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# Government of Antigua and Barbuda

## DRAFT

# Natural Hazard Mitigation Policy and Plan for Antigua and Barbuda

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## Acronyms

G.D.P. – Gross Domestic Product

S.I.D.S. – Small Island Developing States

O.A.S. – Organization of American States

N.O.D.S. – National Office of Disaster Services

D.C.A. – Development Control Authority

N.M.C. – National Mitigation Council

N.M.T.C. – National Mitigation Technical Committee (Technical Steering Committee)

N.G.Os. – Non-Governmental Organizations

C.B.O.S. – Community-Based Organizations

G.I.S. – Geographic Information System

## **Executive Summary**

### **Natural Hazard Mitigation Policy and Plan: Antigua and Barbuda**

#### **Introduction**

The National Mitigation Policy and Plan for Antigua and Barbuda was prepared with financial and technical assistance under the OAS/USAID Post Georges Disaster Mitigation Programme (PGDM). The goal of the PGDM in Antigua and Barbuda is to reduce the vulnerability of population and economic activities from the adverse impacts of natural hazards,

#### ***Tourism***

The economy of Antigua and Barbuda is predominantly dependent on Tourism. The direct and indirect contribution of tourism to the economy is estimated to be about 60% GDP. Over the period 1989 - 1999 the economy was adversely affected by hurricanes and tropical storms, which resulted in a decline in the tourism sector and in overall real economic performance.

#### ***Economic Vulnerability***

In terms of exposure to foreign economic conditions, indicated by the ratio of total trade to GDP, Antigua and Barbuda ranked second out of a total of 114 countries for the 1987- 1989 period. Also, Antigua and Barbuda ranked 14<sup>th</sup> among the 114 countries and 4<sup>th</sup> in the Caribbean in terms of vulnerability to natural disasters. Between 1990-1995, the twin island state was devastated by two major hurricanes that resulted in a recovery and reconstruction cost of approximately US\$500M. Between 1996-1999, the islands were ravaged by three more hurricanes.

#### ***Natural Disasters***

The environment and economy of Antigua and Barbuda are under considerable stress from development activities as well as climatic natural disasters. Both islands have experienced hurricanes, storms surges and droughts. The most damaging hurricanes occurred in 1928, 1960 and 1995. Major earthquakes occurred in 1843 and 1974. Severe drought affected the islands between 1964 and 1968 and in 1983 – 1984 and in 1994 - 2000.

During the period 1989-1999, Antigua and Barbuda experienced the full brunt of six major hurricanes. This resulted in the destruction of coastal settlements, hotels, infrastructure and natural resources and the severe erosion of beaches. The cumulative effect of damages from these hurricanes proved to be catastrophic for the economy and welfare of the people.

Antigua and Barbuda experiences drought conditions every seven years. The drought in 1982 to 1984 saw the surface and groundwater reserves depleted. The drought proved to have devastating effects on the crop and livestock sectors. To mitigate future droughts conditions, the Government installed a desalination unit that became operational in 1987. Desalination water supply now accounts, in some instances, for 70% of the daily domestic supply.

All this experience is the key to developing vulnerability reduction methods: If human activities can cause or aggravate the destructive effects of natural phenomenon, they also can eliminate or reduce them.

#### ***Vulnerability Reduction***

Antigua and Barbuda faces serious threats from natural hazards, in particular hurricanes, coastal storms and droughts. Like most island economies the twin island State is heavily dependent on the natural environment for its survival. The economy of Antigua is characterized by fragile ecological systems, which are under stress from anthropogenic and natural forces. Many of the

current scientific predictions suggest further that global climate change, in particular global warming and related sea level rise, will exacerbate the impacts of natural hazards.

Small island developing states (SIDS), like Antigua and Barbuda, suffer from inherent and physical vulnerability. They tend to share a number of characteristics that not only identify them as a distinct group, but also serve to underscore their vulnerability in the context of sustainable development. (Maul 1996, Leatherman 1997). These include, but are not limited to small physical size surrounded by large oceans, coupled with the influence of ocean currents, limited natural resources, high vulnerability to natural disasters (tropical hurricanes, droughts, and earthquakes), extreme openness of small economies and limited funds and human resources. These characteristics may severely limit the capability of these small islands to mitigate the impacts of natural hazards.

Over the last ten years, Antigua and Barbuda's economy and physical environment have been adversely affected by natural hazards. Hurricanes have caused the most disastrous impacts to Human Settlements, Utilities, Infrastructure and the Tourism Sector. Estimates of the cost of damages resulting from hurricane Hugo in 1989 were, US\$57.08 million or 17.6% of GDP, and for hurricane Luis in 1995 the estimate of damage was US\$128.35 million or 30.5% of GDP.

In the context of these risks and the experience of past disasters, Antigua and Barbuda has developed disaster preparedness and response capabilities, however, these interventions are inadequate to respond to the impacts of natural hazards.

It is projected that, under global climate change, natural hazards such as hurricanes and droughts will increase in frequency and intensity. Given the high vulnerability of Antigua and Barbuda and recognizing the economic dislocation, the government is committed to putting in place a program for Hazard Reduction and Mitigation. To this end, government has sought technical assistance from USAID and the OAS in supporting its efforts in the preparation of a Hazard Mitigation Policy and Plan.

The goals and objectives of the Hazard Mitigation Policy and Plan are to reduce the vulnerability of the population and economic activities in Antigua and Barbuda to natural hazards including Tropical storms and related flooding, seismic hazards and volcanic activity through enhanced capacity of disaster management and vulnerability reduction.

Hazard vulnerability reduction and mitigation measures need to be designed and implemented in an integrated framework. Hazard mitigation planning and management can provide this necessary framework for hazard risk education. In recognition of the benefit of hazard mitigation, the Government of Antigua and Barbuda has decided to formulate and implement a Hazard Mitigation Policy and Plan.

### **Areal Extent of the Plan**

The geographical area of the Plan is Antigua and Barbuda.

### **Scope and Purpose of the Plan**

#### ***Purpose***

The purpose of the plan is:

- To reduce the adverse impacts of natural hazards on human life and property.
- To identify those factors that increase/exacerbate vulnerability to natural hazards.
- To mitigate against the destruction and disruption to economic, ecological and social activities.

- To educate the population to the importance and implementation of mitigation as a tool to minimize vulnerability and risks to natural hazards and thereby strengthening the resilience of Antigua and Barbuda to natural hazards.
- To promote sustainable development that meets the needs of the present without comprising the ability of future generations to meet their needs.
- To strengthen the legislative and institutional capacity to undertake mitigation activities.

### **Scope**

The hazard mitigation plan is a national plan for the State of Antigua and Barbuda and embraces all Government agencies, the private sector, non-governmental and community based organizations.

The Plan, which is comprehensive, addresses all prevalent natural hazards to include primary hazards (hurricanes, floods, droughts and earthquakes) and secondary hazards (storms surges, coastal erosions and landslides) to which Antigua and Barbuda is prone.

The plan seeks to provide guidance in respect of disaster mitigation intervention activities. It is expected that each stakeholder agency/sector will develop and implement plan specific to their requirements within the framework of the National Plan.

The Plan is multi-sectoral and integrated, which requires the support and commitment of all stakeholders. For successful implementation, this participatory approach is vital to ensure that all stakeholders demonstrate ownership and commitment to the goals, objectives strategies and Programs of the Plan

### **Rationale**

Antigua and Barbuda is vulnerable to natural hazards (hurricanes, earthquakes, flooding and droughts and their secondary effects) as was seen over the last decade when the islands were ravaged by a number of hurricanes and a flood. The adverse effects of these disasters are still being experienced. The global warming phenomenon is accelerating the rate of climate change, which is likely to increase sea level rise and the frequency and intensity of natural disasters. Despite the considerable achievements made in disaster preparedness and responsiveness in Antigua and Barbuda, there is still need for a holistic approach to Disaster Planning and Management. This is necessary for strengthening the capacity of the country to respond to the increase in frequency and intensity of natural hazards.

Presently in Antigua and Barbuda, the emphasis is on disaster preparedness and response. Very little effort and resources have been deployed in the planning and co-ordination to mitigate the impacts and recovery from natural hazards. There is also the need to integrate and institutionalize Mitigation Planning in the social, physical and economic development planning process.

The Hazard Mitigation Plan and Policy Guidelines are derived from two fundamental goals, which are:

- 1) The reduction of the Nation's vulnerability to natural hazards, and
- 2) For sustainable development that meets the needs of the present without compromising the ability of future generations to meet there needs.

Mitigation is the only component of comprehensive Disaster Management that has the potential to break the cycle of damage and destruction that can occur when a community is subjected to repeated natural hazards. To be effective, a mitigation strategy must be put in place and ready for implementation when the appropriate window of opportunity opens. This can only be done through advance Planning.

### **Mission Statement**

To provide a policy framework and strategies to ensure measures be implemented to mitigate the impacts of natural hazards for the benefit of Antigua and Barbuda's Development.

### **Institutional Framework for Plan Preparation**

The Institutional Framework For Plan Preparation and Implementation is based on the premise that Disaster Mitigation requires the full involvement of all public sector institutions, private companies, community groups and individuals. To this end, a National Mitigation Council and a National Mitigation Technical Committee were established.

### ***The National Mitigation Council***

To ensure full consultation, participation and commitment to the planning process, a National Mitigation Council and a National Mitigation Technical Committee were established. The composition of the Council is drawn from the Public and Private Sectors, Non-Governmental Organization, Community based Organizations and the Barbuda Council. The National Mitigation Technical Committee guides the formulation and development of the plan, while the National Mitigation Council oversees the work. It is recommended that these bodies be maintained as standing committees.

### **Time Scale**

The Plan will be a long-range plan of ten (10) years duration with Operational Plans of five-year duration to fit in with the time scale of the proposed National Development Plan. There should be an annual review of Operational Plans.

### **Methodology**

The Methodology employed for the formulation, development and implementation of the Plan included the following:

- Definition of the problem
- Hazard Identification and prioritization
- Hazard Analysis and Assessment: involve undertaking an examination of those hazards which affect Antigua and Barbuda and asses the frequency and intensity of these hazards and the likelihood of these hazards occurring in the future.
- Undertake a Vulnerability Analysis to estimate the impact of these hazards on the population, economy, property and biophysical resources.
- Finally, undertake a capability analysis to analyze the capacity of institutions (Public and Private Sector, NGOs, etc.) to effectively undertake and manage mitigation activities.
- Draw conclusions about the acceptability of Antigua and Barbuda's vulnerability to natural hazards and about actions that are being taken or should be taken to mitigate the effects of natural hazards.
- Develop policies, programs, lines of actions and strategies to achieve the goals and objectives.
- Consider alternative means/ strategies for achieving goals and objectives, then select those that are most feasible to implement
- Adopt and implement the Plan
- Monitor the plan and continually evaluate its effectiveness and efficiency using appropriate criteria indicators
- Revise and update the hazard mitigation plan at regular intervals.

A vital element of the planning activities will be a process of consultation and dialogue with all the stakeholders (Government, Private Sector, Non-Government Organizations, Community

Based Organizations) so as to ensure the fullest participation in the planning process, and commitment and support for plan implementation. This consultative process will take place at all stages of the planning cycle.

The National Office of Disaster Services serves as the coordinating committee.

The formulation and development of the plan were informed by the findings of the hazard and vulnerability assessments, and the capability. The conclusion of these studies are that a number of critical facilities in Antigua and Barbuda are vulnerable to the adverse impacts of natural hazards. The institutional capability is inadequate for disaster management and in particular, mitigation.

### **Plan Formulation**

The National Mitigation Plan has four goals:

#### ***Vulnerability Reduction***

The purpose of the goal is to reduce the vulnerability of Antigua and Barbuda from the adverse impacts of natural hazards

#### ***Environmental Management***

The purpose of the goal is to protect the features of the natural environment that will aid in the reduction of natural hazards.

#### ***Public Information and Awareness***

The purpose of the goal is to promote Disaster Mitigation awareness and education by providing information and support to reduce personal death, injury, damage and destruction to property and minimize community disruption

#### ***Institutional Strengthening and Capacity Building***

The purpose of the goal is to enhance the capacity of public and private sector to undertake mitigation activities in a comprehensive and sustained manner.

A number of strategies were developed to achieve the goals and objectives of the plan.

The programs and projects were informed by the results of the hazard and vulnerability assessment. The programs and projects fall under the following headings:

- 3) Policy – The policies included in this plan are to provide an enabling framework for mitigation activities.
- 4) Institutional Strengthening and Capacity Building –The program seeks to strengthen the capability of institutions to plan implement and manage mitigation programs. It also includes a program for strengthening disaster management capability and physical planning capability. Under this program, training at all levels will be taken to enhance capacity.
- 5) Environmental Management – Environmental degradation makes a contribution to the adverse impacts of hazards. The purpose of this program is to develop and implement a program of environmental protection and management.
- 6) Public Education and Awareness – The purpose of this program is to create awareness of disaster reduction amongst policy / decision-makers and communities of the risks posed by natural hazards, and the need to take mitigation measures.
- 7) Legislation – The purpose of this program is to ensure that appropriate disaster management legislations are in place.

The plan also includes mitigation measures for the identified hazards: Drought, earthquakes, Floods, Hurricanes, Coastal and Inland Erosion and Storm Surges.

### ***Incorporating Natural Hazard Mitigation Activities in the Planning Process***

It is recommended that Hazard Mitigation Planning should be integrated at every stage of the social and economic development planning process. Development projects, if they are to be sustainable, must incorporate sound environment and hazard mitigation Management. The most effective approach to reducing the long-term impact of natural hazards is to incorporate natural hazard mitigation activities into the process of integrated development planning and investment project formulation and implementation

Since Disaster Planning and Management is a relatively new Discipline, it is also suggested the personnel at the Ministry of Planning be exposed to Training in Hazard Mitigation Planning. This training could include Workshops and Training at the Tertiary Level.

### **Phasing and Implementation**

The mitigation planning process is devised as an on-going activity rather than a single event, and will be institutionalized and integrated in the national development planning process.

In the implementation of the Mitigation Plan, the Government, through its various agencies, will consult regularly with all stakeholders, including the private sector and Non- Governmental Organizations with a view to ensuring its effective implementation.

### ***Phasing***

The phasing of the Plan is as follows:

- • The plan will be a long-term plan of ten years duration.
- • There will be operational plans of five years duration to fit in with the time scale of the National Development Plan.
- • There should be an annual review of the Mitigation Policy and Plan.

### ***Implementation Strategy***

The elements of the recommended Implementation Strategy are listed as follows:

- 1) On completion of the Mitigation Policy and Plan (the Master Plan), stake holders, which include Government Ministries and Agencies, the Private Sector, Non-governmental organizations and Community Groups will be required to prepare their own Mitigation Plan(s) using the Master Plan as a guideline.
- 2) Integration of Mitigation Planning into the national development planning process.
- 3) Linking the mitigation planning process with the budgeting process in order to translate medium term mitigation plan targets into annual programs and projects for public investment.
- 4) Each Government Ministry/agency will include in their Program Budgets resources for mitigation activities.
- 5) The establishment of a mechanism to facilitate constant dialogue between Government, the private sector, Non-governmental Organizations and Community Groups on Mitigation Policies and Programming.
- 6) A commitment to upgrade the planning in management and administrative capacities of sector Ministries/Government Agencies, key agencies such as the Development control Authority Environmental Division, Ministry of Planning, the Meteorological Division to support plan implementation and review.
- 7) Conduct a program of training/Orientation for the National Mitigation Council, the National Mitigation Technical Committee, Government Ministries/Agencies Disaster

Mitigation Office, the private sector and Community Groups in pertinent areas of Mitigation Planning, Management and Implementation. The objective of this program of training and Orientation is to build capacities to facilitate effective and successful implementation

### **Evaluation, Monitoring and Updating**

Since the Plan is not a static document, it will be necessary to have a System and Mechanism for Monitoring and Evaluation.

Monitoring the progress being made toward the achievement of a Plan is essential to its overall accomplishment. To this end the Planning Groups in consultation with the Mitigation Council will develop a monitoring process and system that will monitor and evaluate the Progress being made by Antigua and Barbuda to mitigate the impacts of natural hazards.

A system of indicators and benchmarks will be used to monitor progress yearly.

Monitoring and evaluation are functions especially well suited for the private sector (profit and non-profit organizations).

The monitoring and Evaluation System should be designed in such a manner that allows for Feedback, Effective Communication, Accountability and Transparency. It should also include a system of reporting.

Monitoring of performance and evaluation of the results of the Mitigation Policy and Plan requires systematic collection of data and analysis along critical paths for on-going inter-active Plan Implementation. The process involves generation of substantial documentation in a form that will assist and making tactical decisions under changing circumstances.

The cycle and rhythm of mitigation plan implementation, monitoring, evaluation, revision and updating, require a cadre of trained persons with the requisites skills and expertise in both the private and the public sectors. Consequently, the Government will organize and implement a program for organizational and institutional strengthening to ensure that agencies are making an effective contribution to the planning and implementation process.

### ***Periodic Review***

There will be a periodic review of the Implementation of the Mitigation Policy and Plan.

# Overview of Antigua and Barbuda: The National Context

## Physical and Environmental Features

Antigua and Barbuda form an archipelagic island state located in the Eastern Caribbean, between latitudes 17° and 18° N and longitudes 61° and 62° W. Antigua is the larger of the two islands, with an area of 280 km<sup>2</sup> (104 sq. miles). The population of Antigua is presently approximately 72,000 with around 25% of that total concentrated in the capital, St. John's. Antigua's topography varies from a South Western hilly volcanic region, to a low rolling (mainly clay) central plain, to a flat upland, low elevated, limestone area in the Northeast. The coastline is very indented with numerous bays, offshore islands and fringed with reefs and shoals.

Barbuda, which lies 42 km north of Antigua, has an area of 160 km<sup>2</sup> (62 square miles). The population of Barbuda is approximately 1,250. The entire population of Barbuda resides in the main town Codrington. The topography, compared to Antigua, is relatively flat. Most of Barbuda is about 3 meters (10 feet) above sea level, except in the highlands located in the north-east, where the highest point is 125 feet (38 meters). A lagoon, averaging about 1.5 miles in width, runs along the western side of the island and is separated from the sea by a narrow sand bar. This lagoon, which is rich in aquatic life, is a valuable source of nutrition for the local population. The coastline is very straight and is backed by extensive sand dunes and, like Antigua, is fringed with numerous reefs.

Antigua and Barbuda is divided into six parishes. The largest of these parishes is St. John's Parish, where the capital city of St. John's is located and where 25% of the total population resides. St. John's city accounts for most of the economic activity. The city, which borders the St. John's Harbour and occupies a land area of 7.4 km<sup>2</sup>, has a relatively high population density of approximately 2,936 persons/km<sup>2</sup>. In contrast, only 2% of the population of Antigua and Barbuda lives on the island of Barbuda.

Given its location and population density coupled with the existence of many small wooden structures, St. John's city is especially vulnerable to hurricanes and surges. This high population density for St. John's city also makes it relatively more vulnerable to droughts than other settlements with respect to water demand and supply. Many households in St. John's, particularly in areas such as Point, Grays Green and Ovals, do not have much space for above ground water storage and therefore must rely almost completely on piped water.

## Climate

The climate of Antigua and Barbuda is directly affected by exposure to the Atlantic Ocean and Caribbean Sea. Some of the main features include uniformly high temperatures, humidity, steady easterly winds and a markedly seasonal rainfall.

The average annual rainfall in Antigua is 40.9 in. (104.1 cm) per annum. Almost 50% of the rain occurs from August to November with a marked dry season during February, March and April. The inter-annual variability of the maximum monthly rainfall over 24 hours is quite large with the month of February receiving 2.2 cm compared to September receiving 8.3 in. (21.2 cm). Rainfall in Barbuda averages between 30 in. (76.2 cm) and 39 in. (99.1 cm) per year.

The mean normal average daily maximum and minimum temperatures for Antigua and Barbuda are 29.4°C and 24.0°C respectively and the range of extreme temperature varies from 17°C to 33°C. The mean annual temperature ranges from 25°C to 26°C. The flat and dry nature of the islands together with the strong easterly winds account for high potential evapo-transpiration rates of approximately 1500 mm/year.

Dry conditions and droughts occur fairly frequently in Antigua and Barbuda, at an interval of approximately every seven (7) years, as reported by the Meteorological Office. Tropical depressions, storms and hurricanes influence the climate of Antigua and Barbuda and contribute significantly to annual rainfall totals.

### Geology & Soil types:

Antigua is divided into three main geological regions:

- 8) The South West Volcanic Region - consists of igneous rock comprising mostly clay loams. The soils are mainly neutral to slightly acidic and well drained.
- 9) The Central Predominantly Clay Plain - comprised of heavy and hard to work clay soils. Most of the area has well drained soils over stratified volcanic detritus and agglomerates.
- 10) The Northeast Limestone Area - includes light soils over calcareous sandstones, heavier soils over calcareous grits and deeper well drained clays over calcareous marl.

Homogenous limestone derived soils cover 78% of Barbuda. There are three main soil types in the limestone regions of Barbuda:

- 1) The Barbuda Series - clay loam containing some kaolinite
- 2) The Codrington Series - black alkaline clay loam soil
- 3) The Blackmere Series - brown soil that is clay loam characterized by rapid drainage.

### Economic Structures and Sectors

The economy of Antigua and Barbuda is dominated by services. The contributions of the sectors to the economy are depicted in the table below

*Table 1. Sectoral Contribution to Gross Domestic Product: 1999*

SECTOR	PERCENTAGE
Agriculture	3.56
Mining & Quarrying	1.91
Manufacturing	2.52
Electricity & Water	3.41
Construction	12.75
Wholesale & Retail	9.64
Hotel & Restaurant	13.71
Transportation	11.74
Communication	9.84
Banks & Insurance	11.59
Real estate & Housing	7.27
Government Services	16.02
Other Services	6.61
(Less Imputed Services)	(10.55)

Source: Government of Antigua, Statistical Department

### Tourism

The economy of Antigua and Barbuda is predominantly dependent on tourism. The direct and indirect contribution of tourism to the economy is estimated to be about 60% of Gross Domestic Product (GDP). The tourism sector also generates directly and indirectly substantial employment opportunities in the order of about twenty percent (20%) of the labour force and about ten to fifteen percent (10% to 15%) of government revenue. The tourism industry is heavily reliant on

natural resources and therefore depends on the proper management of the environment, which will ensure sustainability.

Real Gross Domestic Product grew at an average of eight percent (8%) per year during the period 1983-1988. Over the period 1989 - 1999 the economy was adversely affected by hurricanes and tropical storms, which resulted in a decline in the tourism sector and in overall real economic performance. In 1995 there was a negative growth of 18.5% in the total stay over visitors and a total tourism decline of 9.7%. This resulted in shortfall in tourism earnings by some US\$13.5m. The performance of the economy over the last fifteen years clearly demonstrates the vulnerability of the tourism and agriculture sectors to natural disasters and the dependence of the economy on external markets. This is depicted in the table below.

*Table 2. GDP at factor cost in constant Prices (US\$Millions) for Antigua & Barbuda.*

Y e a r s	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
GDP (US\$ million)	255.5	280.3	305.6	329.6	348.8	331	340	342.6	360.3	382.5	363.5	385.6	407.1	423
Growth Rate	8.8	9.7	9.01	7.72	6.27	2.27	2.73	.85	5.08	6.17	-.45	6.7	5.6	3.38

Source: OECS Economic Secretariat, Central Statistical Division of Government of Antigua and Barbuda

### **Agriculture and Manufacturing**

In contrast to tourism, the agriculture and manufacturing sectors contribute insignificantly to GDP. Current contributions of these sectors are respectively 3.56% and 2.52%.

The fisheries sub-sector makes the greatest contribution (49.75%) to the agriculture sector. This sub-sector has been vulnerable to hurricanes, high winds and rough seas that have caused almost a total loss of fish traps, damage to infrastructure (piers and harbors), vessels and loss of fish days.

### **Public Sector Finances**

Steady growth in Government's expenditure since the 1980s have resulted in current account deficit of 6.5 % of GDP in 1998. In 1998, recurrent expenditure as a percentage of GDP was 34.37% and recurrent revenue was 27.87%.

In 1999, external debt stood at US \$433.7 million, which represents 75% of GDP with debt arrears in excess of US \$149 million. Debt service as a percentage of revenue is in excess of 30-40% of revenue. This unfavorable fiscal position limits the Government's capacity to mitigate the impact of natural disasters.

### **Balance of Trade**

Economic growth, particularly in the tourism sector, has resulted in an increase demand for goods and services in Antigua and Barbuda. Antigua and Barbuda's balance of trade remains in deficit. Imports increased from US \$268.49M in 1990 to US \$422M in 1998. In sharp contrast, exports grew from a mere US \$33.43M in 1990 to US \$40.97M in 1998.

### **Economic Vulnerability**

In terms of exposure to foreign economic conditions indicated by the ratio of total trade to GDP, Antigua and Barbuda ranked second out of a total of 114 countries for the 1987- 1989 period. Also, Antigua and Barbuda ranked 14<sup>th</sup> among the 114 countries and 4<sup>th</sup> in the Caribbean in terms of vulnerability to natural disasters.

Between 1989 and 1995, the twin island state was devastated by two major hurricanes. Estimates of the damages resulting from Hurricane Hugo in 1989 were US\$57.08m or 17.6% of GDP, and for hurricane Luis in 1995, the estimates of damages were US\$128.35m or 20.5% of GDP.

Given the dependence of the country on the tourism sector both for GDP and employment, the fact that this sector is particularly susceptible to hurricane or earthquake hazard (even when damage to hotels and infrastructure may be slight) means that economic vulnerability is particularly high. The loss of revenue and employment if the tourism sector is affected would significantly affect the overall capacity of the country and its population to recover from disaster. In the context of drought, hazard vulnerability has been reduced by the installation of a desalination plant.

Insurance protects against economic loss and permits a rapid recovery of damaged housing and infrastructure. However, according to a representative of NEM (West Indies) Insurance Limited, approximately 30% of the housing stock is currently uninsured and people tend to reduce their insurance cover a year or two after a major disaster, as complacency gradually increases. At the same time, there is a growing reluctance of the reinsurance industry to cover assets in risk prone countries like Antigua and Barbuda, further increasing the economic vulnerability of the island.

### **Natural Hazards and Disasters**

The environment and economy of Antigua and Barbuda are under considerable stress from development activities as well as climatic events and natural disasters. Both islands have experienced hurricanes, storms surges and droughts. The most damaging hurricanes occurred in 1928, 1960 and 1995. Major earthquakes occurred in 1843 and 1974. Severe drought affected the islands between 1964 and 1968 and in 1983 – 1984 and in 1994 - 2000.

From 1950 to 1988, Antigua and Barbuda was spared the onslaught of hurricanes. This fortuitous scenario fostered a disregard for environmental impact assessment in project design and implementation. Construction of hotels and settlements in close proximity to beaches and wetlands were entertained, resulting in the destruction of mangroves and wetlands.

During the period 1989-1999, Antigua and Barbuda experienced the full brunt of six major hurricanes; coastal settlements were destroyed, hotels, infrastructure and natural resources were damaged and there was severe erosion of beaches. The cumulative effect of damages from these hurricanes proved to be catastrophic for the economy and welfare of the people.

Antigua and Barbuda experiences drought conditions every seven (7) years. The drought in 1982 to 1984 resulted in the depletion of surface and groundwater reserves. The drought proved to have devastating effects on the crop and livestock sectors. To mitigate future droughts conditions, the Government installed a desalination unit that became operational in 1987. Desalination water supply now accounts, in some instances, for 70% of the daily domestic supply.

The natural resources of Barbuda on the other hand are not overly stressed due in large measure to the low population density (10 persons per km<sup>2</sup>). Barbuda experiences drought occasionally. Ground water is sourced from wells. The quality of water however is reported to be saline and water contamination occurs as a result of the seepage of toxic waste from existing development. The Barbuda Council and local Government are currently exploring the possibility of installing a desalination plant in Barbuda.

Disasters are extreme events, which disrupt the lives of people. In Antigua and Barbuda, the predominant natural hazards are hurricanes, earthquakes, erosion, drought and occasionally flooding.

Notwithstanding the term “natural,” a natural hazard has an element of human involvement. A physical event, such as a volcano eruption, that does not affect human beings, is a natural phenomenon, but not a natural hazard.

While hurricanes, volcanic eruptions and earthquake are natural phenomena, hazard is also conditioned by human activity and therefore is socio-natural in character. For example, ground water extraction, landfills and drainage may increase earthquake intensities in certain areas. Similarly the destruction of mangroves and natural coastal defenses may increase hurricane hazard.

In Antigua and Barbuda, environmental degradation over recent decades may be leading to increased hazard levels. The destruction of mangrove ecosystems in areas such as Jolly Beach, McKinnon's Salt Pond and Deep Bay; erosion caused by infrastructure development and building on hillsides; beach sand mining on the perimeter of the island and uncontrolled sewerage disposal are examples of documented environmental degradation, which may increase the effect of hurricanes, seismic and other hazards in the country (Caribbean Conservation Association, 1991).

Although humans can do little or nothing to change the incidence or intensity of most natural phenomena, they have an important role to play in ensuring that those natural events are not converted into disasters by their own action. It is important to understand that human intervention can increase the frequency and severity of natural hazards. For example, removing the toe of a landslide to make room for a settlement, can trigger the earth to move and bury the settlement. Thus, human intervention can also cause natural hazards where none existed before.

Finally, human intervention can reduce the mitigation effects of a natural ecosystem. Destruction of the coral reefs, which removes the shore's first line of defense against ocean currents and storm surges, is a clear example of an intervention that diminishes the ability of the ecosystem to protect itself. Extreme cases of destruction of human intervention into an ecosystem include sand mining for construction, and the destruction of mangrove swamps for hotel construction.

All this is the key to developing vulnerability reduction. If human activities can cause or aggravate the destructive effects of natural phenomenon. They also can eliminate or reduce them.

Antigua and Barbuda faces serious threats from natural hazards, in particular hurricanes, coastal storms and droughts. Like most island economies the twin island State is heavily dependent on the natural environment for its survival. The environment of Antigua is characterized by fragile ecological systems, which are under stress from anthropogenic and natural forces. Many of the current scientific predictions suggest further that global climate change, in particular global warming and related sea level rise, will exacerbate the impacts of natural hazards.

Small island developing states (SIDS) like Antigua and Barbuda, suffer from inherent and physical vulnerability. They tend to share a number of characteristics that not only identifies them as a distinct group, but also serve to underscore their vulnerability in the context of sustainable development. (Maul 1996, Leatherman 1997). These include, but are not limited to small physical size surrounded by large oceans, coupled with the influence of ocean currents, limited natural resources, high vulnerability to natural disasters (tropical hurricanes, droughts, and earthquakes), extreme openness of small economies and limited funds and human resources. These characteristics may severely limit the capability of these small islands to mitigate the impacts of natural hazards.

Over the last ten years, Antigua and Barbuda's economy and physical environment have been adversely affected by natural hazards. Hurricanes have caused the most disastrous impacts to human settlements, utilities, infrastructure and the tourism sector. Over the decade 1989 – 1999, the twin island state was ravaged by six major hurricanes.

These hurricanes, taken together, accounted for:

- 7 human fatalities with approximately 475 injured
- 13,359 buildings damaged or destroyed
- 4,286 vehicles damaged or destroyed
- 50% of the work force adversely affected

The total cost of damages over the period (1989 - 1999) to a number of sectors, (Health, Education, Hotel, Agriculture, Fisheries, Environmental, Residential and Commercial properties), is estimated at US\$250 million, with a replacement cost of over US\$425 million.

It is projected that natural hazards such as hurricanes and droughts will increase in frequency and intensity. Given the high vulnerability of Antigua and Barbuda and recognizing the economic dislocation, the Government is committed to putting in place a program for Hazard Reduction and Mitigation. To this end, Government has sought technical assistance from the OAS in supporting its efforts in the preparation of a Hazard Mitigation Policy and Plan.

### **Vulnerability Reduction**

Hazard vulnerability reduction and mitigation measures need to be designed and implemented in an integrated framework. Hazard mitigation planning and management can provide this necessary framework for hazard reduction education. In recognition of the benefit of hazard mitigation, the Government of Antigua and Barbuda has decided to formulate and implement a Hazard Mitigation Policy and Plan.

The major goal of the Hazard Mitigation Policy and Plan is to reduce the vulnerability of the population and economic activities in Antigua and Barbuda to natural hazards including tropical storms and related flooding, seismic hazards.

# SECTION 1 - INTRODUCTION

## 1.1 LEGAL FRAMEWORK

Comprehensive legislation that expressly deals with disaster management and more particularly mitigation does not exist in Antigua and Barbuda. The only legislation that deals with disaster management is the Emergency Powers Act Chapter 148 of the Revised Edition of the Laws of Antigua and Barbuda. Under Sections Two (2) and Three (3) of this Act, the Cabinet is empowered after the occurrence of any hurricane, earthquake, fire or flood to declare the existence of a state of emergency, and to make orders for securing the essentials of life and for the preservation of the health, welfare and safety of the public.

This legislation is inadequate to deal with disaster management, as intervention under this Act is limited to disaster response. The National Office of Disaster Services (NODS), which has responsibility for disaster management, does not have any appropriate legislative mandate for comprehensive disaster management.

There are a number of other Acts and Regulations that are pertinent to Disaster Mitigation. These include:

- The Land Development Control Act No.15 of 1997 and The Land Development Control Regulation No.20 of 1998
- The Building Code
- The Beach Control Act -Chapter 45 and Beach Protection Act -Chapter 46
- The Fisheries Act of 1983
- Marine Areas (Preservation and Enhancement Act) Chapter 257
- Public Health Regulations - Chapter 353

**The Land Development Control Act** empowers the Development Control Authority to carry out both planning and regulatory functions. Under the control and regulatory powers of this Act, all proposed development must first obtain planning permission. The Authority stipulates conditions where structures should or should not be located, and the requirements for structural specifications and for the siting of structures. In pursuance of the planning functions, the Development Control Authority is empowered to develop land use plans and for control as a whole. A National Physical Development Plan has recently been drafted.

**The Building Code** sets standards for building/construction, the type of materials to be used.

**The Beach Control Act (Chapter 45) and Beach Protection Act (Chapter 46)** make provisions for control of sand mining in Antigua, but not in Barbuda.

**Fisheries Act of 1983** protects the marine environment by empowering the authorizing minister to declare any marine area and the adjacent land as a marine resource.

**Marine Areas (Preservation and Enhancement Act) Chapter 257** provides for the declaration of restricted marine areas in order to preserve and protect the flora and fauna.

**Public Health Regulations (Chapter 353)** and the St. John's City Regulations of 1952 deal with the health aspect of building control.

The existing legislative legal framework does not ensure that development is environmentally stable, nor does it provide for an efficient system for development control and planning.

In the absence of a comprehensive disaster legislation, the Hazard Mitigation Policy and Plan has been formulated on the basis of Cabinet Decision and is supported by the limited legislations, which serve mitigation purposes. The Government of Antigua and Barbuda however, recognizes that an appropriate and effective legislative framework is an indispensable instrument to facilitate

the achievement of the goals, objectives, strategies and programs to reduce and minimize vulnerability to natural hazards.

## **1.2 Aereal Extent of the Plan**

The geographical area of the Plan is for Antigua and Barbuda.

## **1.3 Historical Background With Respect To Disasters**

Antigua and Barbuda, like the rest of the Caribbean, is vulnerable to a number of natural hazards. Amongst these are:

- Wind
- Droughts
- Storm Surge
- Earthquake
- Floods
- Coastal and Stream Erosion

### ***Hurricanes***

The records show that, since the seventeenth (17<sup>th</sup>) Century, Antigua and Barbuda has been hit by severe hurricanes in 1681, 1772, 1792 and 1804. In 1950, two hurricanes struck within ten days and destroyed most of the wattle and daub houses on the island. From the available scant records, the total number of deaths was twenty in 1754, twenty eight in 1848, and thirty five in 1871. In 1989, Hurricane Luis caused two deaths and injury to 181 persons. Although no detailed estimates of the damages are available from 1642–1989, there were very substantial damages to properties, infrastructure and the economy, in particular agriculture, during the period of dominance of the sugar industry. Some measures take by way of assistance to persons affected by hurricanes included:

- Enactment by Parliament of the Hurricane Act in 1900, under which loans were offered to the planters.
- On 1<sup>st</sup> January 1913, it became possible for properties to be insured against hurricane damages. Deposits of guarantees of Lloyds Insurance members were made against hurricane damages in the amount of seven million pounds sterling.
- After the hurricane and drought in 1924 and 1925, merchants and planters petitioned for tax relief.
- In 1927, it was mutually agreed that the islands would send telegrams to the British Government referenced “ hurricane movements”
- In 1950, HM Government granted 50000 for hurricane relief.

In the 20<sup>th</sup> Century, Antigua and Barbuda received the most devastating hurricanes. Between 1989 and 1999, the islands were directly hit by six major hurricanes. In 1989, the islands of Antigua and Barbuda were hit by Hurricane Hugo, a strong category 4 hurricane. Hugo was the first to make a direct hit on the islands since 1950.

Hurricane Hugo struck Antigua and Barbuda in September 1989. The force of the winds was approximately 75-80 miles per hour and gusts of over 190 miles per hour were recorded. The southern portion of the island was more affected than the north. Hurricane Hugo caused extensive damages to agriculture, fisheries, housing, tourist accommodation (hotels) and the infrastructure that serves all sectors of the economy. Just when the economy was showing sign of recovery from the post-hurricane low of 1991, Antigua experienced another hurricane in 1995. Hurricane Luis devastated Antigua and Barbuda on September 4<sup>th</sup> and 5<sup>th</sup> 1995. Luis took some thirty-eight hours to pass the twin island States, causing widespread damages to the entire country of a

magnitude never before experienced by the people of this nation. Thousands of people were left homeless; there was widespread damage to homes, schools, clinics, including major damages to Holburton Hospital, utilities, sea and airport, hotels, agriculture and fisheries, fire stations, government buildings and the business sector. Some 7000 persons were left unemployed.

The reports indicate that prior to the Hurricane some 11 000 persons sought shelter. Some 2650 persons were left homeless. Of this figure 500 were in Barbuda. Of the 53 official shelters, 39 sustained damages, of which 21 were major. Some 90% of the shelters were without shelter management systems.

During the period 17–19th November 1999, Antigua was struck by Hurricane Lenny. The ravages of Hurricane Lenny far surpass the damage done by Hurricane Luis and Marylyn (1995), Georges and Jose (1998). This is primarily due to the consequential destruction to infrastructure inclusive of roads, bridges, dams and the colossal soil loss, resulting in degradation of the natural capability of agricultural soils. In some areas potential yield losses will be felt for the next twenty (20) years.

Hurricane Lenny brought very little wind, but excessive rainfall; hence most of the damages were done primarily due to heavy flooding. The power associated with the fast moving water overpowered natural and man-made drainage systems. The greatest negative impact from the storm system has been felt by farmers, their households and farms.

The major affected areas were Cades Bay in the south of the island (where farms have been rendered inaccessible by landslides, stream and road damage), Orange Valley (which suffered major landslides), Parham Lodge (soil erosion), Belvedere/Body Pond (where three has been total destruction of one bridge in the Breakknocks area and serious undermining of one in Hamilton.)

Although the hurricane brought much rainfall, there were many losses in dam storage capacity, due to both siltation of at least 400 ponds/dams and serious damage to one major dam.

*Of major concern is the serious loss of topsoil from the primary production areas generally. It is estimated that approximately 100 acres of topsoil was lost from farms and 27 acres of soil due to landslides. The damages to the agriculture sector, including roads and water storage, are estimated at US\$5.5 million.*

As a result of vulnerability of human settlements and extreme weather events, Antigua and Barbuda have already begun to face the problem of an increase in insurance cost or possible withdrawal of coverage. Within the last decade, these costs have increased significantly.

### ***Drought***

Drought is not a distinct event and, hence, is defined somewhat differently by various sectors. For example, meteorologists designate a drought when the amount of rainfall falls below a threshold value. Hydrologists refer to drought conditions when there are periods where stream flow and reservoir storage volumes fall below normal quantities. The agricultural sector links drought conditions with soil moisture and evaporation demands by crops. In general, economic drought refers to all spheres of human activity affected by lack of rainfall.

Between 1874 and 1949, droughts claimed the lives of fourteen persons.

The average annual rainfall for Antigua is 43 inches. Mean island wide rainfall over 103 years (1874- 1976) was 43.53 inches. Low rainfall occurred during the years of 1874-1947 when on average 32.01 inches of rain fell. Barbuda is arid compared with the rest of the Lesser Antilles. The thirty-year record for Codrington indicates a value of 38.52 inches, however, very dry years (rainfall less than 28.99 inches) have occurred 11 times in 61 years.

In 1983 and 1984, Antigua and Barbuda experienced a severe drought, with an all time low rainfall of 22.2 inches. This drought depleted the surface and groundwater to such an extent that the Government found it necessary to import water from neighboring islands. The drought conditions also forced many farmers to abandon croplands and also encouraged livestock owners to allow their stock to roam freely for fodder. This caused many of the lands to lose their vegetative cover, thereby giving rise to land degradation. The tourist industry also suffered from inadequate water for its guests. As result of the 1983/84 drought, Government purchased and installed a desalinating plant, which is located at Crabbes Peninsula.

During 1993-1994, Antigua also experienced drought conditions, with rainfall of 39.7 inches in 1993 and 30.4 inches in 1994. The effects of this drought on the domestic and hotel sectors were considerably reduced due to the addition of two desalination plants that provided an additional source of water to the national grid. The crop and livestock sectors continued to be extremely vulnerable to drought conditions.

### ***Storm Surges***

Storm surges are mainly shallow water coastal phenomenon (Murray and El-Sabh, 1986). Storm surges result from strong on-shore winds and/or intense low pressure cells and ocean storms. Water height is controlled by wind, atmospheric pressure, waves and swells, local coastal topography and bathymetry, and the storm's proximity to the coast. (OAS, 1991). Storm surges are usually associated with hurricanes and waves, which affect the coast. Historical records of storm surges are not available. In 1995, during hurricane Luis, storm surges of up to 15 feet (5 meters) were recorded by the Meteorological Office.

### ***Earthquakes***

Earthquakes are caused by the sudden release of slowly accumulated strain energy along a fault in the earth's crust. Earthquakes and volcanoes occur most commonly at the collision zone between tectonic plates. Earthquakes represent a particularly severe threat due to the irregular time intervals between events, the lack of adequate forecasting, and hazards associated with these.

- Ground shaking is a direct hazard to any structure located near the earthquake's center. Structural failure can take many lives in densely populated areas.
- Faulting, or breaches of the surface material, occurs as the separation of bedrock along lines of weakness.
- Landslides occur due to ground shaking in areas of relatively steep topography and poor slope stability.
- Ground shaking can trigger liquefaction of gently sloping unconsolidated material. Flows and lateral spreads (liquefaction phenomena) are among the most destructive geologic hazards.
- Subsidence or surface depressions can result from the settling of loose or unconsolidated sediment. Subsidence occur in water logged soils, fill, alluvium, and other materials that are prone to settle.

From recorded data, the city of St. John's was destroyed by an earthquake in 1690. In the 19<sup>th</sup> century, Antigua experience three major earthquakes. The most severe earthquake occurred in 1843, when eighty-three building were completely destroyed, with fatalities estimated at 12-40 persons. The damage, which included the sugar industry, was estimated at EC\$12 million.

The biggest earthquake recorded in Antigua occurred in October 1974. It measured 6.7 on the Richter scale with major damages to the oil refinery and a number of major structures (Cathedrals, Banks and commercial buildings.) The estimated cost of damages was EC\$ 10-15 million. According to J.F. Tomlin and W.P. Aspinall (in the *Bulletin of the Seismological Society of America*. Vol 65. No. 6, p. 1576, December 1975), "A major earthquake (mb=6.6; Ms =7.5, US Geological Survey) occurred in the northern Lesser Antilles on October 8, 1974, causing

damage of Modified Mercalli intensity VIII on this island of Antigua and lower intensities on the more distant islands."

The damage was confined mainly to larger and older buildings, to a petroleum refinery, and to the deep-water harbour. No earthquake-resistant building code existed in most of the Lesser Antilles, and in the majority of cases examined it was clear that structural damage had occurred because the building concerned could not have met the elementary requirements of an elementary code. A few people received minor injuries but, but no fatality was reported.

### ***Floods***

Antigua and Barbuda are tropical islands that usually receive intensive rainfall over short time intervals. However, Antigua has very good drainage characteristics that reduce the effects of flooding. It is observed that flooding occurs around low-lying coastal areas, and hence the need for enforcing zoning and set back regulations.

During the rainy season, heavy rains remove topsoil from barren lands and causing down stream sedimentation of dams, streams and coastal areas. In 1999, hurricane Lenny deposited 23 inches of rain over 2.5 days, resulting in massive flooding. This caused mudslides on some hillsides and accounted for approximately 5 million cubic feet of soil loss. (See Appendix I)

## **1.4 Scope and Purpose of the Plan**

### ***Purpose***

The purpose of the plan is to provide an integrated framework for implementing disaster mitigation activities in the territory.

### ***Scope***

The hazard mitigation plan is a national plan for the State of Antigua and Barbuda and involves the participation of all Government agencies, the private sector, non-governmental and community-based organizations.

The Plan, which is comprehensive, addresses all natural hazards to include primary hazards, such as hurricanes, floods, droughts and earthquakes and secondary hazards (storms surges, coastal erosions and landslides) to which Antigua and Barbuda is prone.

The plan seeks to provide guidance in respect of disaster mitigation intervention activities. It is expected that each stakeholder agency/sector will develop and implement plans specific to their requirements within the framework of this National Plan.

The Plan is multi-sectoral and integrated, which requires the support and commitment of all stakeholders. For successful implementation, this participatory approach is vital to ensure that all stakeholders demonstrate ownership and commitment to the goals, objectives, strategies and programs of the Plan.

## **1.5 Rationale**

Mitigation is the only component of comprehensive Disaster Management that has the potential to break the cycle of damage and destruction that can occur when a community is subjected to repeated natural hazards. To be effective, a mitigation strategy must be put in place and ready for implementation when the appropriate window of opportunity opens. This can only be done through advance Planning.

Both Antigua and Barbuda are vulnerable to a number of natural hazards such as hurricanes, earthquakes, flooding and droughts and their secondary effects. The Global Warming

phenomenon is likely to increase sea level rise and the frequency and intensity of natural disasters. Despite the considerable achievements made in disaster preparedness and response in Antigua and Barbuda, there is still need for a holistic approach to Disaster Management. This is necessary for strengthening the capacity of the country to respond to the increase in the frequency and intensity of natural hazards.

Very little effort and resources have been deployed in the planning and co-ordination to mitigate the impacts from natural hazards. There is also the need to integrate and institutionalize mitigation planning in the social, physical and economic development planning process.

### **1.6 Mission Statement**

The Plan's mission is to provide a policy framework and strategies to ensure measures are implemented to mitigate the impacts of natural hazards for the benefit of Antigua and Barbuda's development.

### **1.7 Institutional Framework for Plan Preparation**

The institutional framework for plan preparation and implementation is based on the premise that disaster mitigation requires the full involvement of all public sector institutions, private companies, community groups and individuals. To this end a Mitigation Council chaired by the Minister of Planning and comprised of senior public servants, members of the private sector and NGOs was appointed to monitor and guide the plan preparation process. A Technical Committee comprising members of all relevant Government agencies, representatives of the private sector, and from the NGOs was set up to carry out day to day activities in the preparation of the plan. The National Office of Disaster Services was the coordinating secretariat for all plan preparation activities. (See Appendix II for composition of bodies)

### **1.8 Time Scale**

The Plan will be a long-range plan of ten (10) years duration with Operational Plans of five-year duration to fit in with the time scale of the proposed National Social and Economical Development Plan.

### **1.9 Methodology**

The Methodology employed for the formulation, development and implementation of the Plan included the following:

- Definition of the problem
- Hazard identification, prioritization and analysis: involves an examination of those hazards which affect Antigua and Barbuda and assess the frequency and intensity of these hazards and the likelihood of these hazards occurring in the future.
- Undertake a vulnerability analysis to estimate the impact of these hazards on the population, economy, property and biophysical resources.
- Undertake a capability assessment to analyze the capacity of institutions (Public and Private Sector, NGOs) to effectively undertake and manage mitigation activities.
- Develop goals and objectives for the hazard mitigation plan
- Develop strategies, policies, programs, and projects to achieve the goals and objectives.
- Adopt and implement the Plan
- Monitor the plan and continually evaluate its effectiveness and efficiency using appropriate criteria indicators
- Revise and update the hazard mitigation plan at regular intervals.

A vital element of the planning process was the inclusion of a process of consultation and dialogue with all the stakeholders (Government, Private Sector, Non-Government Organizations, Community Based Organizations). This was necessary to ensure the fullest participation in the planning process, and commitment to and support for plan implementation.

## Section II: Hazard and Vulnerability Assessments

*Note: The text of this section was taken from the report Hazard and Vulnerability Assessment for Antigua and Barbuda, produced by Eva Hodgkinson-Chin for the Post-Georges Disaster Mitigation Project.*

### Vulnerability Assessment

The vulnerability assessment consisted of the following activities:

- Hazard identification and prioritization
- Hazard analysis
- Facility and resource identification and vulnerability assessment

### *Hazard Identification and Prioritization*

The following are the hazards, which were identified and prioritized. They are listed in order of priority below:

- Wind/ Hurricane
- Droughts
- Storm Surges
- Floods
- Coastal and Stream Erosion
- Earthquakes

### Prioritization

A procedure/methodology was followed for identifying relative importance of the hazards identified at above. The prioritization exercise employed a methodology, which ranked the hazards on a relative ranking scale according to their probability, frequency, area of impact and magnitude. Using this methodology, six priority hazards were identified. A priority listing of the six hazards were generated, and the hazards were weighted from 1 – 6 to generate a Hazard Priority Score (HPS) as listed below: These are the values utilized in this assessment. The Coastal and Stream Erosion was applied to Inland Erosion. The Wave hazard generated by storm was not considered separately, and was therefore assumed to have a value of “1”.

*Hazard Priority Score*

HAZARD	HAZARD PRIORITY SCORE
Wind/Hurricane	6
Drought	5
Storm Surge	4
Floods	3
Coastal and Stream Erosion	2
Earthquake	1

### *Hazard Analysis*

Studies of the vulnerability of Antigua and Barbuda to the identified hazards were carried out and hazard vulnerability maps were produced for the following hazards:

- Wind
- Storm surge
- Waves
- Drought
- Flooding
- Inland erosion
- Beach erosion

Wind, storm surge and waves are caused by hurricane and tropical storm activity and are closely related. The TAOS model was used to generate the vulnerability maps. Drought was analysed on the basis of watersheds and considered environmental, meteorological, hydrological, infrastructural, human and land use factors. Flooding considered factors such as slopes, drainage, ratio of watershed area to flood plain and run-off rates and potential, using the hurricane Lenny rainfall event as the basis of classification. Inland erosion examined sheet and rill erosion, gullying and landslides. Beach erosion considered only those beaches that are monitored by The Fisheries Department of Antigua and Barbuda.

Assessment of Earthquake (Ground Shaking) was not included in this study at this time, as the Seismic Research Unit of the University of the West Indies is currently undertaking an update of the assessment of seismic hazards in the Leeward including Antigua and Barbuda. The output of this assessment will be subsequently added to the Plan.

***Facility and Resource Identification and Assessment***

The process of facility and resource identification and assessment consisted of the definition of the facilities and resources to be considered, data collection, data automation and finally vulnerability assessment.

Critical facilities were defined as the following:

- Any facilities that functioned as a shelter
- Hospitals and clinics
- Government administrative buildings
- Airports, Sea ports and Bridges
- Power, Water and Telecommunications Installations
- Oil and Gas Companies
- Protective Services
- Hotels and Guest Houses
- Historical Sites

**Antigua**

***Hurricanes and Storms***

**Hazard Zones**

Three hazards related to hurricanes and storms were studied: wind, storm surge and waves. Storm surge and waves are dependent upon wind for their generation and the hazards are closely related. The table below indicates the categories used to zone these hazards. It indicates the lower and upper bounds of each of the categories and provides a reference for the hazard maps produced. The Saffir / Simpson Hurricane Scale can be used to convert the categories and bounds in the table below to measurements and damage estimates.

*Wind, Waves and Storm Surge Hazard Categories*

Level	Description	Wind Speed (meters/second)		Surge (m)		Significant Wave Height (m)	
		Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound
0	None	0	17	0.0	0.1	0.0	0.1
1	Low	17	43	0.1	1.0	0.1	1.0
2	Moderate	43	50	0.5	1.5	1.0	1.5
3	High	50	59	1.5	3.0	1.5	2.0
4	Very high	59	100	3.0	100.0	2.0	100.0

Source: Wagenseil, R. 2001. Wind and Storm Surge Technical Report. <http://www.oas.org/pgdm>

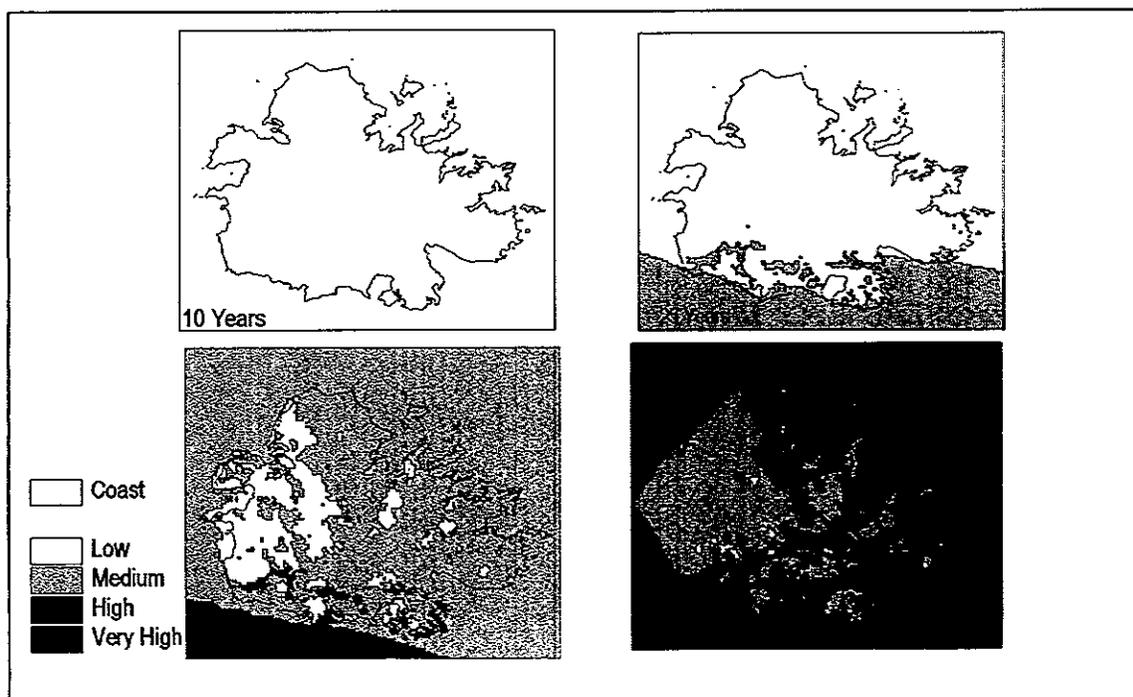
## Wind

### Wind Zones

Map 1 indicates the vulnerability of Antigua to winds by the return periods of 10 years, 25 years, 50 years and 100 years. The 10-year return period subjects the entire island to low vulnerability that is of the tropical storm and hurricane category 2 wind strength. Minimal damage would be expected. The 25-year return period would generate low vulnerability for most of the island with some sections of the southern range experiencing moderate vulnerability. This would create hurricane category 2 winds and moderate damage. For the 50-year return period most of Antigua would be of moderate vulnerability. The western coast would have a low vulnerability with sections of the southern coast subjected to high vulnerability. Category 3 and 4 winds would be expected with extensive and extreme damage. The 100-year storm would place most of the island within the high vulnerability zone. The western third of the island and pockets in the central and eastern districts would have a medium vulnerability. Category 4 winds with extreme damage would be expected.

### Saffir/ Simpson Hurricane Scale

Category	Pressure millibars	Wind				Damage
		m/s	kph	mph	knots	
0 Tropical Storm	>= 995	17 - 32	61 - 119	38 - 74	34 - 63	Some
1 Hurricane	980 - 995	33 - 42	119 - 153	74 - 95	64 - 82	Minimal
2 "	965 - 979	43 - 49	154 - 177	96 - 110	83 - 95	Moderate
3 "	945 - 964	50 - 58	178 - 209	111 - 130	96 - 113	Extensive
4 "	920 - 944	59 - 69	210 - 249	131 - 155	114 - 135	Extreme
5 "	< 920	> 69	> 249	> 155	> 135	Catastrophic

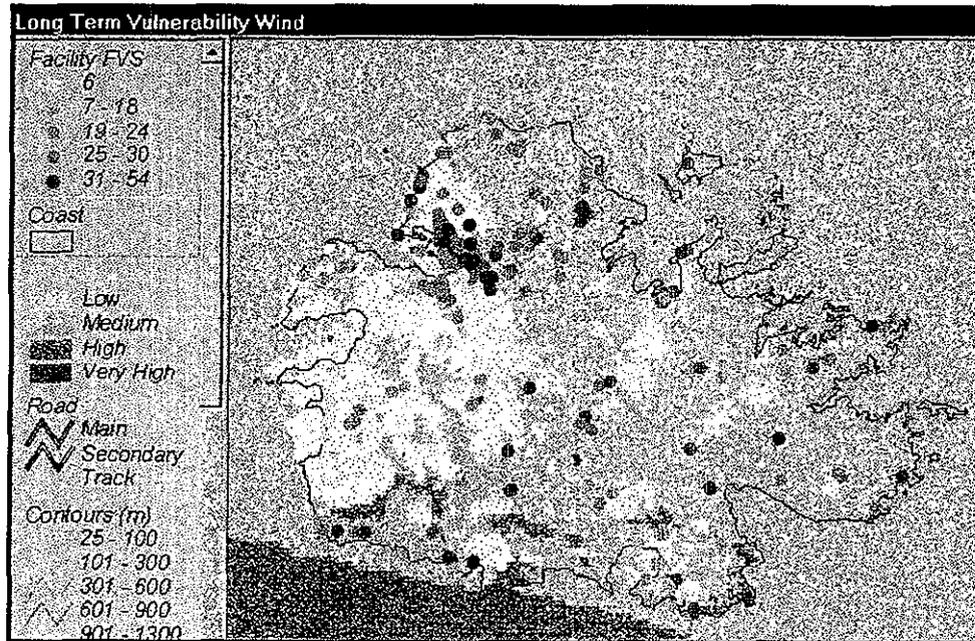


Map 1- Antigua Wind / Hurricane Vulnerability by Return Period

The long-term vulnerability is similar to the 50-year storm. As Map 2 indicates the central and eastern districts of the island are within the moderate vulnerability zone. The western section of the island is low and some sections of the southern range are within a high vulnerability zone.

### Wind Facility Vulnerability Score (FVS)

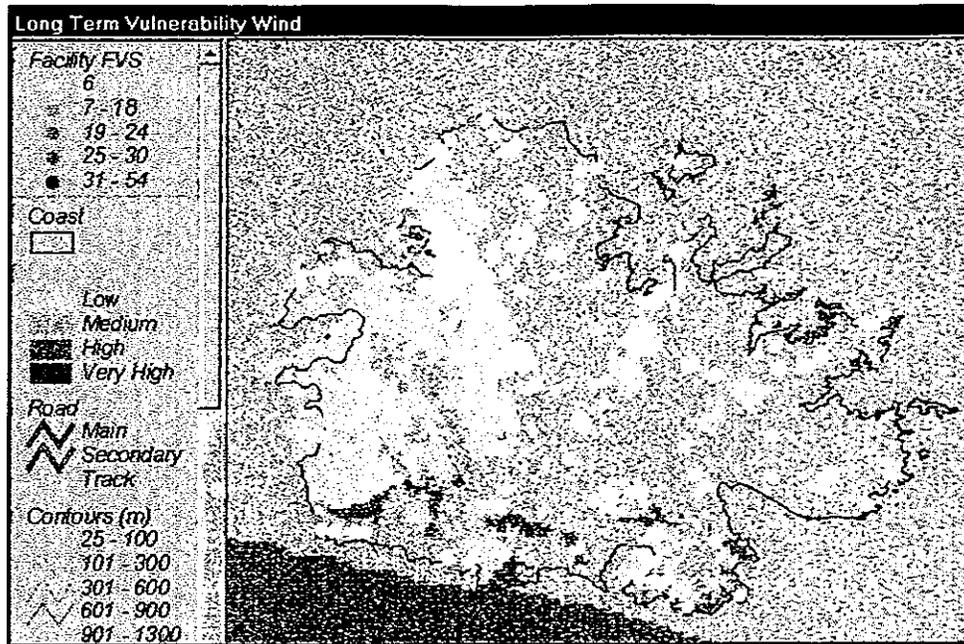
Map 2 indicates the distribution of facilities by wind vulnerability score and the long-term vulnerability to wind. It indicates that facilities with the higher scores are fairly evenly distributed throughout the north, west and southern sections of the island. Map 3 indicates the location of facilities which have scores of more than 50% of the possible wind FVS (42). They are clustered around St. John's and scattered evenly throughout the southern half of the island.



**Map 2- Antigua Long Term Vulnerability to Hurricane / Wind and Facility FVS**

The analysis reveals that several key critical facilities have extremely high FVS. The facilities and their FVS are listed below:

- Holberton Hospital - 54
- Crabbs and Cassada Power Stations - 48
- Crabbs Desalination Plat - 48
- Friars Hill Power Station - 42
- V.C. Bird International Airport - 42



**Map 3. Antigua Facilities with Wind Scores Greater than 21**

In addition, several Shelters had a score of 36 and are listed below in Figure 1.

Name of Facility	Shelters	Type of Facility	Address	Wind FVS
ANTIGUA GRAMMER SCHOOL	1	Secondary School	Old Factory Road	36
T. N. KIRNON SCHOOL	1	Primary School	Coronation Rd.	36
URLINGS PRIMARY SCHOOL	1	Primary School	Urlings	36
METHODIST CHAPEL AND HALL	1	Churches	PARHAM	36
ANTIGUA GIRL HIGH SCHOOL	1	Secondary School	NEWGATE STREET, S	36
FREEMAN'S VILLAGE PRIMARY	1	Primary School	FREEMAN'S VILLAGE	36
JOHN HUGHES METHODIST CHURCH	1	Churches	JOHN HUGHES	36
WILKIES PRIMARY SCHOOL	1	Primary School	Wilikies	36
OLD ROAD ANGLICAN CHURCH	1	Churches	OLD ROAD	36
OLD ROAD PRIMARY SCHOOL	1	Primary School	Old Road	36
PARHAM PRIMARY SCHOOL	1	Primary School	Parham Village	36
NAZARENE CHURCH	1	Churches	VILLA	36
METHODIST CHAPEL	1	Churches	BETHESDA	36

**Figure 1. Antigua Shelters with Wind FVS of 36**

### Feature Vulnerability to Wind

In the long term most of Antigua is moderately vulnerable to winds. The high vulnerability zones consist largely of woodland and grazing lands. The exception is along the southeast coast where the southern section of Dockyard and Shirley Heights are highly vulnerable. Most of St. John's is vulnerable to low winds.

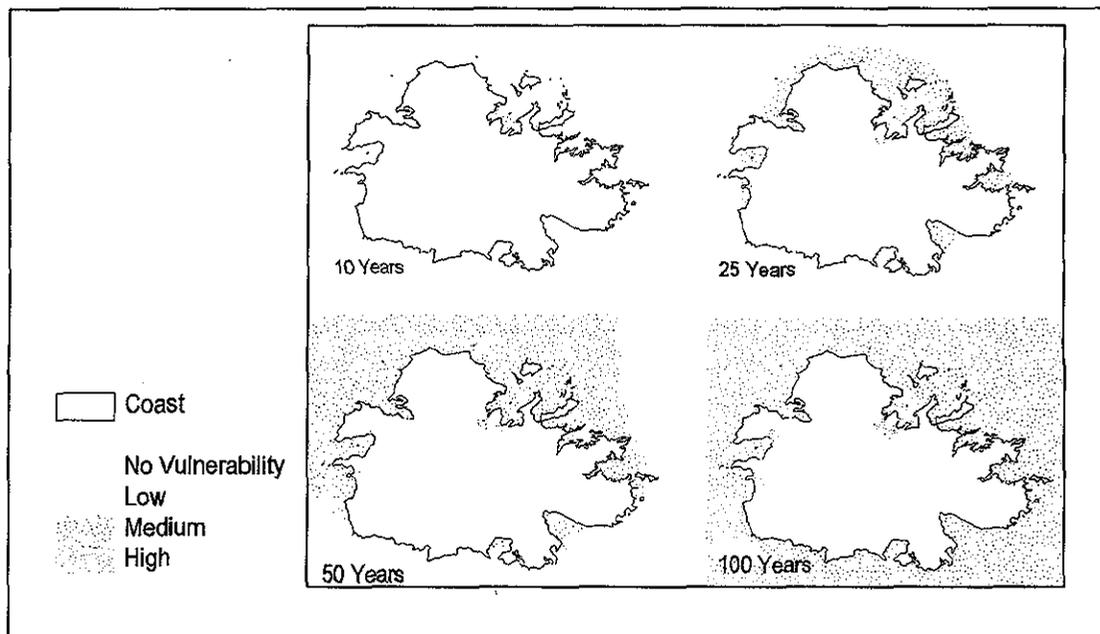
### Storm Surge

#### Storm Surge Zones

Map 4 indicates storm surge vulnerability by return period. It indicates that for the 10-year period the entire coast with the exception of the Fitches Creek / Parham Harbour area would experience low storm surge vulnerability. It would be similar to that experienced in a tropical storm with some damage and surge to the heights of 0.1 to 0.5 meters. The Fitches Creek / Parham Harbour

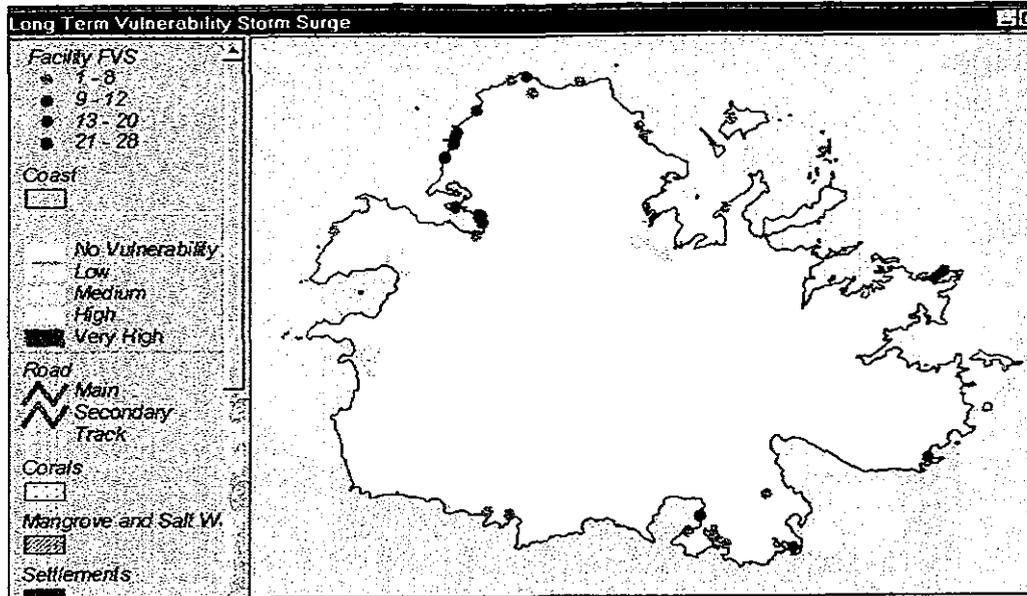
area would experience medium storm surge vulnerability with surge varying between 0.5 and 1.5 meters (minimal damage.)

The 25-year return period would place most of the coast within a moderate vulnerability storm surge zone and the southwestern section of Parham Harbour would be subjected to High vulnerability. Intrusions of moderate storm surge would be expected in the Hanson's Bay and Jolly Harbour areas. The sea would surge in Parham Harbour to 3.0 meters and cause extensive damage. The 50-year return period increases the area of intrusion around Parham Harbour, Hanson's Bay and Jolly Harbour. The 100-year return period increases the vulnerability of the Hanson's Bay area to high vulnerability and results in high storm surge throughout Parham Harbour.



*Map 4- Antigua Storm Surge Vulnerability by Return Period*

Map 5 indicates the long term vulnerability of Antigua to storm surge and indicates that Hanson's Bay and Jolly Harbour are moderately vulnerable to storm surge. It indicates Parham Harbour has a high vulnerability and an inland area to the southwest has moderate and low vulnerability. All bays along the coast would be subjected to moderate storm surge with the exception of those on the southwest that would have low vulnerability.



Map 5- Antigua Long Term Vulnerability to Storm Surge and FVS

### Storm Surge Vulnerability Scores

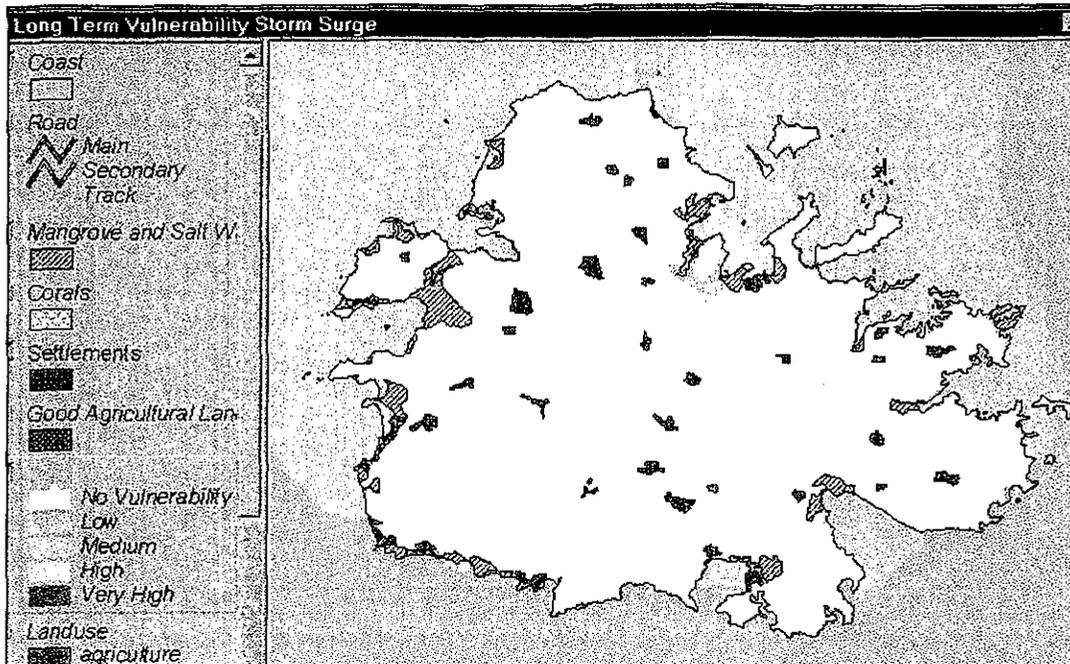
Eleven facilities have scores of more than 14 and Map 5. indicates their distribution. Six of these facilities are hotels on Dickenson Bay / Runaway Bay. Figure 2. lists the facilities. It indicates that the Port of St. John's, Heritage Quay and adjacent government facilities also have high FVS. Nelson's Dockyard has a score of 16.

Attributes of Critical Facilities				
Name	Shelter	Type of facility	Address	Storm FVS
LASHINGS	0	Hotels	RUNAWAY BAY	28
DEEP WATER HARBOUR	0	Sea Port	ST. JOHN'S	20
BARRYMORE BEACH HOTEL	0	Hotels	RUNAWAY BAY	20
SUNSET COVE HOTEL	0	Hotels	RUNAWAY BAY	20
SIBONEY	0	Hotels	DICKENSON BAY	20
NELSON'S DOCKYARD	0	Historical Sites	DOCKYARD, ENGLISH H	16
SANDALS	0	Hotels	DICKENSON BAY	16
MANGO BAY RESORT	0	Hotels		16
DEPARTMENT OF TOURISM	0	Government Administration	Nevis Street	16
HERITAGE QUAY	0	Sea Port	HERITAGE QUAY, ST. J	16
OLD ADMIN. MIN. OF FINANCE	0	Government Administration	High & Long St.	16

Figure 2- Antigua Facilities with High Storm Surge FVS

### Feature Vulnerability to Storm Surge

Most of the coastal features of Antigua are vulnerable to moderate and high storm surge. All the harbours are vulnerable to moderate storm surge. Parham Harbour is vulnerable to high storm surge. In terms of settlement English Harbour and Parham appear to be the only settlements affected. Map 6 indicates that areas of mangrove along the coast will be flooded.



*Map 6- Antigua Feature Vulnerability to Storm Surge*

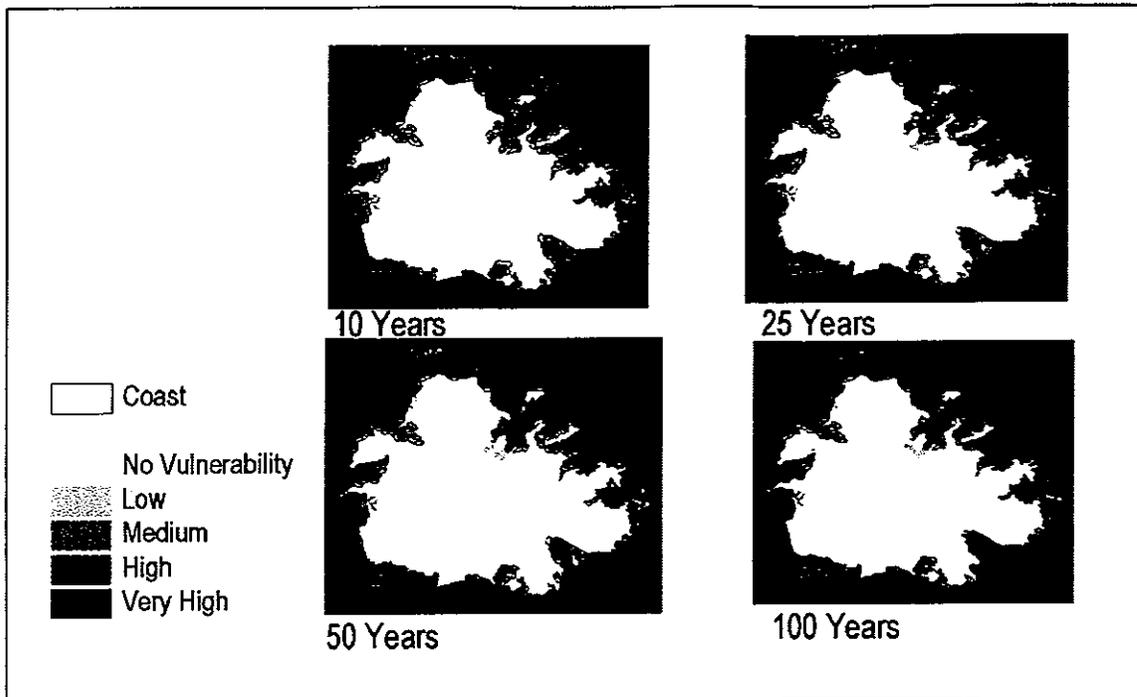
## ***Waves***

### **Wave Zones**

Map 7 indicates the vulnerability of Antigua to the various storm return periods. The 10-year return period indicates high vulnerability and very high wave vulnerability on Northern Runaway Beach. Wave vulnerability is high in the center of Parham Harbour and St. John's Harbour with a mix of low and moderate vulnerability along the coast. Moderate wave vulnerability intrudes into Hanson's Bay and Jolly Harbour. Very high vulnerability is experienced at the mouth of English Harbour and decreases inland.

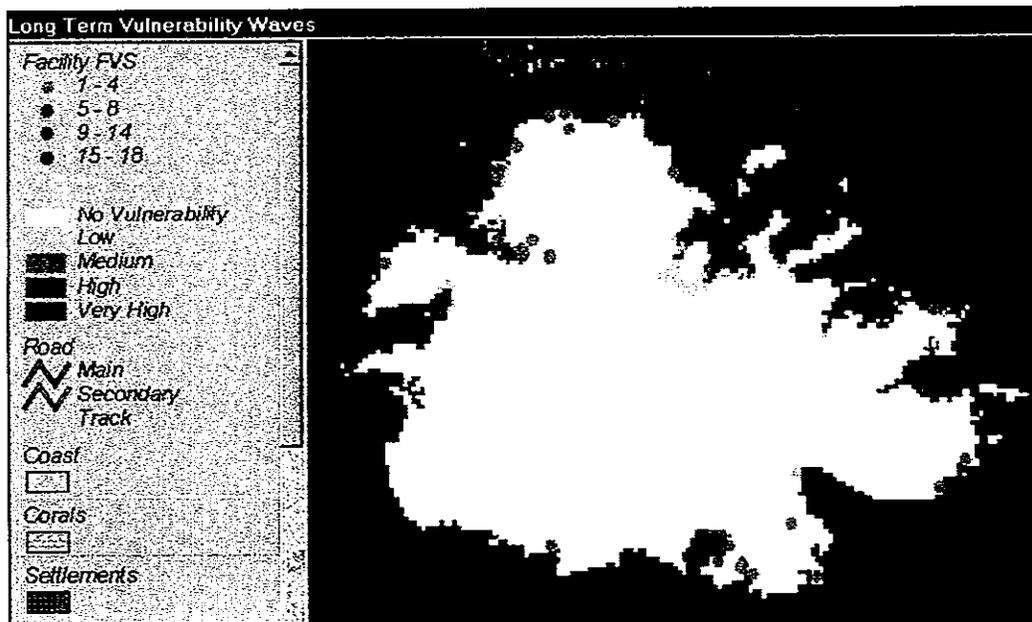
Very high vulnerability zones will experience waves between 2.0 and 10.0 meters. High zones will have waves between 1.5 and 2.0 meters. Moderate vulnerability zones can expect waves between 1.0 and 1.5 and low vulnerability zone will have waves below 1.0 meters.

The 25-year return period intrudes high waves further into Parham Harbour and low waves inland. This intrusion increases with the 50-year storm and with the 100-year storm some high vulnerability can be expected inland of Parham Harbour. The 100-year storm also results in the intrusion of the high vulnerability zone into St. John's Harbour, Jolly Harbour and English Harbour.



*Map 7- Antigua Wave Vulnerability by Return Period*

Map 8 indicates the long-term vulnerability of Antigua to waves. It indicates the intrusion of a zone of very high vulnerability into Parham Harbour, English Harbour and most of St. John's Harbour. Jolly Harbour is located in a zone of high vulnerability and there is a zone of low vulnerability to the south and southwest of Parham.



*Map 8- Antigua Long Term Vulnerability to Waves*

### Wave Facility Vulnerability Scores

Seven facilities have high scores and are listed in Figure 3. They are located on Runaway Bay, Blue Waters Bay, Mango Bay, Dockyard and Coolidge. As expected the locations are closely related to those subjected to storm surge.

Attributes of Critical Facilities				
Name	Miles	Type of Facility	Address	Wave FVS
LASHINGS	0	Hotels	RUNAWAY BAY	9
MANGO BAY RESORT	0	Hotels		7
SUNSET COVE HOTEL	0	Hotels	RUNAWAY BAY	6
NELSON'S DOCKYARD	0	Historical Sites	DOCKYARD, ENGLISH	6
BLUE WATERS HOTEL	0	Hotels	BLUE WATERS BAY	4
BARRYMORE BEACH HOTEL	0	Hotels	RUNAWAY BAY	4
BEACHOMBER HOTEL	0	Hotels	COOLIDGE	4

Figure 3. Antigua Facilities with High Waves FVS

### Feature Vulnerability to Waves

Areas with off shore reefs are somewhat protected but the storm surge does raise the sea level and reduce protection. Very high waves are experienced at sea and within the inner areas of harbours. Jolly Harbour and Parham experience very high waves. There is an intrusion of low waves into the area south west of Parham Harbour that is subjected to storm surge.

### Drought

#### Drought Zones

Drought was analyzed on the basis of watersheds. Antigua was divided into 12 watersheds and the hazard assessed in terms of the "spatial occurrence of vulnerability" factors. The types of factors considered were:

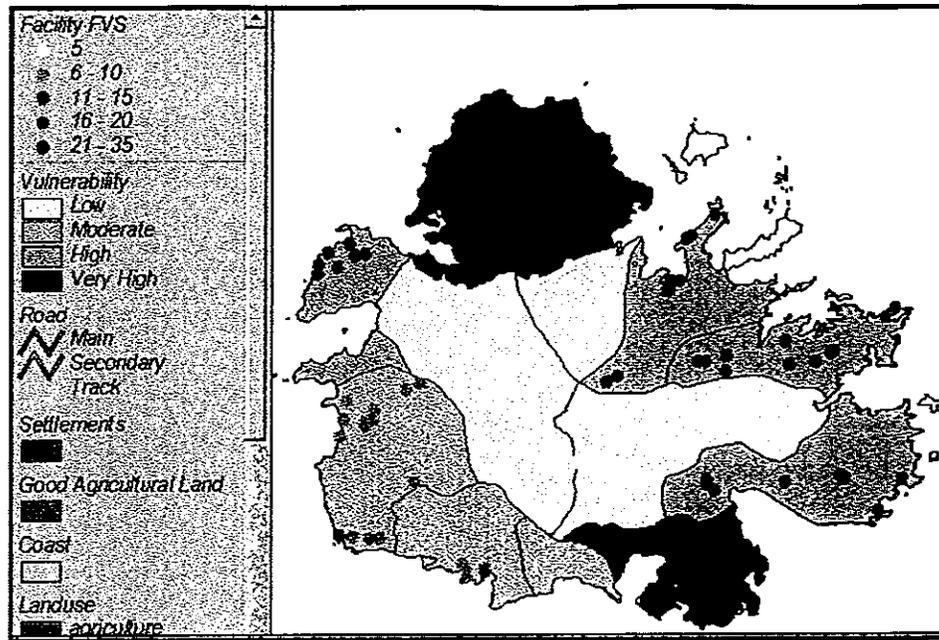
- Environmental and Meteorological
- Hydrological and Infrastructural
- Human and Land Use

Environmental and meteorological factors identified areas with an annual rainfall below 35 inches, exposed to wind and marine influences with shallow soils, slopes greater than 11° and with cactus scrub vegetation. Hydrological and infrastructural factors identified areas with limited resources and inadequate dams or ponds for livestock. The human and land use factors considered grazing, crop location and areas with a population density of more than 5,000 persons per square mile.

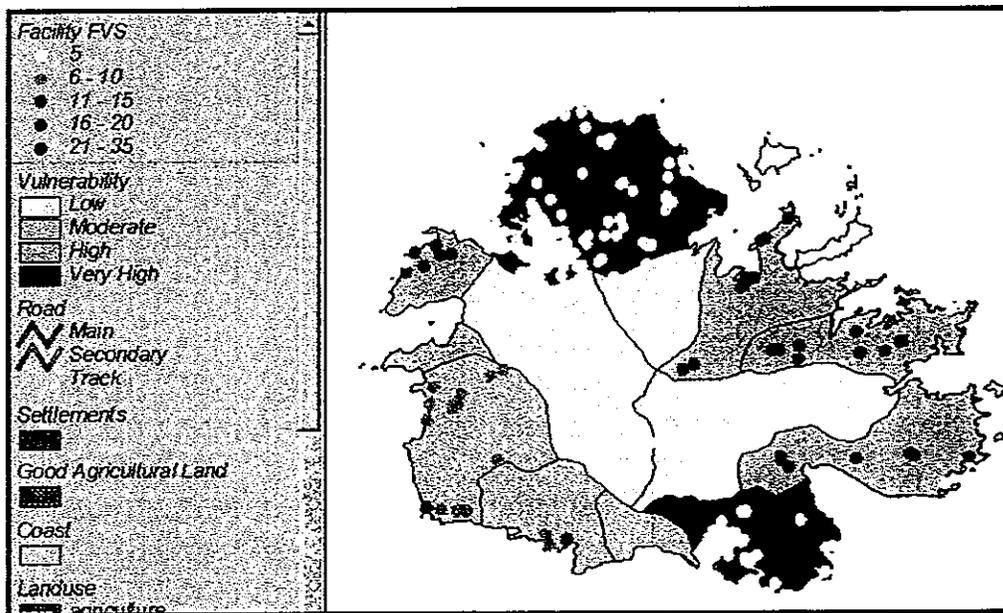
The northeast and southwest of Antigua are most vulnerable to drought. The eastern and western areas are within a high zone of vulnerability. The area identified as the most vulnerable to drought is located at the southeast of Antigua between English Harbour and St. James.

#### Drought Scores

There is a close correlation between high scores and high vulnerability as indicated in Map 9 below. Most of the facilities with more than 50% of the possible FVS are located within the very high vulnerability drought zone indicating the strong effect of location on drought FVS. The exceptions are four hotels, Yepton Hotel, Mango Bay Hotel, Half Moon Bay Hotel and Long Bay Hotel. These facilities are located in a high vulnerability zone as indicated on Map 10.



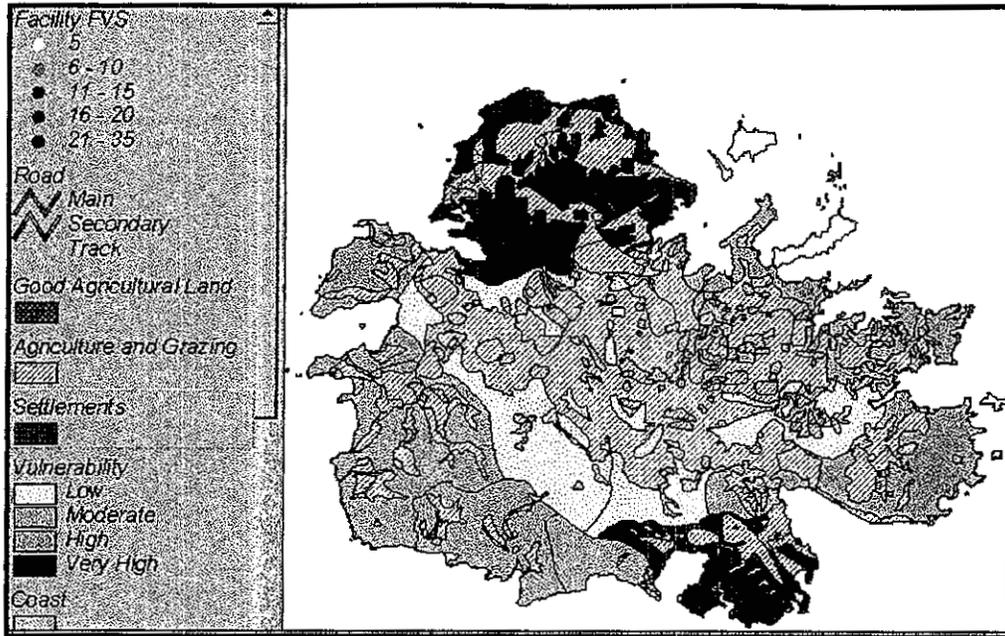
Map 9. Antigua Drought Zones and Facility FVS



Map 10. Antigua Location of Facilities with FVS Greater than 15

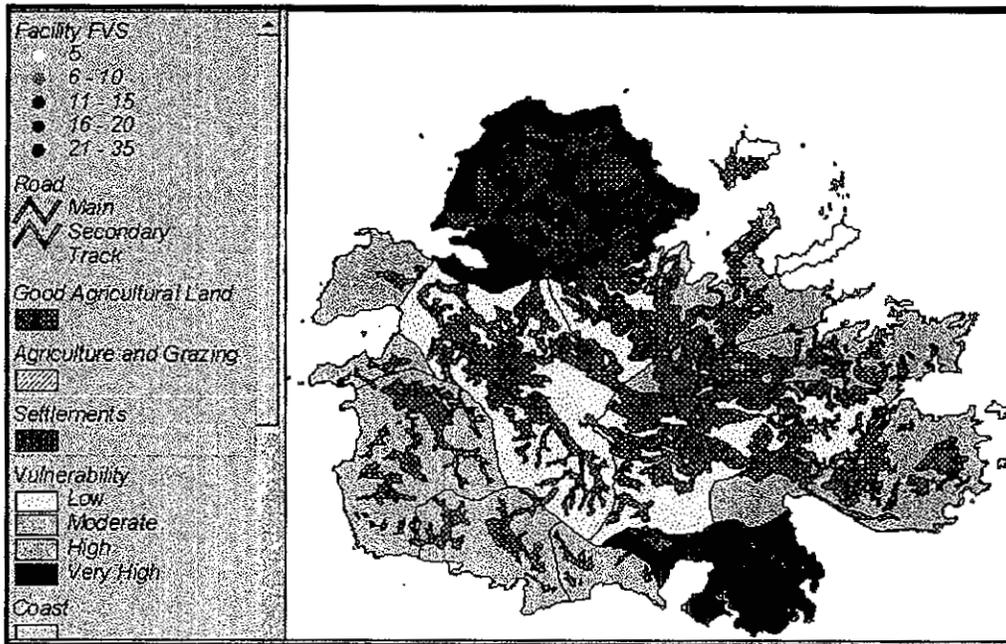
#### Feature Vulnerability to Drought

The settlements of Coolidge, Piggotts, Potters and Falmouth are located in the “Very High” vulnerability zone. Map 11 indicates that approximately 50% of the existing agriculture and grazing is located within high and very high vulnerability zones.



Map 11. Antigua Location of Existing Agriculture and Grazing

Map 12 indicates the location of good agriculture land in relation to drought vulnerability zones. Good agricultural land was defined by DCA on the land capability map as Class 2 and 3 lands, slopes A, B and C and erosion class 01. It suggests that development of agriculture should be encouraged on good agricultural land within low and moderate drought zones.



Map 12. Antigua Location of Good Agricultural Land

## Flooding

### Flood Zones

The flood hazard assessment indicates that the data required for traditional floodplain mapping was not available for Antigua. As a result, the flood analysis “was restricted first to identifying the areas that would generally flood and then to further categorize these areas according to rough estimates of the flood levels expected within the areas.” Areas prone to flooding were identified as those with gentle slopes, poor drainage, large ratios of watershed area to flood plain, rapid run-off to flood plain with high run-off potential.

The hazard category was determined by the depth of each flood plain on the basis of the Hurricane Lenny rainfall event, using the classification indicated in the table below. The assessment indicates that this method of categorization provides a measure of the severity of flooding among the identified zones.

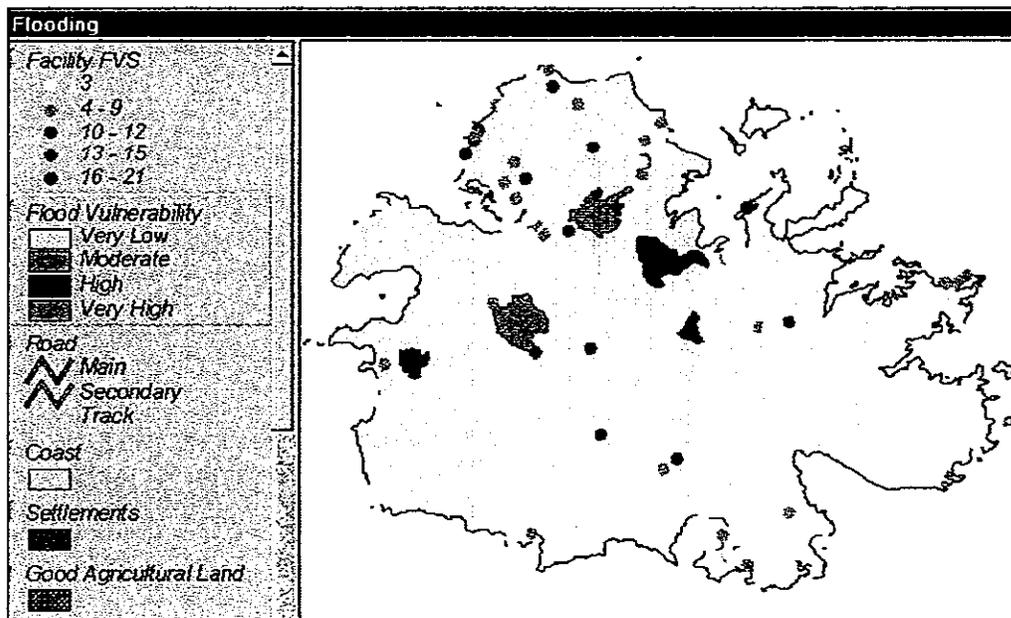
*Flood Plain Water Depth and Hazard Category*

Water depth (mm)	Hazard
>1,200	Very High
1,200 – 600	High
600 – 300	Moderate
300 – 100	Low
<100	Very Low

### Flood Scores

Map 13 indicates the distribution of flood zones and the Facility FVS. The zone of very high vulnerability to flooding is to the north of Bendals Bridge. Most of the island has been categorized as a low vulnerability zone.

Figure 4 lists the facilities with high flood FVS. Four shelters are included on the list, Villa Primary School, Piggotts Seventh-day Adventist Church, Valley High School and Friars Hill. Also included are Cassada Power Stations, Crabbs Desalination Plant and Liberta Police Station.



*Map 13. Antigua Flood Vulnerability Zones and Facility FVS*

Attributes of Facility FVS				
Name	Shape	Type	Address	Flood FVS
NORTH SOUND BRIDGE	0	Bridges	NORTH SOUND CORNER	21
CRABS DESALINATION PLANT	0	Water	CRABBS PENINSULA	18
LASHINGS	0	Hotels	RUNAWAY BAY	18
AMARYLIS HOTEL	0	Hotels	AIRPORT ROAD	18
FRIARS HILL POWER STATION	0	Electricity	FRIARS HILL ROAD	18
GILBERT'S BRIDGE	0	Bridges	GILBERTS	15
SUNSET COVE HOTEL	0	Hotels	RUNAWAY BAY	15
FOLLEY GUT BRIDGE	0	Bridges	FOLLEY'S	15
SIBONEY	0	Hotels	DICKENSON BAY	15
GENERAL POST OFFICE	0	Government Administration	High & Long St.	12
SEVENTH DAY ADVENTIST	1	Churches	PIGOTTS	12
MINISTRY OF AGRICULTURE (LIVESTOCK)	0	Government Administration		12
OLD ADMIN. MIN. OF FINANCE	0	Government Administration	High & Long St.	12
BENDALS BRIDGE	0	Bridges	BENDALS	12
VILLA PRIMARY SCHOOL	1	Primary School		12
H.C. GRANT BUILDING	0	Government Administration	ST. JOHN'S	12
OCEAN VIEW	0	Hotels		12
LIBERTA POLICE STATION	0	Police	Liberta Village	12
VALLEY HIGH	1	Secondary School	BOLANS	12
CASSADA POWER STATION	0	Electricity	BARNES HILL MAIN ROAD	12
GOVERNMENT WORKSHOP OFFICE	0	Government Administration	Factory Road	12
SEVENTH DAY ADVENTIST	1	Churches	NEW WINTHROPES	12
HERITAGE HOTEL	0	Hotels	HERITAGE QUAY, ST. JOHN'S	12
CATHEDRAL CULTURAL CENTRE	1	Community Centres	ST. JOHN'S STREET	12
BARRYMORE BEACH HOTEL	0	Hotels	RUNAWAY BAY	12
LIBERTA CLINIC	0	Clinics	Liberta	12

Figure 4. Antigua Facilities with High Flood FVS

### Feature Vulnerability to Floods

Flooding occurs in the areas upstream of swamps and mangroves. High flooding vulnerability zones exist around North Sound Bridge and North of Bendals Bridge. The areas affected by flooding are generally agricultural and grazing lands.

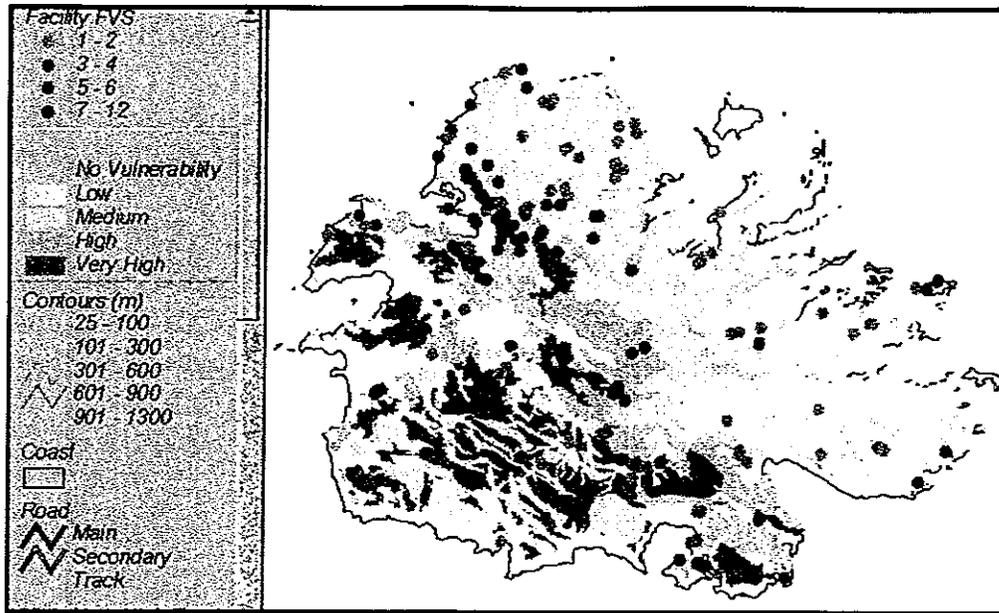
### Inland Erosion

#### Inland Erosion Zones

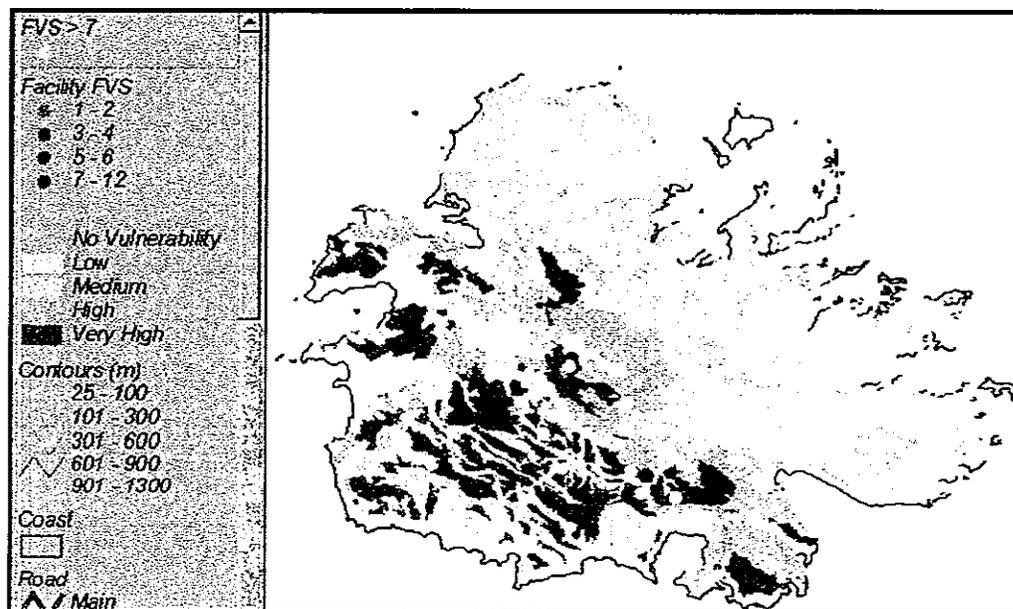
The inland erosion hazard assessment indicates that "simple empirical models were used to produce hazard scores for each land unit" and that "the models integrate the estimated effects of elements of the environment, which cause or influence the hazard and produce a score." The final score is an estimate of the likely occurrence of the hazard at the location. The scores were classified into 5 equal area classes: very low, low, medium, high and very high. Adding classes and then reclassifying produced the final map. It combines gullying, mass movement and to some extent stream bank erosion. Map 14 indicates the inland erosion zones established. The areas with high and very high vulnerability to inland erosion are located within the southwest half of Antigua.

#### Inland Erosion FVS

Map 15 indicates that most of the facilities with the highest vulnerability to inland erosion are located within the southwestern half of Antigua. The facility with the highest FVS (12) is the Copper and Lumber Inn located in Dockyard. Unfortunately, the database assessment of the "V" factor did not differentiate between coastal and inland erosion. As a result, facilities such as Lashings Hotel on Runaway Bay have a high inland erosion score. The assumption must be made because of its location on the coast that it is subject to coastal / beach erosion not inland erosion. Therefore, facilities located on the coast should be ignored for this hazard rating.



Map 14. Antigua Inland Erosion Zones and Facility FVS



Map 15. Antigua Location of Facilities with FVS Greater than 7

### Feature Vulnerability to Inland Erosion

Mainly woodland and rough grazing occupy the zones with high and very high vulnerability to inland erosion. Some central settlements such as Potter's, Sea View Farm and Freeman's Village are located within these zones. The condition of roads in these areas is adversely affected by erosion.

## Beach Erosion

### Beach Erosion Zones

Beach erosion zones are established with the beach setbacks recommended by the DCA and applied to the beaches monitored by the Fisheries Division of Antigua and Barbuda. The Fisheries Division monitors the beach profiles of sixteen beaches in Antigua on a quarterly basis. Emphasis is placed on changes to the beach profile width and data has been collected since 1992. Most of the beaches in Antigua are categorized as medium to high erosion zones. The table below indicates the hazard categories and their respective rates of change.

*Hazard Category and Percentage Change in Beach Profile Width*

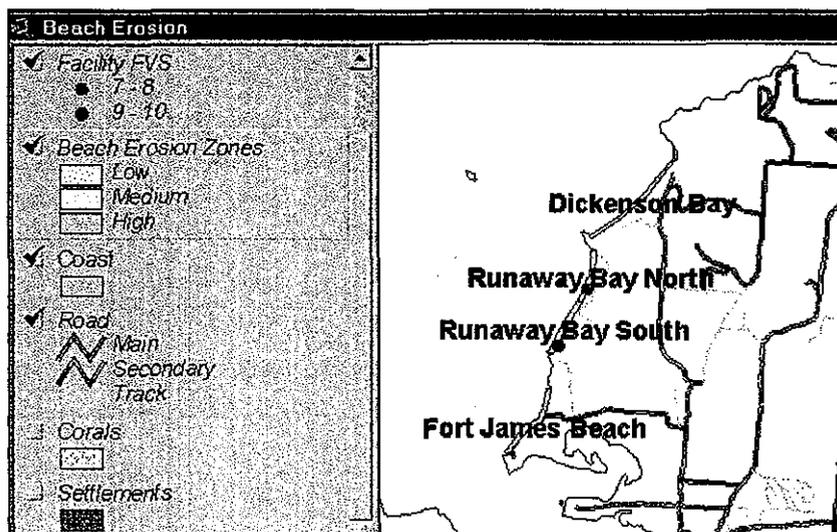
Hazard Category	Rate of Change
Very Low	+3.38 to +5.28
Low	+1.18 to +3.37
Moderate	-0.43 to +1.47
High	-2.34 to -0.44
Very High	-4.25 to -2.35

Nine erosion zones have some effect on facilities and features:

- Dickenson Bay
- Runaway Bay North
- Runaway Bay South
- Lignumvitae Bay
- Crab Hill Bay
- Half Moon Bay South
- Dutchman Bay North
- Long Bay
- Fort James Beach

### Beach Erosion Vulnerability Scores

Only two facilities have scores of more than 50% of total possible score. These facilities, Lashings and Sunset Cove, are both located on Runaway Bay that has a medium rate of erosion. Sunset Cove is the only facility in Antigua located within a beach erosion zone. Map 16 indicates these facilities.



*Map 16. Facilities Most Vulnerable to Beach Erosion in Antigua*

### Feature Vulnerability to Beach Erosion

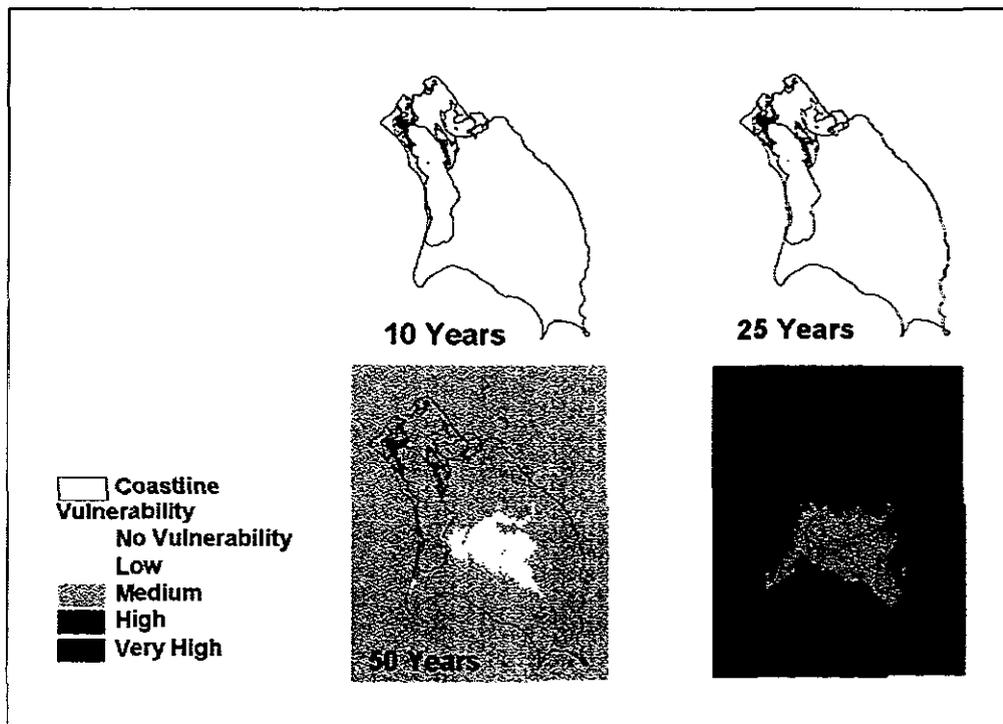
The areas affected by the beach erosion zones are generally tourism development areas such as Dickenson Bay / Runaway Bay on the west coast and Long Bay on the east coast. Other features affected are the airport / military zone in the northeast, swamp and mangrove in the southwest and Crab Hill Bay settlement on the south coast. Dickenson Bay, Long Bay and Deep Bay are the areas with the high erosion rates that affect facilities and features.

### Barbuda

#### Wind

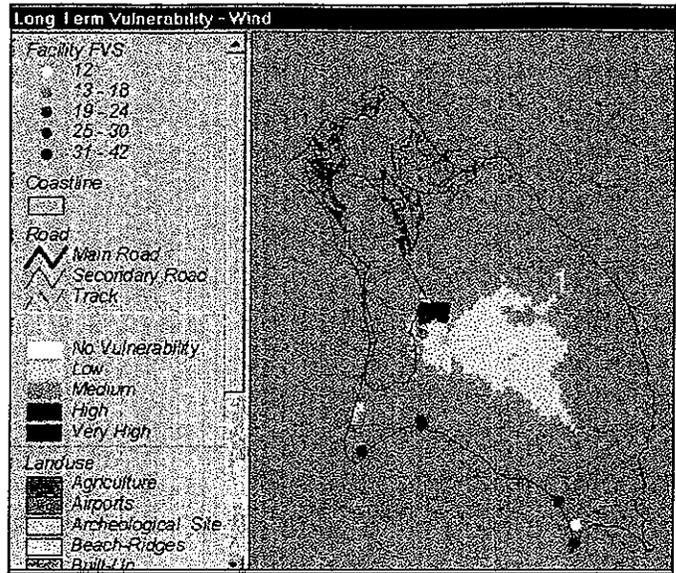
#### Wind Zones

Map 17 indicates the expected vulnerability to winds of Barbuda for various return periods. The 10-year and 25-year storms are predicted to place Barbuda in an area of low vulnerability with winds between 17 and 43 meters/second. The 50-year storm will subject most of the island to moderate vulnerability with an area south of Codrington in a low vulnerability zone. Moderate winds are between 43 and 50 meters / second and would be categorized as a category 2 hurricane. The 100-year storm would place most of Barbuda into a zone of high vulnerability to winds which would be of category 3 hurricane force and extensive damage could be expected.



Map 17. Barbuda Wind Vulnerability By Return Interval

The long-term vulnerability of Barbuda is shown on Map 18. It is similar to the 50-year return storm with a small section on western Palmetto Point experiencing low vulnerability to wind.



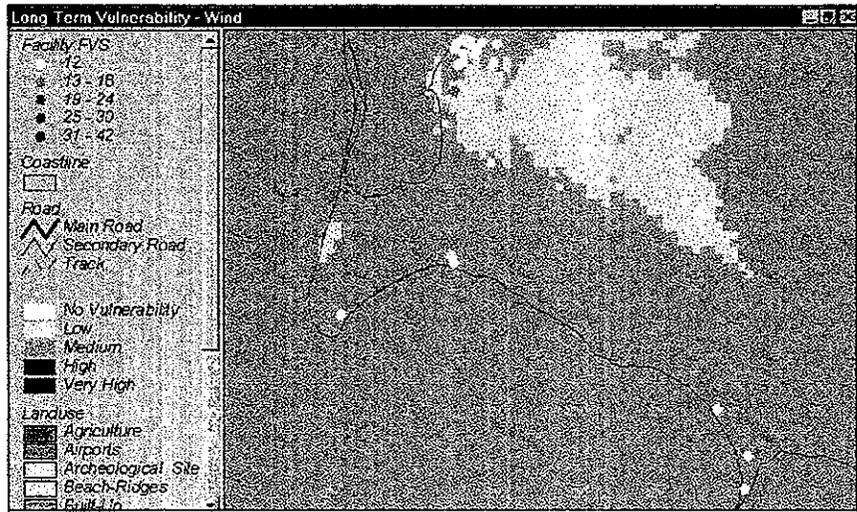
Map 18. Barbuda Long Term Wind Vulnerability

### Wind Vulnerability Score

Map 18 indicates the distribution of critical facilities on Barbuda and their wind FVS. They are clustered around Codrington and the south coast. Very few facilities have low values. Map 19 selects all the facilities that have scores greater than 21. The only exceptions are the Council Hall, Cocoa Point Airport and Hana Thomas Hospital.

### Feature Vulnerability to Wind

Map 18 indicates that most of the features on Barbuda are moderately vulnerable to wind. The area of low vulnerability is to the south of Codrington and is largely occupied by woodlands.



Map 19. Barbuda Features with Wind FVS Greater than 21

### Storm Surge

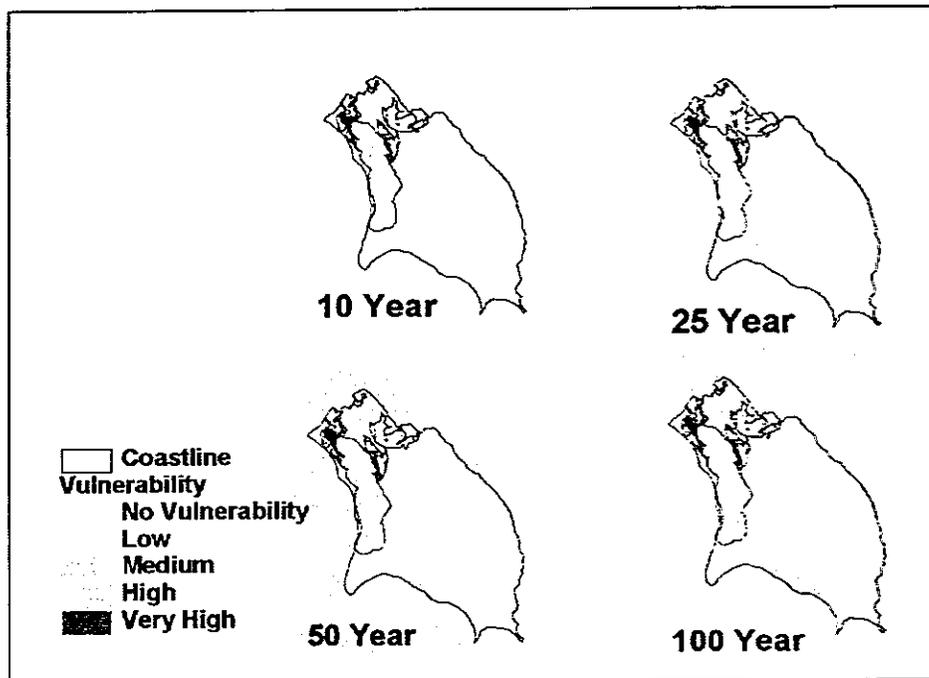
#### Storm Surge Zones

Map 20 indicates the storm surge vulnerability of Barbuda for the 10-year, 25-year, 50-year and 100-year storms. It reveals that the 10-year storm is predicted to generate an area of moderate

storm surge vulnerability that occupies the lagoon, the mouth of the lagoon and extends into the bird sanctuary. The southern portion of the spit may be breached by the surge that can be expected to range between 0.5 and 1.5 meters.

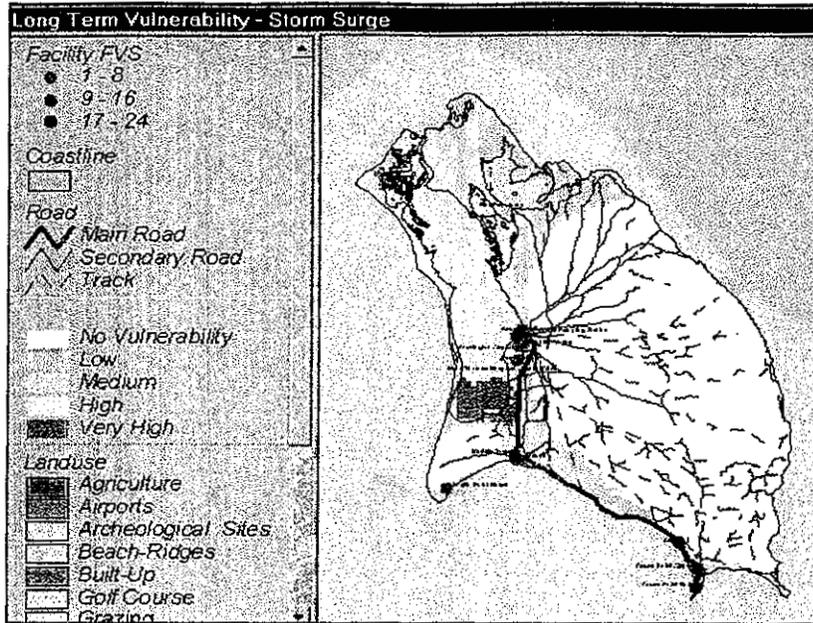
The 25-year storm subjects the entire northeast of the island to moderate surge vulnerability. The south coast and the peninsula between the lagoon and the south coast are also within an area of moderate vulnerability. The southern portion of the lagoon has a high vulnerability with surge between 1.5 and 3 meters.

The 50-year storm subjects the entrance to the lagoon and its southern portion to high storm surge vulnerability. These areas increase in extent with the 100-year storm to include a section of the south coast and most of the north of the island.



*Map 20- Barbuda Storm Surge by Return Period*

Map 21 indicates the expected long-term vulnerability of Barbuda to Storm Surge. The northeast of the island has a low vulnerability. The entire lagoon including the mouth has a high vulnerability with surge building in the south of the lagoon in excess of 3.0 meters. An area of moderate vulnerability extends southwards from the lagoon across the peninsula. The entire coastline has a moderate vulnerability with and intrusion inland along the south coast of low vulnerability.



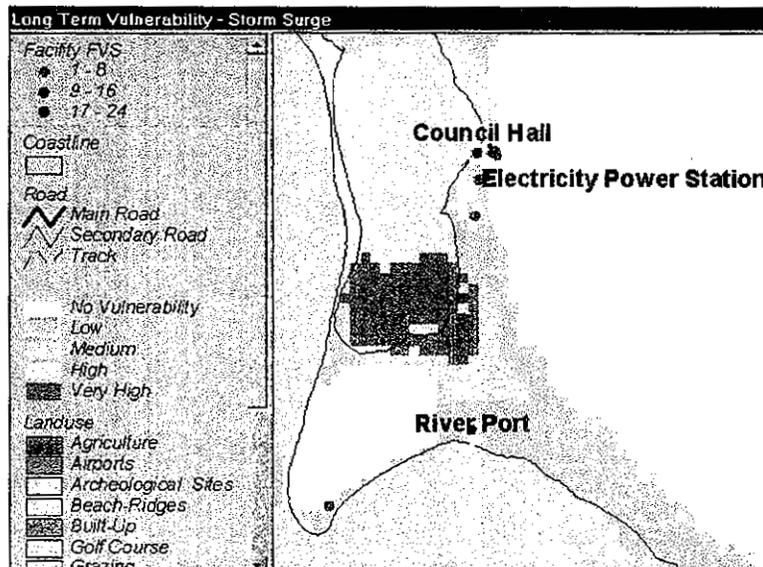
Map 21. Barbuda Long Term Vulnerability to Storm Surge

#### Storm Surge Vulnerability Scores

The Facilities with the highest scores are located along the lagoon in Codrington and on the south coast in the moderately vulnerable area south of the lagoon. Map 22 indicates that the facilities are River Port, Council Hall and The Electricity Power Station with scores of 24, 16 and 16 respectively.

#### Feature Vulnerability to Storm Surge

The Bird Sanctuary, lagoon, sea ports and approximately half of the town of Codrington can be expected to be affected by Storm surge in the long term. Most of the inland areas affected by storm surge are occupied by mixed grazing / woodlands.



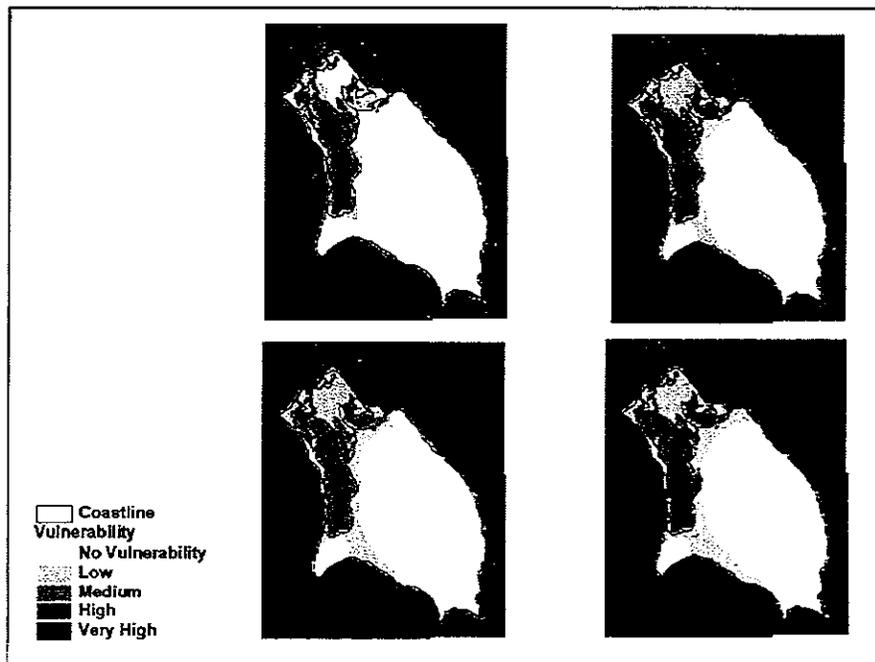
Map 22 – Barbuda Facilities with Highest Storm Surge FVS

## Waves

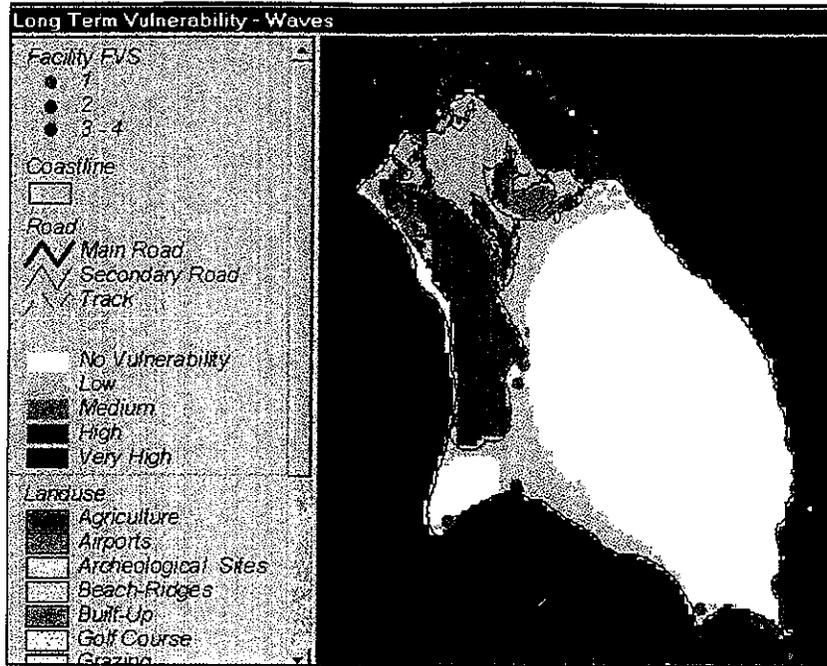
### Wave Zones

Map 23 indicates the vulnerability of Barbuda to waves for each storm return period. The 10-year storm is predicted to subject the lagoon and north coast to moderate vulnerability that would develop waves of 1 to 1.5 meters. Some intrusions of a low vulnerability zone will occur south and east of the lagoon with waves of 0 to 1 meter. The 25-year storm will increase this intrusion and mostly to the north of the island will be within a low wave hazard zone. The north coast will be within a zone of high wave vulnerability. The 50-year return period will marginally increase vulnerability with the further intrusion of moderate waves inland. The 100-year storm will generate a high wave vulnerability zone in the southern and northern sections of the lagoon.

The long term vulnerability of Barbuda to waves is shown on Map 24. The lagoon is within a zone of high vulnerability. The northern section of the island is generally of low vulnerability and a zone of low vulnerability extends southwards from the lagoon to the central portion of the south coast. The southeast tip of the island has high wave vulnerability.



Map 23. Barbuda Wave Vulnerability by Return Period



*Map 24. Barbuda Long Term Vulnerability to Waves*

**Wave Vulnerability Scores**

Only one facility has a high wave score for Barbuda and that is River Port. It is located on the exposed southern coast in the area of the peninsula prone to storm surge and moderate waves.

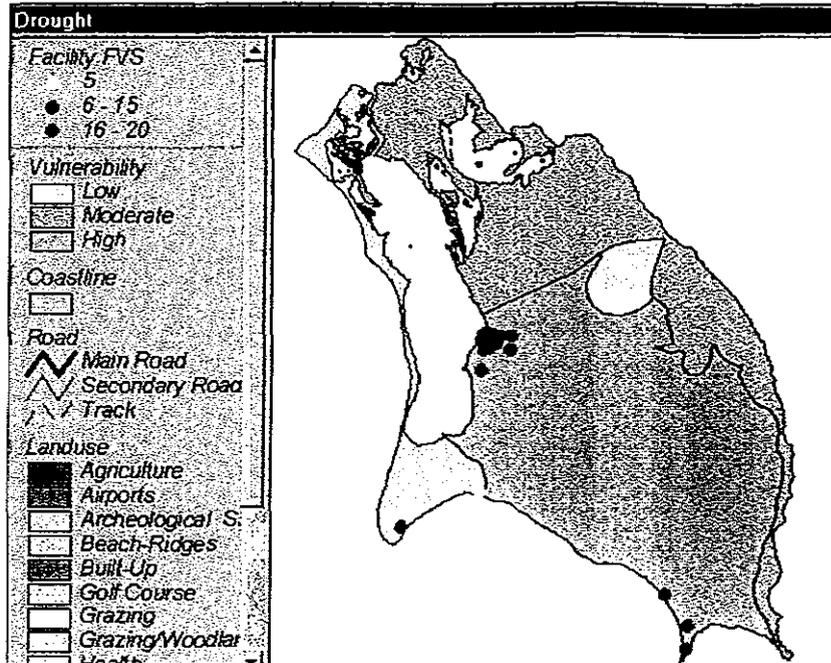
**Feature Vulnerability to Waves**

The areas vulnerable to waves are similar to those vulnerable to storm surge. The lagoon, Bird Sanctuary will be most affected. The eastern sections of Codrington and development along the south coast can expect some damage.

***Drought***

**Drought Zones**

Barbuda was divided into 10 watersheds that were ranked as low, moderate and high vulnerability zones. Map 25 indicates the drought vulnerability zones for Barbuda. The flats lands surrounding Codrington are considered to be the most vulnerable.



Map 25. Barbuda Drought Vulnerability Zones and Facility FVS

### Drought Vulnerability Scores

The facilities with high drought scores are all clustered in Codrington with the exception of Cocoa Point Airport. The following facilities have scores of 20:

- Cocoa Point Airport
- Codrington Airport
- Fire Station
- Water Pumping Station
- Electricity Power Station
- Telephone Sub-Station
- Public Works

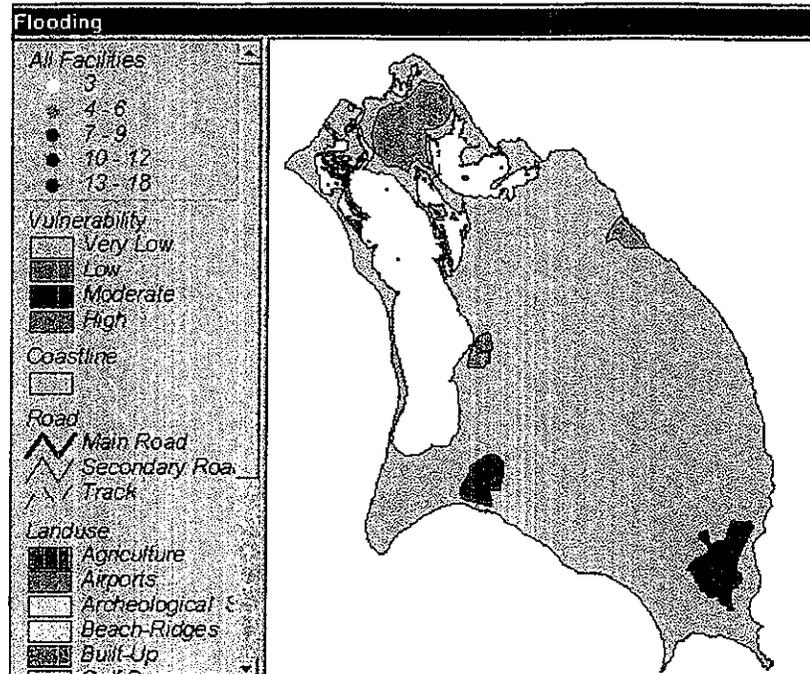
### Feature Vulnerability to Drought

Most of the development in Barbuda occurs within the zone of high vulnerability. The town of Codrington and the entire south coast from River Port to Cocoa Point are located in the high zone. Palmetto Point and its agricultural, industrial and tourism development are located in the zone of low vulnerability

### Flooding

#### Flood Zones

Map 26 indicates the flood vulnerability zones for Barbuda. A very low vulnerability zone with two small low vulnerability zones to the north and northeast covers most of the island. Codrington is located within a zone of high vulnerability. Two moderate zones of vulnerability are located along the southern section of the island.



Map 26 Barbuda Flood Vulnerability Zones

### Flood Vulnerability Scores

Map 27 indicates the distribution of facility flood FVS. Most of the facilities with high FVS are clustered within Codrington within the zone of high vulnerability to flooding. Four facilities with high FVS are located in the zone of very low vulnerability. Palmetto Point Hotel and Cocoa Point Hotel are located along the south coast. Hana Thomas Hospital and Public Works are located along the edge of the high flood zone in Codrington. Figure 5 lists the facilities and their FVS value.



Map 27 Barbuda Flood FVS

<i>Name</i>	<i>Flood FVA</i>	<i>Shelter</i>
Fire Station	18	0
Police Station	18	0
Pentecostal Assembly	18	1
Living Faith Church	18	1
People Church	15	1
Codrington Airport	15	0
Telephone Sub-Station	15	0
Weslyn Holiness Church	15	1
Public Works	15	0
Hana Thomas Hospital	12	0
Cocoa Point Airport	12	0
Martelo Tower	12	0
Palmetto Point Hotel	12	0

*Figure 5 Barbuda Listing of Facilities with High Flood FVS*

#### **Feature Vulnerability to Flooding**

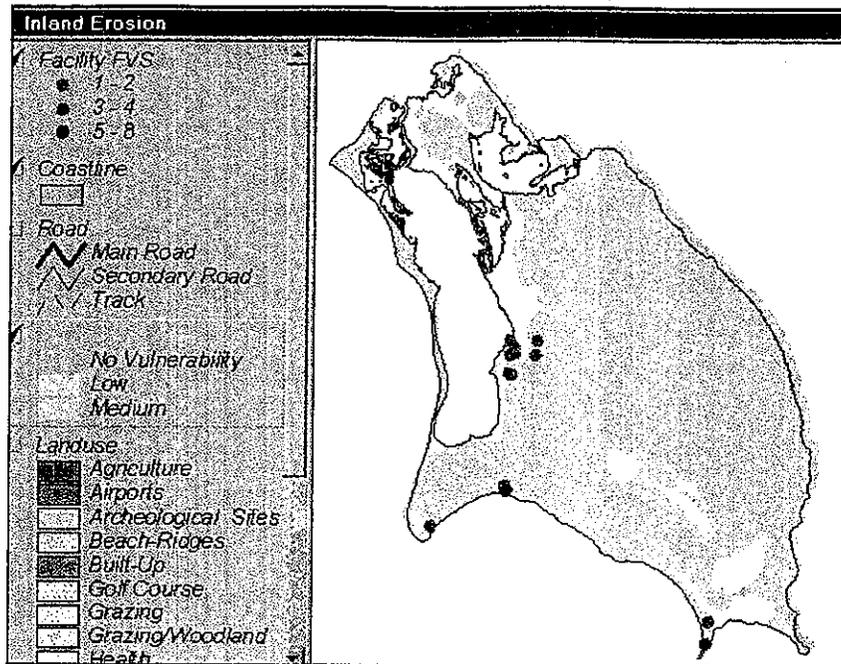
The town of Codrington is the most significant feature vulnerable to flooding on the island of Barbuda. An area of tidal flats and woodland is subjected to low vulnerability in the north. An area of swamp and woodland is moderately to flooding along the south east coast.

#### ***Inland Erosion***

##### **Inland Erosion Zones**

The inland erosion hazard assessment indicates that hazards of sheet and rill erosion and of gully erosion in Barbuda are minimal but wind erosion is relatively important and may provide a building development hazard. Rock falls on the edge of and in the highlands are also to be noted. Barbuda shows the highest hazard ratings on areas with parent materials that may have been wind deposited.

Map 28 shows the zones of inland erosion. The southern and western areas of the island are in a zone of low vulnerability. The eastern section of the island has a moderate vulnerability.



Map 28 Barbuda Inland Erosion and Facility FVS

### Inland Erosion Vulnerability Scores

The facilities on Barbuda are located within the moderate zone of vulnerability. Only River Port has a high score.

### Feature Vulnerability to Inland Erosion

The area of moderate vulnerability is occupied by tidal flats and woodland in the north and grazing / woodland in the east.

### Beach Erosion

#### Beach Erosion Zones

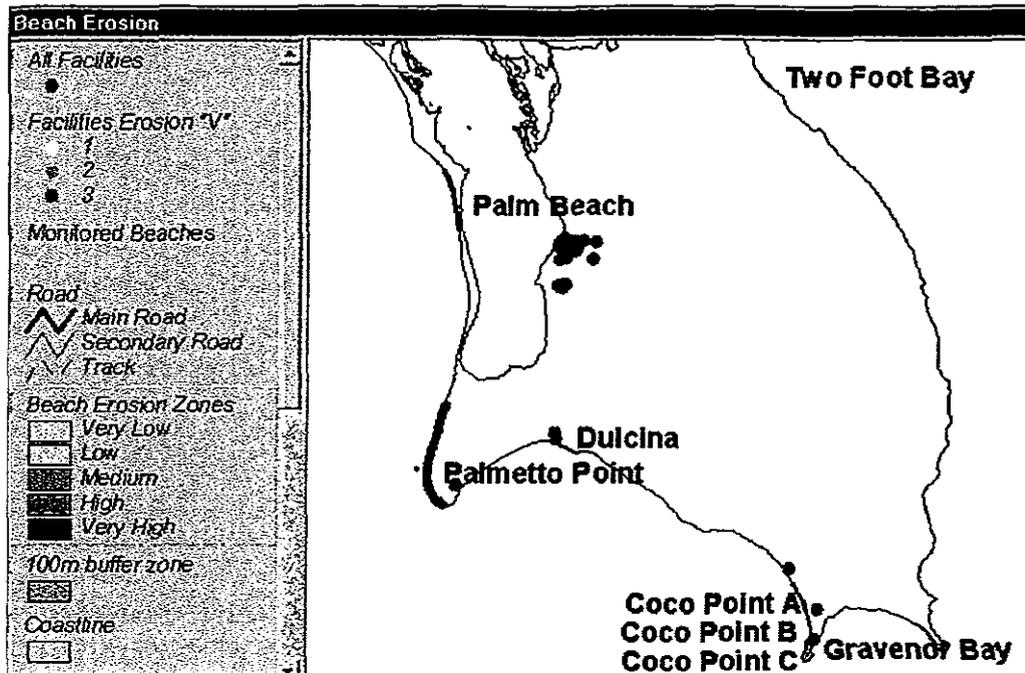
Six beaches have been monitored quarterly in Barbuda since 1995 by the Fisheries Division. Of the six beaches monitored Two-Foot Bay and Dulcina Bay record accretion as the dominant process. Erosion is more dominant on Palm Beach and Palmetto Point and sections of Cocoa Point vary between accretion and erosion. Beach Erosion in Barbuda varies from very low to very high on Dulcina Bay and Palmetto Point respectively. Map 29 indicates the location of beach erosion zones.

#### Beach Erosion Vulnerability Scores

No Facilities in Barbuda were located within Beach Erosion zones. Palmetto Point Hotel and Cocoa Point Hotel were located closest to high and very high Beach Erosion zones.

#### Feature Vulnerability to Beach Erosion

The beaches themselves are the features at risk from erosion. Palm Beach places a section of the spit and therefore the lagoon at moderate vulnerability to beach erosion. The beach at Palmetto Point is very vulnerable to beach erosion.



Map 29 Barbuda Beach Erosion Zones and Facility Vulnerability

## Summary

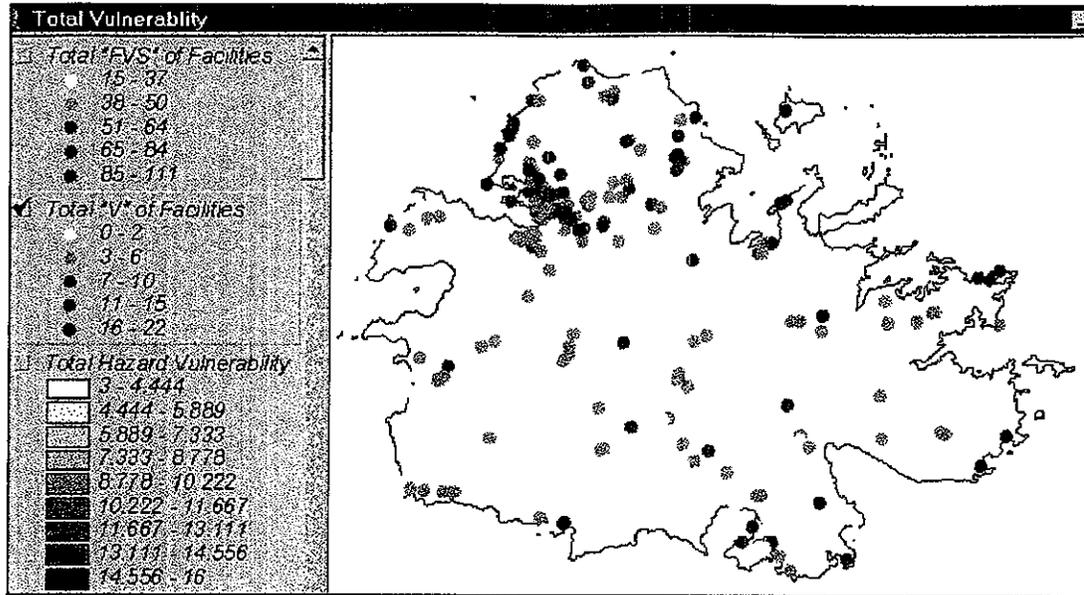
### *Cumulative Vulnerability*

Cumulative vulnerability attempts to consider the total vulnerability of facilities and areas to hazards in order to determine which facilities and areas are the most vulnerable. The cumulative vulnerability of facilities is the total FVS of all hazard types. The cumulative vulnerability of an area is the total of all the hazard zone scores for the area.

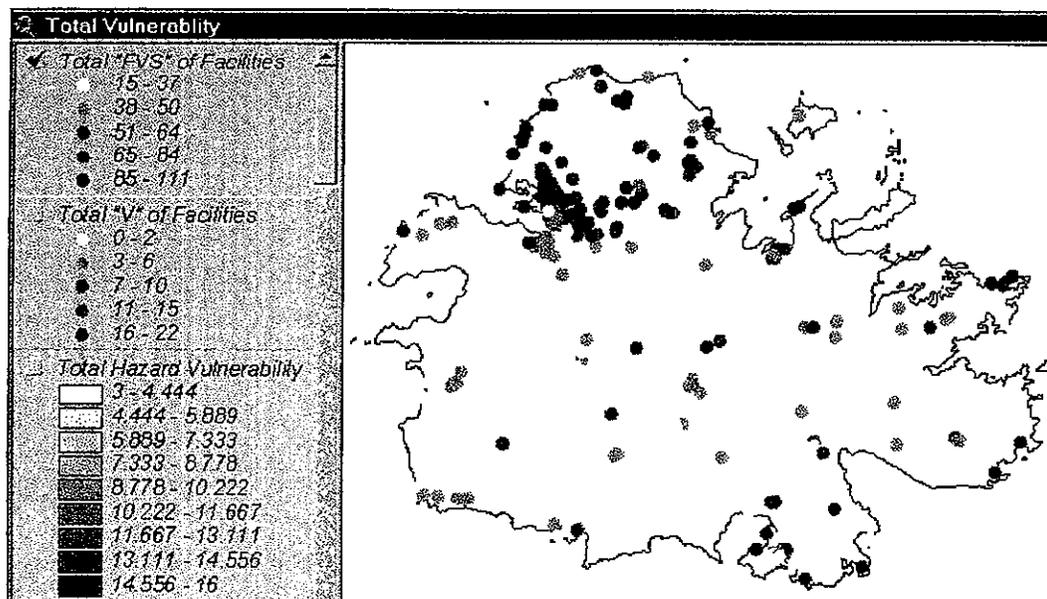
### *Antigua*

#### **Facilities**

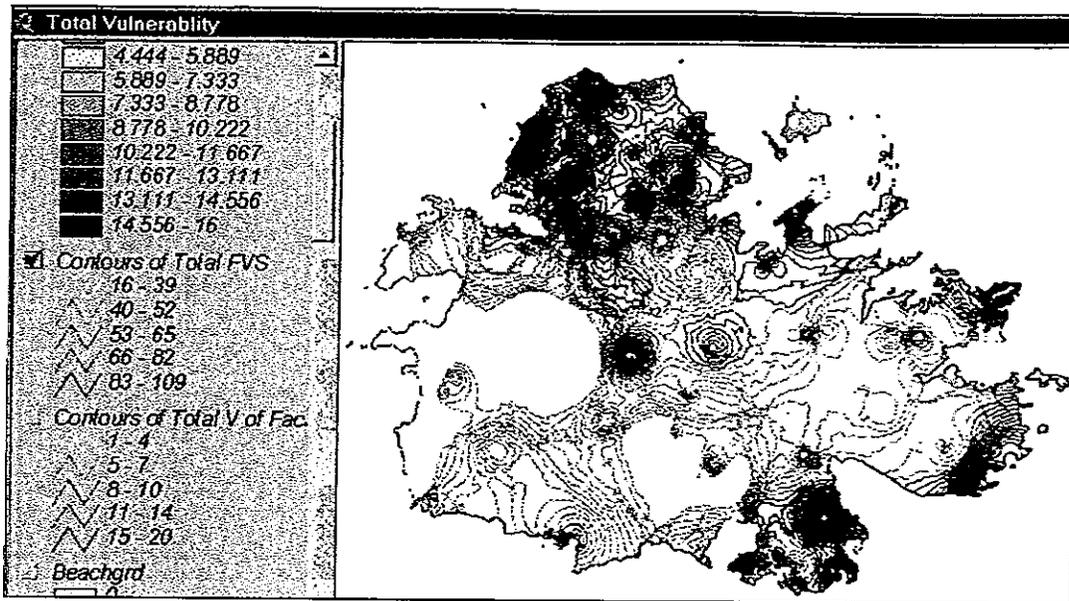
The “V” value of facilities considers their damage history, structural and operational vulnerability. An examination of the total “V” value of facilities (Map 30 ) reveals that the facilities with the highest scores are clustered north of St. John’s and in the Runaway Bay / Dickenson bay and Long Bay areas. Map 31 indicates that the distribution of the total FVS scores is consistent with the distribution of the “V” scores. Map 32 visually represents the location of the highest FVS values with the use of contours. This method is only for visual impact as it allows “hotspots” to be easily seen. It is not meant to suggest that there is a continuous surface of FVS values.



Map 30. Total "V" of Facilities in Antigua



Map 31. Total FVS of Facilities in Antigua

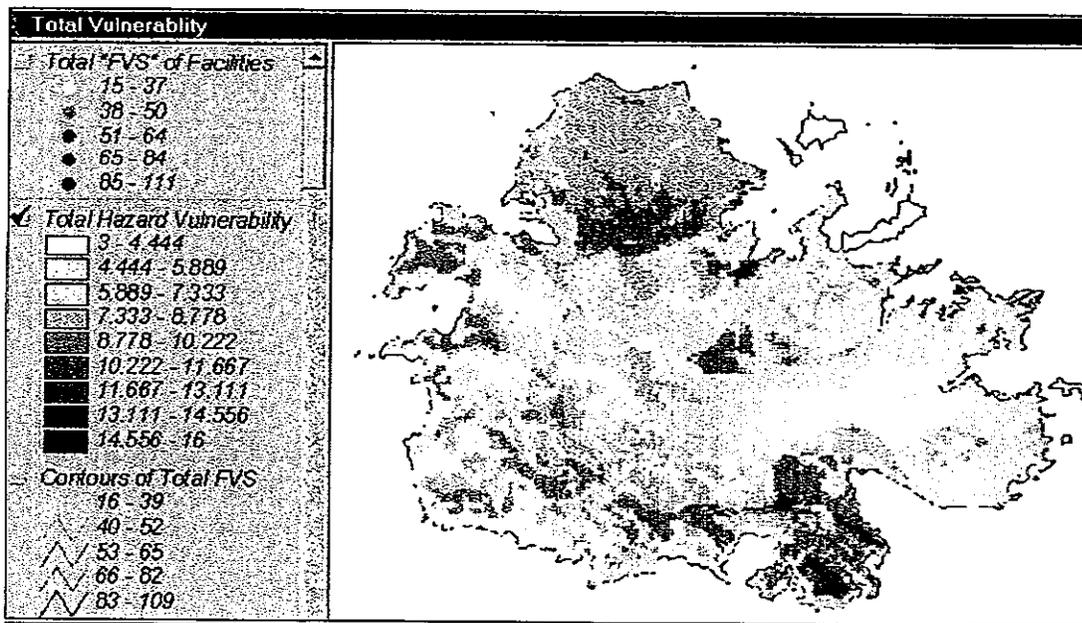


Map 32. Facility "FVS" Hotspots in Antigua

"Hot spots" are caused by a combination of facility distribution patterns and absolute "FVS" values. Areas with higher facility density have a denser contour pattern. Areas with high density and high "FVS" values appear as dark spots. The location of "hot spots" can be used to prioritize further investigation.

### Hazard Zones

Map 33. indicates the total hazard vulnerability zones generated from all hazard vulnerability maps. The values generated are divided into equal classes. The highest total scores are located along the southeast coast in the Shirley Heights area. The area southwest of Parham Harbour also has a high score. The lowest scores are located in a strip across central Antigua.

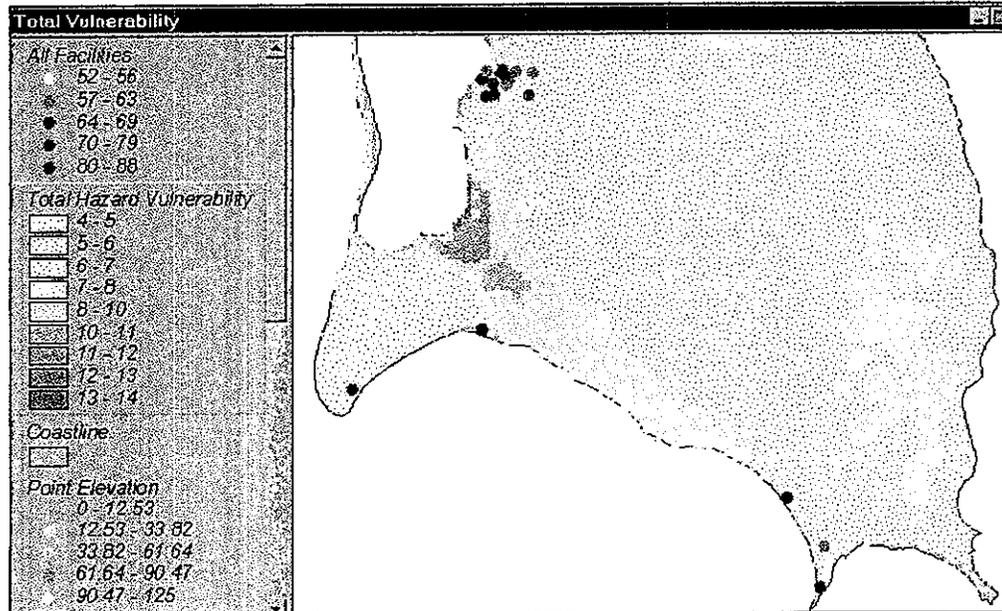


Map 33. Total Hazard Vulnerability Zones in Antigua

## Barbuda

### Facilities

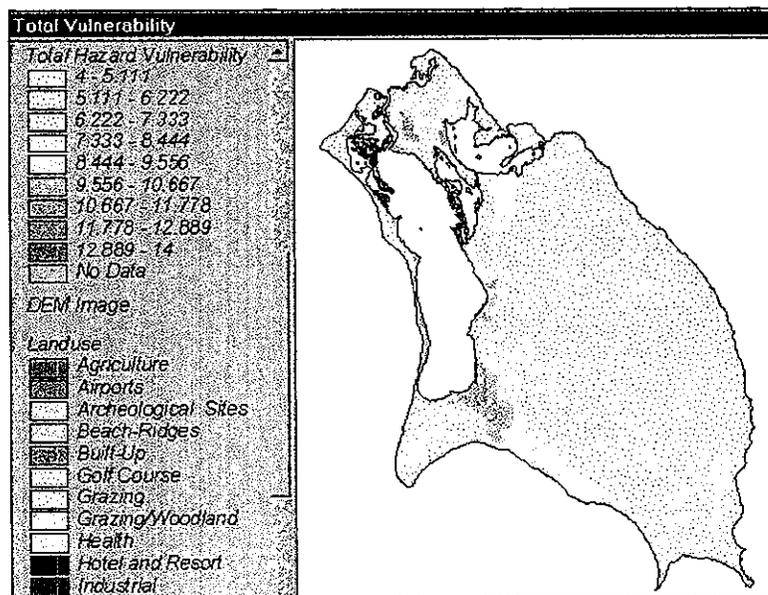
River Port and Codrington Power Station have the two highest total FVS scores. The other facilities with high total FVS are Cocoa Point Hotel, Codrington Fire Station, Codrington Airport and Public Works. Map 34 indicates the distribution of these facilities.



Map 34 Distribution of Facility Total FVS in Barbuda

### Hazard Zones

The most vulnerable areas in Barbuda are south east of the lagoon and east of the mouth of the lagoon. Map 35 shows these hazard zones.



Map 35 Total Hazard Vulnerability in Barbuda

## **Section III: Analysis and Evaluation of Existing Systems**

The following assessment was undertaken on the basis of responses to questionnaires received from Government agencies and non-governmental organizations (NGOs). Twenty-three questionnaires were sent to Governmental institutions and two to NGOs. Twenty-four completed questionnaires were received: twenty-two (22) from government institutions and two (2) from NGOs.

### **Capability Assessments**

The capability assessment revealed that of the twenty-two Government institutions which responded:

- Six (27%) are involved in mitigation activities
- Thirteen (59%) are involved in preparedness and response stages of the disaster management process and
- Three (14%) are involved in preparedness, response and recovery stages of the disaster management process.

The following were the main conclusions made with reference to Government Agencies:

#### ***(A) Institutional Capability***

Of the twenty-two Government Agencies responding, all stated that there is inadequate institutional capability for dealing with disaster management and, in particular, disaster mitigation.

The following common inadequacies were identified:

- Lack of an appropriate policy framework for disaster management.
- Weak institutional and administrative structures.
- Lack of capability to plan, implement and monitor a disaster mitigation program.
- Ineffective institutional co-ordination systems.
- Inadequate financial and human resources for carrying out disaster mitigation planning and implementation.
- Weak linkages between the Government agencies and the private sector.
- An inadequate information system to facilitate the formulation, development, implementation and monitoring of a mitigation plan.

#### ***(B) Legal Capability***

Legal capability refers to the availability and use of legislation, which enables the Government to engage in various hazard mitigation activities.

Of the twenty-two government agencies responding, only four agencies or 19 % have any legislative mandate to undertake mitigation activities. These agencies are the Development Control Authority, Fisheries Division, Central Board of Health and the Antigua Public Utility Authority.

The findings of the analysis showed that comprehensive legislation that deals with disaster management does not exist. The only piece of legislation that directly refers to natural hazards is the Emergency Powers Act. Under this Act, the Cabinet is empowered after the occurrence of any hurricane, earthquake or flood to declare a state of emergency, and to make orders for securing the essentials of life and for the preservation of the health, welfare and safety of the public. This legislation is inadequate to deal with comprehensive disaster management, as it is limited to disaster response.

Other Acts and Regulations that are pertinent to natural hazard mitigation include:

- the Land Development Control Act No.10 of 1997,
- the Land Development Control Regulation No.20 of 1998,
- the Building Code and Guidelines,
- the Fisheries Act of 1983, the Marine Areas (Preservation and Enhancement Act) Chapter 257, the Marine Restriction Order of 1973 and the Marine Preservation and Enhancement Regulation of 1973, that deal with coastal zones, and
- the Public Health Act (Chapter 353) and Public Health Regulations that deal with such mitigation measures as vector control.

Overall, enforcement of the Acts and Regulations that facilitate mitigation are extremely weak. This is due to:

- 1) The lack of appreciation of the need to include mitigation planning in development decision making.
- 2) The lack of adequate administrative structure and a cadre of trained staff with the knowledge and skill to enforce the Acts and Regulations.
- 3) The absence of land use and zoning regulations that can control the amount, timing, quality and density of new developments. All these characteristic of growth can determine the level of vulnerability of a community in the event of a natural hazard.
- 4) The lack of land use regulations that can be effective in preventing unsuitable development from occurring in hazard-prone areas.

#### ***(C) Political Capability***

The result of the capability survey showed that all Government agencies indicated an interest in disaster management and mitigation activities. However, there is a lack of strong commitment to and support for mitigation activities.

Notwithstanding, the indication of interest by government agencies in disaster management and natural hazard mitigation, the political will and support for these activities are not as strong as are required if the Natural Hazard Mitigation Policy and Plan are to be successfully implemented. The capability of a government is obviously linked to its political capability.

Many of the disaster management activities carried out by officials listed in the institutional framework analysis will be politicians, whose decisions are sometimes swayed by the political climate of the moment rather than by long range benefit to the community. Consequently, there needs to be a heightened awareness of mitigation issues by the political leadership and sustained support and commitment to the mitigation goals.

#### ***(D) Financial Capability***

The capability analysis indicates that there is no specific budgetary allocation to facilitate mitigation and that natural hazard mitigation activities are not integrated into the budgetary process.

The capability analysis reveals that:

- 1) All of the twenty-two Government agencies lacked adequate financial capability to carry out mitigation activities.
- 2) There is no specific budgetary provision made for disaster mitigation.

Notwithstanding the above, the public sector finances are under considerable stress with consistent deficits. It will therefore be extremely difficult to effectively finance mitigation activities that require an expenditure of funds from new budgetary sources.

As a result, it will be necessary for the Government to identify mitigation activities that can be undertaken within existing programs, as well as to forge alliances with the private sector, NGOs to assist in finding resources for mitigation activities. In addition, there is an urgent need for Government to take advantage of inter-national and regional co-operation to benefit from technical assistance, technological transfer and grants and loans where possible.

While it is necessary to have adequate financial resources for Mitigation activities, it must be emphasized that Government should adhere to sound mitigation practices by ensuring that government buildings and infrastructure are designed, constructed and well maintained to ensure their resilience in the face of natural hazards.

***(E) Technical Capability***

An analysis of the responses to the capability questionnaire showed that all twenty-two of the Government agencies indicated there is inadequate technical expertise to undertake mitigation activities.

The following are the main areas in which there are deficiencies in Technical Capability:

- Lack of expertise in Disaster Mitigation Planning.
- Lack of training at various levels in Disaster Management.
- Lack of training to undertake Hazard Assessments and Vulnerability Analyses.

The Details are shown in Appendix V.

*Existing and Future Capability to Mitigate the Impacts of Natural Hazards  
In Antigua and Barbuda*

<b><i>Areas Assessed</i></b>	<b><i>Existing Capability</i></b>	<b><i>Future Capability</i></b>
<i>Institutional</i>	Low	Moderate
<i>Legal</i>	Low	High
<i>Political</i>	Moderate	High
<i>Financial</i>	Low	Moderate
<i>Technical</i>	Moderate	High

The table shows that existing Institutional, Legal and Financial Capabilities are low/weak, while Political and Technical Capabilities attracted a moderate score. On the basis of the analysis above an overall assessment was made of existing and future capabilities to pursue Mitigation Activities. The result of the overall assessment shows that existing capability attracted a low rating. This justifies an intervention to strengthen capability.

The Table also shows improvement in overall future capability. This improvement will only take place if active measures are taken to strengthen capability. The details of this intervention can be found in Chapter IV under Programme Areas Institutional, Capacity Building, Training and Legislation.

***Acceptability/Conclusions***

The Table below is based on the probability, magnitude and vulnerability of individual hazards and the existing and future vulnerability to the hazards. The Table also depicts existing and future capability.

The table shows that hurricanes, storm surges and droughts have the highest probability with increasing frequency and intensity, and also with the highest magnitude /impact. The table also indicates that the islands’ vulnerability to these hazards is high. In the case of drought, Antigua’s vulnerability has somewhat been reduced owing to mitigation measures taken by the installation of the desalination plant. The table indicates that existing capability to respond to these hazards is

low / weak. The table also indicates improvement in capability, but this improvement can only take place if active measures are taken to strengthen capability.

*Capability Assessment Summary Chart*

<b>Hazard</b>	<b>Proba- bility</b>	<b>Magnitude/ Impact</b>	<b>Vulnerability</b>		<b>Capability</b>	
			Existing	Future	Existing	Future
<i>Hurricanes / Storm Surges</i>	High	High	High	Low	Low	High
<i>Droughts</i>	High	High	High	Medium	Low	High
<i>Floods</i>	Low	Medium	Medium	Low	Low	High
<i>Coastal and Stream Inland Erosion</i>	Medium	Medium	Medium	Low	Medium	High
<i>Earthquakes</i>	Low	Medium	Medium	Medium	Low	High

The assessment of capabilities of Government agencies in Antigua and Barbuda revealed the urgent need for strengthening in various areas. There is an awareness of an interest in the need for carrying out mitigation activities, however this awareness could be heightened. There is also the need for increasing the technical capabilities for agencies through training.

### **Mitigation Opportunities**

Many opportunities exist for incorporating mitigation measures into existing programs and activities. Amongst these opportunities are:

- Approve the Draft Physical Development Plan and implement the recommendations contained in the Plan for Land Use Planning and Management
- Modification of development system to guide the types, density, design, timing and quality of development
- Enforcement of development regulations
- Land use zoning in vulnerable areas
- Guide development away from high risk areas
- Enforcement of building codes
- Develop policies and zoning maps
- Institutionalize environmental / coastal zone management, environmental impact assessments
- Serious public education / awareness and information programmes
- Integrate natural hazard mitigation planning into social, economic environmental planning

## Section IV: Plan Formulation

### Mitigation Goals

Four major goals were identified and several objectives were derived from these goals. The four broad areas covered by these goals are:

- 1) Vulnerability Reduction
- 2) Environmental Management
- 3) Public Education and Information
- 4) Institutional Strengthening and Capacity Building

The Plan Goals identified are:

- 1) To reduce the vulnerability of Antigua and Barbuda from the adverse impacts of natural hazards.

Antigua and Barbuda are prone to natural hazards, which have been identified in the plan. Over the last ten years, the economy, environment and critical infrastructure have been adversely impacted with consequential social economic and financial costs. The evidence indicates that the frequency and intensity of hurricanes and tropical storms are on the increase. The hazard and vulnerability analysis indicated that vital critical facilities and lifeline systems are located in vulnerable zones. The purpose of this goal is to reduce the vulnerability of the population, economy and infrastructure from the adverse impacts of natural hazards.

- 2) To protect the features of the natural environment that will aid in the reduction of natural hazards.

Development pressures and neglect have substantially damaged many important elements of the natural environment and threaten continuous destruction and degradation in the future. Many of these features, such as wetlands and mangroves, serve to naturally mitigate the impact of natural hazards. Development impacts on the environment in several ways, including:

- Direct alteration of critical habitat by destroying reefs and mangroves, sand mining and dredging of harbours
- Injection of pollutants into the environment such as fertilizers and pesticides commonly used for agriculture
- Over - exploitation of natural resources such as using beach sand for construction.

The islands' natural resource base is crucial to the future of the economy and its protection should be given high priority in mitigation programmes or policy.

- 3) To promote Disaster Mitigation Awareness in Antigua and Barbuda

Society must be fully aware of its vulnerability to natural hazards and aware of means to reduce their impacts before it will insist upon and support measures to mitigate the impacts and take individual steps necessary to protect lives and property. Generating this level of awareness is perhaps the most challenging task. The public must see hazard mitigation as a basic component of civic responsibility. Techniques for articulating this knowledge in a way that impels action by individuals, private sector organizations must be developed, refined and put into practice.

- 4) To enhance the capacity of the public and private sector to undertake mitigation activities in Antigua and Barbuda.

The capability analysis concluded that institutional capability for disaster management and in particular mitigation is weak. It is imperative that institutional capability and capacity building be given priority attention to ensure the successful implementation of the strategies, plans and programs included in this plan.

## **Objectives and Strategies**

The objectives and strategies to be pursued under the respective goals are as follows:

### **Goal I**

#### **Objectives**

The following are the Objectives to achieve Goal #1:

Objective #1: To protect the major economic sectors of Antigua and Barbuda

Objective #2: To protect infrastructure systems of Antigua and Barbuda

Objective #3: To develop necessary legal systems to support mitigation activities.

Objective #4: To reduce damage to existing and future development of Antigua and Barbuda.

Objective #5: To reduce loss of life and personal injury from hazardous events

#### **Strategies**

To realize the objectives, the strategic approaches will be:

##### Objective #1:

- Ensure that buildings which will accommodate such activities are located in areas which are not susceptible to damage from hazardous events.
- Ensure that buildings which will accommodate such activities are built to the require standards.
- Development of mitigation plans for each sector.

##### Objective # 2

- Develop lifeline systems to the highest possible standards
- Ensure that key lifeline systems are located in the least vulnerable areas.
- Retrofit vulnerable buildings that accommodate infrastructure activities.

##### Objective #3

- Preparation and enactment of Comprehensive Disaster Management Legislation.
- The enactment of Comprehensive Disaster Management Legislation
- That the Draft Physical Planning Act should be approved.
- That all existing legislation pertinent to disaster mitigation should be upgraded and strengthened.

##### Objective #4

- That critical facilities which have been identified as vulnerable should be retrofitted so that they can withstand the impacts of natural hazards.
- Ensure that the Building Code is enforced
- Enforce land use controls
- Build public infrastructure to the required standards i.e. to the requirements of the most up-to-date building codes.
- Ensure that hazard mapping is updated so that there is reliable information about vulnerable areas.

##### Objective #5

- Put in place evacuation measures for communities/population that are at high risk
- Development of warning systems to inform the communities about any events which are likely to occur
- Ensure agencies which need to respond are provided with all necessary equipment.
- Adopt and implement the Shelter Management Policy

## **Goal 2**

### **Objectives**

The following are the Objectives to achieve Goal #2:

Objective #1: To maintain a systematic inventory of environmental areas that are at risk to the effects of hazards

Objective #2: To protect environmental features, which can protect existing and future development from the effects of natural hazards.

### **Strategies**

To realize the objectives, the strategic approaches will be:

#### Objective # 1

- Ensure that a comprehensive information system incorporating mitigation concerns is developed for the environment

#### Objective #2

- Ensure that comprehensive environmental legislation is prepared and enacted for Antigua and Barbuda.
- Development and implementation of an environmental policy which will take into account mitigation measures that will aid in reducing the vulnerability of Antigua and Barbuda to hazards.

## **Goal #3**

### **Objectives**

The Objectives for achieving this goal are:

Objective #1: To empower communities so that they will be able to implement mitigation measures to protect themselves from disasters.

Objective #2: To provide the private sector, NGOs and community groups with skills so that they can routinely implement mitigation measures in any projects which they may undertake.

Objective #3: To ensure that the population is exposed to mitigation concepts from the earliest age.

### **Strategies**

To realize the objectives the strategic approaches will be:

#### Objective # 1

- To develop comprehensive programmes and activities with emphasis on community mitigation
- To assist communities with the development of their mitigation programmes.

#### Objective #2

- Develop comprehensive training programmes for the private sector, NGO's and community groups to increase their technical knowledge.

#### Objective #3

- Ensure that disaster mitigation is incorporated in school curricula at all levels.

## **Goal #4**

### **Objectives**

The following are the objectives to achieve the Goal of Institutional Strengthening and Capacity Building:

Objective #1: To ensure that mitigation planning is integrated into the operations of all government departments and agencies.

Objective #2: To develop and strengthen the institutional capacity of all agencies in Antigua and Barbuda.

### **Strategies**

To realize the objectives, the strategic approaches will be:

#### **Objective #1**

- Institutionalize the National Mitigation Council and the National Mitigation Committee
- Provide agencies which carry out mitigation activities with adequate financial and human resources.
- Appointment of a mitigation planning officer.

#### **Objective #2**

- Expand the mandate the National Office of Disaster Services (NODS) to include disaster mitigation
- Provide NODS with staff trained in mitigation planning and management.
- Establish a national hazard database in collaboration with key agencies.
- Develop a comprehensive training programme in all areas of mitigation so that public agencies can develop their skills.

### **Policies**

An enabling policy framework is essential to support hazard mitigation efforts. To this end, Government will give serious consideration to put in place a number of policies, which will guide mitigation actions. The following are the key policy issues to which attention will be given:

- 1) Physical Plans will take account mitigation planning
- 2) Legislation, which will deal with mitigation, will be put in place so that all aspects of mitigation can be dealt with in a comprehensive manner.
- 3) Public infrastructure should be sited in such a manner that they are not located in vulnerable areas.
- 4) Lifeline systems (e.g. electricity and water) should be constructed to the standards required by the appropriate Building Codes
- 5) That the Building Code be continually be reviewed and updated to ensure that they incorporate new information about required standards.
- 6) Climate Change shall be monitored by the Environmental Division and other relevant agencies so that the information can be included in plan preparation at all levels,
- 7) That the relevant agencies will collaborate in the development of environmental and land policies for the coastal zone.

### **Programs and Projects**

The programs and projects were informed by the results of the hazard and vulnerability assessment. The programs and projects fall under the following headings:

- 1) Policy – The policies included in this plan are to provide an enabling framework for mitigation activities.

- 2) Institutional Strengthening and Capacity Building – The program seeks to strengthen the capability of institutions to plan, implement and manage mitigation programs. It also includes a program for strengthening disaster management capability and physical planning capability. Under this program, training at all levels will be taken to enhance capacity.
- 3) Environmental Management – Environmental degradation makes a contribution to the adverse impacts of hazards. The purpose of this program is to develop and implement a program of environmental protection and management.
- 4) Public Education and Awareness – The purpose of this program is to create awareness of disaster reduction amongst policy / decision makers and communities of the risks posed by natural hazards, and the need to take mitigation measures.
- 5) Legislation – The purpose of this program is to ensure that appropriate disaster management legislations are in place.

The details are shown in the tables in appendix VI.

## **Section V: Phasing and Implementation**

Mitigation planning and implementation is an on-going activity and it is proposed that it should be integrated in the national development planning process. This is in recognition of the need to make the Plan an operational document for periodic review and modification as events dictate. The system will provide an early warning capability to enable the Government to identify instances of failure/bottlenecks to implement policies, programmes and projects and allow for quick corrective response.

In the implementation of the Mitigation Plan, the Government, through its various agencies, will consult regularly with all stakeholders, including the private sector and Non- Governmental Organizations with a view to ensuring its effective implementation. The Mitigation Policy and Plan will find its tangible expression in the work and functions of the Ministries and agencies of Government, the National Mitigation Council, the National Mitigation Technical Committee, the private sector and Non-Governmental Organizations. In the implementation of the projects and programmes, these agencies will be encouraged to strive for high levels of efficiency and cost-effectiveness in the delivery.

### **Commitment and Ownership**

It is recognized that for the Plan to guide programming at sectoral, ministerial and community levels, the following must be in place:

- i) A strong commitment to Mitigation Goals and Activities
- ii) An acceptance of the principles and philosophy of mitigation planning and programming
- iii) An acceptance of the validity of the approach taken to the formulation and development of the Plan
- iv) Integration of Mitigation Planning in the national development planning and the budgetary processes.
- v) A sense of “ ownership ” of the Plan so that it becomes a basic tool for defining and guiding mitigation activities.

Recognizing the need for the above requirements, a National Mitigation Council (NMC) and a National Mitigation Technical Steering Committee (NMTC), made up of members from both the public and private sector and NGOs, were established. The purpose of the Council and the Mitigation Committee was to co-ordinate inputs and responses at the Government agencies/Ministerial and Community level and to review documentation and to inform plan development relative to the production of the plan.

It is proposed that the NMC and the NMTC will be standing institutions to advise on problems relating to implementation and to set in motion plans and systems for monitoring/evaluation and updating of the plan document.

The recommended institutional structure for plan implementation is as follows:

#### ***The National Mitigation Council***

To ensure genuine national participation in mitigation activities, The National Mitigation Council will be maintained. This Council will report to Cabinet through its Chairman, the Minister of Planning and Implementation. The functions of the council are:

- 1) To advise Cabinet on Mitigation Policies.
- 2) To oversee the formulation development and implementation of the Mitigation Policy and Plan.

The specific functions of the National mitigation council are:

- 1) To provide policy guidance on mitigation planning and management for submission to Cabinet through its chairman, the Minister of Planning and implementation. (This arrangement of having the Minister of Planning as Chairman of the NMC reflects the policy commitment to integrate mitigation activities in the national socio-economic development planning process).
- 2) To oversee the implementation of the plan.

In the execution of its role, it is expected that the Council will, among other things, establish a common mitigation language to enable everyone to understand exactly what is to be done. The Council should also encourage Public Awareness throughout the nation through schools, workplace, and media publicity.

It is recommended that the National Mitigation Council should remain in place to provide guidance and direction to agencies for specific planning activities.

#### ***The National Mitigation Technical Steering Committee***

This is a Technical Committee made up of representatives of Government agencies, private sector and NGOs. Its general role is to inform and guide the formation and the development of the Plan, monitor, evaluate, review, and recommend updates of the plan: The specific functions and responsibilities of the Committee are:

- 1) To provide technical support and guidance for the formulation and the development of the mitigation policies and plan.
- 2) To ensure that the plan is implemented.
- 3) To monitor, evaluate, and review the plan to ensure that the said Plan is achieving its goals and objectives, and the programs and projects are implemented. It will also make recommendations for updates to the plan.

#### ***National Office of Disaster Services (NODS):***

The National Office of Disaster Services is the agency with the responsibility for disaster management and for putting in place mitigation measures against national hazards. It will be responsible for co-coordinating the efforts of other national, community and other relevant agencies in the formulation and development and implementation of mitigation strategies and programs within the guidelines of the national mitigation policy and plan. Essentially, the role of NODS is to co-ordinate the planning and implementation process.

As the agency responsible for the co-ordination it is imperative that the legal mandate of NODS be expanded to include mitigation. This will have financial implications for the provision of adequate human resources to include a mitigation officer and supporting office structure and equipment. NODS will organize for periodic monitoring, evaluation, review and updating of the plan that commits agencies to mitigation activities within given time schedules. Although NODS is not an implementing agency, it will be responsible for coordinating the national mitigation effort.

#### ***Government's Disaster Liaison Officers***

The roles of disaster/liaison Officers at Government Ministries and agencies should be expanded to include mitigation. These liaison officers should be senior officers and will be required to be trained.

## **Phasing**

The phasing of the Plan is as follows:

- The plan will be a long-term plan of ten years' duration.
- There will be operational plans of five years duration to fit in with the time scale of the National Development Plan.

## **Implementation Strategy**

The elements of the recommended Implementation Strategy are listed as follows:

- 1) On completion of the Mitigation Policy and Plan (the Master Plan), stake holders, which include Government Ministries and Agencies, the Private Sector, Non-governmental organizations and Community Groups, will be required to prepare their own Mitigation Plan(s) using the Master Plan as a guideline.
- 2) The Technical Committee will monitor the plans and advise the Council.
- 3) The mitigation planning process will be linked with the budgeting process to translate medium term mitigation plan targets into annual programs and projects for public investment.
- 4) Each Government Ministry/agency will include in their Program Budgets resources for mitigation activities.

## **Instruments for Implementation**

The principal instruments for implementing the Natural Hazard Mitigation Policy and Plan are:

- The expenditure budget of Antigua and Barbuda
- The revenue budget including taxation, loans and revenue policies
- Grants and Technical Assistance from external sources
- The annual program of Statutory Bodies
- The legislative program

Each should be compatible with the other to comprise a coherent package of mitigation programs and policies, which are consistent with long term goals and objectives of the Government. In this context, the annual budgetary cycle provides a convenient framework for interactive evaluation and plan modification.

## **Section VI: Evaluation, Monitoring and Updating**

Since the Plan is not a static document, it will be necessary to put in place a System for Monitoring and Evaluation.

To this end the Technical Advisory Committee, in consultation with the Mitigation Council, will develop a process for monitoring and evaluating the progress being made by Antigua and Barbuda to mitigate the impacts of natural hazards.

A system of indicators and benchmarks will be used to monitor progress yearly.

The monitoring and Evaluation System should be designed in such a manner that allows for feedback, effective communication, accountability and transparency. It should also include a system of reporting.

The cycle and rhythm of mitigation plan implementation, monitoring, evaluation, revision and updating require a cadre of trained persons with the requisite skills and expertise in both the private and the public sectors. Consequently, the Government will organize and implement a program for organizational and institutional strengthening to ensure that agencies are making an effective contribution to the planning and implementation process.

## GLOSSARY

### **State of Social Behavior**

#### ***Normal State***

Normal societal behavior; partial or total fulfillment of society's needs.

#### ***Emergency State***

Sudden increase in demand of human and material resources due to the impact or threat of an impact by hazard.

#### ***Disaster State***

Demand on human or material resources due to a hazard exceeds response capability.

#### ***Recovery State***

Society recovers from an event and approaches the pre-disaster state.

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#### ***Hazard***

The event itself or the probability of the event.

#### ***Vulnerability***

The extent to which a community, structure, service or geographical area is likely to be damaged or disrupted by the impact of a particular hazard.

#### ***Risk***

A measure of the expected losses due to a hazard event of a particular magnitude occurring in a given area over a specific time period.

#### ***Hazard Assessment***

The process of estimating the probability of the occurrence of a potentially damaging phenomenon of given magnitude within a specific period of time.

#### ***Disaster Management***

Group of activities performed to manage a potential or existing disaster.

#### ***Disaster Mitigation***

Medium and long-term actions taken prior to the occurrence of a disaster event to reduce or eliminate the adverse effects of the disaster.

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#### ***Land Use***

The broad types of uses that are permitted within specified areas.

#### ***Zoning***

The detailing of the use and intensity of development for specified parcels of land.

***Development Standards***

Site planning, building and engineering standards, which are applied to development proposals to achieve conformity with established land, use policy, building codes and other regulations.

***Capability Assessment***

A determination of the jurisdiction's ability to deal with identified hazards and to identify shortfalls in capability.

***Mitigation Opportunities Analysis***

An examination of assessment of all areas of planning and development activities in order to identify mitigation opportunities.

***Sustainable Development***

A process of social, economic, political and environmental change through which the best use is made of all available resources so that present needs are met without compromising the ability of future generations to meet their own needs.

***Facility Vulnerability Score:  $FVS = (L + V) HPS$***

Where "FVS" is the Facility Vulnerability Score, "L" is the Locational Vulnerability, "V" is the Facility Vulnerability and "HPS" is the Hazard Priority Score.

***TAOS***

The Arbiter of Storms, a quantitative storm hazard computer model.

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## List of Proposals

### **PROGRAMME AREA: Strengthening Legislative Framework and Enforcement**

#### ***Name Of Project: Legislation***

- To create the legal requirements to facilitate Natural Hazard Mitigation.
- To providing an effective legal and regulatory framework to facilitate natural hazard mitigation.

#### **Basis For Action**

- Comprehensive legislation that expressly deals with natural hazard mitigation policy, planning and management in all four stages of the mitigation cycle does not exist. The only piece of legislation that directly refers to natural hazard is the Emergency Powers Act Chapter 148 of the Revised Edition of the Laws of Antigua and Barbuda. Under Sections this Act, the Cabinet is empowered after the occurrence of any hurricane, earthquake, fire or flood to declare the existence of a state of emergency, and to make orders for securing the essentials of life and for the preservation of the health, welfare and safety of the public.
- This legislation is inadequate to deal with disaster management, in that it does not address disaster management, hazard mitigation planning and management in all stages.
- Intervention under this Act is limited to disaster response. The National Office of Disaster Services (NODS), which has responsibility for advancing hazard mitigation, disaster preparedness, and emergency measures through facilitating and coordinating the development and implementation of integrated disaster management systems does not have any legislative mandate.

There are a number of other Acts and Regulations that are pertinent to Disaster Mitigation (natural hazard mitigation). These include the Land Development Control Act No.15 of 1997, the Land Development Control Regulation No. 20 of 1998 and the Building Code and Guidelines.

Other applicable legislation include:

- Fisheries Act of 1983, which requires the Fisheries Division to prepare a fisheries management plan,
- Marine Areas Preservation and Enhancement Act (Chapter 257), the Marine Area Act (Chapter 260), the Marine Restriction Order of 1973 and the Marine Preservation and Enhancement Regulation of 1973, which deal with coastal zone and territorial waters,
- Public Health Act (Chapter 353), Public Health Regulations (Chapter 353) and St. John's City Regulations of 1952, which deal with such mitigation measures as vector control

Existing legislation does not provide for an efficient system for development control and planning or ensure that development is environmentally sustainable.

Overall the enforcement of the Acts and Regulations are extremely weak. Amongst the main reasons are:

- There is a lack of appreciation by policy makers and implementers relating to sustainable development and mitigation policies and management to reduce vulnerability to natural hazard.
- Lack of effective co-ordination
- The existing legal framework in Antigua and Barbuda is inadequate to provide for an efficient system for development control and planning and to ensure that development is environmentally sustainable. A Draft Physical Planning Act and Environmental Impact Assessment Regulations were prepared with assistance from the United Nations and

submitted to the Government of Antigua in April 1998. This proposed legislation incorporates expanded building control and development planning provisions and comprehensive new environmental protections measures in one Act that is designed to facilitate land-use planning and sustainable development.

### **Objectives**

The objective is to create the legal and regulatory requirements to facilitate Hazard Mitigation.

The overall objective is to promote the integration of natural hazard mitigation and environmental and development policies through appropriate legal and regulatory policies, instruments and enforcement mechanism.

### **Strategies For Implementation:**

- The preparation and approval of a Comprehensive Disaster Management Legislation.
- Approval and enactment of the Physical Planning Act and Environmental Impact Assessment Regulations.
- Upgrading and strengthening limited existing legislation pertinent to Natural Hazard Mitigation.
- Substantial strengthening of the Building Code.
- Strengthening of the institutional capacity for enforcement and compliance.
- Dissemination of information by way of Public Awareness Program with a view of informing the public and government agencies of vulnerability to natural hazards, and to get support for the legislative policies in the area of disaster mitigation.
- Facilitating easy access to the building code and guidelines by the Public, in particular to Developers and the Construction Industry, so that the provisions of the Building Code will become well known.

### **Agency Responsible**

The Legal Division with strong inputs by way of consultation with the Ministry Responsible for Disaster Management, and key agencies such as the National Disaster Services, the Development Control Authority, the Environmental Division, the Ministries of Planning, Agriculture and APUA.

### **Requirements For Implementation**

- An Enabling Policy and Legislation framework is in place to facilitate Disaster Mitigation.
- Legislation enacted.
- Strengthening of the Institutional Framework to facilitate enforcement and compliance.
- A vibrant and effective Public Education Program.
- Training of Staff in particular Building Inspectors.
- An appropriate Administrative System.

### **Phasing**

September 2001 - March, 2002

### **Resources Required**

- An adequate trained Cadre of Staff with knowledge of the Legislation and policy framework
- Financial and Human Resources and equipment
- An adequate Budget to key agencies to finance implementation of legislation
- An effective and efficient Information System.

**Key Indicators**

- A Comprehensive Disaster Mitigation Legislation is in place and other legislation pertinent to mitigation is in place
- The extent to which enforcement and compliance has reduced vulnerability to natural hazards.
- Trained Staff is in place to facilitate enforcement.
- The services of a Legal Officer are dedicated to key agencies to assist with the effective implementation of Disaster Mitigation and Environmental Legislation.

**Costing**

The costing of all proposals remains to be completed.

***Name Of Project: Strengthen the Capabilities for Physical Planning*****Basis for Action**

- 1) The government has recently outlined a physical development plan for the City of St. John's in Antigua. The benefits from the development of this plan depend upon proper implementation.
- 2) The current policy and legislative framework for social, economic and environmental planning is weak.
- 3) A commitment is lacking at all levels to environmental, social and economic planning, so as to facilitate sustainable development.
- 4) Inter-agency collaboration to facilitate impact assessments is lacking.
- 5) Most homes were not built to hurricane-resistant standards, while coastal development has been indiscriminant. These actions have placed additional stresses on the island, resulting in increased vulnerability to hazards.

**Objectives**

- 1) To strengthen the physical, economic and environmental management process by:
  - (i) Reducing vulnerability to current and future climate variations by implementing appropriate policies and programs (e.g. building codes and coastal zone management).
  - (ii) Integrating environmental planning with social and economic planning, so as to promote sustainable development initiatives.

**Strategies/Actions**

- Formulation of a national policy for sustainable development, incorporating social, economic and environmental development issues.
- Strengthen the capability of the physical planning unit and related agencies to facilitate the implementation of the physical development plan.
- Improve interagency collaboration to improve impact assessments.
- Review and strengthen physical planning legislation as an integral component of environmental legislation.

## **PROGRAMME AREA: Strengthening Legislative Framework and Enforcement**

### ***Name of Project: Strengthening Institutions***

#### **Basis for Action**

The capability assessment indicated inadequacies in all areas—institutional, technical, political, financial and legal—for comprehensive disaster management and, in particular, mitigation.

#### **Objectives**

To strengthen the institutional capacity of agencies in Antigua and Barbuda to plan, implement and manage disaster mitigation programs.

#### **Strategies for Implementation**

- Plan and implement training course/workshop in mitigation activities
- Formulate a comprehensive national policy on mitigating natural hazards.
- Hazard mitigation planning should be integrated into every stage of the social and economic development planning process. Development project must incorporate sound environmental and hazard management. The most effective approach to reducing the long-term impact of natural hazards is to incorporate natural hazard mitigation activities into the process of integrated development planning and investment project formulation and implementation. It is also recommended that the linkage between physical planning and social and economic planning should be strengthened.
- Integrate natural hazard mitigation planning into the budgetary process.
- Institutionalize hazard mitigation planning
- Assign officer responsible for: 1) mitigation planning, 2) implementation of the plan and the preparation of project proposals, 3) monitoring, evaluation and updating of the plan.
- Expand the mandate of NODS and provide it with an adequate cadre of trained staff
- Institutionalize the National Mitigation Council and the Mitigation Committee and provide them with a solid orientation in mitigation planning
- The preparation and approval of comprehensive disaster management legislation
- Approval and enactment of the Physical Planning Act and Environmental Impact Assessment regulations.
- Upgrading and strengthening the limited existing legislation pertinent to mitigation
- Strengthening of the institutional capacity for enforcement and compliance
- Dissemination of information to inform the public and government agencies of vulnerability to natural hazards.
- Facilitating access by the public and construction industry to the building code and guidelines
- Integrate communities in all aspects of mitigation. Empower communities to act.
- Devise effective targeting of mitigation interventions.
- Establish a national disaster database. Compile statistical data on natural hazards and annual reports on the implementation of the database and the mitigation plan.
- Provide adequate financing and human resources for disaster mitigation.
- Establish regional and international cooperation for technical assistance and technology transfer for hazard vulnerability reduction.

## **PROGRAMME AREA: Environmental Management**

*Name of Project: Environmental Protection*

### **Basis for action**

The environment of Antigua and Barbuda is under serious stress due to unplanned development. Among the main environmental problems are land degradation due to over-grazing by animals, deforestation and coastal mis-management. These man-made factors have increased the vulnerability of the country to natural disasters. For example, over-grazing by livestock increases the vulnerability to drought and flooding. To address these problems, a program of environmental protection and management is required.

### **Objective**

To protect environmental features, which can protect existing and future development from the effects of natural hazards.

### **Strategies**

1. Develop and implement an environmental policy
2. Enact and enforce environmental legislation
3. Integrate environmental planning and management into social and economic planning
4. Develop and implement an environmental plan
5. Strengthen the institutional human resource capabilities to undertake environmental monitoring
6. Determine agency jurisdiction for environmental management
7. Strengthen collaboration, coordination, consultation and dialog among agencies and the private sector to address environmental issues
8. Involvement of community groups in environmental planning and management
9. Leverage community-level expertise in the formulation and monitoring of environmental management plans and programmes.

In light of the importance of tourism to the economy and the fact that this industry is heavily dependent upon a healthy environment, environmental protection and management is central to protecting the economy of Antigua/Barbuda.

## **Program Area: Vulnerability Reduction to Natural Hazards**

### *a) Name of Project: Flood Mitigation*

#### **Basis for Action**

The current concern about flooding in Antigua and Barbuda was prompted by the recent experience of Hurricane Lenny in 1999 when about 460 millimeters of rainfall fell over three days. There was flooding island wide, which was very unusual, for the islands were not considered prone to flooding. Hurricane Lenny was phenomenal and far exceeded the previous maximum amounts as the available records showed.

Flooding of the magnitude that had not previously recorded occurred on the island of Antigua and Barbuda between November 17 and 19, 1999, significantly increasing the awareness of the islands' vulnerability to flooding. This hurricane was one of four that hit that hit the islands since 1995. All were accompanied with significant rainfall that had potential for flooding low lying areas and thus add damage caused by high winds.

For Antigua, extensive flooding is confined to about four regions, all primarily located in the northern half where the majority of the population lives. Two of these regions are of critical importance, the flood plain of Cook Creek Watershed, which is densely populated with basic housing, and the Fitches Creek floodplain, also densely populated and containing important road links to the international airport. The other two areas at Potters Village and Parham also have significant population and are vital to the island's network.

#### **Causal Factors**

Many of the problems are owed to the physical characteristics of the watershed and their flood plains and the inadequacy of natural drainage channels. Poor infrastructure design, construction and infrequent maintenance serve to exacerbate the flooding. Additionally, there are pressures for developing for housing in floodplains that, if unchecked, have potential for increased runoff and more severe flooding in these areas.

#### **Barbuda**

In Barbuda, run off generally occurs rapidly due to its very thin soils depths and predominantly limestone surface that provide very little infiltration and relatively low flow retardation. Its watersheds are primarily undeveloped with scrubby vegetation covering most of the area. No rivers and few gullies exist and therefore runoff occurs mainly as sheet flow. Runoff accumulates in depressions; otherwise it may flow into Codrington, the main town, on its way to be discharged in the salt ponds and the sea.

The roads appear to function as drains and just north of Codrington where several roads merge, runoff is concentrated there from a catchments area of about 20km<sup>2</sup>. This area, noted to have suffered worst from hurricane Lenny, contains several abandoned quarry pits whose limestone lining has become blocked with a thin impenetrable soil layer. Water collected from these pits from runoff would remain impounded for several days to weeks owing to slow infiltration rates of the lining. Drainage infrastructure is minimal, consisting of small box drains and small circular culverts throughout Codrington.

#### **Objectives**

To reduce the vulnerability of population and the biophysical environment to the negative impacts of flooding.

### **Strategies**

- 1) Re-valuation of the hydraulic structures within the drains and creeks to determine their capacity for conveying the design run-off. The required capacity of the structures varies depending on the importance of the lands drained. Culverts and bridges on major roadways should be able to carry the 1 in 25 year runoff.
- 2) In the design and construction, preference should be given to free spanning structures, as opposed to ones with closely spaced piers, so as to reduce the chances of debris being entrapped in the small opening.
- 3) Frequent maintenance of the drains, creeks and hydraulic structures also will assist in reducing the likelihood of a flood, or at least it would reduce the severity of it.
- 4) Land Use plans have to be mindful of the potential damage due to flooding and wherever possible desist from approving housing developments within flood prone areas.
- 5) Setback distances from the drains should be established and enforced.
- 6) Cleaning and clearing of drainage systems.
- 7) Use of agronomic practices to prevent sedimentation.
- 8) Utilization of Hazard Mapping and GIS as tools to assist mitigation by planners and to inform and sensitise the public of flood prone areas.
- 9) Prevent/avoid built development in flood prone areas.

### **Requirements For Implementation**

- 1) Human Resources: (1) Water Resources Engineer
- 2) Technical Expertise in Hydrology and Hydraulics
- 3) Engineers with knowledge and experience in the design, construction and maintenance of roads and drainages with the capacity to accommodate run-off from expected events.
- 4) Adequate rainfall and other climatic data to assess frequency and intensity and magnitudes of flooding.
- 5) Continuous monitoring to assess the potential impact of flooding.
- 6) Finally, available and adequate financial and human resources.

### **Agency Responsible**

- Ministry of Public Works
- Ministry of Agriculture
- Development Control Authority
- Antigua Public Utilities Authority
- Community Based Organizations

### **Recommendation for future work (from the Antigua/Barbuda Flood Hazard Assessment)**

To improve flood hazard mapping, the following are required:

- 1) Make available or collect daily rainfall data from at least one other site on the island, preferably with the northeastern region.
- 2) Establish an automatic rain gauge site, perhaps at the airport, to obtain site evidence of the temporal distribution of rainfall on the island.
- 3) Establish a continuous recording rain gauge at Jolly Hill, with periodic evaluation of the statistical properties of the database, to determine the return periods of specific 24-hour rainfall events.
- 4) Establish at least one crest gauge within each major flood plain of concern.
- 5) Undertaking of detailed surveying of Cook Creek and its flood plain at 25-meter intervals at every major change of feature within the creek and undertake extensions of such detailed work to other flood plains identified in the maps as needed.
- 6) Train Public Works and/or NODS personnel to apply HEC-1 HEC-RAS or similar programs for updating the flood hazard maps when additional information becomes available.

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## ***b) Name of Project: Drought Mitigation***

### **Basis for Action**

Amongst the specific water resources issues in Antigua and Barbuda are:

- 1) Water resources scarcity: Available fresh water resources including the desalination capacity is currently about 220m<sup>3</sup> per person per year, which falls far below the common benchmark for water scarcity of about 1000m<sup>3</sup> per person per year.
- 2) High seasonal and inter-annual variability: Antigua and Barbuda are tropical with highly variable inter-annual variations in precipitation. Most of the rainfall is received with severe intensity during the rainy season (July –December)
- 3) High exposure of watersheds to stress and pollution. The major watersheds are exposed to a number of economic systems (crop and livestock production, human settlements etc.) that can cause the water capacity to be stressed and polluted.
- 4) The fresh water resources of Antigua and Barbuda are currently under strain from population growth and economic expansion as well as the current climate variability.

### **Inadequate Reservoir Design and Catchment Management**

Many of the water storage structures are not holding water effectively due to improper design and management. Some of these watershed management problems include employing bad farm techniques, such as slash and burn practices, planting up and down excessive sloping areas, and indiscriminate cutting of trees for charcoal burning.

### **Drought**

Drought is a recurrent feature of Antigua and Barbuda's climate. It occurs when there is an extended period of deficiency in rainfall relative to what is considered normal. Environmental, hydrological, human and land use factors also contribute to vulnerability of droughts.

In Antigua approximately 50% of the existing agriculture and grazing areas are located in high and very high vulnerability zones, as are the communities of Coolidge, Pigotts, Potters and Falmouth. Roughly the southern two thirds of Barbuda, including Codrington and key facilities, are within the area of high vulnerability. Sand mining has polluted the aquifer, increasing salinity. The intervals are shortening between droughts and the effects are exacerbated by overgrazing, high demand by tourist industry, water seepage from mains, inadequate water storage capacity (surface and cisterns); also by improperly managed watersheds, land use and agricultural practices that curtail crop production and/or causes high production cost through mains water being used for irrigation. Lack of policy and legislation further aggravates the situation.

### **Major Issues**

- Overgrazing is the primary contributing factor to Antigua and Barbuda' vulnerability to drought. Trends in vegetation, habitat and landscape degradation are key factors contributing to the country's vulnerability to drought.
- Meteorological Data: A nation-wide network of meteorological stations is required to collect data and monitor rainfall, evapotranspiration, relative humidity to build the country's database for informed analysis and decision-making.
- Vegetation Classification Mapping: Existing vegetation data is inadequate for drought management.
- Agricultural Water Storage Infrastructure: There is an imbalance in the distribution of agricultural storage reservoir and ponds.
- Portable Water: The current water rationing indicates that desalinated water has reduced but has not eliminated vulnerability to drought.
- A number of hotels have installed reverse osmosis plants and have become less vulnerable to drought. Most hotels, guesthouses and villas still depend on the Antigua Public Utilities

Authority for most of their potable water supply. Properties without the capacity to produce most of their potable water supply are still affected by drought rationing. There is need to carry out a survey to determine the extent of vulnerability to drought in the vital tourism sector.

- Water conservation practices by hotels are limited to the use of water saving toilets and showerheads.
- There is considerable wastage of water on hotel properties due to leaks, poor irrigation practices, absence of a reliable level of wastewater treatment plants to allow for reuse for landscaping and failure to meter water for different major property uses so as to detect waste.
- The relatively high cost of producing desalinated water, compared to ground water and surface water, is major constraint to a water supply that would not be affected by variable rainfall.
- In Antigua water is frequently lost to leaks from supply mains due to lack of repairs and a programme of preventive maintenance.
- Although most building supply stores carry water saving toilets, showerheads and faucets, there has been no national water conservation programme that targets households.

### **Barbuda**

In Barbuda major ground water aquifer has been affected by sand mining activity.

Although a large proportion of households in Barbuda is without mains connection, vulnerability to drought is reduced by extensive nature of ground water resources on the island. However water from wells is often brackish and risks contamination by virtue of their location relative to septic tanks and soak ways.

Water quality is therefore a critical issue particularly in droughts when cistern water is not available for cooking and drinking.

A reverse osmosis plant that was to ensure a more reliable supply of potable water was proposed by APUA in 1996. This plant was rejected by residents because water from the plant would have been dumped in the Codrington lagoon.

### **Objectives**

To reduce the vulnerability of Antigua and Barbuda to the adverse impacts of Drought.

### **Strategies**

A. Develop and Implement a National Programme of Water Conservation.

Water conservation at the household level should include:

- Installing a displacement device that reduces the water a toilet tank uses, smaller toilet tanks, using low faucets, self-shut of taps.
- Allowing lawns to grow one or two inches
- Washing vehicles with water in buckets
- Retrofitting of old building with specific devices for water conservation
- Use of water saving /conservation fitting should be made mandatory in new buildings. It should also be mandatory for cisterns to be constructed with new residential properties.

In support of these mitigating measures, Government may consider giving incentives to the public for installing special fittings /devices for water conservation and for the construction of larger tanks/cisterns so that additional water is available during dry spells.

In the Tourism Sector, hotels should:

- Install reverse osmosis plants to endure a reliable source of water during drought and recycled water/grey water for irrigation purposes as well as using other devices for conservation of water.
- Take stringent measures to eliminate or reduce water wastage at hotel properties due to leaks.

**B. Waste Minimization:**

APUA should repair/replaces leaking pipes and institute a programme of preventive maintenance.

**C. Improved Livestock Management Practices**

This requires control and reduction of the significant number of free-ranging goats.

**D. Soil and Water Conservation in the Agricultural Sector**

The use of mulching techniques and water-conserving irrigation is to be encouraged. The Ministry of Agriculture is to prepare a mitigation plan for the sector.

**E. Redesign of water catchments and construction of additional water storage facilities like ponds and dams for the agriculture sector,**

**F. Rehabilitate and maintain water catchments.**

**G. Avoid pollution of water catchments**

Clearing of debris from ghauts and protection of watercourses are necessary and need to be undertaken with a multi-sectoral approach.

**H. Forest and ground cover to be planted to maintain watersheds and water moisture.**

**I. Meteorological Data**

A nation-wide network of meteorological stations be installed to collect data and monitor rainfall, evapo-transpiration, relative humidity etc, to inform the country's database for informed analysis and decision-making.

**J. Public Information Programme**

The highest priority should be given to the preparation and implementation of a public information and awareness programme to sensitize and involve the nation in drought mitigation.

**K. Barbuda**

For Barbuda the following are the main strategies:

- Prevent Sand mining in the major groundwater aquifer
- Land Use Practices to avoid water sources from becoming contaminated due to their location relative to septic tanks and soakways
- Water Conservation
- Re-visit the proposal for the installation of a Reverse Osmosis Plan

***C) Integrated Water Resources Management***

**Purpose**

- 1) To mobilize and build capacity within the public and private sector for cross-sectoral water resource management;
- 2) To analyze and update, where necessary, the legal and regulatory framework;
- 3) To build awareness across society of the importance of conserving and managing water resources;
- 4) To ensure participation of civil society as stakeholders in water resource management;
- 5) To develop appropriate water resource monitoring systems and information services;

**Strategies/Actions:**

- 1) Identify key issues constraining effective water resource management by analyzing the issues, identifying possible solutions and recommending options for implementation;
- 2) Design and implement a National Program for public consultation and awareness training in water resource management;
- 3) Implement an integrated water resource management and planning program utilizing appropriate policies and strategies developed through consultation.

**Requirements For Implementation**

- Human Resources : Water resources planner, engineer and other relevant personal for Integrated Water Resources Management
- Establishment of multi-sectoral water resources planning and management committee
- Continued hazard and vulnerability assessments.
- Use Of GIS to delineate areas prone to Drought
- Technical Assistance and Institutional and Capacity Building
- Formulation and Implementation of National Water Policy
- Adequate financial investment and human resources.

**Agencies Responsibility**

- Antigua Public Utility Authority
- Development Control Authority
- National Office of Disaster Services
- Public Works
- Ministry of Agriculture
- Ministry of Planning
- Legal Affairs.
- Community Based Organizations

**Phasing**

The Integrated Water Resources Management Project should take at least five years to complete. However, it is recommended that the low cost proposals (non-structural in the main) with effective mitigation benefits be immediately implemented immediately.

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***C) Name of Project: Coastal Zones*****Strategies/ Actions**

To establish an Integrated Coastal Management Plan. Such a plan should consider the following:

- Developments in coastal zones being subjected to an environmental impact assessment (EIA)
- Compilation of an environmental/coastal database to include resource availability and usage, mapping and monitoring; such a database is to be continually updated.
- Strengthening institutional capabilities for coastal zone management.
- Promoting capacity building, by way of training in key agencies, so as to increase technical and administrative capabilities in areas such as enforcement and regulatory measures.
- Establishment and management of marine reserves and protected areas for identified critical coastal habitats and resources in Antigua and Barbuda.

These areas should be directed towards preservation and enhancement of selected habitats for recreation, tourism, education and science as well as maintaining biological diversity and ecological process.

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#### **D) Name of Project: *Mitigating Inland Erosion***

##### **Objectives**

To reduce the vulnerability and damage caused to population, property and the environment from rain-induced and wind erosion.

##### **Strategies**

- 1) Plan adequate drainage
- 2) Develop and implement integrated land use management with the National Physical Development Plan
- 3) Retain windbreaks; avoid large areas of exposed soil; use vegetation strips.
- 4) Conserve and maintain soil fertility
- 5) Plant shelter beds, ground cover and reforest vulnerable areas particularly upland slopes and watershed
- 6) Compile and maintain database to guide planning for sustainable development
- 7) Owners in highly vulnerable areas, that are at high risk, or whose property compounds the problem of erosion, be assisted to modify and or prepare emergency plans
- 8) Mitigation of mass movement induced problems Monitor and avoid areas that are Provide cut off drains Uses stabilizing techniques
- 9) Keep drainage ways clean of impediments - do not fill with solid waste etc.
- 10) Avoid using potentially endangered land for permanent structures

##### **Requirements for Implementation**

- 1) National Physical Development Plan with sustainable development standards and guidelines ratified
- 2) Legislation and enforcement to ensure conformity to the standards and guidelines ratified for land use management to mitigate erosion and landslides
- 3) Inventory of capabilities
- 4) Continue Studies to develop Data Bases on rainfall, land use and other environment Data
- 5) Strengthening of institutional capabilities for training
- 6) Allocation of Human resources with the requisites training and expertise in the area of inland flooding, design and constructions of drainage systems and culverts, soil and water conservation
- 7) Allocation of personnel and equipment to carry out the strategies

##### **Agency Responsible**

- 1) Development Control Authority
- 2) National office of Disaster Services
- 3) Ministry of Agriculture -Forestry and Extension Division
- 4) Public Works
- 5) Antigua Public Utilities Authority
- 6) The Environmental Division
- 7) Farmers Organizations

##### **Phasing**

Phasing will be included after details for implementation are finalized.

##### **Key Indicator**

- 8) Policy and legislative Framework in place for inland flood mitigation
- 9) Capability Exist for Inland Erosion
- 10) Drainage, road construction and regular maintenance in place to mitigate inland erosion.

## **Program Area: Disaster Management**

### ***Name of Project: Strengthening Natural Disaster Management***

#### **Basis for Action**

- Antigua and Barbuda is vulnerable to natural hazards (hurricanes, drought and surges) as was seen over the last decade when the islands were ravaged by a number of hurricanes.
- The global warming phenomena are accelerating the rate of climate change that is increasing the frequency and intensity of hurricanes and sea level rise.
- Despite the considerable achievements made in disaster responsiveness in Antigua and Barbuda, there is still the urgent need for strengthening capacity in order to respond to the anticipated increase in frequency and intensity of natural disasters.

#### **Disaster Management**

Notwithstanding that considerable progress has been made in disaster preparedness and response, over the last decade disaster risk levels have increased as development has intensified and the frequency and intensity of natural hazards has increased. It is imperative that there should be a paradigm shift from disaster preparedness to a holistic and comprehensive approach to disaster management and planning.

#### **Objectives**

The overall purpose of this proposal is to strengthen Antigua and Barbuda's disaster management capabilities to cope with the adverse effects of natural hazards.

- 11) To assist the Government of Antigua and Barbuda in strengthening its Disaster Preparedness and Management capabilities through the establishment of a holistic management plan.
- 12) To reduce the vulnerability of the population, social and economic activities and the biophysical environment to natural hazards/disasters including hurricanes, droughts, floods, storm surges and sea level rise through an effective, holistic and comprehensive Disaster Management System.

#### **Strategies/Actions**

- Discuss and develop an effective hazard/mitigation policy and operational plan.
- Strengthen relevant agencies particularly NODS and the Meteorological Office by increasing logistical communication and technical capacity with provision for adequate financial resources.
- Expand NODS' mandate and provide it with appropriate legislative authority.
- Strengthen the professional and technical staff with appropriate training.
- Establish a disaster management database.
- Encourage greater participation of sectoral and community groups in disaster management support building on some of the excellent work done by the Red Cross and others.
- Improve communication links, especially radio, to provide effective early warning bulletins.
- Strengthen disaster services capability to factor risk considerations into disaster planning.
- Develop and utilize hazard mapping so as to effectively target vulnerable communities and natural resources.
- Establish a comprehensive National Emergency Shelter Policy incorporating relevant infrastructure and programs. Included should be appropriate training for emergency and shelter managers.
- Develop and implement educational programs that target safe building practices coupled with effective insurance guidelines.
- Upgrade or provide meaningful facilities and equipment for NODS.

- Improve cooperation and collaboration between the private and public sectors.
- Encourage strong community participation.
- Provide adequate financial and human resources from both public and private sector.
- Strengthen the investigative and scientific capabilities to understand the types of hazards, the causes and what mitigation options are available. Scientific exchanges with other organizations involved with similar work should be encouraged.

**Program Area: Vulnerability Reduction**

*Name of Project: Mitigation Proposals for Human Settlements and Tourism Sectors*

**Basis for Action**

Human settlements and tourism sectors have been adversely impacted by natural hazards, particularly hurricanes, storm surges and droughts.

**Objective**

To reduce the vulnerability of human settlements and the tourism sector to the impacts of natural hazards.

**Strategies**

To achieve the objective, the following strategies will be pursued:

*Hazard Mapping*

- Use hazard maps to identify/delineate those areas that are vulnerable to the adverse impacts of natural hazards

*Flood Control*

- Ongoing cleaning of watercourses and drains, and the prevention of filling of natural drainage systems
- Implement land use controls and enforcement, including zoning regulations, which are legal regulations that demarcate specific areas for different types of land uses; building codes, planning and infrastructure standards; and setback requirements for the coastal zone.
- Retrofit existing structures. Refurbish and retrofit old structures to bring them up to standard and strengthen their resilience to the effects of natural hazards
- Build capacity for environmental planning and mitigation against natural hazards
- Improve the existing forecasting and early warning systems
- Further develop a public information and awareness program.

## Appendix I: Damage from Hurricane Lenny

### *Damage from Hurricane Lenny (Agricultural Sector of Antigua)*

Description	Damage	Estimates (US\$)
Miles of farm road	80 km	2,962,960
Water storage loss (siltation)	714,290 million m <sup>3</sup>	571,850
Water storage loss (damaged dams)	71,430 m <sup>3</sup>	280,000
Acres silted	30 ha	
Number of ponds silted	400	74,074
Dams & overpasses damaged	10	111,100
Soil loss from farms	40	1,111,200
Vegetable loss (early planted)	180	20,370
Vegetable loss (standing crop)	60	185,185
Fruit:		
Pineapple	2	7,965
Banana	8	16,320
Mango/citrus	2	37,040
Housing & Fencing	1,000	11,100
Animal loss:		
Small ruminants	200	22,200
Large ruminants	25	13,900
Swine	110	12,200
Poultry	5,600	51,850
Number of farm workers affected	2,700	
Number of farm families affected	1,400	

Source: Ministry of Agriculture, Lands & Fisheries (1999 preliminary assessment)

## Appendix II: Composition of the National Mitigation Council and Committee

*The Composition of the National Mitigation Council and the National Mitigation Technical Committee*

<b>Group 1: National Mitigation Technical Committee</b>	<b>Group 2: National Mitigation Council</b>
<ol style="list-style-type: none"> <li>1. Environmental Awareness Group (EAG)</li> <li>2. Disaster Committee – Commissioner</li> <li>3. Engineering and Contractors Association</li> <li>4. Ministry of Public Works</li> <li>5. IT Specialist</li> <li>6. Hotel Association</li> <li>7. Ministry of Legal Affairs</li> <li>8. Transport Board</li> <li>9. A.P.U.A.</li> <li>10. NGO – e.g. Red Cross</li> <li>11. Ministry of Agriculture and Fisheries</li> <li>12. Insurance – Private Sector</li> <li>13. D.C.A.</li> <li>14. Unions</li> <li>15. Christian Council (Church Groups/Assocs.)</li> <li>16. Tourism</li> </ol>	<ol style="list-style-type: none"> <li>1. A.P.U.A. – General Manager</li> <li>2. A Private Sector Organization (e.g. A.H.T.A.)</li> <li>3. Tourism – Permanent Secretary (P.S.)</li> <li>4. Agriculture – P.S.</li> <li>5. Public Works – P.S.</li> <li>6. NGO – e.g.: S.Y.N. (Something U Need)</li> <li>7. Ministry of Health – P.S.</li> <li>8. Secretary of Defense Council</li> <li>9. D.C.A. – Town &amp; Country Planner</li> <li>10. Transport Board – General Manager</li> <li>11. Barbuda Council – Secretary</li> </ol>

### Appendix III: Antigua- Facilities by Type and Hazard FVS

TYPE	NAME	ADDRESS	Shelter	Beach	Surge	Waves	Wind	Inland	Drought	Flood	
Airport	V.C.BIRD INTERNATIONAL AIRPORT	Coolidge	0			0	42		2	25	9
Bridges	BENDALS BRIDGE	BENDALS	0			0	6		0	5	12
	BIG CREEK BRIDGE	VALLEY ROAD	0			0	6		2	5	6
	FOLLEY GUT BRIDGE	FOLLEY'S	0			0	12		2	5	15
	GILBERT'S BRIDGE	GILBERTS	0			0	12		2	15	15
	NORTH SOUND BRIDGE	NORTH SOUND	0			0	12		4	5	21
	ADVENTIST CHURCH	URLINGS	1			0	30		0	10	3
Churches	ADVENTIST CHURCH	GLANVILLES	1			0	24		0	15	3
	ADVENTIST CHURCH	BENDALS	1			0	24		2	5	3
	ADVENTIST COMMUNITY CENTRE	LIBERTA	1			0	18		8	5	3
	ANGLICAN CHURCH	PARHAM	1			0	18		2	15	3
	ANGLICAN SERVANTS QUARTERS	ST. PHILLIPS	1			0	30		2	15	3
	BAXTER METHODIST CHURCH	ENGLISH HARBOUR	1			0	30		6	20	3
	CASSADA GARDENS METHODIST	CASSADA GARDENS	1			0	30		2	20	3
	CEDAR GROVE ADVENTIST CHURCH	CEDAR GROVE	1			0	30		2	20	3
	CEDAR GROVE WESLEYAN HOLINESS	CEDAR GROVE	1			0	30		2	20	9
	CHURCH OF CHRIST	BENDALS	1								
	CHURCH OF GOD PROPHECY	COOKS HILL	1			0	0	24	8	5	3
	FIVE ISLAND MORAVIAN CHURCH	FIVE ISLAND	1			0	0	24	8	15	3
	FIVE ISLANDS SHILOH CHURCH	FIVE ISLANDS	1			0	0	24	2	15	3
	FORT ROAD ADVENTIST CHURCH	FORT ROAD	1			0	0	30	4	20	3
	FREEMAN'S VILLAGE METHODIST	FREEMAN'S VILLAGE	1			0	0	30	6	15	3
	GRACE APOSLOTIC CHURCH	LOVELACE ROAD	1			0	0	30	4	20	3
	GRAYS HILL PENTECOSTAL	PERRY BAY	1			0	0	24	0	20	3
	GREEN BAY NAZARENE CHURCH	GREEN BAY	1			0	0	24	2	20	3
	JEVHOVAH WITNESS KINGDOM HALL	GAMBLES TERRACE	1			0	0	24	4	20	3
	JOHN HUGHES METHODIST CHURCH	JOHN HUGHES	1			0	0	36	8	5	3
	LOVELACE ADVENTIST CHURCH	LOVELACE ROAD	1			0	0	24	0	20	3
	METHODIST CHAPEL	BETHESDA	1			0	0	36	2	15	3
	METHODIST CHAPEL AND HALL	PARHAM	1			0	0	36	2	15	3
METHODIST HALL	FREETOWN	1			0	0	24	2	15	3	

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TYPE	NAME	ADDRESS	Shelter	Beach	Surge	Waves	Wind	Inland	Drought	Flood		
Churches	MOUNT OF BLESSING CHURCH	WIRELESS ROAD	1		0	0	30		2	20	3	
	NAZARENE CHURCH	VILLA	1		0	0	36		0	20	3	
	OLD ROAD ANGLICAN CHURCH	OLD ROAD	1		0	0	36		0	10	3	
	PERRY BAY PEOPLE CHURCH	PERRY BAY	1		0	0	24		2	20	3	
	PILGRIM HOLINESS CHURCH	NEW WINTHROPES	1		0	0	24		2	20	3	
	SEVENTH DAY ADVENTIST	NEW WINTHROPES	1		0	0	30		2	20	12	
	SEVENTH DAY ADVENTIST	PIGOTTS	1		0	0	24		0	20	12	
	SHILO GOSPEL HALL	ST. JOHNSON	1		0	0	30		2	20	3	
	ST. JOHN'S CHURCH OF CHRIST	GOLDEN GROVE	1		0	0	30		4	5	3	
	ST. JOSEPH ANGLICAN CHURCH	URLINGS	1		0	0	30		0	10	3	
	ST.MARKS	PIGOTTS	1		0	0	30		4	20	3	
	TINDALE ADVENTIST CHURCH	VALLEY ROAD	1		0	0	30		8	5	3	
	VILLA BETHEL CHURCH	VILLA	1		0	0	30		0	20	3	
	VILLA ST. ANDREW'S CHURCH	VILLA	1		0	0	30		4	20	3	
	WESLEY HOLINESS	BOLANS	1		0	0	24		6	10	3	
	ZION CHURCH OF GOD	VILLA	1		0	0	30		0	20	3	
	Clinics	ALL SAINTS HEALTH CENTRE	A I Saints	0		0	0	30		8	5	3
		BENDALS CLINIC	Bendals Rd.	0		0	0	30		2	5	3
		BETHESDA CLINIC	BETHESDA	0		0	0	12		2	15	3
		BISHOPGATE STREET CLINIC	ST. JOHN'S	0		0	0	12		0	20	3
BOLANS CLINIC		Bolans Village	0		0	0	24		8	10	3	
CEDAR GROVE CLINIC & CRES		Cedar Grove	0		0	0	30		2	20	3	
CLARE HALL & ST. JOHNSON'S VILLAGE		Clare Hall Village	0		0	0	18		4	20	3	
COBBS CROSS CLINIC		Cobbs Cross Villag.	0		0	0	30		2	20	3	
FREETOWN CLINIC		Freetown	0		0	0	30		2	15	3	
GRAYS FARM HEALTH CENTRE		Grays Farm	0		0	0	30		2	20	3	
JENNINGS CLINIC		Jennings	0		0	0	18		2	10	3	
JOHN HUGHES CLINIC		John Hughes	0		0	0	36		0	5	3	
JUDGES HILL CLINIC		Judges Hill	0		0	0	30		2	20	3	
LIBERTA CLINIC		Liberta	0		0	0	30		2	5	12	
NEWFIELD CLINIC		NEWFIELD	0		0	0	36		2	5	3	
OLD ROAD CLINIC		Old Road	0		0	0	36		0	10	3	
OTTOS NEWTOWN CLINIC		Ottos New Town	0		0	0	6		4	20	3	
PARES CLINIC		Pares Village	0		0	0	36		2	15	3	
PARHAM CLINIC		Parham Village	0		0	0	36		2	15	3	

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TYPE	NAME	ADDRESS	Shelter	Beach	Surge	Waves	Wind	Inland	Drought	Flood	
Clinics	PIGOTTS CLINIC		0		0	0	12		4	20	3
	POTTERS CLINIC & COMMUNITY	Potters main Road	0		0	0	30		8	5	3
	ST. JOHN'S HEALTH CENTRE	BROWNS AVENUE	0		0	0	6		0	20	3
	ST. JOHN'S HEALTH CENTRE	All Saints d.	0		0	0	36		0	10	3
	SWEETS CLINIC	Sweets Village	0		0	0	36		4	5	3
Community	WILLIKIES CLINIC	Wilikies	0		0	0	30		2	15	3
	ADVENTIST CHURCH	BOLANS	1		0	0	24		2	10	3
	CATHEDRAL CULTURAL CENTRE	ST. JOHN'S STREET	1		0	0	30		0	20	12
Electricity	COMMUNITY CENTRE	YORKS	1		0	0	24		4	20	3
	CASSADA POWER STATION	BARNES HILL MAIN	0		0	0	48		2	20	12
	CRABS POWER STATION	CRABBS	0		0	0	48		0	15	9
Fire	FRIARS HILL POWER STATION	FRIARS HILL ROAD	0		0	0	42		4	20	18
	ALL SAINTS FIRE STATION	All Saints	0		0	0	36		8	5	3
	ST. JOHNS FIRE STATION	Factory Rd.	0		0	0	42		0	20	9
Government	V.C. BIRD FIRE STATION	Airpo t, Fire Station	0		0	0	30		2	20	3
	AGRICULTURE EXTENTION OFFICES	Valley Rd.	0		0	0	30		0	20	3
	ALLIANCE FOR SOCIAL WELL BEING		0		0	0	36		0	20	3
	ANTIGUA & BARBUDA TRANSPORT	Factory Road	0		0	0	24		4	5	3
	APUA MAIN ADMINISTRATION OFFICE	CASSADA GARDENS	0		0	0	24		2	20	3
	BOARD OF EDUCATION	North Street	0		0	0	24		0	20	3
	CENTRAL HOUSING & PLANNING	All Saints Rd.	0		0	0	24		0	20	3
	CLARENCE HOUSE	English Harbour	0		0	0	36		0	20	3
	CUSTOMS & EXCISE DEPARTMENT	Church St.	0		0	0	30		0	20	3
	DEPARTMENT OF COOPERATIVES	Upper High Street	0		0	0	24		0	20	3
	DEPARTMENT OF TOURISM	Nevis Street	0		16	3	24		0	20	3
	ESTABLISHMENT	Redcliffe St.	0		0	0	18		0	20	3
	FREE TRADE ZONE	COOLIDGE	0		0	0	24		2	20	3
	GENDER AFFAIRS (Craft)	Cross Street	0	2	0	1	24		2	20	9
	GENERAL POST OFFICE	High & Long St.	0		12	0	36		0	20	12
	GOVERNMENT OFFICE COMPLEX	Queen Eliz. Hgh.	0	4	0	2	18		8	20	3
	GOVERNMENT PRINTERY	Factory Rd.	0		0	0	42		4	20	9
	GOVERNMENT WORKSHOP	Factory Road	0		0	0	36		4	20	3
	GOVERNMENT WORKSHOP OFFICE	Factory Road	0		0	0	30		8	20	12
	H.C. GRANT BUILDING	ST. JOHN'S	0		8	0	24		0	35	12
	HEALTH EDUCATION UNIT	Factory Rd.	0		0	0	36		6	20	3

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TYPE	NAME	ADDRESS	Shelter	Beach	Surge	Waves	Wind	Inland	Drought	Flood		
Government	HEALTH INFORMATION DIV. / AIDS	Cemetery Road	0		0	0	24		4	20	3	
	HIGH COURT		0		0	0	42		6	20	9	
	HUMAN RESOURCES CENTRE	Factory Rd.	0		0	0	30		6	20	3	
	IMMIGRATION DEPARTMENT	Old Parham Rd.	0		0	0	24		4	20	3	
	INDUSTRIAL COURT	Redcliffe St.	0		0	0	30		0	20	3	
	INLAND REVENUE	Newgate St.	0		0	0	24		0	20	3	
	JOB PROGRAMME	Factory Rd.	0		0	0	30		4	20	9	
	MAGISTRATE COURT	Nevis Street	0		0	0	24		0	20	3	
	MIN. AGRIC., LAND & FISHERIES	Nevis Street	0		0	0	30		0	20	3	
	MIN. COMMERCE, INDUSTRY,	Corn Alley	0		0	0	24		0	20	3	
	MIN. OF JUSTICE & LEGAL AFFAIRS	Redcliffe Street	0		0	0	24		0	20	3	
	MIN. OF LABOUR (HEADQUARTERS)	Redcliffe St. & Corn	0		0	0	18		0	20	3	
	MIN. OF TOURISM & ENVIRONMENT /	Queen Eliz. Hgh.	0		0	0	30		4	20	9	
	MINISTRY OF AGRICULTURE		0		0	0	42		8	5	12	
	MINISTRY OF EDUCATION	Church St.	0		0	0	48		0	20	9	
	MINISTRY OF PLANNING	Church St.	0		0	0	18		0	20	3	
	MINISTRY OF PUBLIC WORKS	ST. JOHN'S STREET	0		0	0	36		0	20	3	
	NAT. DRUG MONEY LAUNDERING CO.		0		0	0	24		0	20	3	
	NATIONAL OFFICE OF DIASTER	American Rd.	0		0	0	36		4	5	3	
	OLD ADMIN. MIN. OF FINANCE	High & Long St.	0		16	0	30		0	20	12	
	OMBUDSMAN OFFICE	Deanery Lane	0		0	0	30		0	20	3	
	PARLIAMENT BUILDING	Queen Eliz. Hgh.	0	2	0	1	30		6	20	3	
	PLANT PROTECTION UNIT	Friars' Hill	0		0	0	12		2	20	3	
	PRIME MINISTER OFFICE	Queen Eliz. Hgh.	0		0	0	12		4	20	3	
	TREASURY	High Street	0		0	0	30		0	20	3	
	Guest Houses	PARADISE INN		0		0	0	24		4	25	6
		STEPHENDALE		0		0	0	36		4	25	6
VIENNA INN			0		0	0	30		4	25	3	
Historical	BETTY'S HOPE	BETTY'S HOPE	0		0	0	24		4	15	3	
	FORT BARRINGTON	GOAT HILL	0		0	0	18		0		3	
	FORT JAMES	FORT JAMES, ST.	0		0	0	42		0	20	3	
	MONKS HILL	FALMOUTH	0		0	0	6		8	5	3	
	NELSON'S DOCKYARD	DOCKYARD,	0	6	16	6	30		12		3	
	SHIRLEY HEIGHTS	ENGLISH H RBOUR	0		0	0	36		0	20	3	
Hospitals	HOLBERTON HOSPITAL	Queen Eliz. Hgh.	0		0	0	54		6	35	9	

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TYPE	NAME	ADDRESS	Shelter	Beach	Surge	Waves	Wind	Inland	Drought	Flood	
Hospitals	MENTAL HOSPITAL	Skerrits Pasture	0		0	0	36		4	20	3
	MT. ST. JOHN'S MEDICAL CENTRE	MIHAEL'S MOUNT	0		0	0	6		0	20	3
Hotels	ADMIRALS INN	DOCKYARD	0		0	0	6		6	20	3
	AIRPORT HO EL		0		0	0	36		2	25	3
	AMARYLIS HOTEL	AIRPORT ROAD	0		0	0	36		2	20	18
	BARRYMORE BEACH HOTEL	RUNAWAY BAY	0		20	4	36		0	20	12
	BEACHOMBER HOTEL	COOLIDGE	0		8	4	12		2	20	3
	BLUE WATERS HOTEL	BLUE WATERS BAY	0		8	4	12		2	20	3
	CARLISLE BAY HOT L		0	2	4	1	36		2	15	6
	CATAMARAN	FALMOUTH	0		0	0	12		0	20	3
	CITY VIEW HOTEL		0		0	0	18		0	20	3
	COPPER AND LUMBER INN	DOCKYARD	0		4	3	6		6	20	3
	COURTSLAND HOTEL		0		0	0	36		2	25	3
	CURTAIN BLUFF	OLD ROAD	0		0	0	12		0	10	3
	DOVE COVE HOTEL	DRYHILL ESTATE	0		0	0	12		0	20	3
	FALMOUTH HARBOUR BEACH	FALMOUTH	0		0	0	12		0	20	3
	FALMOUTH HARBOUR HOT L		0	2	8	1	30		8	25	3
	FALMOUTH HOTEL		0	2	8	1	30		8	25	6
	GALLEY BAR AND BOUTIQUE	DOCKYARD	0		0	0	12		0	20	3
	GALLEY BAY HOTEL	FIVE ISLANDS	0		0	0	12		0	15	3
	GULF VIEW HOTEL	NEW GATE STREET	0		0	0	12		0	20	3
	HALE HOUSE		0	2	12	1	24		2	20	6
	HALF MOON BAY HOTEL		0	6	12	3	30		6	20	6
	HAWKSBILL BEACH RESORT	FIVE ISLANDS	0		0	0	6		0	15	3
	HERITAGE HOTEL	HERITAGE QUAY,	0	6	12	3	24		6	20	12
	ISLAND INN	ANCHORAGE ROAD	0		0	0	24		4	20	3
	JOE MIKES HOTEL	NEVIS STREET AND	0		0	0	24		0	20	3
	JOLLY CASTLE	BOLANS	0		0	0	6		0	10	3
	JOLLY HARBOUR	BOLANS	0		0	0	6		0	10	3
	JUMBY BA RESORT		0		8	0	36		0		
	LASHINGS	RUNAWAY BAY	0	10	28	9	36		10		18
	LONG BAY RESORT		0	2	12		30		4	20	6
	LORD N ISON CLUB		0		4	0	30		2	25	6
	MANGO BAY RESORT		0	6	16	7	30		6	20	6
	MARINA BAY HOTEL		0	2	12	1	24		2	25	9

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TYPE	NAME	ADDRESS	Shelter	Beach	Surge	Waves	Wind	Inland	Drought	Flood		
Hotels	MILL REEF HOTEL		0	4	0	2	42		4	15	3	
	OCEAN VIEW		0	4	8	2	30		6	25	12	
	PELICAN ISLE H TEL		0		0	0	30		0	15	3	
	PINEAPPLE RESORT		0	2	8	1	36		2		6	
	REX BLUE HERON		0		0	0	12		0		3	
	REX HALYCON COVE	DICKENSON BAY	0		0	0	6		0	20	3	
	ROYAL ANTIGUAN		0		0	0	12		6	15	3	
	SANDALS	DICKENSON BAY	0	6	16	3	30		6		9	
	SANDPIPER HOTEL		0	4	12	2	30		6	25	9	
	SIBONEY	DICKENSON BAY	0	6	20	3	36		6	20	15	
	ST. JAMES CLUB		0	4	12	2	36		4	20	3	
	ST. JAMES CLUB VILLA	MAMORA BAY	0		0	0	12		0	20	3	
	SUNSAIL CLUB COLONNA	HODGES BAY	0		4	1	12		0	20	3	
	SUNSET COVE HOTEL	RUNAWAY BAY	0	8	20	6	36		4	20	15	
	TRADEWINDS HOTEL	DICKENSON BAY	0		0	0	30		0	20	3	
	YEPTON HOTEL		0	2	4	1	24		2	20	3	
	Military	ANTIGUA & BARBUDA DEFENCE	Crabbs ( Parham)	0		0	0	12		0	15	3
	Nursery	GRACE HILL PRE-SCHOOL	LIBERTA	1		0	0	24		2	5	6
	Other	DELUXE THEATRE	HIGH STREET	1		0	0	30		0	20	9
	Petroleum	KING GEORGE THE V GROUND	KING GEORGE PARK	1		0	0	24		0	20	3
TEXACO WEST INDIES		COOLIDGE	0		0	0	36		2	20	9	
WEST INDIES OIL REFINERY		FRIAR'S HILL ROAD	0		0	0	24		4	20	9	
Police	ALL SAINTS POLICE STATION	All Saints Village	0		0	0	36		6	5	3	
	BOLANS POLICE STATION	Bolans	0		0	0	30		2	10	3	
	COLLIDGE POLICE STATION	Collidge	0		0	0	30		2	20	9	
	DOCKYARD POLICE STATION	English Harbour	0		0	0	30		6	20	9	
	FREETOWN POLICE STATION	Freetown	0		0	0	30		6	15	3	
	GRAYS FARM POLICE STATION	Grays Farm	0		0	0	30		2	20	3	
	LIBERTA POLICE STATION	Liberta Village	0		0	0	24		2	5	12	
	PARHAM POLICE STATION	Parham town	0		0	0	36		0	15	3	
	POLICE HEADQUARTERS	American Rd.	0		0	0	36		4	25	3	
	ST. JOHNS POLICE STATION	Newgate St.	0		0	0	30		0	20	3	
	WILKIES POLICE STATION	Willikies Village	0		0	0	30		2	15	3	
	Primary	BENDALS PRIMARY SCHOOL	Bendals Village	1		0	0	24		6	5	3
		BETHESDA PRIMARY SCHOOL	Bethesda	1		0	0	30		6	15	3

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TYPE	NAME	ADDRESS	Shelter	Beach	Surge	Waves	Wind	Inland	Drought	Flood		
Primary	COBBS CROSS PRIMARY SCHOOL	Cobbs Cross	1		0	0	30		2	20	3	
	FIVE ISLANDS PRIMARY SCHOOL	Five Islands	1		0	0	24		6	15	3	
	FREEMAN'S VILLAGE PRIMARY	FREEMAN'S VILLAGE	1		0	0	36		6	15	3	
	GLANVILLES PRIMARY SCHOOL	Glanvilles	1		0	0	30		2	15	3	
	GREEN BAY PRIMARY SCHOOL	Green Bay	1		0	0	24		4	20	3	
	IRENE WILLIAMS PRIMARY SCHOOL	Sweets Village	1		0	0	12		2	5	3	
	JENNINGS PRIMARY SCHOOL	Jennings	1		0	0	24		0	10	3	
	JOHN HUGHES PRIMARY SCHOOL	John Hughes	1		0	0	30		2	5	3	
	LIBERTA PRIMARY SCHOOL	Liberta	1		0	0	18		8	5	3	
	MARY E. PIGOTT PRIMARY SCHOOL	Ottos	1		0	0	24		6	20	3	
	OLD ROAD PRIMARY SCHOOL	Old Road	1		8	0	36		0	10	3	
	PARES PRIMARY SCHOOL	Pares Village	1		0	0	24		2	15	9	
	PARHAM PRIMARY SCHOOL	Parham Village	1		0	0	36		2	15	9	
	T. N. KIRNON SCHOOL	Coronation Rd.	1		0	0	36		4	20	9	
	URLINGS PRIMARY SCHOOL	Urlings	1		0	0	36		0	10	3	
	VILLA PRIMARY SCHOOL		1		0	0	30		0	20	12	
	WILKIES PRIMARY SCHOOL	Wilikies	1		0	0	36		2	15	3	
	Prisons	PRISON	Coronation Rd.	0		0	0	12		0	20	3
		PRISON ( REHABILITATION CENTRE)	Factory Rd.	0		0	0	42		6	20	3
Sea Port	DEEP WATER HARBOUR	ST. JOHN'S	0	4	20	2	12		4	20	3	
	ENGLISH HARBOUR	DOCKYARD,	0	2	8	1	6		2		6	
	HERITAGE QUAY	HERITAGE QUAY,	0	4	16	2	6		4	20	3	
	JOLLY HARBOUR	JOLLY BEACH	0		0	0	6		0	10	6	
Secondary	ALL SAINTS SECONDARY SCHOOL	All Saints Village	1		0	0	30		4	5	3	
	ANTIGUA GIRL HIGH SCHOOL	NEWGATE STREET,	1		0	0	36		0	20	9	
	ANTIGUA GRAMMER SCHOOL	Old Factory Road	1		0	0	36		4	20	3	
	CLARE HALL SECONDARY SCHOOL	Clare hall	1		0	0	30		4	20	3	
	VALLEY HIGH	BOLANS	1		0	0	24		0	10	12	
Telecommunic	BOGGY PEAK	BOGGY PEAK	0		0	0	30		8	10	3	
	PUBLIC INFORMATION & A.B.S RADIO	OLD PARHAM	0		0	0	24		4	20	6	
Water	CRABS DESALINATION PLANT	CRABBS PENINSULA	0		4	0	48		2	15	18	
	DELAPS PUMPING AND TREATMENT	BODKIN'S ESTATE,	0		0	0	36		2	5	3	
	GRAYS HILL RESERVOIR AND PUMPING	GRAYS HILL	0		0	0	30		8	5	3	

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## Appendix IV: Barbuda Facilities by Type and Hazard FVS

Type	Name	Address	Shelter	Wind	Waves	Surge	Drought	Flood	Inland
Airport	COCO POINT AIRPORT	COCO POINT	0	12	1	12	20	12	2
	CODRINGTON AIRPORT	CODRINGTON	0	30	0	8	20	15	2
Churches	LIVING FAITH CHURCH	CODRINGTON	1	30	0	0	15	18	0
	PENTECOSTAL ASSEMBLY	CODRINGTON	1	30	0	0	15	18	2
	PEOPLE CHURCH	CODRINGTON	1	30	0	0	15	15	0
	WESLYN HOLINESS CHURCH	CODRINGTON	1	30	0	0	15	15	0
Electricity	ELECTRICITY POWER STATION		0	42	1	16	20	9	0
Fire	BARBUDA FIRE STATION		0	30	1	8	20	18	2
Government Administration	BARBUDA COUNCIL HALL	CODRINGTON	0	12	1	16	15	9	0
	NEW BARBUDA COUNCIL	CODRINGTON	0	24	0	4	15	9	0
	POST OFFICE AND TREASURY	CODRINGTON	0	30	0	12	15	9	0
	PUBLIC WORKS		0	36	0	0	20	15	2
Historical	MARTELO TOWER		0	24	1	12	5	12	2
Hospitals	HANA THOMAS HOSPITAL	CODRINGTON	0	18	1	4	15	12	2
Hotels	CAY CLUB		0	30	0	12	15	9	0
	COCO POINT HOTEL	COCO POINT	0	30	2	12	15	9	4
	PALMETTO POINT HOTEL	PALMETTO POINT	0	30	1	8	15	12	2
Police	BARBUDA POLICE STATION	CODRINGTON	0	30	0	4	15	18	0
Sea Port	CODRINGTON WHARF		0	24	2	12	15	3	2
	RIVER PORT		0	36	4	24	5	6	8
Telecommunication	TELEPHONE SUB-STATION		0	30	0	4	20	15	0
Water	WATER PUMPING STATION		0	30	0	0	20	9	

## Appendix V: Deficiency in Capability

Agency	Institutional	Legal	Political	Financial	Technical
National Office of Disaster Services (NODS)	<p>Weak institutional capacity and administrative structure.</p> <p>Current operations concentrate on disaster preparedness and response.</p> <p>Need to expand mandate to include Comprehensive Disaster Management and more particularly, Mitigation.</p> <p>Inadequate working environment.</p>	No Legislative Mandate	<p>All Government agencies indicated an interest in disaster management and mitigation activities.</p> <p>Notwithstanding the indication of interest by Government agencies in disaster management and mitigation, the political will and support for these agencies is not as strong as required if the Hazard Mitigation Policy and Plan is to be successfully implemented.</p>	Lack of funding for mitigation.	Inadequate cadre of Training Staff.
Development Control Authority	<p>Weak institutional capability and administrative structure.</p> <p>Weak inter-agency coordination.</p> <p>Need to recognize mitigation and incorporate it in Physical Planning.</p>	<p>Physical Planning Legislation is old and no longer relevant. Additionally legislation is not enforced.</p> <p>New legislation pending—comprehensive Physical Planning Act and Environmental Legislation—is required and adequate enforcement provided.</p>		Inadequate funding for disaster mitigation	<p>Inadequate number of trained staff and in particular building inspectors.</p> <p>Need for capacity building in mitigation planning.</p>
Ministry of Planning	<p>Weak institutional capacity.</p> <p>No capacity in mitigation planning.</p> <p>Need to incorporate Hazard Mitigation Planning with Socio-economic and Environmental Planning.</p>			<p>Inadequate funding for socio-economic planning.</p> <p>No funds for mitigation planning.</p>	<p>Inadequate numbers of trained staff.</p> <p>Need for Capacity Building in Mitigation Planning.</p>
Ministry of Finance	<p>Need for institutional strengthening and capacity building.</p> <p>Need to recognize mitigation in the budgetary process.</p> <p>Need to incorporate hazard mitigation in the budgetary process.</p>			No provision in National Budget for mitigation.	<p>Inadequate number of trained staff.</p> <p>Need to recognize mitigation planning in the Budgetary Process.</p>

<b>Agency</b>	<b>Institutional</b>	<b>Legal</b>	<b>Political</b>	<b>Financial</b>	<b>Technical</b>
National Solid Waste Authority	Need to strengthen Institutional Capability. Need to recognize hazard mitigation planning.	No specific legislative mandate for mitigation.		Lack of funding for mitigation.	Inadequate cadre of trained staff. Need for training of staff in Disaster Mitigation.
Meteorological Services	Need to recognize disaster mitigation and planning issues. Need for human resources and equipment to upgrade early warning systems. Need to generate appropriate hazard data for use in planning and mitigation.			Lack of funds for mitigation and for replacement of Capital Equipment.	Need for training of staff in Disaster Management and more particularly, Mitigation.
Public Information Division	Weak institutional capacity. Need to recognize Natural Hazard Mitigation Issues in order to deliver Public Awareness Programs on natural hazards and their impacts.			Lack of funds for mitigation and replacement of capital equipment and hardware.	Need for training of staff in Disaster Management Communications. Need to place a high priority on mitigation in the Agenda for Information Program Delivery.
Port Authority	Weak institutional capability. Need to recognize mitigation planning.			No provision for mitigation.	Lack of capacity in disaster management and more particularly, mitigation.
V. C. Bird International Airport	Need to strengthen institutional capacity. Need to recognize mitigation planning.			Lack of funding for mitigation.	Lack of capability in disaster management and more particularly, mitigation.

<b>Agency</b>	<b>Institutional</b>	<b>Legal</b>	<b>Political</b>	<b>Financial</b>	<b>Technical</b>
Agricultural extension	<p>Weak institutional and administrative structure.</p> <p>Need to take into account mitigation planning for Agricultural Sector, which is particularly vulnerable to natural hazards – hurricanes, droughts and floods.</p> <p>Need for mitigation for agricultural sector.</p>	No legal capability.		No funding for mitigation.	Need for capacity building in disaster management and in particular, mitigation for the Agricultural Sector.
Fisheries Division	<p>Weak institutional capability.</p> <p>Need to give more emphasis on hazard mitigation planning in the program of activities.</p> <p>Weak inter-agency coordination.</p>	Legislation inadequate particularly for coastal zone management.		Inadequate funding for mitigation activities.	Need for training in disaster management and in particular, mitigation with emphasis on Coastal Zone Management.
Forestry Division	<p>Weak institutional and administrative structure.</p> <p>Inadequate working environment</p> <p>Need to take account of mitigation planning for the forestry sector.</p>	<p>Old and outdated Forestry Legislation and not enforced.</p> <p>New legislation is required and adequate enforcement provided.</p>		No funds provided for mitigation activities.	Lack of expertise in disaster management and more particularly, mitigation.
Ministry of Education	<p>Weak institutional capability and administrative structure.</p> <p>Need to take account of mitigation planning for the education sector.</p> <p>Need for disaster mitigation plan.</p>			No funds provided for mitigation activities and to retrofit school buildings.	<p>Lack of skills in disaster management and mitigation.</p> <p>Need for training in disaster planning and management.</p>

<b>Agency</b>	<b>Institutional</b>	<b>Legal</b>	<b>Political</b>	<b>Financial</b>	<b>Technical</b>
Board of Education	Need to place great emphasis on mitigation. Need for mitigation plan for the Board itself and for school buildings.	No legal capability.		Inadequate funds for mitigation and to retrofit school buildings to hurricane resistant standards.	Lack of expertise in disaster management and in particular, mitigation. Need for training in disaster mitigation for Board staff and builders / contractors engaged by the Board to construct and maintain school buildings.
Ministry of Health	Need for strengthening institutional capability. Need to take mitigation planning in agencies' program activities. Need for a mitigation plan for the Health Sector.			No funding for mitigation activities.	Lack of expertise in disaster management and more particularly, mitigation.
Holberton Hospital	Weak institutional capability and administrative structure. Need to recognize mitigation plan.			Lack of funding for mitigation.	Lack of expertise in disaster management and in particular, mitigation. Need for training in disaster management and mitigation. Need for training in triage for causality staff.
Central Board of Health	Weak institutional Capability and administrative structure. Need to recognize mitigation planning.	Inadequate legislation.		Lack of funds for mitigation.	Lack of expertise in disaster management and more particularly, mitigation.

<b>Agency</b>	<b>Institutional</b>	<b>Legal</b>	<b>Political</b>	<b>Financial</b>	<b>Technical</b>
Community Nursing	Weak institutional Capability and administrative structure. Need to recognize Community Mitigation.			Lack of funds for mitigation activities.	Lack of expertise in disaster mitigation. Need for training in disaster management and community mitigation.
Roads Division of the Ministry of Public Works	Weak institutional Capability and administrative structure. Need to take mitigation planning into Ministry's Program of Activities.	No legal capability.		Lack of funds for mitigation activities.	Lack of expertise in disaster management and in particular, mitigation. Need for training in disaster and construction for natural hazard resistant roads, drains and government buildings.
Ministry of Trade and Commerce	Weak institutional Capability and administrative structure. Lack of disaster management plan. Need to recognize mitigation planning.	No legislation.		Lack of funding for mitigation activities.	Lack of expertise in disaster management and more particularly, mitigation. Need for training staff in Mitigation Planning Management.
Antigua Public Utilities Authority (APUA)	APUA implemented mitigation activities such as installation of a desalination plant and the burial of telephone cables. Not withstanding the above, there is need to strengthen institutional capability for planning.	Inadequate legislation.		Inadequate funds for mitigation activities	Experience and skills available for mitigation activities. These skills should be constantly upgraded. APUA's facilities that are located in hazard zones are to be reviewed and retrofitted.

<b>Agency</b>	<b>Institutional</b>	<b>Legal</b>	<b>Political</b>	<b>Financial</b>	<b>Technical</b>
Ministry of Tourism and the Environment	Weak institutional and administrative structure. Need to take account of mitigation planning. Lack of an Environmental Policy. Need for mitigation plan for the Tourism Industry.	Lack of Environmental Legislation.		Lack of funding for mitigation activities.	Lack of expertise in disaster management and in particular, mitigation.  Need for training for tourism and environmental offices in mitigation.
Non-Governmental Organizations (NGOs)	Need to strengthen coordination amongst NGOs.			No funding for mitigation.	Need for training in mitigation.
Antigua and Barbuda Red Cross  St. Vincent de Paul Society of the Roman Catholic Church	Need to strengthen coordination amongst NGOs.			No funds for mitigation.	Need for training in mitigation.

## Appendix VI: Strategies, Policies and Programs

### Goal #1 – Vulnerability Reduction

Projects, Programs and Policies	Objectives	Responsible Agencies (Primary/Secondary)	Requirements for Implementation
Protection of Major Economic Sectors and Infrastructure	To protect the major economic sectors of Antigua and Barbuda	Development Control Authority NODS Private Sector Agencies w/ support Barbuda Council & other relevant authorities in Barbuda	Ensure that buildings which will accommodate such activities are located in areas which are not susceptible to damage from hazardous events. Ensure that buildings which will accommodate such activities are built to the require standards. Development of mitigation plans for each sector.
	To protect infrastructural systems of Antigua and Barbuda	Development Control Authority NODS Antigua Public Utilities Authority Antigua Power Company Barbuda Council & other relevant authorities in Barbuda	Develop lifeline systems to the highest possible standards Ensure that key lifeline systems are located in the least vulnerable areas. Retrofit vulnerable buildings which accommodate infrastructural activities.
Disaster Management Legislation	To develop necessary legal systems to support mitigation activities.	Ministry of Legal Affairs NODS Ministry responsible for disaster Barbuda Council & other relevant authorities in Barbuda	Preparation of Comprehensive Disaster Management Legislation The enactment of Comprehensive Disaster Management Legislation That the Draft Physical Planning Act should be approved. That all existing legislation pertinent to Disaster Mitigation should be upgraded and strengthened.

<b>Projects, Programs and Policies</b>	<b>Objectives</b>	<b>Responsible Agencies (Primary/Secondary)</b>	<b>Requirements for Implementation</b>
Reduction of Losses / Damages to Future and Existing Development	To reduce damage to existing and future development of Antigua and Barbuda.	NODS Development Control Authority DCA Public Works Antigua Public Utilities Authority Barbuda Council & other relevant authorities in Barbuda	That critical facilities which have been identified as vulnerable should be retrofitted so that they can withstand the impacts of natural hazards. Ensure that the Building Code and land use control are enforced. Build public infrastructure to the required standards i.e to the requirements of the most up-to-date codes. Ensure that hazard mapping is updated so that there is reliable information about vulnerable areas. Ensure that physical land use plans used to guide future developments
	To reduce loss of life and personal injury from hazardous events	NODS Meteorological Office Barbuda Council & other relevant authorities in Barbuda	Put in place evacuation measures for communities/population that are at high risk Development of warning systems to inform the communities about any events which are likely to occur Ensure agencies which need to respond are provided with all necessary equipment. Adopt and implement the Shelter Management Policy

## **Goal #2 – Environmental Protection**

<b>Projects, Programs and Policies</b>	<b>Objectives</b>	<b>Responsible Agencies (Primary/Secondary)</b>	<b>Requirements for Implementation</b>
Environmental Protection and Management	To maintain a systematic inventory of environmental areas which are at risk to the effects of hazards	Ministry of Environment (lead agency) Development Control Authority Ministry of Planning Fisheries and other ministries related to natural resources Community Groups Barbuda Council and other relevant authorities in Barbuda	Ensure that a comprehensive information system incorporating mitigation concerns is developed for the environment

**Goal #3 – Public Information and Education**

Projects, Programs and Policies	Objectives	Responsible Agencies (Primary/Secondary)	Requirements for Implementation
Training in Community Preparedness	To empower Communities to implement mitigation measures to protect them.	National Office of Disaster Services (NODS)- Lead Agency  Department of Social Improvement and Community Improvement.  Barbuda Council & other relevant authorities in Barbuda	To develop comprehensive programmes and activities with emphasis on community mitigation  To assist communities with the development of their mitigation programmes.
	To provide the private sector, NGOs and community groups with skills so that they can routinely implement mitigation measures in any projects which they may undertake.	NODS  Barbuda Council and other relevant authorities in Barbuda	Develop comprehensive training programmes for the private sector, NGOs and community groups to increase their technical knowledge.
	To ensure that the population is exposed to mitigation concepts from the earliest age.	NODS  Ministry of Education (lead agency)  Barbuda Council and other relevant authorities in Barbuda	Ensure that disaster mitigation is incorporated in school curricula at all levels.

**Goal #4 – Institutional Strengthening and Capacity Building**

Projects, Programs and Policies	Objectives	Responsible Agencies (Primary/Secondary)	Requirements for Implementation
Mitigation Planning	To ensure that mitigation planning is integrated into the operations of all government departments and agencies.	Cabinet Ministry responsible for disaster management NODS Ministry of Finance Barbuda Council and other relevant authorities in Barbuda	Institutionalize the National Mitigation Council and the National Mitigation Committee Provide agencies which carry out mitigation activities with adequate financial and human resources. Appointment of a mitigation planning officer.
	To develop and strengthen the institutional capacity of all agencies in Antigua and Barbuda.	Cabinet NODS Ministries and Agencies responsible Inter-agency collaboration Barbuda Council & other relevant authorities in Barbuda	Expand the mandate the National Office of Disaster Services (NODS) to include disaster mitigation Provide NODS with staff trained in mitigation planning and management. Establish a national hazard data base in collaboration with key agencies. Develop a comprehensive training programme in all areas of mitigation so that public agencies can develop their skills.