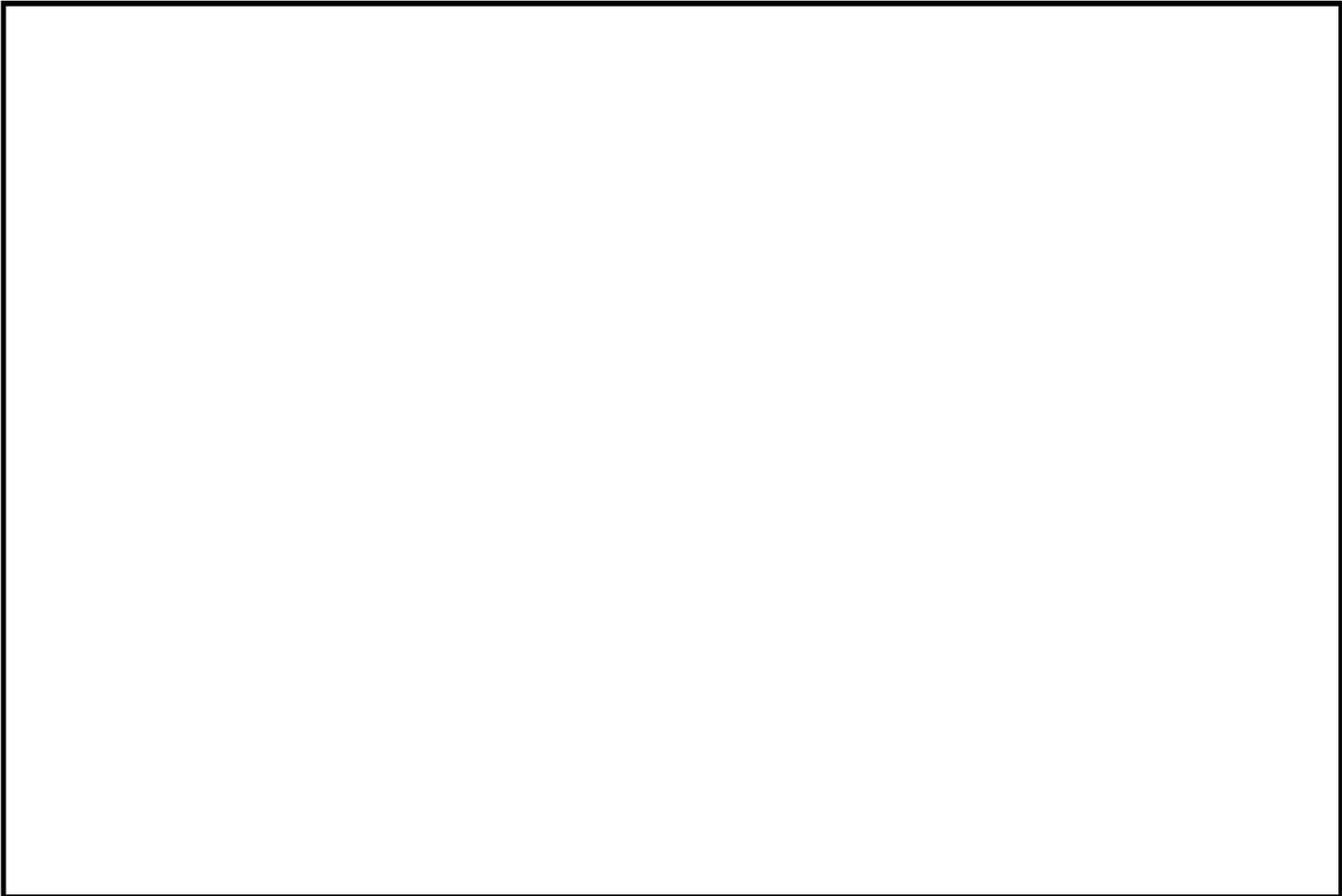


Photo courtesy EAG

Table 1.2: Yearly Rainfall Totals (1960-2000)

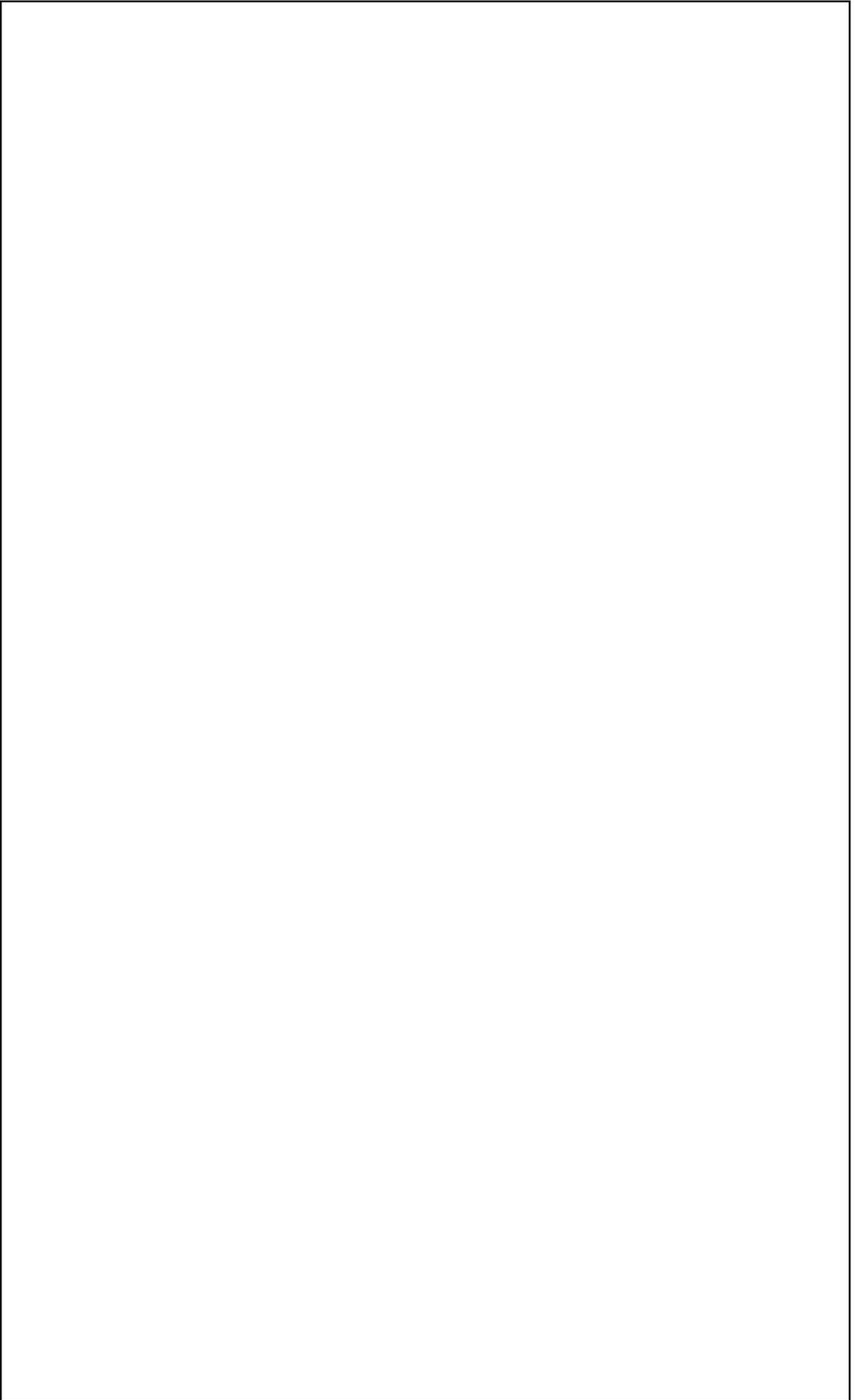
Table 1.3a Annual rainfall totals for V.C. Bird Airport (1960-1999)

--

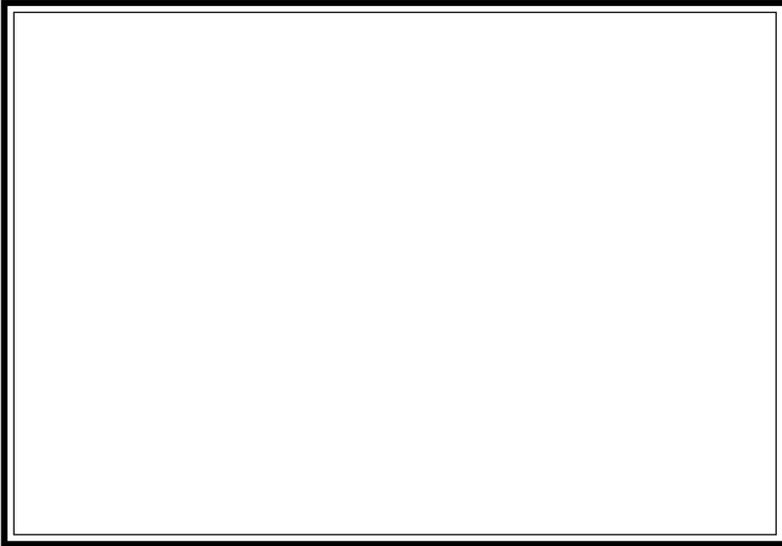
Table 1.3b Annual rainfall averages for Antigua (V.C. Bird Airport, 1960-1999)

--

Figure 1.3 Annual rainfall distribution for Antigua (Isohyets in inches)



1.2 SOCIO-ECONOMIC BACKGROUND

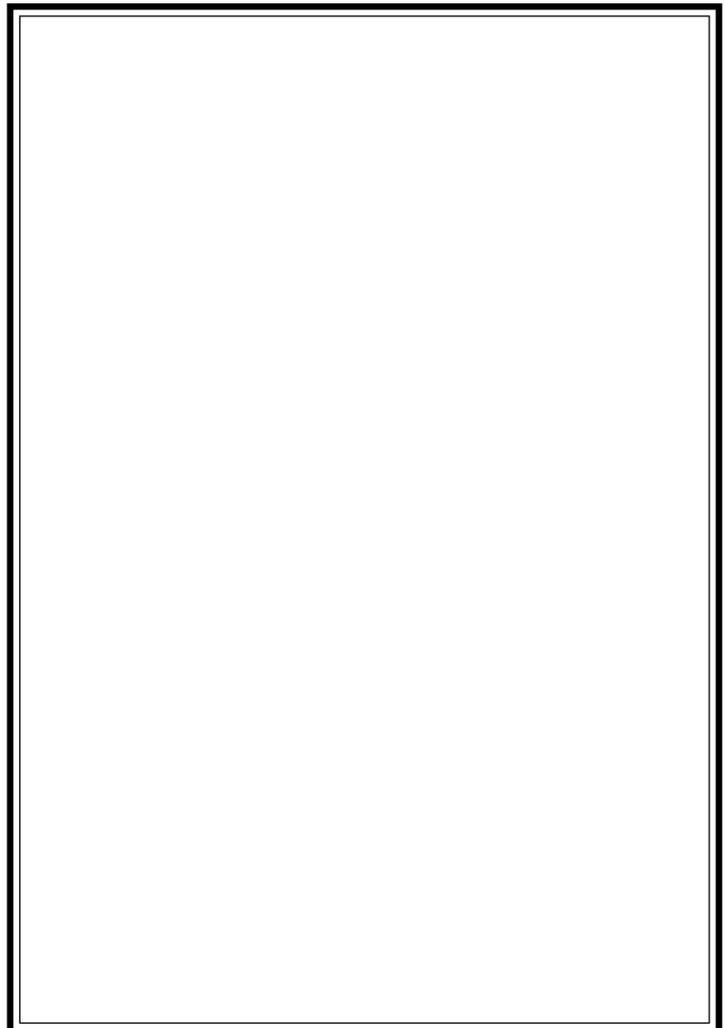


Reproduction of an etching first published in 1876

Because of its physical characteristics Antigua appears to have a comparatively large number of pre-Columbian archaeological features. Its many mangroves and reefs provided large quantities of marine resources for sustenance, while limestone provided raw material for primitive tools for the island's first human inhabitants. Numerous archaeological sites have been found, particularly along the coast, and it is believed that non-agricultural and aceramic peoples inhabited the islands from as early as 3000 B.C.

The islands' modern history begins in the latter part of the fifteenth century when they were stumbled upon by Columbus in his search for a sea route to the riches of the east. They were soon opened up to international trade and production. Diseases and the hardships of a regime of slave labour resulted in the decimation of native peoples and created the need to introduce imported labour. The islands developed over the centuries as a leading Caribbean sugar colony of the United Kingdom with the vast majority of the work force, and of the general population, being made up of slaves imported from Africa.

Photo courtesy Eddison Nias



In terms of social indicators, Antigua and Barbuda is categorized as a middle-income developing country. This reflects the relatively high standards of health care, education, access to infrastructure and economic growth that the nation has achieved, notwithstanding the obstacles imposed by small size. Table 1.3 provides a list of select social indicators for Antigua and Barbuda.

Table 1.4: National Circumstances (1994)

As an independent nation, Antigua and Barbuda has continued its membership of the Commonwealth and ~~became~~ **became** the 157th member of the United Nations where the country has played an active role in the Association of Small Island States (AOSIS) and in other regional groups. The country is also a member of the Organization of American States (OAS), the Organization of Eastern Caribbean States (OECS), the Caribbean Community (CARICOM) and the Organization of American States (OAS) as well as various regional and international organizations. Antigua and Barbuda shares a common currency and Central bank with the other OECS member States.

Antigua and Barbuda has a democratic form of government, based on the Westminster parliamentary system. The members of the House of Representatives are elected every five years throughout seventeen constituencies. The Executive branch is headed by the Prime Minister and Cabinet of Ministers. An independent judiciary ensures the rule of law, operating a common law jurisdiction.

Since the 1960's the tourism sector, based on the country's beautiful beaches and marine environment has been the dominant engine for economic growth and development. Table 1.4 provides statistics on tourist arrivals by air and sea during select years of the 1990s.

Table 1.5: Antigua and Barbuda Tourist Arrivals

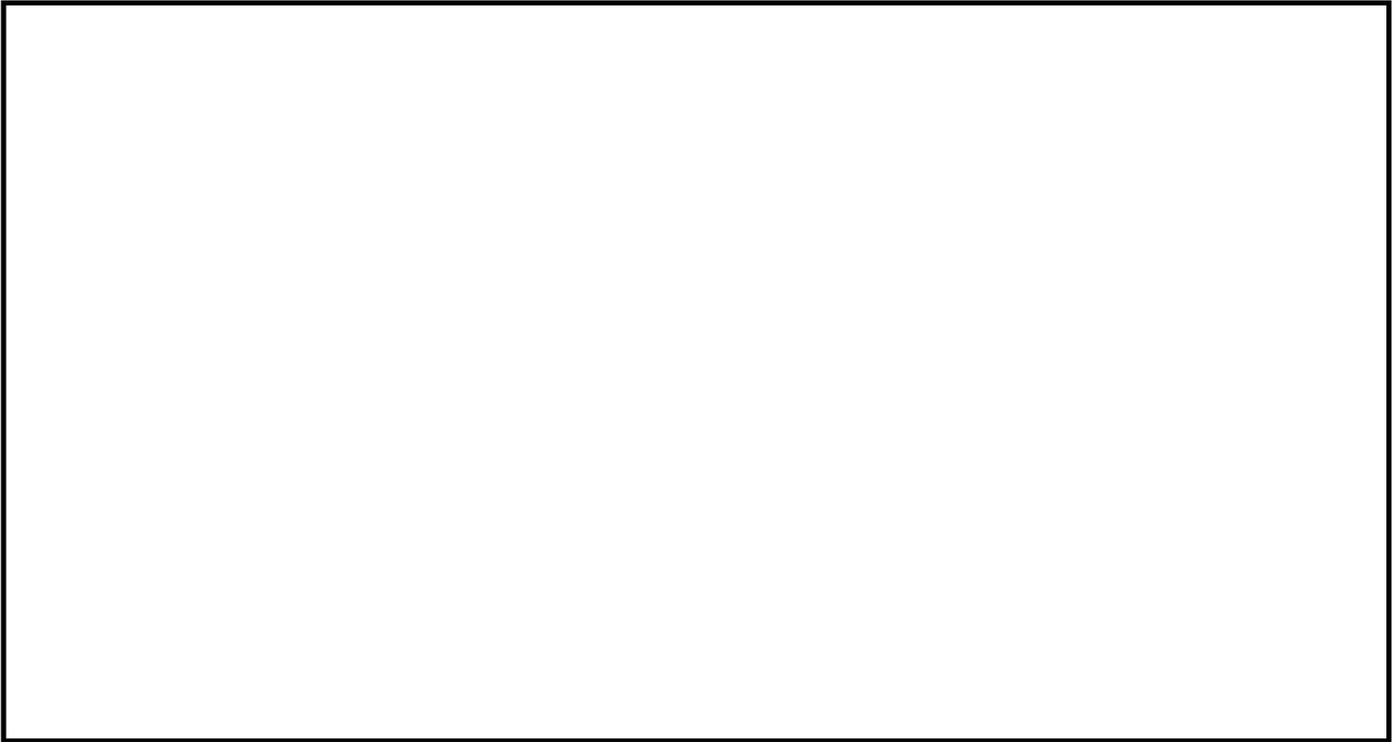


Photo courtesy Eddison Nias

One significant development in Caribbean tourism during this period has been the growth of cruise tourism, which has come to assume an increasing share of the tourism market.

The 1990's have also seen the impact of hurricane activity on the tourism sector. These have adversely affected the performance of the sector and underlined its vulnerability to weather extremes and changes in climate.

At present the tourism sector is estimated to contribute directly and indirectly some 60% of GDP. In addition to hotels and restaurants the sector has forged substantial linkages with other sectors such as transport and communications, agriculture, and wholesale/retail.

In contrast to tourism, agriculture has been affected by a period of steady decline in terms of its contribution to gross domestic product and exports. At present the sector contributes approximately 3% of national GDP with much of this coming from the fisheries sub-sector, which also contributes substantially to the sector's export earnings. Generally speaking the agricultural sector remains underdeveloped with low capital inputs and only minimal attention placed on sustainable agricultural practices. Principal agricultural outputs comprise fisheries (including lobster and conchs from Barbuda); livestock and poultry; and garden produce for local, tourist and export markets.

There is very little manufacturing industry in Antigua and Barbuda, most of it consisting of small-scale assembly and agro-processing for the local market. The small size of the sector reflects the lack of economies of scale for manufacturing enterprises in the context of such small economies, especially in an era of market liberalization and competition from lower cost producers in developed and developing countries.

The informal sector is also another important part of the national economy, comprising primarily persons engaged in various retail trades as well as in the provision of services. The informal sector is also closely linked to the tourism and agricultural sectors.

Government policy since the 1990's has been to seek to diversify the country's economy through the establishment of offshore financial services and the promotion of other service sectors. These efforts have achieved a fair measure of success although the sector is quite vulnerable to regulatory changes in developed OECD countries. Important sectors include construction, transportation and communications and government services. Table 1.6 provides an indication of sectoral contributions to gross domestic product (GDP) including those for 1990 and 1994, the base years for the GHG inventory conducted for Antigua and Barbuda.

Table 1.6: Antigua and Barbuda GDP by Economic Sector

In a recent joint report on Small Island Developing States (SIDS) the Commonwealth Secretariat and The World Bank have identified a number of characteristics of micro States that tend to highlight their vulnerability to external forces (economic, environmental and political). These include:

- volatility of national income
- susceptibility to natural disasters
- limited institutional capacity, and
- dependence on foreign technological and financial inputs.

While small States, such as Antigua and Barbuda, have always faced these limitations, they are now forced to make their way in a global economic dispensation that has become increasingly unsympathetic to the condition of small countries. The progressive and rapid liberalization of world trade, the sudden loss of markets and the diminution of official development assistance have all conspired to present enormous transitional challenges for small States. These pressures will be intensified by the development challenges likely to be unleashed by anthropogenic climate change.

Table 1.7: Select Economic and Social Statistics

Life Expectancy at Birth of Males is 72 years.
Life Expectancy at Birth of Females is 74 years.



Photo courtesy Timothy Payne

CHAPTER 2

NATIONAL GREENHOUSE GASES INVENTORY

2.1 INTRODUCTION

In compliance with Articles 4 and 12 of the United Nations Framework Convention on Climate Change (UNFCCC), the Government of Antigua and Barbuda, a Non-Annex I Party to the UNFCCC Convention, undertook an Inventory of its Net Anthropogenic Emissions by Sources and Removals by Sinks of Greenhouse Gases (GHG's), not controlled by the Montreal Protocol, within the extent of its capacities and in accordance with the Intergovernmental Panel on Climate Change (IPCC) Guidelines.

This Chapter provides a brief description of the appropriate methodologies and an analysis and interpretation of the data on anthropogenic GHG emissions and sinks, on a sector-by-sector basis for Antigua and Barbuda for the Reference Year, 1990. Because of the dominating influence of the Energy Sector, data for 1994 is also provided for this sector.

An Inventory of Carbon Dioxide (CO₂), Methane (CH₄) and Nitrous Oxide (N₂O) was conducted. Other greenhouse gases that contribute to Tropospheric Ozone (O₃) formation, such as Non-Methane Volatile Organic Compounds (NMVOC), Carbon Monoxide (CO) and Nitrogen Oxides (NO_x) were also included in the inventory.

The IPCC Revised 1996 Guidelines for National Greenhouse Gas Inventories (Volumes 1,2 and 3), together with the accompanying Software, were used as the basis to undertake the necessary calculations on GHG Emissions and Removals.

The GHG Inventory was done on an individual sector basis for the Energy, Industrial Processes, Agriculture, Land Use and Forestry and Wastes Sectors.

In accordance with the Guidelines set out by the IPCC, Carbon Dioxide (CO₂) emissions from International Bunkers and Biomass are not included in the National totals and are reported separately in the Inventory.

2.2 ENERGY SECTOR

Methodology

Both the aggregate fuels supply-based Reference Approach (top-down) and the policy-oriented source categories Sectoral Approach (bottom-up) were used to calculate the GHG Inventory for the Energy Sector.

There is no production of primary and or secondary fossil fuels in Antigua and Barbuda, However, secondary fuels including gasoline. Jet kerosene, gas, oil/diesel, heavy fuel oil (bunker C) fuel oil and LPG are imported for local consumption (See Table 2.I).

Table 2.1: Supply (Import) of Fuels (kt) for Antigua and Barbuda in 1990 and 1994

Energy is produced through the combustion of these secondary fuels for use in the power-generating utilities, transport, agriculture/fishing, manufacturing, commercial, residential, tourism and international bunkers sectors.

Local activity data for fuels supplied were converted to an appropriate unit (kt) so as to facilitate the direct application of the IPCC Conversion Factor (TJ/kt) in order to derive the Apparent Consumption in TJ, by taking into account the appropriate specific gravity (Kg/l.) of the fuels. In most cases, for lack of country-specific data, the Default Values of the Conversion, Emission and Carbon Oxidation factors as furnished by the IPCC, when available, were used. In certain instances, as for example the Conversion Factor for solid biomass (charcoal), these values were extracted from countries of similar characteristics or from the same geographical area (e.g. Costa Rica, Guyana).

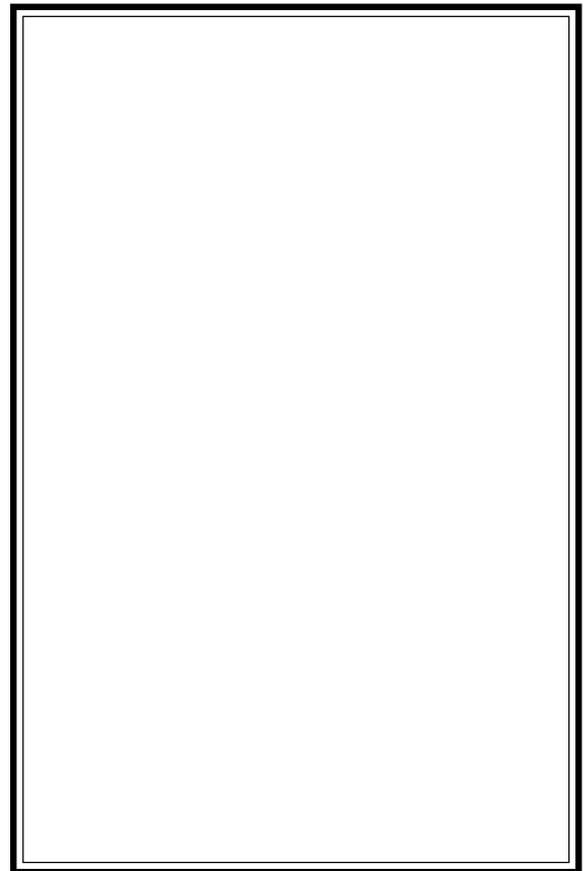


Photo courtesy Eddison Nias

CO₂ Emissions from Energy Combustion

Combustion of fossil fuels in the Energy Sector is the main source of CO₂ emissions in Antigua and Barbuda.

Data analyses of CO₂ emissions using both the Reference and Sectoral approaches show that for 1990 CO₂ emissions totaled 288.30 Gg (Reference) and 288.13 Gg (Sectoral). Similarly, in 1994, CO₂ emission totaled 334.40 Gg (Reference) and 333.86 Gg (Sectoral). In both cases the Reference and Sectoral approaches agree to within less than 1%. (see Table 2.2). Also, CO₂ emissions increased by about 16 %, from 1990 to 1994, reflecting an increase in use of fossil fuels driven by economic expansion.

Table 2.2: CO₂ Emissions from Energy Sources according to the Reference and Sectoral Approaches for Antigua and Barbuda (1990 and 1994)

Of these CO₂ emissions, the greatest proportions result from the combustion of Residual Fuel Oil (45.2 % in 1990 and 46.9 % in 1994), used exclusively for thermal electricity production, from Gas/Diesel Oil (29.2 % in 1990 and 27.6 % in 1994), used for electricity generation and road vehicular transport from Gasoline (22.3 % in 1990 and 22,1 % in 1994) for vehicular road transport, mainly, and agriculture and fishing. Small amounts of CO₂ emissions also result from LPG use (3.3 % in 1990 and 3.4 % in 1994) in the residential sector.

Further CO₂ emissions, included under Memo Items, result from the sale and combustion of Jet Kerosene (167.30 Gg in 1990 and 230.79 Gg in 1994) by the International aviation industry and minimally, from the combustion of charcoal (3.4 Gg in 1990 and 1994) in the residential sub-sector of the Energy Sector. (See Table 2.3.)

Table 2.3: CO₂ Emissions (Gg) from Energy Sources and Fuel Combustion Categories (1990 and 1994)

Within the Energy Sector, CO₂ Emissions from the Energy Industries Sub-sector of the Energy Sector, representing almost exclusively thermal power generation, totaled 173.49 Gg of CO₂ in 1990 and 203.79 Gg of CO₂ in 1994, which accounts for 60.2 % and 60.9 % respectively of the total CO₂ emissions. A further 83.67 Gg in 1990 and 95.11 Gg in 1994, which represents 29.0 % and 28.5 % of CO₂ emissions, was produced by the Road Transport Sector in 1990 and 1994 respectively. In addition, a further 167.30 Gg (1990) and 230.79 (1994) of CO₂ was emitted by International Bunkers. Also 3.42 Gg of CO₂ was emitted, in both 1990 and 1994 by Solid Biomass (charcoal), another memo item.

Table 2.4: CO₂ Emissions (Gg) from Energy Source and Fuel Combustion Categories (1990 and 1994)

Memo Items

The current IPCC methodology requires that emissions from International Bunkers and Biomass within the Energy Sector be reported separately in the GHG Inventory of a country,

CO₂ Emissions from International Bunkers

To date estimates of Emissions from International bunkers are limited to emissions from jet kerosene sold to aircraft that fly internationally. CO₂ emissions from aviation international bunkers for the years 1990 and 1994 were calculated using the IPCC Tier I approach. The results are reported in Table 5. Jet kerosene sold to International Air Transport bunkers amounted to 167.30 Gg in 1996 and to 230.79 Gg in 1994.

CO₂ Emissions from Biomass Fuel

In Antigua and Barbuda biomass fuels that are burned for energy are primarily firewood, charcoal and some agricultural waste.

Table 2.5 gives total CO₂ emissions from biomass fuels (firewood, charcoal) for the years 1990 and 1994 in Gg. In both years the estimates for CO₂ emissions are similar, amounting to 3.42Gg.

Table 2.5: CO₂ Emissions from Memo Items (1990 and 1994)

Non-CO₂ Emissions

Non-CO₂ emissions of Methane (CH₄), Nitrous Oxide (N₂O), Nitrogen Oxides (NO_x), Carbon Monoxide (CO) and Non-Methane Volatile Organic Compounds (NMVOC) are insignificantly small, in both 1990 and 1994, for the Energy sector in Antigua and Barbuda (See Table 2.6.) Also, Sulphur Dioxide emissions are

estimated to be 2.82 Gg in 1990 and 3.25 Gg in 1994, with the highest emissions coming from the combustion of Heavy Fuel Oil for thermal electricity production (See Table 2.7).

Table 2.6: Non-CO₂ Emissions (Gg) from Fuel Combustion by Source Category (1990 and 1994)

Table 2.7: Non-SO₂ Emissions from Fuel Combustion by Source/ Category (1990 and 1994)

2.3. INDUSTRIAL SECTOR

Antigua and Barbuda does not have a major Manufacturing or Industrial sector, so that CO₂ emissions from light manufacturing or heavy industries are minimal. The Food and Beverage industry, which is linked to the Tourism industry, a key sector of the Antigua and Barbuda economy, is the main emitter of GHG's (NMVOC).

Methodology

NMVOC emissions derive from bitumen used in road paving asphalt, the manufacture of alcoholic beverages (rum) and food production (bread and cakes). All activity data are country-specific and were obtained from the Department of Statistics of the Ministry of Planning of the Government of Antigua and Barbuda. However, all emission factors were taken as Default Values from the IPCC Workbooks.

NMVOC Emissions

For the Inventory Year, namely 1990 NMVOC emissions from Road Paving Asphalt was 0.53 Gg, from the manufacture of Alcoholic Beverages (Rum) 0.10 Gg and from Food Production (Bread and Cakes) 0.02 Gg. (See Table 2.8.)

Table 2.8: NMVOC Emissions. (Gg) from the Industrial Sector (1990)

2.4. AGRICULTURE SECTOR

Methane (CH₄) is the only perceptible GHG emitted by the Agriculture Sector. CH₄ emissions are limited to emissions from Enteric Fermentation and Manure Management from animal stocks.

Methodology

All activity data is for the Reference Year, namely 1990. Three-year averages are not provided, because there were no significant changes in the data between 1989 and 1991, which would skew the results. Activity data on animal population according to species are country-specific and were obtained from the Ministry of Agriculture of Antigua and Barbuda. However, emission factors for enteric fermentation and manure management were taken as default value from the IPCC Workbooks. Where this was not possible, as for instance emission factors for poultry, this was taken from other similar countries (e.g. Costa Rica, Guyana).

CH₄ Emissions

In 1990, total annual emissions from Domestic Livestock amounted to 1.06 Gg, the great majority (95%) coming from Enteric Fermentation (1.01 Gg), the remainder coming from Manure Management (0.05 Gg) (See Table 2.9).

Table 2.9: CH₄ Emissions from Animal Stocks in the Agriculture Sector (1990)

2.5 LAND USE AND FORESTRY SECTOR

Antigua and Barbuda, being relatively small islands, forest cover is of limited extent. Detailed data on Land-Use and Forestry are not available. Limited data sets and expert estimations (Forestry Division, Government of Antigua and Barbuda) place total forest acreage at 13,450 hectares, consisting mainly of Moist Tropical

Forests (2,200 hectares), Dry Tropical Forests (10,750 hectares) and Mangroves (500 hectares). Open Savanna account for about 10 hectares. Changes in these acreages over the last 20 years are estimated to have been minimal.

Based on local expert judgment, it is assumed that all forests of Antigua and Barbuda are anthropogenically-impacted, given the small forest area and the population distribution.

Methodology

All activity data is for the Reference year 1990. Three-year averages are not provided, because there are no significant changes in the data between 1989 and 1991.

Activity data on Species and Areas (hectares) of forest/biomass stocks, on Annual Growth Rate (t dm/ha) of forests and other trees and savannas and on Commercial Harvest (m³) are country-specific and were obtained from the Forestry Division, Government of Antigua and Barbuda and to a limited extent from the FAO Statistical Yearbook. However, Conversion and Emission Factors relating to Carbon Fraction, Biomass Conversion/Expansion and Fraction of Biomass Oxidized were taken as Default values from the IPCC Workbooks. Furthermore, where published data was lacking, as for instance fraction of biomass burned on-site and off-site, these were estimated from comparisons with other countries in the region (Guyana, Costa Rica).

CO₂ Emissions/ Removals

CO₂ Emissions and Removals from the Land Use Change and Forestry sector derive from removals of CO₂ from carbon uptake due to re-growth through conversion of forests and grasslands and to emissions from forest and grassland conversion due to burning and decay of biomass.

The data analyzed for the year 1990 show a Removal of 219.19 Gg due to Growth Changes in Forest and other Woody Biomass Stocks and a further Removal of 0.9 Gg of CO₂ due to re-growth by the Abandonment of Managed Lands. On the other hand, Forest and Grassland Conversions account for 123.26 Gg of CO₂ emitted through burning and decay of biomass. This results in a Net Removal (Sink) of 96.83 Gg of CO₂ from Land Use Change and Forestry in Antigua and Barbuda.

Table 2.10: CO₂ Emissions and Removals and Net/Sink (Gg) for Land Use and Forestry Sector (1990)

Non-CO₂ Emissions

Because of the limited land area and forest clearing over the last several decades in Antigua and Barbuda trace gas emissions of Methane (CH₄), Carbon Monoxide (CO), Nitrous Oxide (N₂O) and Nitrogen Oxides (NO_x) due to burning of biomass are negligible.

2.6 WASTE SECTOR

In the Waste sector, GHG emissions are limited to Methane (CH₄) from Solid Waste Disposal Sites (SWDS) and to indirect Nitrous Oxide (N₂O) emissions from Human Sewage.

Solid Waste Disposal on Land

The Solid Waste Disposal on land in Antigua and Barbuda is limited to a single Sanitary Landfill disposal site located on the outskirts of the capital, St. John's. A large part of the waste is burnt. While there are small uncontrolled open dumps scattered in the rural areas, the volumes involved are very small and are therefore not included in the Inventory.

Methodology

Activity data pertaining to Municipal Solid Waste (MSW) disposed at Solid Waste Disposal Sites is country-specific data obtained from the National Solid Waste Management Authority and the Department of statistics of the Ministry of Planning, Government of Antigua and Barbuda. However, the IPCC Default values for the Waste sector were used.

CH₄ Emissions

Data analyses using the above methodology provide Net Annual Methane Emissions from Solid Waste Disposal Sites of 3.61 Gg in 1990 for Antigua and Barbuda (See Table 2.11).

Table 2.11: CH₄ and N₂O Emissions from the Waste Sector (Gg)

Indirect Nitrous Oxide Emissions from Human Sewage

There are no centralized sewage or wastewater treatment facilities in Antigua and Barbuda. Most residences, especially in the urban areas are equipped with individual cesspits and the waste is disposed of at the municipal dump. In the rural areas, there are some residences that use pit latrines. However, some of the hotels have their own sewage treatment facilities.

Methodology

Nitrous oxide (N₂O) emissions from Human Sewage were estimated from country-specific data on Population and Per Capita Protein Consumption (kg/person/yr) as obtained from the FAO Statistical Balance Sheets for Antigua and Barbuda. However, the IPCC Default factors for Fraction of Nitrogen in Protein and Emission of N₂O were used to estimate the emissions of N₂O from Human Sewage.

N₂O Emissions

Nitrous Oxide (N₂O) emissions in Antigua and Barbuda were estimated to be extremely small being of the order of 0,0051 Gg in the year 1990. Thus, N₂O emissions in Antigua and Barbuda are very low and for all intents and purposes, statistically insignificant.

Other sources for this GHG are from agricultural activities such as synthetic fertilizer usage and field burning of crop residues. Organic amendments to soil are done on a very small scale and this is particularly related to kitchen gardens.

2.7. SUMMARY OF EMISSIONS/REMOVALS

A short summary of the major Emissions by Sources and Removals by Sinks on a sector-by-sector basis for Antigua and Barbuda for the Reference year 1990 is provided in Table 2.12 and Figures 6 and 7.

Table 2.12: CO₂ Emissions and Removals by Sector (1990)

It is evident that the major source of CO₂ emissions is from the Energy sector (288 Gg), which virtually accounts for all of the net CO₂ emissions.

The Land Use and Forestry sector, which is also responsible for some amount of CO₂ emissions, through Forest and Grassland Conversion (123.26 Gg), is however a Net Sink for CO₂ with a Net removal of (-) 96.0 Gg CO₂ because of Net Removal of CO₂ of growth Changes in Forest and other Woody Biomass Stock - 219.19 Gg of CO₂. Memo Items, namely International Aviation Bunkers (167.3 Gg CO₂) and Burning of Biomass (charcoal) (3.42 Gg CO₂) amount for further CO₂ emissions.

Table 2.13: Non-CO₂ Emissions and Removals by Sector (1990)

Comparatively small amounts of Non CO₂ GHG's were emitted or removed in Antigua and Barbuda for 1990. CH₄ emissions which totaled 4.6 Gg derived mainly from Landfills in the Waste Sector (3.61 Gg CH₄) and from Enteric Fermentation and Manure Management (1.06 Gg CH₄) from the Agriculture Sector. N₂O

Emissions, on the other hand are restricted to emissions from Human sewage (0.0051 Gg N₂O) in the Waste Sector.

NMVOC emissions derive exclusively from Road-Paving Asphalt and the Food and Beverage industries in the Industrial sector (0.65 Gg NMVOC).

The only other significant GHG in Antigua and Barbuda in 1990 was SO₂ (2.83 Gg SO₂), which was emitted through the combustion of Gas/Diesel Oil, residual fuel Oil and gasoline in the energy sector.

Finally, NO_x and CO emissions are negligible in Antigua and Barbuda for 1990, being close to zero.

2.8 SOURCES OF UNCERTAINTY

The calculations of sources and sinks of GHG's for the different sectors, as described above, incorporate several levels of uncertainty with respect both to the country activity data and the various conversion and emission factors. The ratings of these uncertainties is based on the IPCC methodology (Revised 1996).

Energy Sector

The main source of uncertainty is the partitioning of the total fuels used in the different sub-sectors. This limits the results of the Sectoral Approach somewhat. However, for the Reference Approach, where the total fuels used are lumped together, there is lesser or very little uncertainty. Almost all activity data have been sourced locally, mainly from Government Ministries and agencies.

Another source of uncertainty in the Energy Sector, regarding activity data, is with respect to the Memo items. For International Marine Bunkers, for instance, data were not available for this inventory. Also, country statistics on charcoal and firewood (Biomass) burning were estimated. As for the emission factors for the various GHG's (CO₂, CH₄, N₂O, NO, CO and NMVOC) the IPCC default values (mostly Tier 1) were used in almost all instances, since country-specific measurements are not available.

Industrial Sector

GHG emissions in Antigua and Barbuda are restricted to NMVOC in the Road Paving and Alcoholic Beverages and Food Production industries. Activity data for these were obtained primarily from the Antigua and Barbuda Department of Statistics of the Ministry of Planning. However, the NMVOC emission factors are based on the IPCC default values, which may be somewhat unrepresentative based on the age and condition of the factories. Here again country specific conversion factors are not available.

Agriculture Sector

Several areas of uncertainty are encountered. Government Statistics and expert judgment were used to obtain estimates of some animal populations since national data did not cover all types of livestock. Also, no data on the field burning of agricultural residues were available and this activity was ignored. In relation to prescribed Burning of Savannah, this is not a regular activity and may occur in small areas during the dry seasons. Actual data on savannah burnt annually were not available and this activity was not included in the inventory.

Land Use Change and Forestry

There are a number of uncertainties relating to GHG emissions and removals in this sector. There was a difficulty in assessing the fraction of the forested area which was anthropogenically impacted. In Antigua and Barbuda, selective logging is done mainly for lumber and charcoal production. As such, determining the actual area disturbed from logging operation presents some difficulties and is based on expert judgment.

With regards to emission and conversion factors, the IPCC default values were used. Given the very general nature of these default values, country-specific values such as annual growth rate of forests may be quite different and introduce significant uncertainty in the GHG emissions and removals calculations. Data on abandonment of managed lands were not available. However, initial assessment indicates that this will be insignificant. Hence, it was not considered in the inventory.

Waste Sector

The methodology utilizes population statistics of urban areas and this was used in the calculation of CH₄ emissions from solid waste disposal sites. The default values for the rate of waste generation (Guyana) were used and the urban population statistics were also estimated. There is high uncertainty here since the actual amount of waste deposited in disposal sites was not used because of lack of available data.

In the case of N₂O emissions from human sewage, the IPCC default values were used. Also the per capital protein consumption that was used was derived from the FAO Statistical balance Sheet for Antigua and Barbuda.

Furthermore, although there are both domestic and industrial sources of wastewater in Antigua and Barbuda, CH₄ emissions were not calculated because there is only very limited data on the anaerobic treatment of wastewater.

Summary of Uncertainties

In summary, the GHG emissions and removals for Antigua and Barbuda for the different sectors were calculated on the basis of available data. However, it must be cautioned that there are uncertainties in these estimates and

the degree of uncertainty varies between sectors.

2.9. CONCLUSIONS

Antigua and Barbuda is a net emitter of GHG's. For CO₂, almost all of the emissions derive from the Energy Sector (288.14 Gg in 1990 and 334.5 Gg in 1994). This is to some degree mitigated somewhat by the Land Use and Forestry Sector, where there is a net removal (-96.8 Gg CO₂ in 1990).

Non-CO₂ emissions are very small and derive from NMVOC emissions in the Industrial Processes Sector, from CH₄ emissions in the Agriculture and Wastes Sectors, from N₂O emissions in the Waste Sector and from SO₂ emissions in the Energy Sector.

The most serious constraints to the preparation of a GHG Inventory for Antigua and Barbuda are the need to strengthen the institutional capability for this activity as well as the need to improve on data quality and availability. This is particularly so for the non-energy sectors, where much of the activity data required is not presently collected. Many of these constraints can be overcome through the provision of technical and financial assistance.

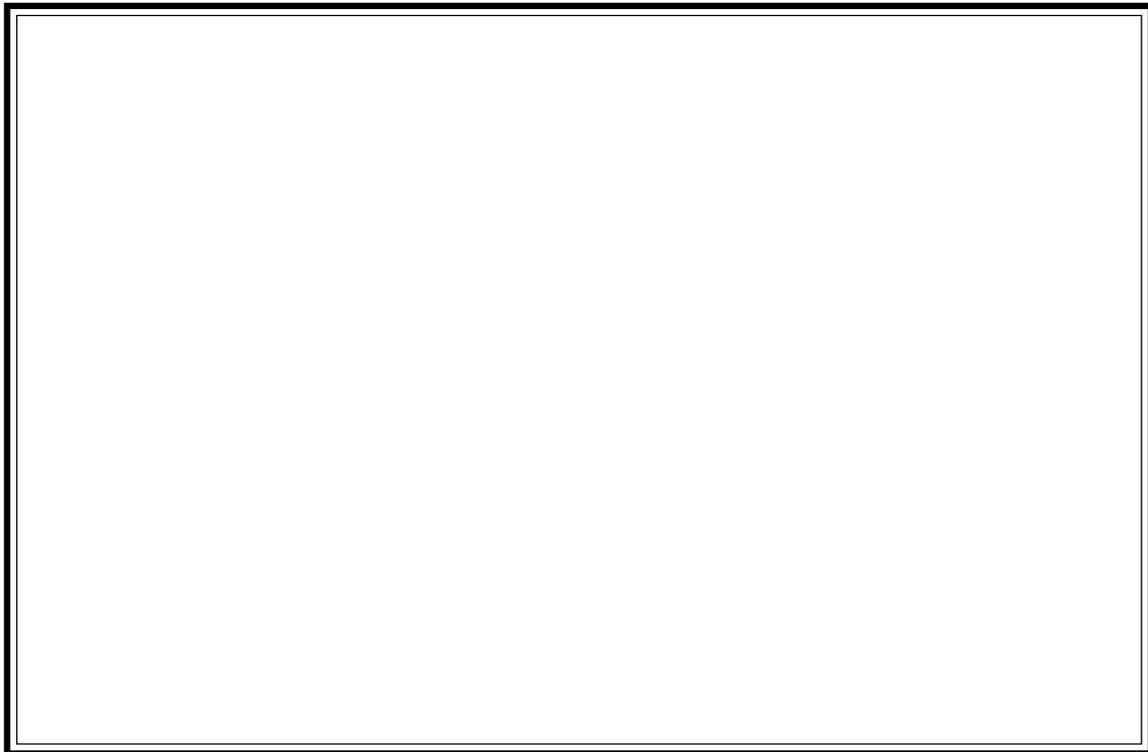


Photo courtesy Eddison Nias

CHAPTER 3

MITIGATION ASSESSMENT

3.1 INTRODUCTION

Climate Change mitigation refers to attempts to stabilize levels of atmospheric GHG's so as to prevent dangerous interference with the climate system. Non-Annex I countries like Antigua and Barbuda are expected to pursue mitigation goals and objectives within the context of their continuing efforts to achieve sustainable development. The GHG Inventory highlights the predominant role of the energy sector in terms of GHG emissions for Antigua and Barbuda.

Antigua and Barbuda is virtually 100% dependent on imported petroleum products for its energy sources. In 1998 the country imported approximately 1.2 million barrels of petroleum products, down slightly from 1.3 million barrels the year before. The Energy supply and demand functions are dominated by the electricity generation and transportation sectors which together account for more than 90% of GHG emissions. These factors highlight the need for Antigua and Barbuda to pursue a path of sustainable energy based on:

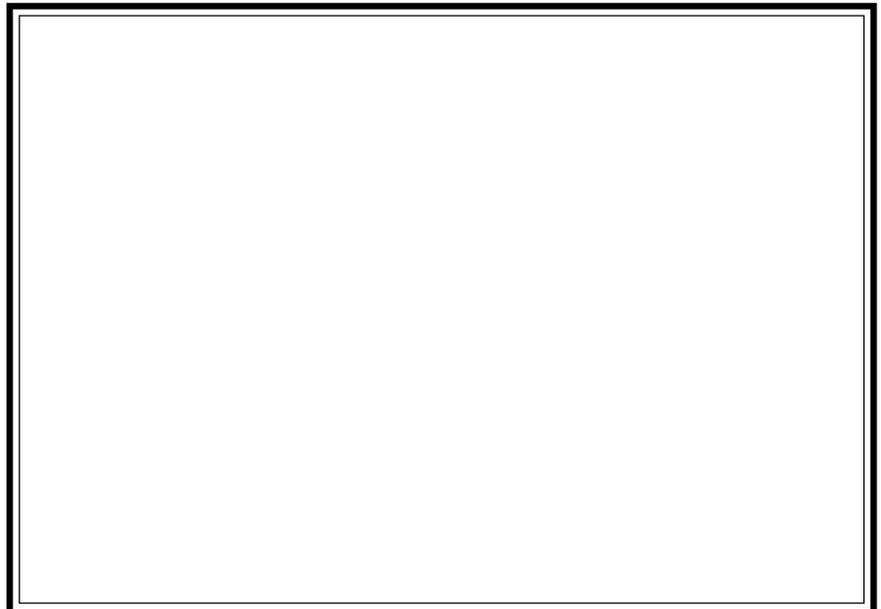
- improved efficiency of energy use
- more effective use and transformation of conventional fuels; and
- wider use of renewable sources of energy.

3.2. ELECTRICITY

The distribution and sale of electricity is the exclusive right of the country's State owned public utility, the Antigua Public Utilities Authority (APUA). The Utility was established by legislation as a statutory corporation in 1973 with the purpose of providing an integrated management structure for water, electricity and telephone services.

Peak demand for electricity in Antigua is 33.3 MW, which is supplied from

fossil fuel fired power stations. Reciprocating diesel engines account for 70% of the installed capacity on the island of Antigua with the remaining 30% originating from a dual purpose (water and electricity) steam plant.



Part of the 69KV Transmission Network that contributes to reliable electricity

Peak demand on the island of Barbuda is estimated nominally at 350Kw all of which originates from diesel powered engines.

Table 3.1: Electricity Sales (Kwh) (1995 - 1998)

For electricity the largest single consumer consumption category is the residential/domestic sector with some 50,000 MW.h in 1998 out of a total of 120,000 MW.h. This was followed by the commercial sector with 36,000 MW.h. Tourism with 21,000 MW.h and government with 12,000MW.h (including street lighting).

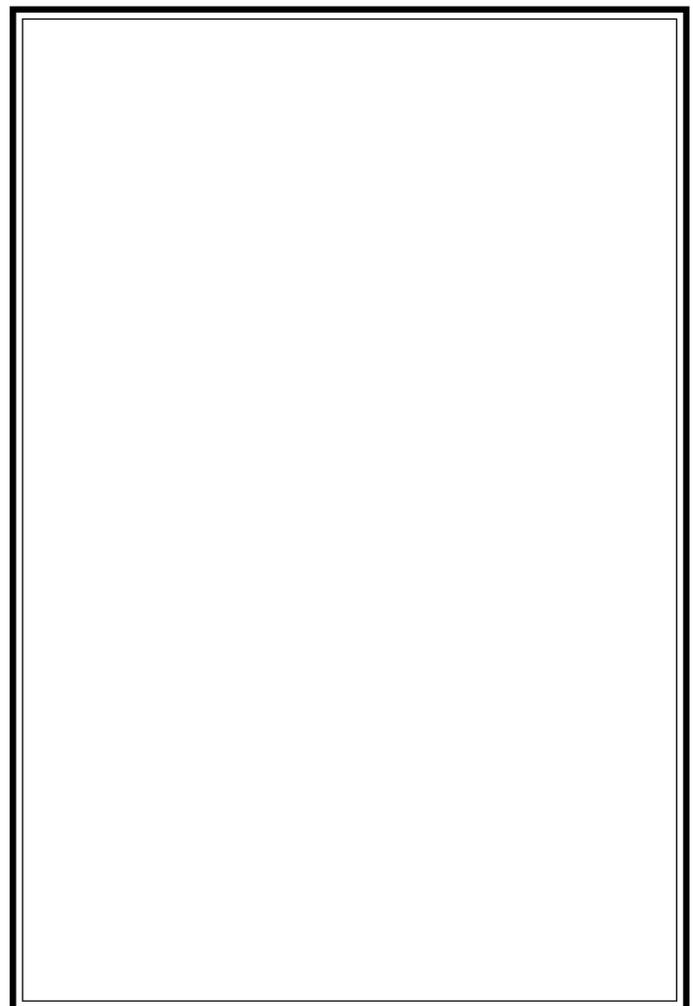
3.3 RENEWABLE ENERGY

Antigua and Barbuda would appear to have considerable potential for renewable energy utilization. This is particularly so for application of wind and solar technologies. A critical factor is that the country has already achieved full electrification using conventional power sources thereby affecting the economics of alternative renewable energy applications generally most suitable to isolated locations.

Wind Energy

Historically wind power was used extensively in Antigua for sugar production reflecting the presence of a favourable wind regime. More recent attempts to use wind energy for electricity generation have been less successful.

Important barriers remain towards rapid and widespread adoption of wind energy as a mechanism for Antigua and Barbuda to achieve sustainable development and reduce its level of GHG as part of the attainment of the ultimate objective of the UNFCCC. The first barrier is the cost factor. Wind power remains a more expensive initial capital investment than



A mill on the Betty's Hope Estate, established in 1674

petroleum fired plants. Another critical issue relates to technology transfer and especially the need to ensure that maintenance and operational capabilities are developed and in place. Another barrier is the absence of a suitable database on wind measurements for potential applications. Finally, awareness of available technologies is generally low.

Solar Energy

Antigua and Barbuda is reported to have one of the best solar regimes in the Caribbean in terms of potential for energy development. In fact, one type of solar energy application, solar water heaters, has already achieved commercial success in Antigua and Barbuda, with estimated substantial savings in electricity and GHG emissions. Nevertheless, substantial opportunities still exist for achieving even greater utilization of this application with associated benefits in foreign exchange and GHG savings. The essential option must therefore be to promote further use of solar heaters while also increasing awareness of other solar applications and promoting their use in niche markets (e.g. offshore telecommunications) where commercial technologies and applications already exist.

However, notwithstanding the tremendous improvements which have made most solar applications (and particularly photovoltaics) more economic, these technologies remain largely oriented towards rural and isolated applications where it is not economically viable to extend grid based conventional electric power or other petroleum-based energy source. This situation hardly applies in Antigua and Barbuda where there is already virtually 100% penetration of the electric grid.

3.4 TRANSPORTATION

The GHG Inventory establishes that the transportation sector is the second largest source of GHG emissions in Antigua and Barbuda. Reductions in emissions from the transport sector are generally regarded as among the most difficult to achieve due to its almost complete dependence on petroleum fuels and affiliation to entrenched transportation lifestyles.

As a technologically dependent country, reliant on external sources for virtually all its technology needs in the transport sector, there are serious constraints to the levels of intervention that can effectively be made by policy makers in Antigua and Barbuda. Consequently many of the changes in transportation efficiencies likely to result in reductions in GHG emissions will be driven by technology and economic forces independent of policies and actions taken at the national level. Some movement in this regard has already begun as witnessed by the recent announcements by leading automakers to improve the energy performance of automobiles. Certain types of domestic action are possible, however, and as the IPCC has noted in its Second Assessment Report (SAR), actions on transport will need to be devised on a country specific basis reflecting the peculiar circumstances which obtain.

The second line of intervention for the transport sector in countries like Antigua and Barbuda involves reducing traffic congestion as an instrument for improving productivity, reducing costs and minimizing growth in GHG emissions. This is increasingly pertinent in Antigua where recent years have seen growing traffic congestion leading to commuters spending ever-increasing amounts of time in traffic, losses in productivity and additional operational costs for transport. In fact some efforts have already begun to improve traffic flows in and around the main commercial areas.

3.5 RECOMMENDATIONS FOR PROMOTING GHG MITIGATION

The following recommendations are aimed at promoting GHG mitigation in Antigua and Barbuda. Specifically, these recommendations are targeted towards GHG reductions in the context of enhancing economic growth and development, in line with the spirit and text of the UNFCCC.

a) Institutional Frameworks for Energy Management

The need to promote energy management in line with sustainable energy development guidelines will require a dedicated institutional presence capable of coordinating training, research, data collection and promotion of pilot project activities.

Given the present situation it would be useful to seek international partnerships in developing and initially supporting capacity building for sustainable Energy Management. This might include mid-term and short-term training for technical personnel, strengthening hardware and software capabilities, and short-term technical support for establishing technical and management systems related to energy management.

An additional area for attention will be establishing the legal framework for institutionalizing sustainable energy management. This will require, inter alia, that a review be undertaken at some stage to identify opportunities for strengthening present legal arrangements and exploring new opportunities, including those that may arise from out of the implementation of the Clean Development Mechanism and other aspects of the implementation of the UNFCCC and the Kyoto Protocol.

b) Electricity

Approaches to managing GHG emissions from Electricity will require action on at least two fronts. In addition to further increasing production efficiencies, the amount of energy consumed at end use should also be managed through improvements in end use efficiencies. Policies are required that will help to enhance economic returns through reducing demand for fossil fuels.

The approach should involve activities aimed at promoting savings through efficiency improvements at the household, commercial and tourism levels. The experience of Demand Side Management programmes in the region should be reviewed with a view to possible development and implementation of such a programme. The Electricity Utility may need to strengthen its energy efficiency awareness programmes and capability and could doubtless benefit from appropriate regional and international technical support in this regard. This is related to the need to establish a programme of Energy Audits aimed at identifying opportunities for improvements in end use efficiency for major consumers. Here again opportunities would appear to exist for international support in guiding and supporting required actions for energy efficiency and GHG mitigation.

c) Renewable Energy

Two renewable energy technologies - wind and solar - clearly exist as options for contributing towards Antigua and Barbuda's GHG mitigation efforts while at the same time contributing to sustainable development. Both of these technologies already exist at levels of commercialization, which make them accessible for introduction, and expansion in the case of solar water heaters. Additionally, it may be desirable in certain circumstances to promote technology transfer and capacity building for certain renewable energy technologies as part of attempts to ensure that capabilities exist for future applications.

In relation to Wind Energy an immediate priority would seem to be for a comprehensive assessment of the resource as part of an overall feasibility study for grid integrated wind power for Antigua and Barbuda. This should involve the Electricity Utility and include within its scope the need for long-term capacity building in the Utility.

Government policy has already been successful in promoting the use of solar water heaters. However, potential for further growth does exist. As with wind resources, the opportunity should be sought for conducting a solar resource assessment as part of a feasibility study for possible solar applications in Antigua and Barbuda.

d) Transport

The road Transport sector constitutes one of the fastest growing sources of GHG in Antigua and Barbuda and throughout the world, illustrating the difficulties involved in tackling energy sustainability in this sector. Crucial to success is to integrate GHG mitigation objectives with wider societal goals such as reduced traffic congestion and increased economic productivity.

Priorities for action include the development of a road transportation Master Plan. Within this Plan, goals for sustainable transportation modes will need to be set as part of wider socio-economic planning. This is an area where international cooperation is also required. Immediate objectives include programmes for creating consumer awareness of the economic benefits of proper engine maintenance and vehicle operation.

Effective implementation of these measures will however require a combination of national, regional and international initiatives and actions if inherent capacity, financial and resource constraints are to be overcome.

CHAPTER 4

CLIMATE CHANGE VULNERABILITY AND ADAPTATION

4.1 INTRODUCTION

The UNFCCC recognizes that Climate Change poses a threat to the survival of small island States such as Antigua and Barbuda. Sea level rise, higher temperatures and changes in the frequency and intensity of tropical storms will have important adverse impacts upon the country's economy and ecology. This requires building the capacity for identifying the possible impacts of changes in weather and climate on the various sectors. The need also exists for development of an integrated perspective that takes into account other elements of vulnerability – economic, environmental and institutional – that will also affect the extent of vulnerability to climate change.

Antigua and Barbuda has conducted a climate change Vulnerability and Adaptation Study aimed at enabling the country to identify those sectors likely to be most vulnerable to climate change and to devise appropriate adaptation response measures.

4.2 CLIMATE CHANGE SCENARIOS

Synthetic scenarios of climate change were developed for Antigua and Barbuda. The use of large-scale global circulation models (GCM's) was considered inappropriate for an island the size of Antigua and Barbuda. Additionally, the lack of data and limited time frame for the study precluded the use of mathematical and biophysical climate models. It was also considered important to use relatively simple and easily understood scenarios that decision makers and the wider public could comprehend.

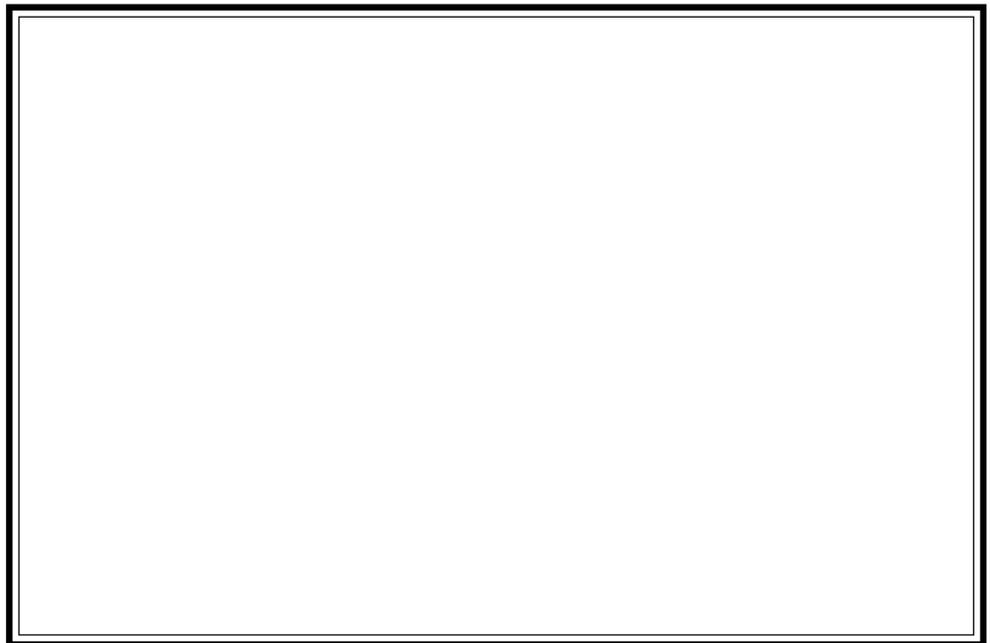


Photo courtesy EAG

The synthetic scenarios consisted of increased hurricane/tropical storm activity and more intensified drought conditions. The scenarios, presented in Table 4.1 and Table 4.2 assume a linear increase in the number of storms and hurricanes. In addition, a projected sea level rise was calculated for use in the coastal zone and human settlements sectors. These synthetic scenarios are based on IPCC and other projections of the likely impacts of anthropogenic climate change on the islands of the Caribbean.

The scenarios are also based on existing climate stresses. Over the past decade four major hurricanes have hit the islands resulting in a significant amount of damage. Their dangers arise from a combination of factors including high winds, heavy rains and storm surges.

Droughts have also occurred on the islands with some frequency. Periods of prolonged dry spells or droughts have resulted in water shortages in all settlements, particularly those in drier parts of the islands. Water supply is therefore a critical issue, and the situation is expected to become worse with population growth and the expansion of tourism, both of which are expected to increase the demand for water. Such extreme events can be used to provide insights into the potential impacts of climate change.

Table 4.1: Hurricane Scenarios for Antigua and Barbuda

- **No. of storms: Linear increase based on 35 year mean (1960-1995)**
- **Storm surge: Qualitative; depends on category of hurricane.**

Table 4.2: Drought Scenarios for Antigua and Barbuda

In September 1995, Hurricane Luis devastated Antigua and Barbuda followed within a week by Hurricane Marilyn, which also brought devastation to the country. Virtually all the major tourism facilities located along the coast were damaged resulting in closures and lost revenue. Antigua and Barbuda experienced a 17% decrease in the number of tourists following the Hurricane. Approximately 7000 persons were left unemployed.

Data indicate that the total cost of damages amounted to EC\$346.54 million, or 30.49% of the GDP at factor cost in 1994. The magnitude of the impact was over twice that of Hurricane Hugo in 1989 six years earlier.

4.3 BASELINE SOCIO-ECONOMIC SCENARIOS

Climate change will not be the only factor influencing the future of Antigua and Barbuda. Social and economic conditions are expected to change, affecting both the country's vulnerability and resiliency to climate change.

It is therefore an important step in any assessment to consider the trends that are likely to occur in the absence of climate change. Scenarios of climate change can then be superimposed on these baseline scenarios to suggest more probable impacts of climate change. Projections of socio-economic scenarios for Antigua and Barbuda were made for a thirty-year time frame, using 1991 as a baseline year.

Population growth and urbanization are already contributing to a scarcity of low-hazard development sites. Developments in high vulnerability, hazard prone areas carry a high risk, which can only partially be ameliorated by structural measures. Future domestic water demands in Antigua and Barbuda are projected to increase in proportion to population and economic growth.

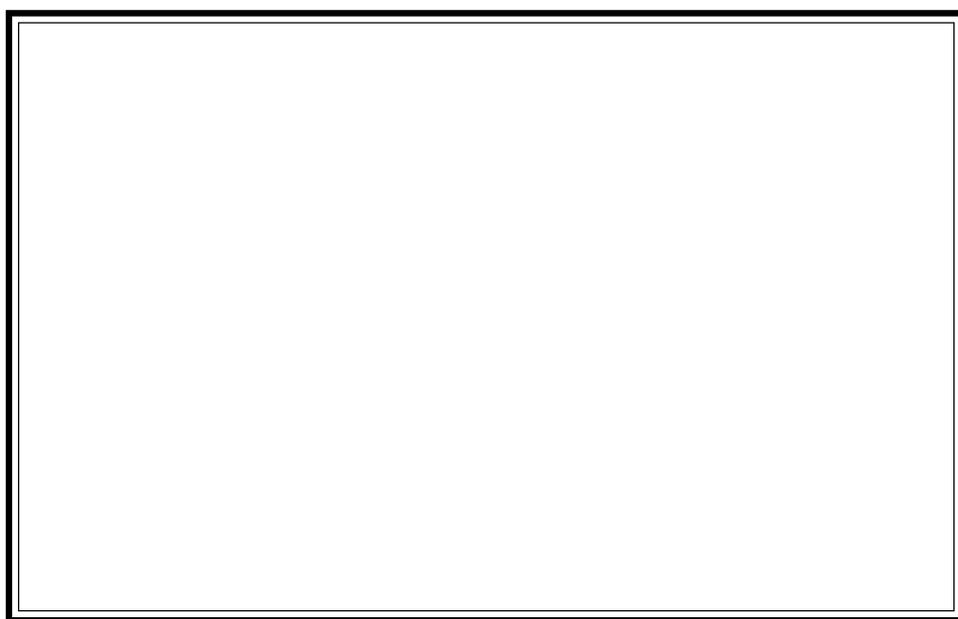


Photo courtesy Timothy Payne

The economy of Antigua and Barbuda is expected to grow from between 1.8% and 6% per annum by 2021, with a middle scenario of 4% growth per annum. These growth rates are consistent with economic projections made by the World Bank for Antigua and Barbuda.

Depending on future investments made in the tourism sector the number of tourists could increase to as much as 930,000 by 2005. Such growth would necessitate an expansion and improvement in infrastructure such as roads, seaports, airports, telecommunications and other facilities. Both population growth and a growth in tourism are anticipated to have multiplier effects that will result in increases in construction, transportation, communication and financial service sectors.

These growth scenarios imply that climate change will have its impact on an economy and society that is quite different from the present one. As a small island nation, Antigua and Barbuda is constrained by the land area that can be used to accommodate future expansion. If climate change is superimposed on the baseline scenarios, then the areas are deemed suitable for growth and expansion are even more limited.

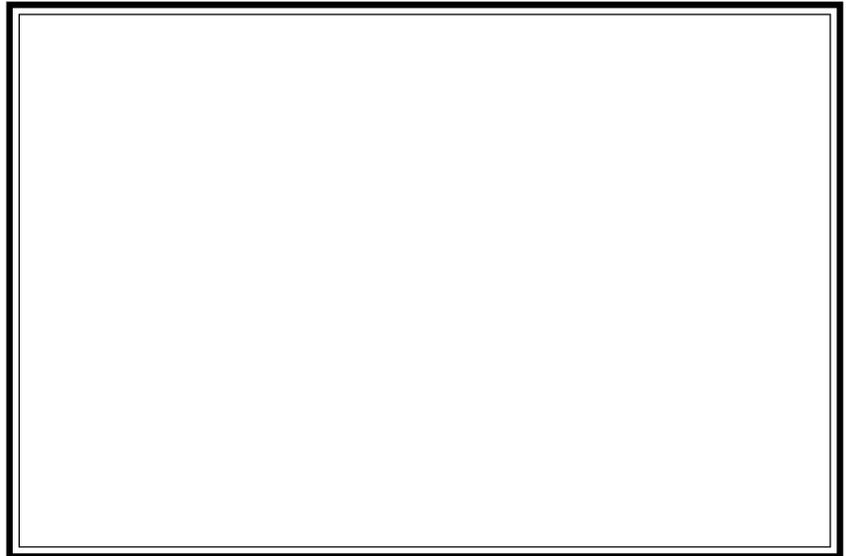
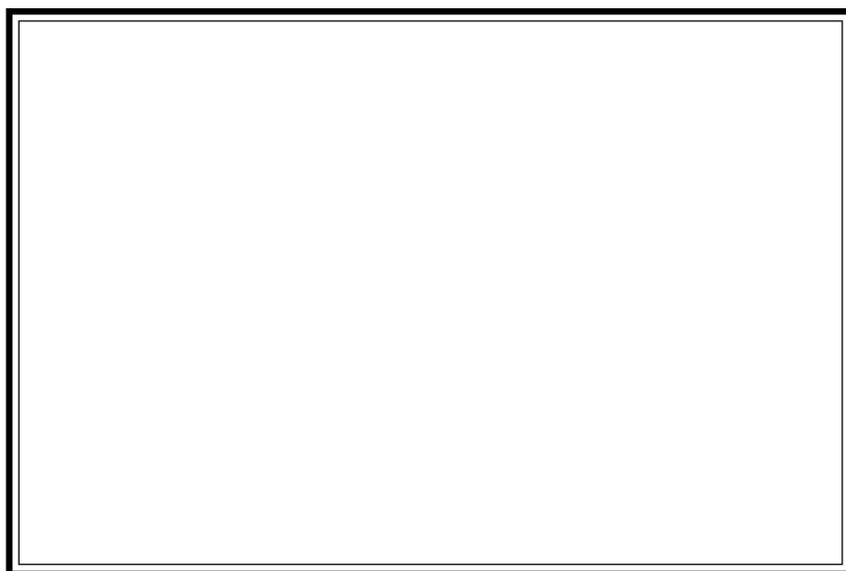


Photo courtesy Timothy Payne

4.4. HUMAN SETTLEMENTS AND TOURISM

Many of Antigua and Barbuda's human settlements and tourist developments are located in coastal areas. The spatial distribution of settlements has for the most part, evolved through natural trends rather than through policy and planning. To achieve an efficient form of development there is a need to place greater emphasis on long range physical planning and control of urban development.

The importance of locational factors was evident during the 1995 and 1999 hurricane seasons, when the country was hit by two hurricanes in the space of one month. Heavy rains and storm surges produced localized flooding and landslides. A great deal of the damage inflicted on housing and public buildings by Hurricanes Luis and Lenny can be traced to inappropriate standards for methods and materials used in construction and to inadequate developmental control.



Hurricane and tropical storm activity also have major impacts on the country's vital tourism industry. In 1995 Hurricanes Luis and Marilyn devastated coastal areas, causing severe damage to hotel and other tourism properties and leading to significant reductions in tourism arrivals and adversely affecting employment and foreign exchange. Similar experiences occurred in 1998 and 1999 with the passage of Hurricanes Jose, Georges and Lennie.

Photo courtesy EAG

In an assessment of the country's largest human settlement, thirty four percent of the major settlements were classified as low vulnerability, 28% were classified as medium vulnerability, 19% were classified as high vulnerability, and other 19% were evaluated as very high vulnerability. Inland settlements tended to have lower vulnerability ranking than coastal or flood plain-oriented settlements. This is not surprising, given that they are located a sufficient distance from the impact zone of the storm surges and rising sea level. Nevertheless, some island settlements particularly those located upon slopes facing or exposed to the coast, are susceptible to strong winds, including, prolonged and high intensity hurricane winds. Combined with high extreme rainfall events, the sloping aspect could initiate landslides, erosion, and slippage.

To assess the effects of sea level rise, topographical maps with contour intervals of ten feet were used, along with hydrographical maps. The projected sea level rise will lead to an increase in the risk of floods produced by storm surges. Settlements on the southwestern coast were found to be most vulnerable, and much of Barbuda is likely to be inundated under a one metre sea level rise scenario. The location of tourism facilities on or near beaches makes the tourism sector particularly vulnerable to the threat of sea level rise. In general it was found that the vulnerability of human settlements was likely to be most affected by extreme events, particularly hurricanes. Sea level rise, especially in Barbuda and in many coastal communities and areas (in St. John's, Urlings, Dickenson Bay, English Harbour, Falmouth, Parham) could also be expected to have significant impacts. Data collection for assessment of vulnerability remains a priority for this sector.

The following adaptation measures are recommended to reduce settlement vulnerability in Antigua and Barbuda:

1. Hazard mapping to identify those areas that are most vulnerable to the effects of climate change.
2. Flood control, including the cleaning of watercourses and drains.
3. Land use controls and enforcement, including zoning regulations, building codes and planning infrastructure standards, and setback requirements for the coastal zone.
4. Retrofitting of existing structures to strengthening their resilience against the hazards of climate change and hurricanes.
5. Capacity building, particularly the strengthening of institutions responsible for environmental management.
6. Improvement in the forecasting and early warning system to increase preparedness.
7. Public education and information to raise public awareness about climate change.
8. Insurance initiatives to reduce vulnerability of properties.

4.5. COASTAL ZONES

More than 60% of the population of Antigua and Barbuda lives within the coastal zone. Population increases and tourism-based developments are already putting pressure on coastal resources. In addition, reclamation of lands, sand mining and the lack of a comprehensive system to control flooding and sedimentation have increased the country's vulnerability to erosion, coastal flooding, and storm damage.

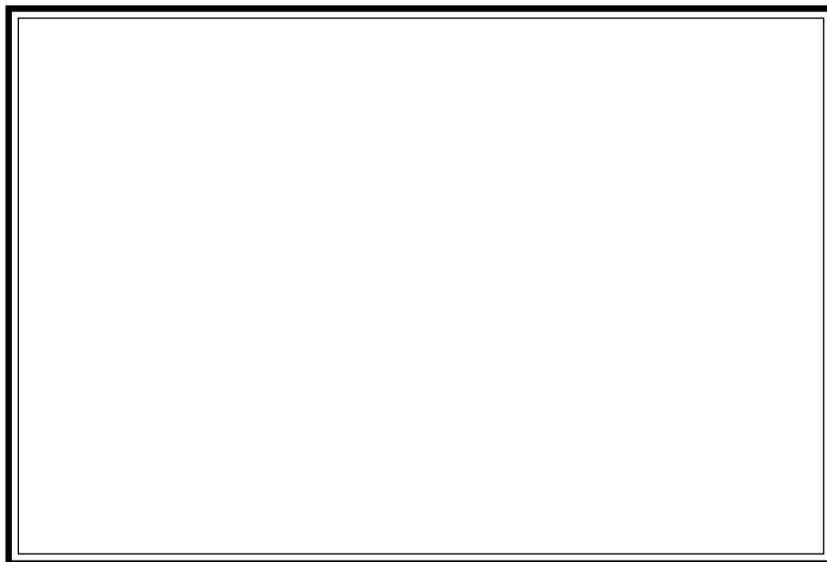


Photo courtesy Philmore Mullins

Antigua and Barbuda's coastal resources include mangroves and wetlands, coral reefs and sea grass beds, and beaches. The dominant species of mangrove on both islands is red mangrove (*Rhizophora*), mixed with black mangrove (*Avicennia*), white mangrove (*Laguncularia*) and occasionally button mangrove (*Conorcarpus*). Mangrove systems are important habitats for fisheries in the eastern Caribbean islands.

It is expected that climate change will significantly disrupt the mangrove ecosystems around Antigua and Barbuda. Many of these areas are presently under stress from natural and anthropogenic sources. Temperature change itself is expected to have minimal effect on mangrove ecosystems. However, changes in precipitation patterns such as increase in flooding or droughts, would alter the seawater to fresh water balance and thus significantly affect mangrove ecosystems. A decrease in precipitation would reduce productivity as well as increase exposure to seawater, leading to salt stress.

Sea level rise will result in the greatest impact on mangrove systems. A rise in sea level could cause mangroves to retreat shore wards, however, if sedimentation does not keep pace with the rising sea level, then erosion of the sub straight could be expected. Increased sedimentation from anthropogenic sources could result in stable or slowly retreating mangrove areas in larger systems. Fringing mangroves on the other hand, would be significantly reduced, as they have slow rates of sediment accumulation.

It is estimated that Antigua and Barbuda is currently using its mangrove systems at an average annual rate of about 1.5 – 2.0 % with a sea level rise of 3 – 4 mm per year. There would be little or no mangroves in Antigua by 2075, since the coastal slopes of most areas do not allow for landward retreat. With a sea level rise of 10 mm per year, this condition would be reached as early as 2030 or 2035. The condition is different from Barbuda, where extensive lowlands could theoretically accommodate retreat for a longer period.

Sea grasses located on Antigua's shelf and inter-tidal zones are also important resources. Sea grass beds are of

considerable importance to fisheries: they serve as nursery areas for many species of fishes, lobster and conch. The distribution of sea grass beds is generally controlled by water depth and salinity. Climate change will affect both coral reefs and sea grass beds. The impacts are related to sea level changes and fluctuations in temperature that effects critical habitats intense storms that cause direct physical damage and indirect effects of increased precipitation which leads to an increase in sediment supplied to coral reefs, sea grass beds and mangrove areas.

Coral reefs are currently growing precariously close to their maximum temperature tolerance of 30°C. Therefore, even small increases in temperature are expected to have detrimental effects.

Some of Antigua and Barbuda's most important resources, especially in terms of tourism, are its extensive beaches. Sandy beaches form the dominant coastal landscape of Antigua and Barbuda. The major use of beaches on these islands include tourism, recreation, fish landing sites, a source of fine aggregates used in building construction, and habitats for nesting turtles and other animals and plants. Anthropogenic factors affecting beaches include sand mining activities, dredging, and building of hard structures too close to the shoreline.

The dominant impact on the beach system will arise from any change in sea level, combined with the cumulative effects of hurricanes. Using a sea level rise of 3.0 mm per year over the next three decades, and then 4.0 mm per year until 2100, the shoreline of Antigua and Barbuda is anticipated to retreat nearly 40 metres. This corresponds to a retreat of 1 metre for every 10 mm of sea level rise. Beaches on underdeveloped coastlines, as in most of Barbuda, may continue to retreat inland as they erode. On developed coastlines where the beach cannot move inland because of concrete and hard structures, the beach may get narrower and narrower and eventually disappear.

The impacts of Hurricanes on Caribbean coastlines include erosion, retreat of the land edge or sand dune along with the beach, and accretion. In Antigua and Barbuda, it is anticipated that erosion will dominate, along with most of the coast, despite some accretion in a few areas. The amount of beach erosion depends on the characteristics of that particular hurricane, coastline shape, width of the offshore shelf and the presence of local features such as coral reefs. Along with sea level rise, the net effect of erosion will be a reduction in the land area of Antigua and Barbuda.

Coastal aquifers contribute to the water resources of Antigua and Barbuda. Whereas Antigua is heavily dependent upon desalinated water for domestic and other purposes, Barbuda depends greatly on its ground water resources. Rising sea level will threaten the viability of fresh water aquifers and other sources of groundwater. Most of the main aquifers, wells, sinkholes and water bodies in Barbuda are located relatively close to the coast. The depth of the water table is generally less than 1.5 metres in the lowlands. Any increase in sea level can affect the level and salinity of the groundwater supplies. With the projected sea level rise, the main aquifers and wells may be fully or partially inundated and the groundwater supplies could become

permanently lost. This will threaten the entire economy of the Island of Barbuda.

For Antigua and Barbuda's coastal zone, adaptation strategies include protective measures to restore beach and/or protect property. These include periodic beach nourishing, dune restoration and in some cases littoral drift replenishment. However, such activities are usually implemented without any appropriate studies or research. Long-term strategies for Antigua and Barbuda's coastal zone include retreat and accommodation options. The retreat option involves the general control of coastal development, including the phasing out of development in vulnerable coastal areas. The vulnerability assessment indicates that

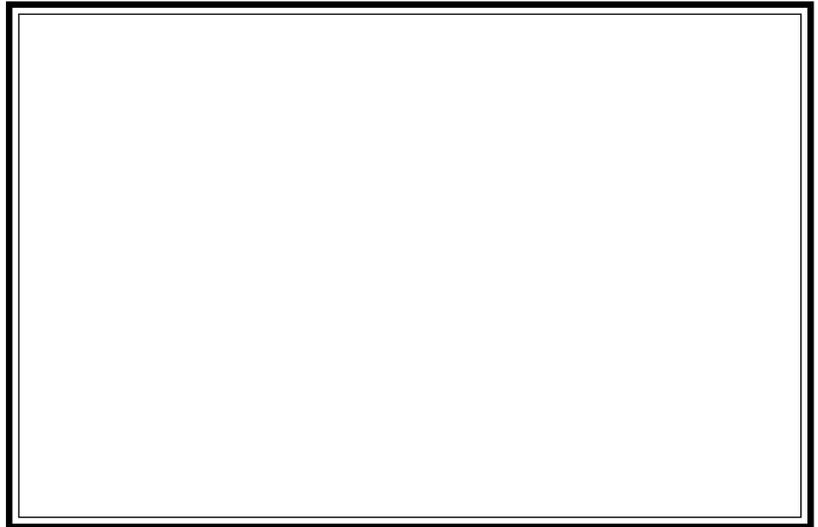


Photo courtesy Philmore Mullins

additional efforts are required to evaluate the range of coastal adaptation identified by the IPCC and other agencies. The impact of extreme events also emerges as a primary source of adverse impacts on the coastal resource base. Further technical and scientific work is also needed to understand the impact of climate change on coastal areas.

4.6. FISHERIES SECTOR

While the impacts of climate change on coastal areas is of prime concern to Antigua and Barbuda, there is also concern that climate change will affect fishery resources and fishing activity in the waters surrounding the islands. The most difficult aspect of detecting climate- induced impacts on the fishery sector of Antigua and Barbuda lies in distinguishing climate- related changes from changes resulting from exploitation. All significant fishery resources found in the waters of Antigua and Barbuda are exploited, and in several cases over exploited. Thus, there are likely to be visible declining trends in the abundance of some stocks.

Antigua and Barbuda's Exclusive Economic Zone (EEZ) covers an area of 110,071 km². However, the majority of fishing takes place on Antigua and Barbuda Shelf, which encompasses an area of 3,4000 km². The fisheries of Antigua and Barbuda are based on a wide variety of demersal and pelagic resources. Demersal resources are found primarily in association with the Antigua and Barbuda Shelf. They include spiny lobster, conch, shallow reef fishes, and deep reef fishes. Pelagic resources are found on the shelf, at the shelf edge and in oceanic regions of EEZ. Many large pelagic species, which migrate throughout the Caribbean region and beyond are likely to compensate for climate change by adjusting their migratory routes and distribution patterns. The issue of concern to Antigua and Barbuda lies in the availability of these species in local waters under climate change conditions.

Most fishery resources of importance to Antigua and Barbuda have early life history stages (egg and larvae) that drift in the plankton. Once the young leave the plankton, some coastal habitats such as mangrove ponds and sea grass beds as juveniles, before moving to their adult habitats. Consequently, any impacts on the habitats in which they spend their early life may affect the numbers and sizes of recruits that survive to enter the fishery. The implications of climate change for coastal zones were discussed above. In addition, any changes in coastal circulation, either wind driven or due to changes in large scale ocean currents impacting on shelf topography, may affect recruitment.

In addition to potential impacts on biomass and production of fisheries, the availability of fish stock may be affected by climate change. Climate change and variability may affect the availability of fish by altering the distribution of the resource, or by changing the way that they interact with the fishing gear. Evidence shows that weather has considerable influence on the availability of the major demersal resources of the island shelf. Changes in the weather, particularly in the seasonal cycle, are likely to affect availability of these resources to fishermen.

Inputs and costs related to fishing could also be affected by an intensification of the seasonal cycle, any by any increase in the frequency of storms. Harsher weather conditions in the windy season increase the following factors:

- travelling times to fishing grounds,
- fuel costs because of rough seas,
- labour costs because of the working conditions, and
- maintenance costs because of damage to the vessel, equipment and fishing gear.

In fact, destruction of fishing traps during the windy season is one of the main costs attributable to weather.

Storm and hurricane damage has a major impact on the fishing industry. About 16% of the total fleet was either destroyed or lost as a result of Hurricane Luis, and another 18% was damaged. In addition to the cost of replacement and repair to fishing vessels and gear caused by a hurricane, there is a loss of revenue due to disruption of the fishing industry. After this hurricane, many individuals who were unemployed due to the closure of hotels and businesses sought short-term employment in fishing. Most of this short-term effort was probably directed at already overexploited near-shore areas. Thus the immediate response to hurricanes may lead to further overexploitation of near-shore resources.

The effects of climate change on marine ecosystems cannot be easily mitigated by engineering measures. The better the quantity and quality of important coastal habitats, the less likely it will be that climate change will affect them and the fisheries that depend upon them. Nevertheless, given the vulnerability of coastal habitats to hot anthropogenic actions and climate change, it may be useful to consider the development of pelagic fisheries in Antigua and Barbuda. Due to the seasonal nature of pelagic resources, it would be necessary to use multipurpose vessels that could be used to catch demersal fish in the off-season, the strategy should aim for the replacement of existing smaller vessels, rather than to add to the fleet and exert additional pressure on demersal resources.

Figure 4.1a Map showing locations of main reef systems of Antigua

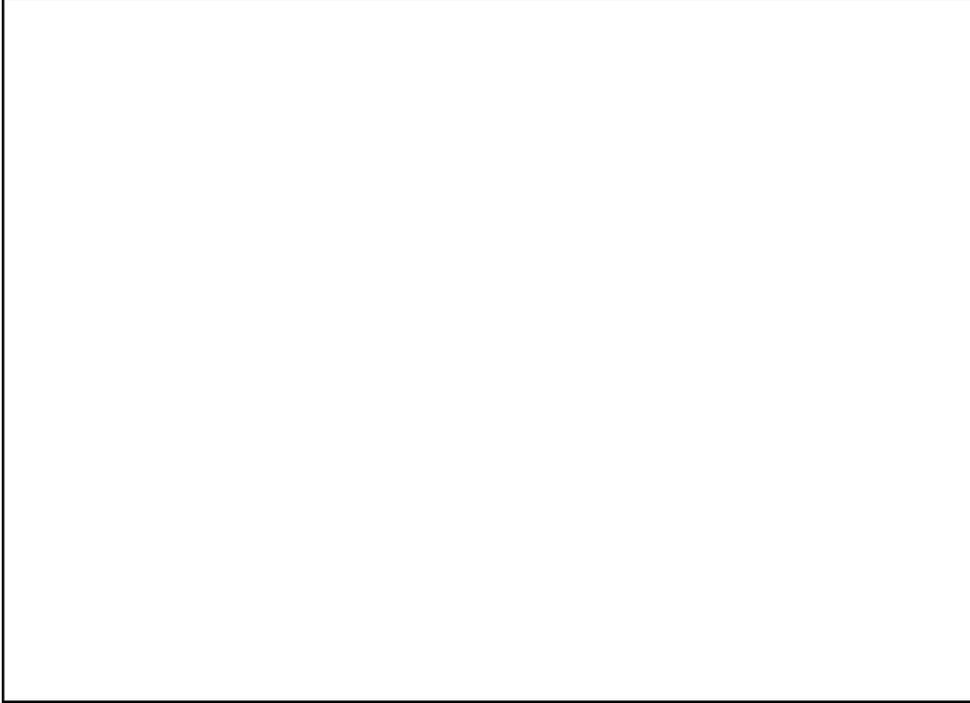
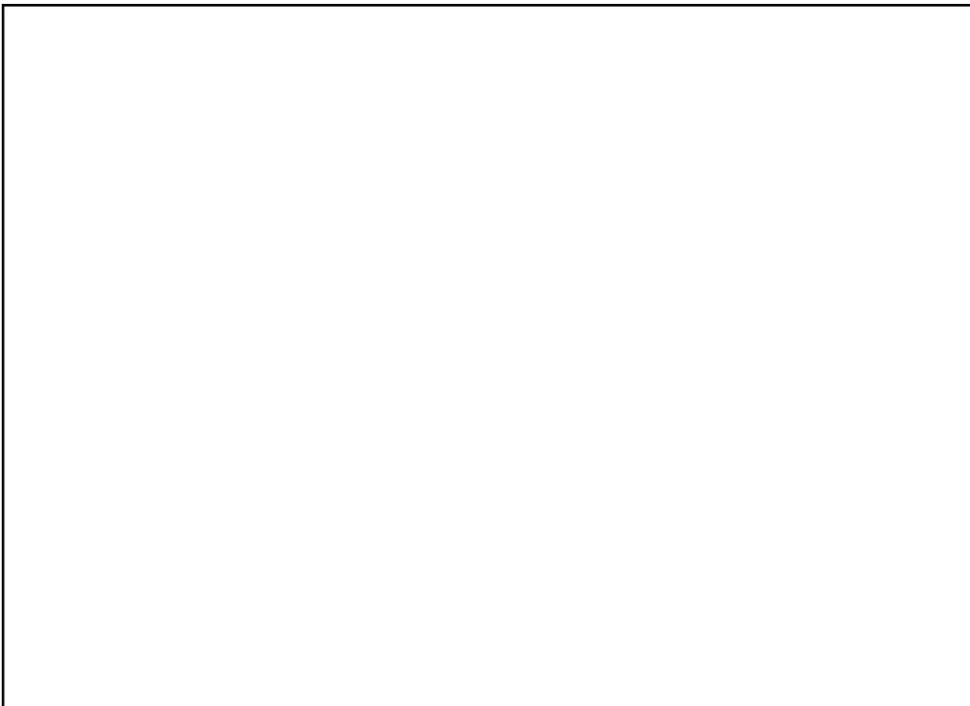


Figure 4.1b Map showing locations of main reef systems of Barbuda



4.7 AGRICULTURAL SECTOR

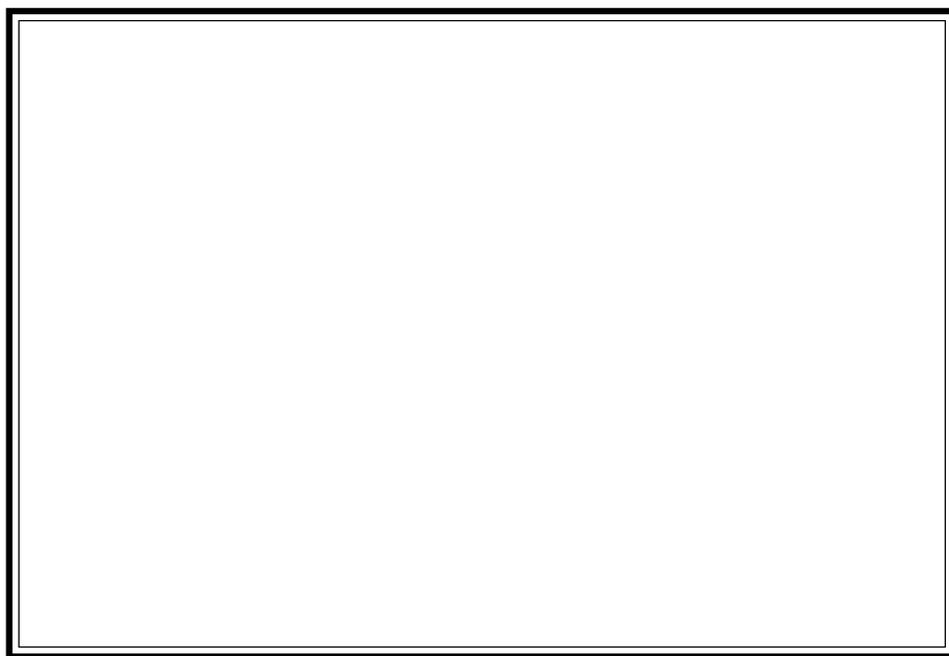


Photo courtesy Timothy Payne

The population of Antigua and Barbuda depends on fresh fruit, meat and vegetables for proper nutrition. Although agriculture presently contributes a small percentage (4%) to the gross domestic product (GDP), the government is seeking to increase this percentage in the future. As a net importer of food, Antigua and Barbuda's food supply patterns may be affected both in terms of price and availability if climate change affects global food production.

There is also the possibility that climate change could have direct effect on the agricultural sector.

Antigua has seven broad categories of land classes, ranging from land that can be easily cultivated to bare rock and flooded land. Antigua's main crops include eggplant, carrot, cabbage, onion, sweet pepper, pumpkin, yams, sweet potato, tomato and squash. Most of the produce is consumed locally. Some of the vegetables and tree crops are sold to hotels, as well as limited amounts to export markets.

Livestock include cattle, small ruminants, poultry, and pigs. Livestock production in Antigua is characterized as a low-input and low-output system in which growth of the herd represents the main priority. As a result, livestock numbers have increased significantly, to the point where overgrazing has become a problem. Many of the cattle and small ruminants graze on rough pasture that is communal land, often on former sugar estates. All livestock production is consumed locally.

Increased concentrations atmospheric Co₂ may benefit all crops and pastures, to some extent. However, increased temperatures and higher potential evapotranspiration rates can be expected to adversely affect tree crops and corn. A moderate sea level rise would have little direct effect on agriculture, livestock, and forestry. Exceptions are the tree crops, whose roots extend into water tables that could become saline. Wetter conditions would be beneficial to most crops and trees, although some water logging could also be expected. Drier conditions on the other hand, would be detrimental, unless irrigation water is made available.

For livestock, climate change is likely to result in a shortage of forage and feeds, water shortages, increasing effects of pests and diseases, damage to sheltered animals, damage to or loss of housing, stress conditions,

loss of productivity and production, loss of income, and loss of investment.

The effects of drought are extremely harsh on crops. When drought occurs, plant growth virtually comes to a halt and the country appears parched. Only a few deep-rooted and salt-tolerant species such as Mango (*Mangifera indica*), coconut (*cococ nucifera*), and Acacias (*Acacia sp.*) are not affected by drought. The most widespread damage to cropland from drought usually takes the form of soil erosion and leaching. Lack of rain and overgrazing of pastures result in the erosion of areas by wind.

Drought also has a large impact on the livestock sector. Impacts from 1983/1984 and 1993/1994 droughts include loss of body weight, a high percentage increase in both external and internal pastures, an increase of diseases, low fertility and reproductive rates for males and females, later maturation of offspring, and an increase of calves' mortality. At the other extreme, heavy rainfall can also be damaging to agriculture. A large amount rainfall (28-0 mm or more), that may accompany thunderstorms that can result in waterlogged soils, a decrease in aerobotic activity, and a loss of soil microbia. High intensity rainfall also saturates the soil and causes drainage and water waste to erode the banks and floors. Silting along waterways impedes drainage after the storm has passed, thereby increasing the possibility of future flooding. The effective storage potential of surface reservoirs and ponds is also reduced.

Hurricane force winds and rains prove to be destructive to most species of vegetables. In addition to the loss of actual crops, infrastructure, such as farm buildings, is often damaged. In the absence of crops insurance, which presently does not exist for the agricultural sector, complete or heavy crop losses make infrastructure replacement very difficult or impossible. The livestock sector can also be devastated by the severe storm. Poultry and small ruminants are often victims of high winds and intense wetting. They may die or be severely stressed and go into prolonged molt.

From the perspective of adaptation, the study identified an urgent need to develop a comprehensive cross-sectoral water policy, which would include the use of water for agriculture. At the same time, the introduction of drought-tolerant varieties in Antigua and Barbuda should be investigated, along with the possibilities for mulching irrigations. For the livestock sector a reduction in the number of animals per hectare can be considered a possible adaptation to long-term climate change. Development of high protein fodder as well as additional storage for fodder was also identified as a potential adaptation to drought.

4.8 WATER RESOURCES

The provision of a safe and sufficient water supply already represents an important challenge for the country. Consequently, the quantity and quality of water supply in Antigua and Barbuda are particularly vulnerable to any reduction in availability. Study on the water resource sector examined the impact of climate change on the national hydrological cycle and water resources availability, as well as impacts on the economics of water supply and demand. It also considered adaptation measures to increase the country's preparedness to meet the

future scenarios for water availability.

A national water distribution system forms a major input into vital sectors of the economy, including tourism and agriculture. It also contributes to the public health and general welfare of the population. The expansion of tourism and the increase in construction activities has led to more intensive land use and pollution, which in turn have affected watersheds, largely through increased erosion and siltation. The contemporary water resource issues that apply to Antigua and Barbuda include the following:

- water resource scarcity,
- high seasonal and interannual rainfall variability,
- high exposure of watersheds to stress and pollution,
- inadequate reservoir design and catchment management,
- high risk and vulnerability to floods and droughts, and
- sharing of water between sectors.

Water demand projections are driven primarily by population and economic growth rates. The highest increase is related to the development of the tourist sector. Water demand is forecasted to reach 5,800,000 m³ by 2020. The combined inputs of groundwater, surface water and desalinated water are expected to meet this demand.

The assessment of climate change impacts considered the three major sources of water in Antigua and Barbuda: surface water, ground water, and desalinated water. These three sources supply the nation water distribution system and contribute to the vital economic sectors of the economy. In addition, rainwater harvesting at the household level is an important source of drinking water for the majority of the population.

Figure 4.2a. Location of major watersheds in Antigua

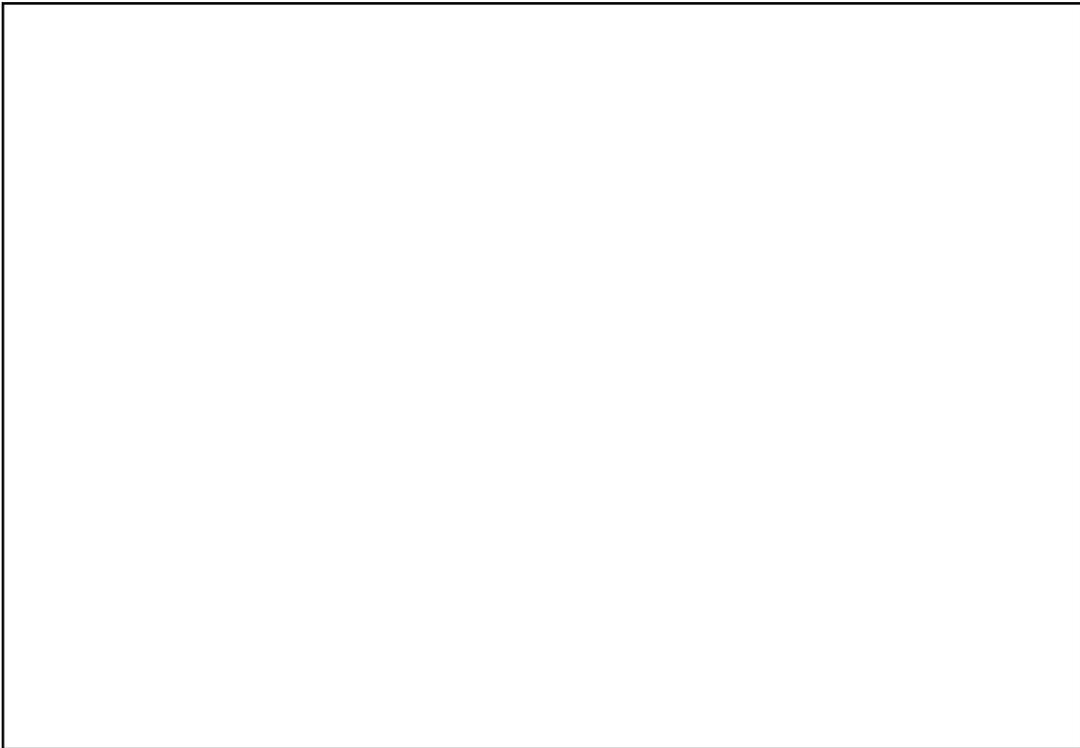


Figure 4.2b. Location of watersheds in Barbuda



Table 4.3 Current Resources and Water Supply and Demand Situation

The six major watersheds cover 43% of the island's area and contain approximately 70% of Antigua's population, 80% of the groundwater supplies, and 90% of the surface water supplies. They also correspond to the main centres for economic activity. The situation in Barbuda is quite different. An arid island with no perennial surface streams and only a few seasonal lakes and inland depressions, its main source of water supply is ground water, which is becoming increasingly saline.

The total reservoir storage capacity is only equivalent to about one year's water demand, and is therefore dependent on full annual replenishment to avoid shortages. Relatively small changes in temperature and precipitation, together with the cumulative effects on evapotranspiration and soil moisture, can result in relatively large reductions in runoff due to the combined effects of decreased precipitation and increased evapotranspiration. On the other hand, more intense rainfall would increase runoff and the risk of flash flooding. Preliminary observations suggest that high intensity rainfall conditions are more favourable when it comes to the filling of reservoirs than more evenly distributed rainfall.

Options for coping with the possible impacts of climate change and increased uncertainty about future supply and demand for freshwater include the following:

- more efficient management of existing supplies and infrastructure,
- institutional arrangements to limit future demands,
- promoting conservation,
- improving monitoring and forecasting systems for floods and droughts,
- rehabilitation of watersheds,
- construction of new reservoir capacity to capture and store excess flows, and
- construction of deep wells.

Due to Antigua's small landmass and its increasing demands for water, the expansion of reservoir capacity is likely to decline in the future. The feasibility of constructing more dam capacity to meet future requirements for flood control and water supply should, nevertheless, be investigated. Given the limited possibilities for increasing the storage capacity of surface water in Antigua and Barbuda, there is a strong possibility that the country will become more dependent on fresh water from desalination of seawater or saline groundwater. Efforts need to be pursued to facilitate the transfer of technologies for water desalination to small states like Antigua and Barbuda likely to be adversely affected by global climate change.

4.9 HEALTH IMPACTS

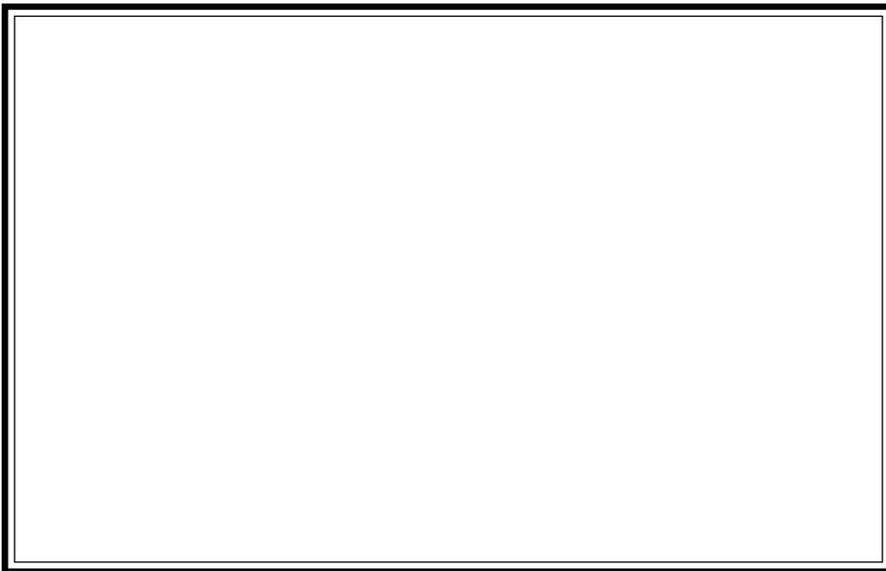


Photo courtesy Timothy Payne

Antigua and Barbuda has made important strides in meeting the health care needs of its people. However climate change will have a number of implications for human health. For example, changes in precipitation patterns may affect the availability of water for consumption and other domestic and agricultural uses impacting on public health and nutritional levels. Flooding may lead to the biological contamination of water sources and an expansion of the

habitat for vectors like the *Aedes aegypti* mosquito, which transmits dengue fever. Droughts, on the other hand, may lead to shortages of water, resulting in an increased risk of the transmission of diseases such as cholera, typhoid and bacterial dysentery.

Extreme weather events such as hurricanes present direct threats in terms of human mortality and morbidity, and greater threats to public health infrastructure. Hurricane Luis caused extensive damage to Antigua's main hospital and most of the clinics and health centers.

Dengue is endemic in the Caribbean and dengue-like illness has been reported in the Americas for over 200 years. Until the 1960's, most dengue outbreaks occurred at intervals of one or more decades, but thereafter, the intervals have shortened: to what extent this is related to changes in climate parameters is unclear. The last major outbreak in Antigua was 1981, when 77 cases were identified. The potential for dengue transmission is dependent on the population of the *Aedes aegypti* mosquito, as measured by the *Aedes* household infestation index and a number of other factors. An epidemic potential model was run using several scenarios of temperature changes: baseline, +1°C, +2°C and +4°C. Although the model was run with limited data, results indicated that transmission of dengue was dependent upon both temperature and precipitation. However, the epidemic potential also appears to increase as a result of temperature increases alone.

In general, climate change scenarios for hurricane activity, drought, and temperature increases will result in significant adverse health impacts affecting infrastructure as well as health morbidity and mortality patterns. The most vulnerable groups are likely to be the elderly, persons in risk prone areas, and persons with existing health complications. These impacts will come upon a health sector already burdened by lack of financial, technical and institutional resources. Additional research is needed to identify the possible health implications associated with climate change.

Adaptations in the health sector include programmes for improved health data management and monitoring, public awareness activities and technological interventions in such areas as solid and liquid waste management.

4.10 CONCLUSION

Climate change can be expected to have widespread adverse impacts on Antigua and Barbuda. Adaptation options will also have to be cross-sectoral and should aim to reduce existing vulnerabilities while also building capacities for enabling sustainable development. Data collection and monitoring of weather and environmental parameters will be an important element of adaptation. However, the magnitude of projected impacts means that action must also involve a wide range of technical and financial assistance programmes. Regional and international cooperation will also be essential for sharing and pooling resources and for transfer of appropriate technologies.

However, international action must focus on efforts to reduce emissions of GHGs to levels that will not produce irreversible adverse impacts on the environment. The Vulnerability and Adaptation assessment points to the extreme vulnerability of Antigua and Barbuda to many of the projected impacts of climate change. Clearly, many of these impacts will produce severe socio-economic and ecological results that will strain, and may even be beyond the adaptive capacity of such a small country.

CHAPTER 5

GENERAL DESCRIPTION OF STEPS TAKEN

5.1. INTRODUCTION

Article 12.1 (b) of the UNFCCC requires States to provide a general description of steps being taken to implement the Convention. The following represents an outline of some of the principal actions being taken by the Government and people of Antigua and Barbuda to meet its obligations under the Convention.

5.2. RESEARCH AND SYSTEMATIC OBSERVATION

The research and systematic observation of weather and climate-related events and systems are important elements of the country's efforts to attain sustainable development and are essential to determining the extent of changes in weather and climate parameters affecting Antigua and Barbuda. Nevertheless, efforts in this regard are constrained by a variety of technological, financial and other factors.

The centerpiece of the country's climate research and systematic observation resource is the national meteorological service with its headquarters at the V.C. Bird International Airport. The Met office fulfills a number of vital services for Antigua and Barbuda and neighboring countries in the northeastern Caribbean. These include the systematic collection and analysis of meteorological data, providing information and data services to maritime and aviation interests, and serving as the official source of information for tropical storms and hurricanes. In fact, within the context of a micro-State with limited technical and scientific capabilities, the service is the agency regarded as having the mandate to provide information on a range of natural events and phenomena not directly related to meteorological conditions. These include volcanic, astrological and seismic activity.

At present, data collected by the met service consists of hourly values of air temperature, atmospheric pressure, cloud conditions, rainfall events, significant weather events, humidity, wind direction and speed, and visibility. This data is entered into the global weather exchange database for exchange, as well as kept locally as climatological records. The service has data extending back to the year 1962, as well as some earlier data, mainly rainfall collected by the Ministry of Agriculture and interested private individuals and businesses.

A recent addition to the information base accessible to the national met service is the data provided from a tidal gauge installed as part of the regional CPACC project. This instrument provides data on such parameters as wind speed, wind direction, sea surface temperature, air temperature, atmospheric pressure, rainfall, tidal data, relative and barometric pressure as measured over the sea surface. The tidal gauge forms part of a

regional network providing data and information to a regional data processing and storage centre using real time satellite technology. The CPACC project is funded by the Global Environment Facility (GEF) and implemented by the University of the West Indies Centre for Environment and Development (UWICED) in conjunction with the Organization of American States (OAS).

Since the devastation wrought to the eastern Caribbean by Hurricane Luis in 1995 public appreciation and perceptions of the met service has focused on the vital role that the agency provides in terms of hurricane and disaster preparedness. Presently the forecasting and tracking capabilities of the national met service consist of trained meteorologists and forecasters, meteorological observers and technical officers.

At the regional level cooperation in research and systematic observation also includes the programmes of the Caribbean Meteorological Organization and the Caribbean Institute of Meteorology and Hydrology.

Notwithstanding the important strides made in improving technical capabilities, significant gaps remain in terms of enabling the country to adequately assess the processes and impacts of anthropogenic climate change. Financial and technical limitations restrict the geographical scope for data collection, most notably in Barbuda where vulnerabilities to existing climate stresses are already high due to the island's topography and economic dependency. Budgetary constraints impose technical, logistical and personnel restrictions on the work of the met service.

Efforts for improving research and systematic observation presently underway include:

- training of a number of persons up to the degree level in meteorology, computer science, mathematics and other areas,
- changing the office structure –meteorologists, climatologists, research officer – to allow for a more specified approach, and
- in-house development of computer software needed to help solve some problems and to provide information to the public.
- identifying some important areas for research e.g. the investigation of a positive trend in temperature, in support of global warming, sea level rise and the apparent reduction in rainfall over Antigua and Barbuda.

Another effort towards research and systematic observation involves efforts by the Fisheries Department of the Ministry of Agriculture to collect and analyze data on changes in sea-level at various coastal sites. This has been an ongoing programme for a number of years and has already generated useful data on changes in beach profiles indicating that erosion in some coastal areas is at rates far exceeding global averages. The sea-level monitoring programme has been implemented with technical assistance provided through UNEP.

Various other public sector and NGO environmental agencies are also involved in the monitoring and assessment of natural ecosystems sensitive to changes and shifts in weather and climatic patterns.

5.3 PUBLIC AWARENESS

Public awareness of climate change will be an essential requirement if meaningful attempts towards adaptation and mitigation are to be effective in SIDS such as Antigua and Barbuda. In many instances information on, and awareness of, climate change may be the single most important tool for facilitating sustainable adaptation to climate change.

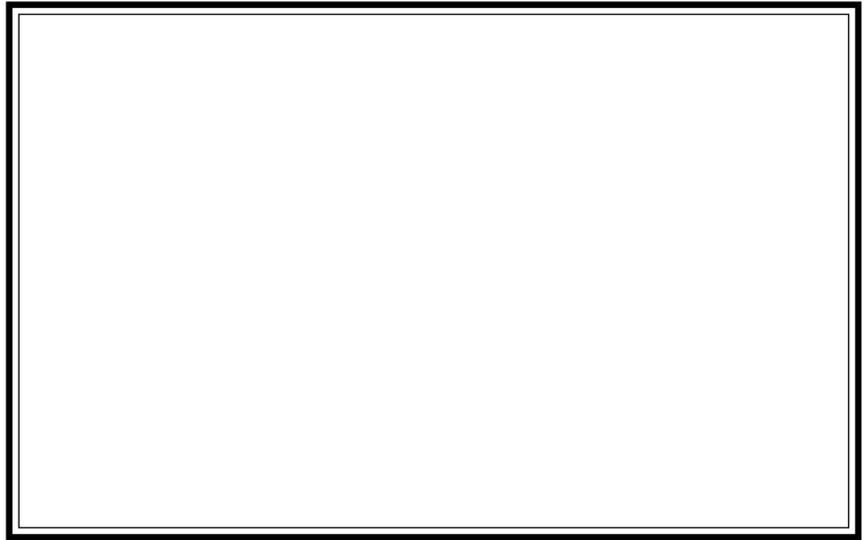


Photo courtesy Timothy Payne

Extreme weather events since 1995 have heightened public perceptions of changes taking place in weather patterns. However, there is generally very little understanding of the processes or significance of climate change. Importantly, there is little recognition that present unsustainable practices may be heightening vulnerability to anticipated impacts of climate change. This points to the need for public awareness of climate change as a prerequisite for advancing efforts in achieving the objectives of the UNFCCC.

The initial attempt towards a specific national programme of public awareness of climate change in Antigua and Barbuda was implemented as part of a 1997/98 UNEP sponsored project to undertake pilot studies of climate change impact assessment and adaptation. This public awareness programme was a multi-pronged initiative targeted at schoolchildren, select coastal communities identified as particularly vulnerable, and the general public. Among the media utilized were a museum display and preparation of a video broadcast on national television. The regional CPACC project has also allowed for the development of targeted public awareness programmes.

Some public awareness activities have been conducted within the framework of the Enabling Activity project implemented as part of the country's obligations under the UNFCCC. Specifically the project activities allowed for a programme of sensitization for select stakeholders. This has included non-governmental organisations as well as influential public service bodies. Other groups targeted were schoolchildren, district disaster committees and the island community of Barbuda.

The area of public awareness will require substantial additional efforts in view of its essential role in building constituencies of public support for adaptive measures as well as in building stakeholder perceptions of possible impacts. Along with efforts at the country level, such as those noted above, there would appear to be opportunities for regional coordination and cooperation in the development and delivery of public awareness activities. This should involve utilizing regional resource agencies involved in media and public awareness working

alongside national and regional bodies working on climate change-related activities.

5.4 CAPACITY BUILDING

Capacity building can be regarded as the ability of individuals and institutions to make and influence decisions and perform functions in an efficient and sustainable manner. At the individual level, capacity building involves a process of empowerment in changing attitudes and behaviors, developing skills, and obtaining knowledge. At the institutional level capacity building encompasses overall organizational performance and functioning, as well as the ability to adapt to changing circumstances. Systemic capabilities include the overall policy environment and availability of systems level resources.

Small island developing States such as Antigua and Barbuda possess innate capacity limitations at all three levels. Nevertheless, developing and building national and regional capacity has been and remains a priority for Antigua and Barbuda as an essential instrument for achieving the ultimate objective of the UNFCCC.

Antigua and Barbuda's participation in the UNEP Country Studies on Climate Change Impacts and Adaptations Assessments implemented in 1997-1998 provided the country with its first major involvement in a project aimed specifically at building capacity for climate change. Arising out of the project has been the creation of a small cadre of technical experts trained in internationally acceptable methods of climate impact assessment.

The regional CPACC project has also been a principal instrument for building capacity at national and regional levels. CPACC outputs have particularly sought to strengthen the ability of public and private sector agencies and stakeholders in coastal areas through various training, research, public outreach and policy dialogue activities. In view of the success of CPACC in promoting capacity building, a critical issue becomes the need for sustainability of regional mechanisms if long-term capacity is to be built for addressing the multi-sectoral implications of climate change.

The programme of Enabling Activities has also been a major activity in building national capacity to meet the obligations of the UNFCCC as well as in addressing the wider impacts and implications of climate change. Capacity building efforts under the Enabling Activity have centered around developing and institutionalizing the country's initial Greenhouse Gas Inventory, undertaking a vulnerability and adaptation assessment, identifying mitigation measures, promoting public awareness, and preparing the Initial National Communications.

These various initiatives at building capacity have been important in laying a foundation for further work needed in institutionalizing concerns for climate change in Antigua and Barbuda. In particular, given the likely wide-ranging implications of climate change on virtually all aspects of socio-economic activity, it is necessary that decision makers at all levels are empowered with the skills, knowledge and capacities for reducing vulnerabilities and advancing sustainable development within the context of the UNFCCC. Similarly,

institutional processes and systemic abilities will require sustained support and assistance to facilitate the fostering of the type of macro policy frameworks that SIDS such as Antigua and Barbuda will need to implement if they are to achieve sustainable development.

5.5. SUSTAINABLE DEVELOPMENT INITIATIVES

In addition to programmes relating to climate change, there are a number of ongoing initiatives to enhance prospects for sustainable development in Antigua and Barbuda. These include:

- strengthening of the environment Division of the Ministry of Tourism,
- development of a National Physical Development Plan,
- establishment of an economic planning commission,
- development of a national Biodiversity strategy and action plan,
- upgrading solid and liquid waste management systems,
- improving inter-sectoral coordination for environmental management, and
- protection of certain key environmental habitats.

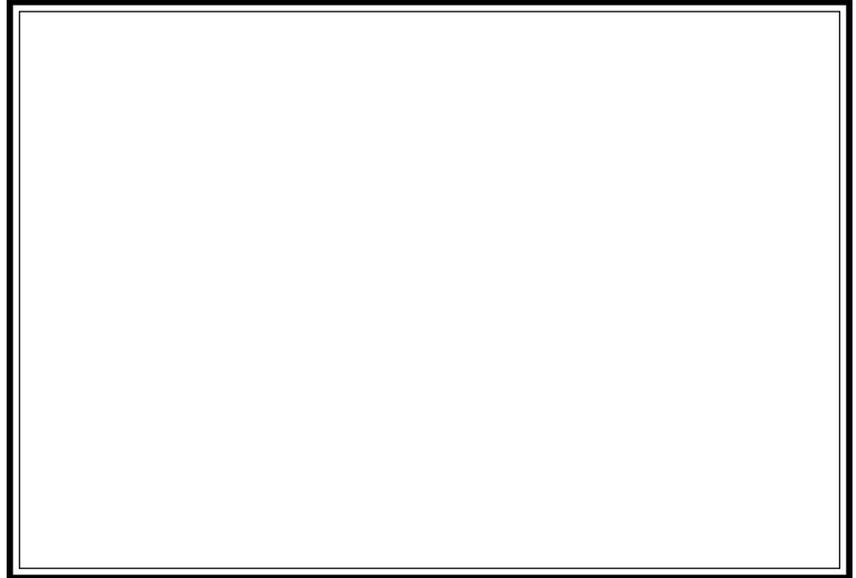


Photo courtesy Timothy Payne

All these measures are intended to provide the country with an increased capacity to pursue programmes aimed at environmental protection for sustainable management. They represent important complements to the actions that will need to be pursued to respond to the challenges arising from anthropogenic climate change.

CHAPTER 6

FINANCIAL AND TECHNOLOGICAL NEEDS AND CONSTRAINTS

6.1 INTEGRATING CLIMATE CHANGE INTO DEVELOPMENT PLANNING

Adapting to challenges imposed by global climate change will require that Antigua and Barbuda be in a better position to integrate climate change considerations into ongoing and proposed development activities. This will require strengthening national planning capabilities through technical support in a range of areas, as well as establishing an institutional focal point for coordination, and in some instances, implementation of climate change-related programmes.

Objectives

1. To ensure that relevant agencies and organizations possess the necessary skills and technical resources associated with assessing and responding to the increased impacts of climate change;
2. To build the capacity and awareness of community, governmental and private sector organizations for adaptation to climate change;
3. To promote the transfer of climate change adaptation technologies;
4. To establish framework processes for applying and integrating adaptation measures into national development strategies;
5. To improve data collection and analysis relating to vulnerability and adaptation measures.

Strategies/Activities

- Establishment of an institutional focal point for climate change.
- Support to national agencies and organizations for assessing and responding to climate change.
- Facilitation of inter-sectoral coordination and exchange of information and data on climate change.
- Development and implementation of frameworks for integrating climate change into the planning process.

- Strengthening public awareness activities.
- Provision of technical assistance (computer hardware and software) for climate change activities.

6.2 CLIMATE CHANGE PUBLIC AWARENESS AND INFORMATION

Knowledge and awareness of climate change are required at both technical and general levels if Antigua and Barbuda is to be able to adapt meaningfully to future challenges. This is essential in terms of building the levels of support required for pursuing adaptation measures. Additionally, it is necessary to establish information distribution and access systems for providing information and data for decision-making at technical and policy levels.

Objectives

- Creating public awareness of climate change among a wide range of stakeholders including public, private and community sector organization.
- Establishing sustainable systems for storage and dissemination of climate change-related information.

Strategies/Activities

- Strengthening of awareness among the general public as to the likely impacts of climate change and the short-, medium- and long-term adaptation actions required.
- Developing mechanisms for enabling the flow of information and data on climate change to decision makers, the media, and the general public.
- Providing information to stakeholders on matters pertaining to climate change.

6.3 PROMOTING SUSTAINABLE ENERGY

A number of measures are necessary for enabling Antigua and Barbuda to achieve sustainable energy management in line with the ultimate objective of the UNFCCC. These include a range of institutional strengthening and capacity-building measures for key agencies, resource assessments for renewable energy, promoting electricity conservation, and development of a comprehensive road transportation Master Plan.

Objectives

- Promoting economic and social development within the context of managing in emissions of greenhouse gases.

- Building capacity at the national level for improving efficiency in use of conventional fuels.
- Prompting the development and use of renewable energy resources, including capacity building measures necessary for achieving this objective.

Strategies/Activities

- Institutional strengthening
- Renewable energy resource assessments
- Electricity Demand Side Management study and programme
- Energy audits
- Transport sector planning.

6.4 PURPOSE-BUILT STORM SHELTERS

Intensified hurricane and tropical storm activity since 1995 has illustrated the importance of constructing purpose built hurricane/storm shelters able to withstand Category Five storms. This is particularly important for low income and other vulnerable groups. These structures would also serve as community centers outside of their use as emergency shelters, and would be useful pilot models for application in other Caribbean countries.

Objectives

- Reduction of loss of life and injuries through availability of pilot purpose-built hurricane shelters for vulnerable communities.
- Provision of a model for cost effective purpose-built community emergency shelters.
- Reduction of present utilization of schools and other non-purpose-built facilities as emergency shelters.

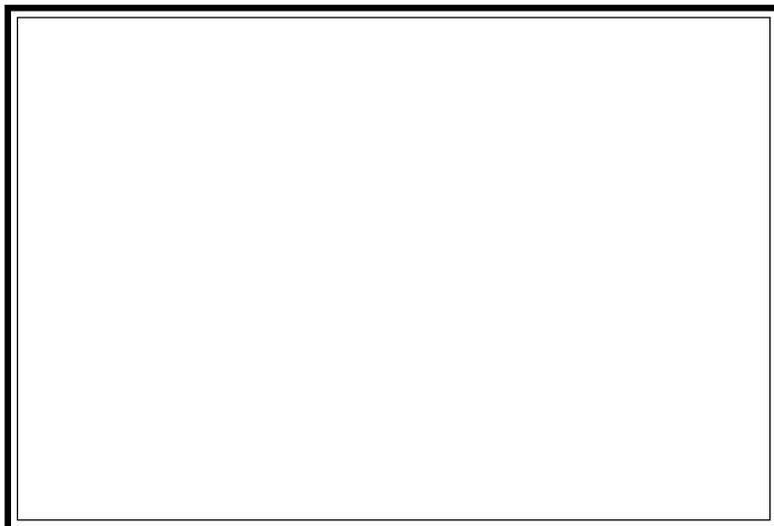


Photo courtesy Philmore Mullins

Strategies/Activities

- Design and construction of appropriate structures
- Training in emergency management construction techniques and technologies
- Refund technology transfer.

6.5 PRIORITIZED PROJECTS REQUIRING FINANCIAL RESOURCES FROM THE GLOBAL ENVIRONMENT FACILITY (GEF)

1. Capacity building to develop and maintain a climate change programme to:

- Identify major sources and sinks of GHGs and estimate their magnitudes;
- Estimate uncertainties associated with each GHG emitted and removed:
- Identify existing trends in emission and removals of each GHG during an inventory period and make comparative analysis based on existing trends;
- Provide technical support for policy-making, negotiations, legislation regulation and enforcement, monitoring, and awareness-raising and community Participation:
- Develop and apply appropriate methodologies and information sources:
- Identify, assess, and implement investment instruments relevant to adaptation:
- Develop and implement integrated coastal zone management plans;
- Undertake more in-depth public awareness and education at all educational levels and within all sectors of society; and
- Enhance the collection, management, archiving, analysis, interpretation and dissemination of data on climate change.

2. Energy Efficiency/renewable energy:

- Demand side management IDSM! demonstration project to create a DSM program unit within the APUA;
- Demonstration project to promote compact fluorescent lamps (CFLs) for residential use;
- Demonstration project for grid-connected renewable energy technologies and their commercial and economic potential within the SIDS context; and
- Development and implementation of long-term renewable energy policy programmes, including the development and application of carefully-selected technological and institutional leapfrogging strategies.

3. Adaptation:

- Identify and implement country-specific Stage II and Stage III adaptation activities;
- Enhance disaster preparedness and disaster management, including contingency planning for land degradation, droughts, and floods in areas prone to extreme weather events; and
- Strengthen existing or establish early warning systems for extreme weather events in an integrated and interdisciplinary manner.

6.6 ESTABLISHMENT OF A CARIBBEAN CLIMATE CHANGE CENTRE

The nature of the problems associated with climate change means that Antigua and Barbuda and other vulnerable Caribbean SIDS will need to build long-term capacity to respond to this challenge. While this capacity is required for national actions the success of the regional CPACC project points to the critical role which regional efforts have for cost effectively building capacity among countries with similar sustainable development challenges and objectives. Ongoing work points to the importance of additional work to develop regional climate models, strengthen GHG Inventory data gaps, conduct training for personnel in key sectors likely to be impacted by climate change (water, coastal zones, health etc), conduct additional research into vulnerability and adaptation, and promote public awareness.

Objectives

- Strengthening national and regional technical capabilities for climate change.

- Allowing for enhanced networking and exchange of information on climate change.
- Promoting appropriate regional actions and reduce the possibilities for unnecessary duplication of efforts.
- Provision of a regional focal point for scientific, technical and policy related matters pertaining to climate change.

Strategies/Activities

- Facilitating regional policy dialogue on development of a regional climate change center.
- Participating in ongoing regional initiatives for promoting the ultimate objectives of the UNFCCC.
- Leading and participating in regional capacity building activities.

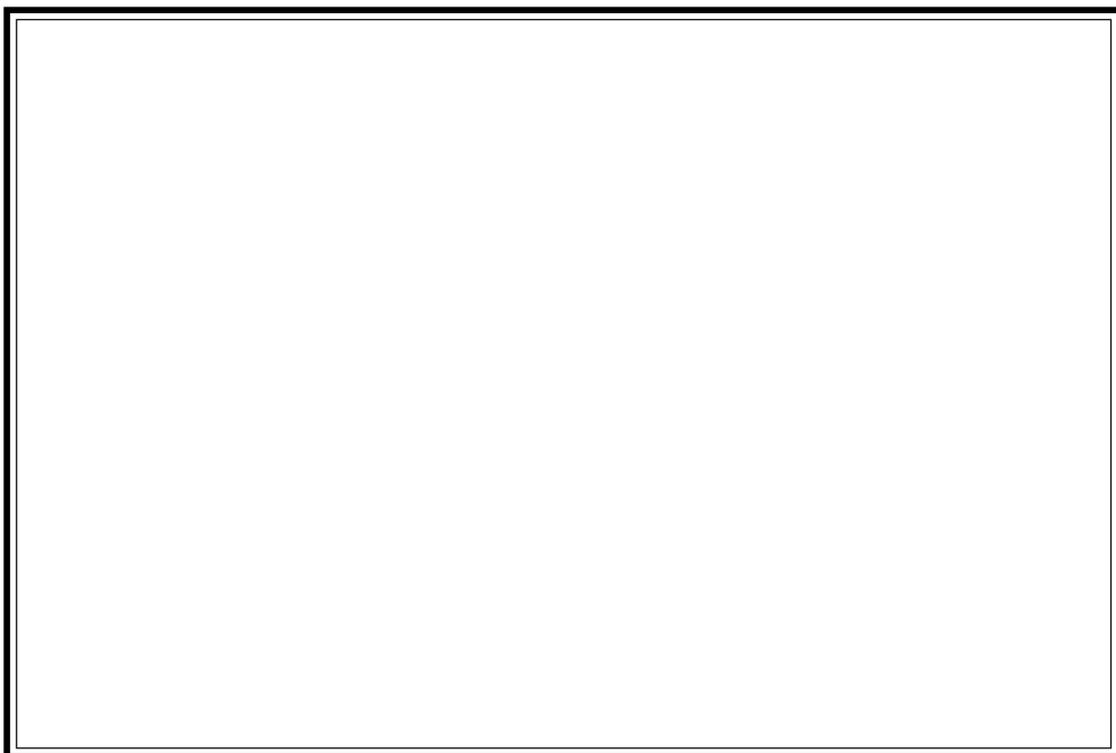


Photo courtesy EAG