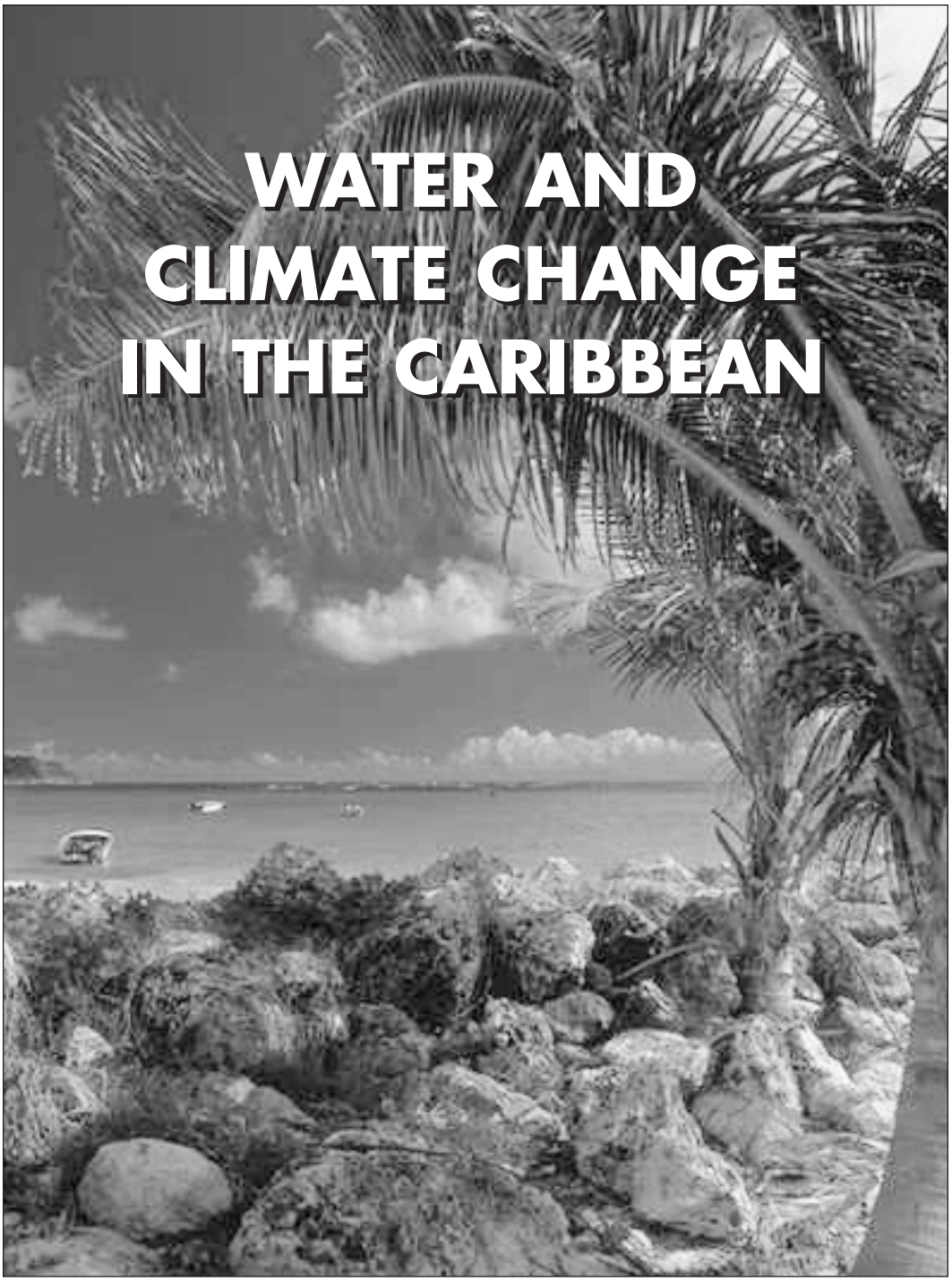

WATER AND CLIMATE CHANGE IN THE CARIBBEAN

Paper Prepared by *Impact Consultancy Services Inc.* in collaboration
with the *Caribbean Environmental Health Institute (CEHI)*
and the *Organization of American States,*
Unit for Sustainable Development and Environment

Funding Provided by *International Secretariat of the Dialogue on Water and Climate*

October 2002.

ABSTRACT

The 2001 Report of the Inter-governmental Panel on Climate Change (IPCC) provides a very daunting assessment of the vulnerability and adaptive capacity of Small Island Developing States (SIDS) to climate change and climate variability. The Report notes in part that because the adaptive capacity of human systems in SIDS is generally low and vulnerability high, they are likely to be among the countries most seriously impacted by climate change. The report cautions that islands with very limited water supplies are highly vulnerable to the impacts of climate change on the water balance. The greatest vulnerabilities are likely to be in unmanaged water systems and systems that are currently stressed or poorly and unsustainably managed due to policies that discourage efficient water use and protection of water quality, inadequate watershed management, failure to manage variable water supply and demand, or lack of sound professional guidance.

Taking the aforementioned IPCC Report as its cue, this Paper seeks to articulate a Programme of Action for SIDS in the Caribbean, that can be applied to adapt to the hydrological effects of climate change and climate variability and to additional uncertainty, so as to lessen their vulnerabilities. The Paper is meant to contribute to the Global Dialogue on Water and Climate that will feed into the 3rd World Water Forum, to be held from 16-23 March 2003 in Kyoto, Japan.

Part 1 of the Paper provides the geographical context of small island states in the Caribbean. Part 2 examines the theoretical constructs of climate change, climate variability and economic, social, and environmental vulnerability. In this Part, the Paper argues that because of the centrality of water resources to economic, social and environmental sustainability, any negative impact on the water balance will exacerbate the social, economic and environmental vulnerability of small island states. Part 3 of the Paper examines the status of water resources in Caribbean SIDS and assesses the capacity of national institutions to manage water resources effectively. The effectiveness and appropriateness of the Decision Support Systems (DSS) within the water sector is also assessed. In this regard, the Paper notes that little use is being made of existing climate information. This part of the Paper concludes that building capacity to make effective use of such information, within the broader context of an Integrated Water Resource Management (IWRM) ethic and the application of IWRM techniques, offers Small Island Developing States the best hope of mitigating the economic, social and environmental impacts of climate change and climate variability. Part 4 of the Paper examines the vulnerability of Caribbean countries to climate change, in terms of the likely impacts on Human Health and Sanitation; Agriculture and Food; Coastal Zones and Marine Ecosystems; Hydrology and Water Resources and Insurance and Financial services, respectively. Possible coping strategies are proposed in each area.

The Paper concludes in Part 5 by proposing a Programme of Action to move the Dialogue on Water and Climate (DWC) towards the Third World Water Forum and beyond.

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 The Geographic Context

The English-speaking, small island states in the Caribbean, that are the focus of this Paper, are too numerous and too diverse in nature to be characterized individually. Five are single states (Barbados, Dominica, Grenada, Jamaica, and Saint Lucia), three are twin-island states (Antigua and Barbuda, Saint Kitts and Nevis, and Trinidad and Tobago) while two are multi-island states (The Bahamas and Saint Vincent and the Grenadines).

The most significant geographical feature of Caribbean SIDS is their distribution, over some 1,600 km., on a curve in the waters separating the United States' Florida Peninsula from the northern tip of South America. The Bahamas at the northern end of this chain is about 288 km. from Miami, while Trinidad and Tobago at the southern end is less than 28.8 km from the coast of Venezuela. The islands at the Atlantic edge of the curve – Antigua and Barbuda and Barbados – lie at a maximum distance of some 1600 km east of the mainland. Caribbean countries exhibit significant variation in size, population densities and stages of development. Three countries (Guyana, Suriname and Belize) are relatively large landmasses on the mainland of South and Central America while the other ten are small island developing states, varying in size from 47,000 sq. km (Haiti and the Dominican Republic) to 269 sq. km (Saint Kitts and Nevis). Most of the islands fall within the seasonal hurricane belt and are therefore prone to a type of natural disaster that has done enormous damage to their economies.

The region has a maritime tropical climate, with mean daily temperature ranging from 24 degrees Celsius in February to 31 degrees Celsius in August. Topographies vary from extended coastal plains below sea level (Guyana), to flat coastal plains quickly moving into highland interiors reaching peaks of 2,256m (Jamaica). There is a wide variation in rainfall amounts with countries such as Haiti and Antigua and Barbuda receiving less than 200 cm annually while countries like Dominica receive 770 cm annually. Seasonal variability of rainfall in the region is also high with peaks at the start of the Hurricane season (May) and around the end of the season in the months of October and November. There is a distinct dry period from December to March/April during which household water is often rationed, some rivers go underground and activities in rain-fed agriculture are significantly reduced.

2.0 THE THEORETICAL CONSTRUCTS OF THE PAPER

2.1 Characteristics of Vulnerability

The term "vulnerability" refers to proneness to damage from external forces. Vulnerability has become associated with Caribbean SIDS because these countries tend to be very exposed to factors outside of their control. *Economic vulnerability* means the risks faced by these economies from exogenous shocks to the systems of production, distribution (including and especially markets), and consumption. Environmental vulnerability is concerned with the risk of damage to the country's natural ecosystems (e.g., coral reefs, wetlands, freshwater, coastal areas and marine resources, forests, and soils). *Social vulnerability* reflects the degree in which societies or socio-economic groups of people are affected negatively by stresses and hazards whether brought about by external forces or intrinsic factors – internal and external – that negatively impacts the social cohesion of a country (UNDP 2002). Key features of the economic, social and environmental vulnerability of Caribbean SIDS are shown in Table 1.

2.2 Climate Variability and Climate Change

Climate change in IPCC usage refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the UN framework Convention on Climate Change (UNFCC), where climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to the natural climate variability observed over comparable periods (IPCC, 2001). Climate variability is normally associated with multi-year, climate-ocean regimes and switches from one regime to another.

The IPCC in its most recent Report entitled: Climate Change 2001: Impacts, Adaptation and Vulnerability identifies water resources, agriculture (especially food security) and forestry, coastal zones and marine systems (fisheries), human settlements, energy and industry, insurance and other financial services and human health among the areas that are most sensitive to climate change.

The motivation to attempt to mitigate the wide-ranging impacts of climate change is provided partly in the fact that the very survival of small island states is under significant threat and also from the realization that the regional climate is becoming more variable with an accompanying increase in extreme weather events in the Caribbean over the past decade. Caribbean SIDs are already contending with dramatic increases in insurance costs over this period.

Table 1: Economic, Social and Environmental Features of Caribbean SIDS

ECONOMIC FEATURES	SOCIAL FEATURES	ENVIRONMENTAL FEATURES
■ Small population size ■ Extreme economic openness ■ Narrow resource base ■ Low mineral endowment ■ Low domestic savings and investment capacity ■ Limitations in the volume and range of production factors ■ Inability to benefit from economies of scale ■ Low per capita incomes ■ Small size of domestic markets. ■ Lack of an indigenous technological base ■ Tendency in the export sector towards product and market concentration ■ High per capita cost of installing and maintaining infrastructure ■ High dependence on external trade ■ Excessive transit, transport and transshipment cost especially for landlocked small states. ■ Lack of ready access to international capital markets. ■ Low aggregate GDP ■ High income volatility ■ Low capacity for risk absorption	■ Underdeveloped public and private sectors; ■ High population densities ■ Limited human resource capacity ■ Limited institutional capacity due to limited HR base ■ Susceptibility to brain drain ■ Susceptibility to HIV/AIDS and other communicable diseases ■ Increased consumption rates due to growing populations ■ High rates of unemployment and under-employment ■ Vulnerability to energy shocks ■ High dependency ratios ■ High rates of poverty ■ Geographically dispersed rural settlements	■ Increased vulnerability to extreme natural and man-made disasters such as climate change, and extreme weather events ■ Thin freshwater lenses that are easily contaminated ■ Susceptibility to water stress ■ Susceptibility to land degradation ■ Small variability in climate and soil ■ Fragility of ecosystems to pests, disease and human activities ■ Limited financial, technical and administrative capacity to cope with the consequences of Climate Change ■ Extensive interface between land and sea

3.0 THE CURRENT SITUATION IN WATER RESOURCES MANAGEMENT IN THE CARIBBEAN

Concerns about the status of freshwater availability have abounded for at least the last three decades. All Caribbean countries have ratified the various international Conventions that address the sustainable development of water.

Many of the national targets set by the region during the United Nation's International Decade for Drinking Water Supply and Sanitation in the 1980s have been achieved and even exceeded in some cases. Commendable strides have been made to establish policy and institutional frameworks to manage water resources and to conserve water in countries such as Barbados and Jamaica and to a lesser extent Trinidad and Tobago, Saint Lucia, and Antigua and Barbuda. Still, the region has been hard-pressed to maintain the coverage and quality standards set in the face of increased demand, induced by high population growth rates and the thrust to achieve and maintain robust annual growth rates. Rapid development in the urban areas, improved sanitation and health practices in rural areas, and persistent growth in tourism and industrialisation, especially in the more developed countries of the region, have significantly increased the demand on freshwater resources. Indiscriminate use of forests and the encroachment on protected areas of watersheds have resulted in significant changes in the water-retention capacity of the soil. Changes in rainfall patterns have been associated with serious droughts in some countries resulting in water shortages, sometimes over extended periods. Deterioration and malfunction of the municipal water supply and sewage treatment system, poor maintenance and weak attempts at rehabilitation of irrigation distribution systems have created added problems in water resources management.

3.1 Water Supply

Except for The Bahamas and Antigua and Barbuda, rainfall is the main source of freshwater in the Caribbean, yielding three basic water types: direct rain, surface and groundwater. Rainfall distribution patterns differ significantly across the region with Dominica receiving the most rainfall - as much as 300 inches (7700mm.) per year in some areas at high elevation and Antigua and Barbuda at the other extreme receiving an annual average of 39 inches (1000mm) per year. Barbados uses primarily groundwater, while Antigua and Barbuda use mainly desalination plants to meet their water needs. The geology of these islands is dominated either by porous limestone, which does not support streams, or by dense volcanic rocks that limit filtration. There are no permanent streams or rivers in Antigua and Barbuda. Dominica uses water for hydroelectric purposes and this source accounts for up to 50% of its electricity supply.

Data on water availability are scarce except in Jamaica, Barbados, the Bahamas, Haiti and Antigua and Barbuda. Except for Jamaica, few of the countries are able to project future water demand in a comprehensive manner. However, there is sufficient information to suggest wide variation in the status of water resources and its management across the region. Some countries are experiencing water stress at current levels of abstraction of groundwater and in extreme cases such as Barbados, current estimated demand equals or exceeds maximum annual renewable freshwater resources. In many of the countries annual per capita freshwater availability falls below the 1000 cubic metre mark commonly used to measure scarcity. On the other hand, Guyana and Dominica are endowed with large amounts of freshwater and countries such as Saint Vincent and the Grenadines, Grenada and Saint Kitts and Nevis are still fairly comfortable with their respective water situation (IICA 1999).

Surface water is usually of high quality and is suitable for all uses as reflected in measurements for parameters such as acidity/alkalinity, Total Dissolved Solids (TDS) and Coliform. However, in some pockets in many of the countries, such as Trinidad and Tobago and Jamaica, the pollution of water resources is a major environmental problem. Industrial and municipal effluents have significantly impacted surface water quality and have limited use of surface water. There are few examples where saltwater intrusion affects streams and where excessive drilling of wells

for agriculture and fishponds has resulted in saltwater intrusion. Water quality degradation can also be attributed to:

- high population densities, especially in cities where there is a concentration of direct pollution sources of pathogens, oxygen consuming organic matter nutrients, metals and organic micro-pollutants;
- changes in land use through construction, deforestation and agriculture and the associated use and leaching of agricultural chemicals;
- inappropriate disposal of human, animal and household wastes
- climate variability.

3.1.1 Interventions in surface and sub-surface flow

A few countries (Jamaica and Saint Lucia) have built dams to control water supplies on a large scale. Saint Lucia is also exploring the feasibility of building several mini-dams as part of its irrigation programme. It is not clear whether the environmental impacts of these dams are being continually assessed as part of an overall dam management programme. Of particular concern, would be the effects of such structures on the hydrology of the river basin downstream from the dam, especially if the dam was completely closed during the filling period (as was the case in Saint Lucia). A related concern is silt entrapment, which, apart from reducing the life span of a dam may also reduce the nutrient supply to lands downstream, thereby requiring replacement by chemical fertilizer.

Other forms of intervention are linked to flood control, with channel widening, straightening and deepening and the construction of by-pass channels, being the most popular techniques. In many cases however, these measures have tended to address the effects rather than the causes of floods, which in many cases are due to ecologically-unsuitable land use patterns

3.1.2 Interventions at the groundwater phase

The various characteristics of groundwater in the Caribbean have not been thoroughly researched and therefore the management of this resource is being compromised. Research undertaken elsewhere reveals that nearly half of the stored groundwater is recoverable.

Groundwater resources are replenished by direct rainfall. Abstractions are mainly from public water supply wells and springs but there are abstractions from privately-owned and operated wells for industrial commercial and agricultural purposes. While in countries like Barbados, current groundwater extraction levels, either equal or exceed the developable and sustainable ground yields for most of the groundwater units, information generated in other countries such as The Bahamas and Jamaica indicate that there is no net shortage of groundwater. However, where groundwater is the only source or an important source of freshwater, there may be shortages due to inefficiencies in distribution. Further, in those countries with a heavy reliance on groundwater, urbanisation is posing a serious problem, reducing opportunities for groundwater recharge and lowering the groundwater table. Except where contaminated by industrial and municipal effluents or seawater intrusion, groundwater is usually adequate for all standard uses.

3.1.3 Interventions at the saline level

Over the past decade or so, intervention at the saline level through the use of desalination plants has increased considerably, especially in water-stressed countries like Antigua and Barbuda, Barbados and The Bahamas. However, desalination plants are increasingly being used in other countries, especially by hotels and beverage manufacturers, who require greater control over water quality and greater reliability of supply. It is anticipated that the use of these plants will increase as their capital and operational costs are reduced.

3.2 Water Demand

Under pressure to sustain the livelihoods of growing populations, Caribbean governments have been focusing on the development of their service sectors (tourism and non-tourism), industry, agriculture and food sectors respectively, all of which are heavy users of water.

Studies done by the National Water Commission of Jamaica revealed that the tourism sector there demands ten (10) times more water per capita than the domestic sector and four (4) times more water than the commercial sector (Jones, 1993). Many countries are seeking to increase the size of their tourism plant, a move which will create an exponential increase in water demand for maintaining swimming pools, lawns, golf courses, sewage disposal and for personal hygiene. Encouragingly, several hotels are "going green" and are instituting water saving and recycling programmes. Many of the newer models of cruise ships are now equipped with desalination plants.

Water demand within the agriculture and food sector in the region has not been thoroughly assessed in many countries. Where assessments are done, the transpiration from cultivated plant ecosystems is rarely taken into account. However, it can be assumed that this demand will vary, depending on the contribution of the agriculture sector to the gross domestic product (GDP) of a country. Thus, the demand is likely to be relatively low in The Bahamas, Barbados and Antigua and Barbuda and high in Jamaica, Trinidad and Tobago and the Windward Islands. Using simulation models (mixed crops, rice fish ponds) in all the major areas where irrigation is practiced, or where potential exists for irrigated agriculture, and based on existing efficiencies, Jamaica projects that national demand for irrigated water is likely to increase from its current level of 760 MCM/year (458MIGD), to 1388 MCM/year (807MIGD) by 2015 (IICA, 1999). The demand for water is likely to increase especially in the banana producing Windward Islands where efforts are ongoing to make farming operations more viable by increasing productivity and quality. Saint Vincent and the Grenadines and Saint Lucia are aiming to irrigate 4000 acres of farmland within the next three years. In Jamaica, 250,000 acres of farmland is under irrigation, representing about 15% of the potential irrigable area.

Demand is also expected to increase as farmers seek to satisfy the food requirements of the tourism sector by moving into non-traditional areas of agriculture such as livestock production, shrimp farming and horticulture. While these "non irrigated" agricultural water uses have not been assessed, proxy figures supplied by the United States Department of Agriculture suggest that they could be high. As examples, a pig of body weight 75-125 lb. (34-57kg) needs 16 lb. (7-25kg) of water per day; a lactating cow needs 60-102 lb. (27-46kg) per day in order to produce 5-30 lb. of milk (US Department of Agriculture 1955).

While data on the use of water by industry is not available, it is assumed that this demand is high, given the fact that the manufacturing of soft drink, beer, paper, bottled water and rum dominate all the countries in the region. As the market for these products expands under the influence of the service sector, the demand for water by industry is also expected to increase, presenting more challenges to water managers.

Very little research, if any, has been undertaken locally to help build an understanding of the interactions between the hydrological cycle and associated priority issues such as ecosystems health, land-use impacts and forest cover, climate change and variability and attendant vulnerability to floods and droughts. However, given the absence of clear policies and strategies governing imperatives such as water rights, soil protection and control, and watershed and river protection, it is safe to assume that the health of freshwater and the ecosystems that support it, and thus human health, are being compromised by conditions of water surplus and scarcity respectively.

The rapidly growing population and attendant demands for land and water for income generation, has led to significant encroachment on sensitive water catchment areas and in some instances to unregulated abstraction of water. Further, waste discharge (domestic, industrial, agricultural) is also not regulated resulting in poor water quality especially in the lower reaches of the river system. As the residual stream flows necessary to support aquatic biota has not been determined, it is possible that current abstractions may in some cases exceed that required for sustaining environmental quality.

3.3 The Legal, Policy and Institutional Framework

3.3.1 National Setting

Over the past decade, several countries have sought to improve the legal, policy and institutional framework for water resources management. Barbados, Jamaica Trinidad and Tobago and Saint Lucia have designed national water policies and are seeking to streamline water laws and institutions. However, the efforts being made by these and other countries in the region are still some distance away from the IWRM ideal.

In nearly all countries, there are multiple institutions and agencies involved in water resources management, but there is no effective institutional mechanism in place to coordinate the inputs of these entities. Jamaica (through its National Environmental and Planning Agency) and Trinidad and Tobago (through its Environmental Management Authority) are examples of two countries where some degree of coordination takes place, not only within the water sector, but also between the water sector and other areas of the environment and the economy.

Generally, there is a halting commitment to development planning and participatory planning in the water sector. Stakeholder participation in the design, organization and management of water resources is not being embraced as a means of enhancing ownership and sustainability. Thus, the mechanisms to drive decision-making and consensus building around issues, such as water rights and water markets are not in place and therefore cannot positively influence the outcomes of investment decisions.

3.3.2 Regional Setting

At least three regional organisations are active in water resources management namely:

- The Caribbean Environmental Health Institute (CEHI)
- The Caribbean Basin Water Management Programme (CBWMP)
- The Caribbean Water and Wastewater Association (CWWA)

Established in 1979 as a technical institution of the Caribbean Community, CEHI's mission is to provide environmental health leadership to its member States in order to improve and support policy development decisions that are consistent with the goals and targets of the Caribbean Cooperation in Health Initiative and in collaboration with national, regional and international institutions. CEHI's areas of responsibility include:

- Protecting, preserving and improving sources of drinking water;
- Improving coastal water quality;
- Improving liquid waste and excreta disposal through the development of effluent standards;
- Provision of laboratory services in support of environment health monitoring; and
- Vector control; and
- Solid waste management (including hazardous waste).

The CBWMP was created in 1975 as a programme, to provide training on a regional basis for employees of national water utilities, with emphasis on a self-sustaining, delivery system and to develop local "in-house" training capability within the utilities themselves. In 1996, CBWMP's role was expanded to include:

- The development and promotion of performance standards for water utility operations; and
- The promotion of a human resource management culture to support organizational excellence.

Since its inception in 1991, the CWWA, which is a professional association, has worked towards:

- Advancing the science, practice and management of water supply and wastewater disposal;
- Promoting education and training in water supply and wastewater disposal; and
- Encouraging study, research and development and application in water supply and wastewater disposal.

Over the past six years or so, there has been heightened collaboration between the above-mentioned regional institutions. CBWMP and

the CWWA are bound by an Inter-organization Agreement reached in 1997, to participate in joint, inter-organizational approaches to identifying, analyzing and solving water supply and wastewater management problems, through information sharing and joint execution of training and technical programmes.

3.3.3. Decision Support Systems

Decision Support Systems (DSS) within the water sector are grossly inadequate, as reflected in the paucity of data on water resources generally and on water and climate in particular. Generally, regular water resources assessments are not being undertaken and where these are done, they do not include:

- Demand Assessment (which examines the competing uses of water with the physical resource base and assesses demand for water);
- Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA) (which examine how social and institutional structures affect water use and management) and risk and vulnerability assessment (which examines the likelihood of extreme events, such as floods and droughts as well as the vulnerability of the society to them and the appropriate mitigation strategies to deal with these events).

Many countries are unable to establish sustained, focused and reliable research programmes and have devolved this function to regional institutions such as CEHI and CWWA and the University of the West Indies (UWI). A sample of noteworthy research activities undertaken over the past five years is shown in Table 2.

The Caribbean Institute of Meteorology and Hydrology (CIMH) routinely collects rainfall data from 16 Caribbean countries. While its records date back to the 1970s, earlier records on rainfall are also available. Data types include:

- Synoptic (cloud, wind, weather, temperature, pressure, humidity, visibility and rainfall);
- Climatological (maximum/minimum temperatures, rainfall, sunshine, radiation and evaporation); and
- Hydrological (daily/monthly values of rainfall, river stage).

Daily meteorological data are received from 9 states (Guyana, Trinidad and Tobago, Grenada, Barbados, Saint Vincent and the Grenadines, Antigua and Barbuda, Saint Kitts and Nevis, Cayman Islands and Belize). Hydrological data are received from 10 states (Grenada, Barbados, Saint Vincent and the Grenadines, Saint Lucia, Montserrat, Antigua and Barbuda, Saint Kitts and Nevis, Anguilla,

Table 2: A Sample of Research Activities in Water and Climate in the Caribbean

BARBADOS	JAMAICA	SAINT LUCIA
■ The Use of the Groundwater Monitoring System developed by Brigham Young University for g/water and transport analysis ■ The Use of the Hydraulic Network Model to assess the distribution system geometry for pipelines larger than 150mm ■ An assessment of the impact of water usage by the tourism sector ■ Regional Evaluation of Saltwater Intrusion in Aquifers.	■ On-going monitoring and research to improve knowledge on the availability and quality of water island-wide through the development of risk and vulnerability maps. ■ Recycling of effluent through the use of the "mud stacking" process, to extract caustic soda and water. ■ The use of aquatic plants in wastewater treatment ■ Regional Evaluation of Saltwater Intrusion in Aquifers	■ Evaluation of improved water supply intake for surface water sources ■ The Development and Integration of Biotic and Chemical Monitoring with Land Use Assessment for Tropical River Resource Management (CEHI)

British Virgin Islands and Cayman Islands). However, use of this data is limited, as no direct access is available. CIMH is not configured to serve as a data provider and prefers to collaborate with other agencies/institutions wishing to work with its data.

With the advent of the Caribbean Planning for Adaptation to Climate Change Project (CPACC) in 1996, the collection of Climate Change-related data particularly dealing with Sea Level Rise (SLR) improved. (Annex 1 refers).

3.4 Education and Training

Presently, there is no comprehensive training programme in water resources management being implemented in any of the countries. Very few countries have an adequate stock of skills across the spectrum of management needs. However, most countries have adequate trained personnel in water and forest conservation and management. From time to time, regional agencies such as the Organisation of Eastern Caribbean States' Environmental and Sustainable Development Unit (OECS/ESDU), the Caribbean Natural Resources Institute (CANARI), the Caribbean Council for Science and Technology (CCST), CEHI and CWWA have delivered workshops on various aspects of water resources management. CEHI routinely conducts short-term training in areas of water quality testing and in the management of sewage treatment plants. A number of policy makers have also been trained in converting data to information for decision-making.

As part of the CPACC project, training workshops were delivered in several climate change - related areas including:

- Coral reef monitoring for climate change;
- The use of vulnerability information in land use planning and investment decision-making;
- Vulnerability and risk assessment analyses; and
- Resource valuation, environmental accounting and environmental investment decision-making.

Support was also provided for participation in the UWI's one-year modular Certificate in Geographic and Land Information System (CGLIS) over a period of three years. This support included providing equipment and software to the Centre for Resource Management and Environmental Studies (CERMES) at the UWI's Cave Hill Campus in Barbados. This enabled CERMES to become a second Centre for the CGLIS programme along with the Lands and Surveys Department at the St. Augustine Campus of UWI, in Trinidad and Tobago.

A Masters of Science Degree Programme in climate change is being offered by the UWI, which commenced in the 2002/2003 academic year. In the first year of the programme, lecturers were drawn from Canada, with the UWI providing the lecturers needed in subsequent years.

4.0 VULNERABILITY AND RISK ASSESSMENT AND ADAPTATION STRATEGIES

Understanding and quantifying the risks posed by climate change and climate variability are critical to the formulation of appropriate strategies. This section assesses the known and predicted risks and outlines various adaptation strategies that may be employed in the following areas:

- Human Health and Sanitation
- Agriculture and Food
- Coastal Zones and Marine Eco-systems
- Hydrology and Water Resources
- Insurance and Financial Services

4.1 Impacts on Human Health and Sanitation

The IPCC predicts that changes in the total amount of precipitation and in its frequency and intensity, will directly affect the magnitude and timing of runoff and the intensity of floods and droughts, thus impacting negatively on a range of human health-related variables, including:

- Vector/rodent borne diseases;
- Respiratory diseases
- Water-borne diseases
- Cardiovascular diseases

4.1.1 Coping/Adaptation Strategies

The experience in the Caribbean confirms that floods and droughts during the wet and dry seasons respectively, are inevitable features of climate variability. Consequently, the core strategies in this area must include:

- Establishing effective and timely forecasting and warning systems to support the implementation of coping mechanisms;
- Generating information on water/climate interactions and ensuring its integration in disaster preparedness plans, that address critical threats such as saltwater intrusion, floods, drought and coastal erosion;
- Implementing public education and awareness strategies for drought and flood preparedness;
- Improving water management;
- Improving crop and livestock management; and
- Managing land use in flood prone areas.

Under Component 7 of the Adaptation to Climate Change in the Caribbean (ACCC) Project, funded by Canadian International Development Agency (CIDA), Caribbean countries intend to pursue additional adaptation strategies for the protection of human health from adverse climate change impacts. These strategies are driven by the need to develop a more methodical and systematic identification of health impacts resulting from climate change to ensure that appropriate intervention options, can be identified and implemented.

It is proposed that this Component should focus on the following:

1. Collection of climate and health data for selected countries, including a rapid assessment to determine where the best data exists. Related activities are to include:
   - Identifying agencies that are likely to maintain data bases on climate and health;
   - Identifying and contacting resource persons in select countries;
   - Developing procedures for obtaining and recording the relevant data;
   - Assessing data received for quality and completeness;
   - Preparing Country Reports indicating data availability and gaps;

2. A detailed data review and analysis for three (3) pilot countries (including Cuba) found to possess the best data on climate variations and health impacts. Related activities are to include:
   - Organizing countries on the basis of data quality
   - Selecting two pilot countries (plus Cuba)
   - Conducting analyses of health impacts of climate variation, focusing on statistically significant trends;
   - Liaising with stakeholders;

Further, it is proposed that resources be applied to build the requisite capacity in Caribbean SIDS to support a sustained epidemiological surveillance programme. Such approach is warranted given the likelihood of the unavailability of many of the objective conditions for data capture, including an adequate population base and the resultant lack of homogeneity in data collected; a lack of consistency in the quality of data across various diseases; differences between the countries in the way people are treated; and privacy considerations.

In addition, the Caribbean Epidemiology Centre (CAREC) has embarked on a three-year project to determine whether a relationship exists between climate variability/climate change and the incidence of Dengue Fever and to use the knowledge gained to influence the appropriate responses at the national and regional level. Further details of the CIDA/ACCC and CAREC projects respectively are provided in Text Boxes 1 and 2.

Text Box 1 : Adapting to Climate Change in the Caribbean (ACCC) Project

This project emerged out of a desire of Caribbean Governments to sustain the successes and the momentum generated by the CPACC Project, between December 2001 (CPACC's end date) and the commencement of a successor GEF-funded project entitled: Mainstreaming Adaptation to Climate Change (MACC). A feature of the institutional arrangements underpinning the ACCC/MACC phase was the decision of CARICOM Governments to establish a Caribbean Community Climate Change Centre (CCCCC) to inter alia, execute the ACCC/MACC and to serve as a Centre of Excellence on Climate Change issues in the Caribbean. Key objectives of the ACCC include:

- Ensuring that the CCCCC become a sustainable institution for all Climate Change related activities in the region;
- Ensuring that countries of the region begin to build Climate Change adaptation into planning and assessment processes in all key economic and social sectors;
- Ensuring that the region's scientific and technical competence to address Climate Change issues is strengthened;
- Ensuring soundly-based and national and regional involvement in international climate change negotiations; and
- Ensuring that citizens, private sector and governments of the region have the necessary knowledge and information to support and conduct appropriate response initiatives at home and internationally.

The CDN$2.9M ACCC Project will be implemented over 30 months. Project execution is being undertaken by de Romilly and de Romilly Ltd., and Global Change Strategies International (GCSI) based in Canada. The project consists of the following nine components:

- Preparation of a detailed project design and Business Plan for the CCCCC;
- Public Education and Outreach (PEO)
- Integrating Climate Change into a Planning Process Using a Risk Management Approach
- Strengthening Technical Capacity
- Integrating Adaptation Planning in Environmental Assessments for National and Regional Development Projects
- Formulating Implementation Strategies for Adaptation in the Water Sector
- Formulating Adaptation Strategies to Protect Human Health
- Formulating Adaptation Strategies for Agriculture and Food
- Fostering Collaboration/Cooperation with non-CARICOM Countries

4.2 Impacts on Agriculture and Food

The IPCC (2001), while it notes that crop yield responses to climate change can vary widely, depending upon variables such as: species and cultivar; soil properties; pests and pathogens; the direct effects of carbon dioxide on plants and interactions between carbon dioxide air temperature, water stress mineral nutrition, air quality and adaptive responses, asserts (with high confidence) that climate-sensitive, primary resource industries, such as agriculture, forestry and fisheries are highly vulnerable to the impacts of climate change – associated hazards such as floods, droughts and the salinization of water supplies and soil.

Little can be done to guard against the loss of critical habitats such as coral reefs, mangroves and sea-grasses and/or to arrest the modifica-

Text Box 2: CAREC's Project on Climate Change and Dengue Fever

This 3-year project is linked to a significant increase in the incidence of Dengue Fever across the Caribbean. Its primary objective is to determine: whether a relationship exists between climate variability/climate change and the incidence of Dengue Fever; to determine the extent of such a relationship and thereafter to use the knowledge gained to influence the appropriate responses at the national and regional level. Its starting point is the construction of databases, followed by structured analysis and thereafter training in "statistical down-scaling" at post-graduate level. While 21 countries will be involved, four (Jamaica, Barbados, Trinidad and Tobago and Saint Kitts and Nevis) will be used as pilot countries. Activities will include:

- Development of a Climate Change data base;
- Development of an epidemiological monitoring system and collection of current data;
- Study of vulnerability through retrospective and prospective studies;
- A socio-economic study (in Jamaica only); and
- A knowledge, attitude, practices and behaviour (KAPB) survey.

tion of ecosystem functioning, other than ensure that such loss is minimized so that these habitats can have the highest possible resilience to whatever impacts that occur (Mahon, 2002).

Disruption in agriculture and food production will present additional social and economic hardship for marginal farmers and fishers who already have to contend with unfavourable market conditions and declining commodity prices. The majority of fisheries in the Caribbean are small scale, involving the use of open vessels with outboard engines that are highly vulnerable to the effects of extreme weather events. Any intensification in the seasonal cycle that brings extreme events in the first quarter of the year (in which pelagics can be fished) or during the second half of the year, can significantly affect the livelihoods of fishers and reduce the consumption of fish which is an important source of protein (Mahon 2002).

4.2.1 Coping/Adaptation Strategies

According to the IPCC, costs will be involved in coping with climate-induced, yield losses and adaptation of livestock production systems. These agronomic and husbandry adaptation options could include for example, adjustments to planting dates, fertilization rates, irrigation applications, cultivar traits and selection of animal species. More specifically, actions should focus on increasing the productivity of water, by inter alia:

- Improving crop varieties through plant breeding, aided by biotechnology, that produce more drought-resistant varieties or varieties of crops that yield more mass per unit of water consumed;
- Switching to crops that consume less water or that generate higher economic or physical productivity per unit of transpiration;
- Promoting better soil management, fertilization and pest and weed control so as to increase the productivity of land and the amount of water that is consumed;
- Improving irrigation water management through better timing of water supplies to help reduce stress at critical crop growth periods;
- Using more deficit, supplemental and precision irrigation; and
- Encouraging improved farming practices like land levelling, ridging and others that increase water intake after rainfall and improve the retention capacity of water.

Additional measures are proposed under the Mainstreaming Adaptation to Climate Change (MACC) Project. The project will assist farming communities, through agricultural departments,

with the identification of crops and agricultural practices that are best suited to Climate Change -induced conditions and will strengthen the analysis and planning capacity of Ministries of Agriculture and Forestry in the preparation of Action Plans to address the anticipated impacts of Climate Change.

4.3 Impacts on Coastal Zones and Marine Ecosystems

Large scale impacts of climate change on oceans are expected to include increases in surface temperatures and mean global sea level, decreases in sea-ice cover and changes in salinity, wave conditions and ocean circulation (IPCC, 2001). The Panel's predictions that many coastal areas are likely to experience increased levels of flooding, accelerated erosion, loss of wetlands and mangroves and saltwater intrusions into freshwater sources, are supported by the results of the coastal vulnerability assessments that were conducted at select sites in Barbados, Guyana and Grenada, under component 6 of the CPACC[1].

For Guyana, the assessment noted that agriculture, human settlements, infrastructure, fisheries and water resources were likely to be significantly affected by SLR, due to erosion, inundation and salinization. Under certain SLR scenarios, there could be inundation of up to 150m inland in the capital (Georgetown) and Onverwagt. The intrusion of brackish water into the upper reaches of Demerara, Mahaica and Essequibo Rivers has also been predicted, posing serious consequences for agriculture, with the prime agricultural lands being seriously affected. In the Georgetown area, it may be necessary to retreat up to 5km inland to avoid the consequences of SLR.

The assessment for Grenada found that the most significant impacts of SLR would be on human settlements and coastal infrastructure, tourism and water resources. According to one scenario (1m SLR by 2100) the beaches at all sites will disappear and there will be significant inundation of coastal infrastructure. A combination of the same scenario with the added impact of a storm surge from a Category 2 Hurricane, is likely to flood homes, businesses and other social and economic infrastructure in all the sites studied.

For Barbados, tourism, human settlements and water supply were shown to be extremely susceptible to SLR. With respect to biophysical impact, erosion and inundation were ranked as a more pressing concern than salinization. Direct damage from storms plus beach erosion could devastate the tourism plant. The results of the assessment indicated that virtually the entire south and south-west coasts of the island will be exposed to elevated water levels during a 1:100 year storm and extensive flooding of these areas can be expected.

4.3.1 Coping/Adaptation Strategies.

The studies reinforced the value of coastal vulnerability and risk assessment as key activities that countries must undertake in designing strategies for adaptation to Climate Change. The development of more robust vulnerability and risk assessments in the region is being proposed under the MACC project. Additional adaptation options include:

- The development of an adaptation policy framework, within the context of a climate change policy framework;
- Capacity building to enhance future vulnerability and risk assessments;
- Public education and awareness including sensitisation of policy makers; and
- Incorporation of the study's results in national planning policies, laws, and programmes.

It is intended that the MACC project will move beyond CPACC's focus on coastal zone management, to address the land use planning and integrated natural resource management dimension. Stakeholders will be assisted with the formulation and implementation of cost-effective options for protection against SLR, and the redesign of infrastructure to meet future Climate Change impacts. In addition, MACC will work with planning agencies to develop a methodology for explicit consideration of the risk of long-term Climate Change in land use planning and the integration of Climate Change considerations into the environmental impact assessment (EIA) process.

1. The assessments were done using the methodology outlines in UNEP's Handbook on Methods of Climate Change Impact Assessment and Adaptation Strategies.

4.4 Impacts on Hydrology and Water Resources

The effects of Climate Change on hydrology and water resources are projected to be as follows:

- A decrease in stream flow and groundwater recharge rates in many water stressed countries;
- An increase in irrigation demands due to higher temperatures and higher crop evaporative demand;
- An increase in flood magnitude and frequency (especially in coastal and low-lying areas) and landslides;
- The degradation in water quality through higher water temperatures and increased pollution load from runoff and overflows of waste facilities;
- A significant disruption of ecosystems;
- Increases in sea surface temperatures and mean global sea level;
- Accelerated erosion, loss of wetlands and mangroves and sea water intrusion into freshwater sources; and

4.4.1 Coping /Adaptation Strategies

The review in Part 3 of this Paper, confirms that notwithstanding some positive developments at the national and regional level, the water resources management situation in the Caribbean is generally unsatisfactory, with few structures in place to buffer the effects of hydrologic variability on water quality and supply, that global climate change can bring.

The IPCC asserted that the greatest vulnerabilities are likely to be in unmanaged water systems and systems that are currently stressed or poorly or unsustainably managed, due to policies that discourage efficient water use and protection of water quality, inadequate watershed management, failure to manage variable water supply and demand or lack of sound professional guidance. The IPCC has recommended that water resource management techniques particularly those of IWRM can be applied to adapt to the hydrologic effects of Climate Change.
IWRM is defined as a process that promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (GWP, 2000). While many of the coping strategies identified earlier have a climate change focus, they are also consistent with basic IWRM principles and techniques. This consistency is strengthened by the fact that climate change is but one of the many variables that must be factored into the overall management of water resources. The span and depth of the projected impacts of climate change across virtually all sectors of the economy, the society and the environment, strengthens the relevance of IWRM as the basis for sustaining the involvement of all stakeholders in the management of water, in all its aspects and interactions within the hydrologic cycle.

However if IWRM is to be effectively introduced and sustained, attention will have to be given to the following actions:

(a) Promoting IWRM, through policy and legislative frameworks;
(b) Building the human resource capacity of water resource agencies;
(c) Promoting effective water pollution prevention and control;
(d) Fostering appropriate cultural and attitudinal change; and
(e) Improving the water resources information base.

(a) Promoting Integrated Water Resources Management

Governments should urgently explore the possibility of establishing an appropriate institutional mechanism for coordinating national and community-based agencies with responsibilities for water and land. Such a mechanism should be empowered to:

- Formulate and implement water policy, including limitations on use of ground and surface water resources and allocations for health and sanitation, agriculture, industry and habitat for aquatic life;
- Decide on interventions to be carried out within the water sector and coordinate the monitoring of their use and effectiveness;

- Assist in the development and enforcement of national water quality standards;
- Monitor water quality and quantity;
- Liase with all agencies dealing with natural resources management related to water;
- Design and implement an overall strategy for the sustainable use of water resources and prepare action programmes that consider existing institutional, financial and physical constraints and options;
- Provide for public participation in the formulation of policies and strategies;
- Use facilitation, mediation, assisted negotiations and other techniques of alternative dispute resolution to better manage competition among uses;
- Review legislation and regulations governing the water sector and monitor their enforcement;
- Coordinate research; and
- Design and deliver public education and awareness programmes on water resources management issues.

(b) Building Human Resource Capacity

Water resource management institutions should be encouraged to strengthen their human resource management policies and practices so as to ensure that current and future personnel are exposed to formal and/or informal training, as appropriate, in IWRM. A priority target group for such training would be water managers, who should be exposed to training in such areas as environmental impact assessment, conflict resolution, institutional design, policy design, information management and designing and implementing participatory and gender sensitivity processes. National and regional educational institutions should be encouraged to provide programmes on IWRM and to design courses on implementing water-based strategies for sustainable land use.

(c) Promoting effective, water pollution prevention and control

Priority attention must be given to designing and adopting measures to prevent and control the pollution of water resources and their supporting ecosystems. At the institutional level, the focus of initiatives should seek to build the requisite regulatory capacity, including the development of a legislative framework that: (a) establishes appropriate preventative and corrective measures; (b) strengthens enforcement agencies, and information/communication systems; (c) develops education and training institutions; and (d) establishes water management indicators.

In addition, attention should be given to the following:

- Maintaining ecosystem integrity through the protection of water resources from negative impacts caused by development, resource exploitation and natural processes;
- Protecting public health against disease vectors and from pathogens;
- Ensuring sustainable water use and ecosystem protection on a long-term basis;
- Implementing the "polluter pays" principle; and
- Implementing a sustained and comprehensive water quality programme.

(d) Fostering appropriate cultural and attitudinal change.

IWRM will require changes of deep-seated cultures and values in individuals, institutions, professionals and social organizations within civil society. Thus, emphasis must also be placed on water campaigns to persuade users to adapt their behaviour to the water cycle and to recognize that water is neither limitless nor free. In designing these programmes, the knowledge and perceptions of key target groups must be used. Key points should include:

- Creating a basic understanding of the water cycle (where it comes from and where it goes) and conservation practices, through teaching in schools and colleges and via the media;
- Promoting awareness among decision makers of the water cycle and its implications;
- Explaining the need for everybody to protect against water pollution;
- Improving public awareness of watersheds and aquatic ecosystems and the ways in which these resources can be used in a sustainable manner;
- Providing decision-makers with syntheses of the best available scientific data so that they

understand interactions among water uses and users;
- Facilitating broad stakeholder participation in water planning and operating decisions
- Developing self-regulating water institutions;
- Increasing the willingness of users to pay or contribute to water services; and
- Awareness for planning for emergencies.

(e) Improving the water resources information base

The management of water resources requires adequate, reliable and representative data. Support should be given to research and training initiatives aimed at strengthening national efforts to promote the sustainable use of water resources. Priority needs include:

- Evaluations of the total economic value of the resources and aquatic ecosystems of watersheds;
- Estimates of water availability, use and loss;
- Monitoring and evaluation of policies and procedures to strengthen the integration and management of water and land uses, manage water demand and promote sustainable use of aquatic resources;
- Sustained assessments of climate and hydrological data;
- Ensuring the accuracy and integrity of primary data on the state of water resources, including through closer scrutiny and maintenance of recording instruments;
- The development of working relations and data exchange between sector institutions representing either impacts on water resources or use of water resources;
- Analysis of socio-economic aspects, including user behaviour, elasticity of demand, the potential effects of demand management, urban growth and changing land use patterns; and
- Strengthening the operations of the CIMH and CEHI.

Sustained assessments of climate and hydrological data are critical to building an understanding and quantifying the risks from climate change and climate variability and introducing the appropriate coping strategies. Full use should be made of the IPCC's Climate Change Adaptation through Integrated Risk Reduction Method, which focuses on:

- Data knowledge and tools;
- Awareness raising and capacity building;
- Assessments;
- Mainstreaming adaptation;
- Implementation;
- Evaluation and monitoring; and
- Feedback.

Use should also be made of the guidelines for Comprehensive Hazard and Risk Management (CHARM) that was developed by the South Pacific Applied Geosciences Commission (SOPAC). CHARM is promoted as a comprehensive hazard and risk management tool and/or process, within the context of an integrated national planning process.

Support with the implementation of some of the actions listed above should be forthcoming through the MACC project and the Integrating Watershed and Coastal Area Management Project (IWCAM) respectively. The interventions being considered under the MACC include:

- Assisting water resources agencies with the identification, formulation and adoption of selected measures that would enable key economic sectors and local user communities to adapt to the anticipated reduction in water supplies, (including pricing tariff structures and incentives for water use management) under scenarios of climate-induced variability.
- Supporting the formulation of long-term regional adaptation.
- Expanding and strengthening the existing knowledge base to facilitate global climate change impact assessment strategy as a basis for decision making on adaptation, including: strengthening the climate impact monitoring network established under CPACC through full integration with the Global Climate Observing System (GCOS); down-scaling global climate models in support of decision-making on adaptation at the national and regional level; and the development of impact scenarios and identification of vulnerability reduction strategies.
- Public education and outreach including enabling access to information for integrated development planning and decision-making.

4.5 Insurance and Financial Services

Natural hazards have direct links with the stock of human, physical (and financial) capital, which in turn affects production, consumption, investment and the current account of the balance of payments. An analysis of the major impact of catastrophic events on 16 countries (6 from the Caribbean region and 10 from Latin America) for the period 1970-99, shows that catastrophic events lead to: (i) a substantial decline in the growth of output; (ii) a substantial decline in the growth of investment; (iii) a more moderate decline in consumption, especially in private consumption and (iv) a worsening of the current account of the balance of payments (World Bank, 2002). These findings are consistent with those of the IPCC, which anticipates that climate change and changes in weather-related events perceived to be linked to climate change, would increase actuarial uncertainty in risk assessments, place upward pressure on insurance premiums and/or lead to certain risks being reclassified as being uninsurable, with subsequent withdrawal of coverage (IPCC 2001).

The situation is exacerbated by the thinness of the insurance market for catastrophic risk in the Caribbean, which is characterized by "high" prices and "low" transfer of risk. According to the World Bank, this thinness can be attributed to the following factors:

- Risk identification and forecasting are insufficiently developed. Forecasting techniques are costly and institutions responsible for research and prevention of disasters are nonexistent and/or grossly under-funded. In the absence of the appropriate forecasting capacity to identify and forecast risk, international insurers have set catastrophe premiums at nearly the same level as those applied in developed countries.
- Insurers do not discriminate by zone of risk or the implementation of risk-reduction that lead invariably to adverse selection and moral hazard, which in turn lowers the quantity of risk transfers.
- Individuals are prone to under-invest in mitigation and under-insure.
- Land use regulations are not enforced. The

Table 3: Coping Strategies in the Insurance Sector

MARKET FAILURES	RECOMMENDED PUBLIC SECTOR INTERVENTIONS
1. Underdevelopment of risk identification and forecasting.	■ Foster scientific research ■ Improve available technology ■ Ensure the dissemination of information to risk-management agencies
2. Insurers do not discriminate by zone of risk or the implementation of risk-reduction measures.	■ Same as above
3. Under-investment in mitigation and under-insurance by individuals.	■ Undertake information campaigns to sensitise the public about catastrophic risk; ■ Provide tax credit for the purchase of catastrophe insurance ■ Provide incentives to invest in risk reduction measures
4. Land use regulations and building codes are non-existent or are poorly enforced.	■ Establish land use regulations and building codes; ■ Effectively enforce land use regulations and building codes
5. Inadequate regulation	■ Eliminate restrictions on foreign insurance companies ■ Eliminate restrictions on international diversification of assets; ■ Develop domestic capital markets

presence of properties in high-risk areas either prevents insurance companies from offering comprehensive coverage to those who most need insurance protection, or places the cost of insurance out of reach of those who cannot afford high premiums.
- The presence of regulatory guidelines that restrict investments together with the presence of underdeveloped financial markets.

4.5.1 Coping/Adaptation Strategies

Recommendations for public sector interventions to address the aforementioned constraints are set out in Table 3 on previous page.

In addition, the feasibility of establishing an insurance pool among Member States in the Alliance of Small Island States (AOSIS) should be explored. The idea was first mooted in 1991 by Vanuatu, on behalf of AOSIS. This insurance pool was to draw its revenue from mandatory contributions from developed countries and alleviate the financial burden of loss and damage suffered by the most vulnerable SIDS and low-lying developing countries as a result of climate change and/or SLR. While no insurance related mechanisms have so far been implemented under the UNFCCC or the Kyoto Protocol, the workshop on initial actions relating to adverse effects of climate change, held in March 2000 highlighted the need to explore insurance related actions further, particularly as a means of addressing potential losses from climate - related disasters. This decision has the support of AOSIS which has called for workshops to be convened to cover the insurance issues arising from adaptation to the adverse effects of climate change and those arising from adaptation to the adverse effect of response measures.

5.0 THE ROAD TO KYOTO AND BEYOND

The findings, conclusions and recommendations emerging from the analysis of the current state of water resource management in the Caribbean highlight the extent of the transformation that is required to the policy, legal, institutional and research arrangements to enable Caribbean countries to take full account of and to respond in a timely and effective manner to the vagaries of climate change and climate variability. Given the current state of play, the cost of implementing these changes will be high. But the cost of inaction will undoubtedly be higher. One of the main challenges will be in convincing governments of the importance of investing in capacity development for IWRM. This will require sustained and concerted action and dialogue among all stakeholders and among all small island states forming the AOSIS group.

Fortunately, the analysis has revealed that a solid base exists both in the Caribbean and in the Pacific that can swiftly be built upon. The combined capacity of institutions like CEHI, CBWMP, CWWA, CCST, OECS/ESDU, SOPAC and South Pacific Regional Environmental Programme (SPREP), is not insignificant. The advent of the Caribbean Community Climate Change Centre (CCCCC) will provide the region with additional capacity dedicated to undertaking sustained investigation of climate change and climate

Text Box 3: The Caribbean Community Climate Change Centre (CCCCC)

Created in February 2002, the CCCCC represents a natural progression of the work of the CPACC institutionalising Climate Change at the national and regional levels. The Centre will operate as a CARICOM agency with independent management. A Board of Directors will provide operational oversight. The Centre will serve as a regional institution that will articulate support and sustain the programme of action on Climate Change. It will be self-sufficient and will generate its revenue from the services that it provides, such as project execution, provision of services to governments and the private sector. Other proposed revenue streams include: a Trust Fund established with support from international foundations and contributions from the private sector; the proposed Climate Change Adaptation Fund and fees for certification services provided under the Clean Development Mechanism (CDM).

variability phenomena and related issues and mainstream its findings within the broad development policy and planning framework of Caribbean countries.

The interventions proposed as part of the Caribbean Dialogue on Water and Climate (CDWC) with CEHI as the Convenor and the OAS as Technical Secretariat, provides an excellent basis for an eventual full-fledged Island States Water Partnership (ISWP). Already, there is active collaboration among small island states from the Caribbean and Pacific regions on Water and Climate Change issues through SOPAC. A delegation from the Caribbean participated in the Pacific leg of the DWC, in Fiji in July 2002, and a delegation from the Pacific took part in the Caribbean leg in Saint Lucia in October 2002. The two regions are to make a joint presentation on Water and Climate Change issues at the Third World Water Forum scheduled for Japan in March 2003.

The Third WWF is a "critical path event" in the evolution of a proposed ISWP, as it offers a unique opportunity for small island states to demonstrate their collective resolve to address their own problems. The articulation at that Forum, of a detailed Programme of Action (POA) for IWRM that is fully owned by stakeholders in the respective regions, will help to attract the support of development partners from the international community. With the endorsement of AOSIS, the POA on IWRM can form the basis for the design of discrete projects, which can be tabled at the proposed follow-up Conference to the UN Global (Barbados) Conference on the Sustainable Development of Small Island Developing States (UNGCSIDS).

Possible Elements of an Action Programme are contained at Annex 2 to this Paper. They include recommendations emanating from the Fiji and Dominica leg of the DWC.

ANNEX 1

The Caribbean Planning for Adaptation to Climate Change Project (CPACC)

Following the UN Global Conference on SIDS, a number of CARICOM member countries and the OAS took the initiative to formulate a regional project - the Caribbean Planning for Adaptation to Global Climate Change (CPACC) . The project was approved for funding by the GEF in mid 1997 and was completed in December 2001. It was executed by the OAS, with the University of the West Indies' Centre for Environment and Development (UWICED) as the regional implementing agency and the World Bank as the GEF Implementing Agency.

The overall objective of the project was to support the efforts of Caribbean countries to cope with the adverse effects of Global Climate Change (GCC), particularly sea-level rise in coastal areas, through vulnerability assessment, adaptation planning, and capacity-building linked to adaptation planning.

More specifically, the project was expected to assist national governments and UWICED to:

- Strengthen the regional capacity for monitoring and analysing climate and sea-level dynamics and trends;
- Identify areas particularly vulnerable to the adverse effects of Climate Change and sea -level rise;
- Develop an integrated management and planning framework for cost-effective response and adaptation to the impacts of global Climate Change on coastal and marine areas;
- Enhance regional and national capabilities to prepare for the advent of global Climate Change through institutional strengthening and human resource development; and
- Identify and assess policy options and instruments that might help to initiate the implementation of a long-term adaptation programme, in vulnerable coastal areas.

** Participating countries included: Antigua and Barbuda, Bahamas, Barbados, Belize, Dominica, Grenada, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago*

The CPACC was designed as a regional project. Its implementation modalities emphasized a cooperative approach – the agencies involved and 12 participating countries – to developing the requisite capacity at the national level to continually assess the impacts of climate change on the coastal resources and, by extension, on the societies and economies of the participating countries. The project comprised four regional and five pilot action components. The regional components were as follows:

- Design and establishment of a sea-level/climate monitoring network;
- Establishment of databases and information systems;
- Inventory of coastal resources and use; and
- Formulation of a policy framework for integrated coastal and marine management.

Countries were given an opportunity to decide the national pilot components in which they wished to participate. Their selection was as follows:

- Coral-reef Monitoring for Climate Change (Bahamas, Belize, Jamaica);
- Coastal Vulnerability and Risk Assessment (Barbados, Grenada, Guyana);
- Economic Valuation of Coastal Resources (Dominica, St. Lucia, Trinidad and Tobago);
- Formulation of Economic/regulatory Proposals (St. Kitts & Nevis, Antigua and Barbuda); and
- Greenhouse-gases Inventory and Vulnerability Assessment of the Agriculture and Water sectors–St. Vincent and the Grenadines.

The Project has developed a successful approach to regional cooperation in addressing the countries' concerns with the impact of climate change. This approach, acknowledged as a model for the Caribbean and other regions, is based on a coordinated effort, in which all twelve countries participated in national pilot/demonstration actions and regional training and technology transfer activities. Project activities were focused on planning for adaptation to GCC in vulnerable areas, and include the collection and dissemination of sea level and climate data in each country, impact and vulnerability studies, and the assessment of policy options to address adaptation issues. These enabling activities were complemented by selective capacity-building activities, aimed at creating or strengthening endogenous conditions and capabilities necessary to prepare and implement a long-term program for adaptation to GCC.

Concrete outputs of the CPACC include:

- Access to data derived from state-of-the-art sea level and climate monitoring stations installed across the region.
- The establishment of a sea level/climate observation network in the participating countries, to enable the region to start compiling data relevant to monitoring the impact of climate change, in particular SLR.
- The development of a CPACC Web site which served as an integral aspect of the Project, by facilitating the dissemination of technical and meeting reports, contact information, information on events, progress reports and work plans, and other project-related material.
- The development of a Coastal Resources Information System (CRIS) supported by training in each of the countries, in data collection and automation, feature extraction for satellite imagery, database design and system maintenance and system use for decision making.
- Strengthened capacity to analyse critical climate variability and change issues and to develop a policy framework for adaptation responses.
- Strengthened capacity of participating countries to undertake regular monitoring of coral reefs for climate change impacts, through the development of a monitoring methodology and the training of country teams in its application.
- Training in the development and use of a methodology for carrying out coastal vulnerability and risk assessments.
- The generation of a methodology for economic valuation of coastal and marine resources in Saint Lucia, Dominica, and Trinidad and Tobago and trained pilot country teams in its application.

Each participating country is in the process of developing a Coastal Resource Inventory System (CRIS), which will be an essential tool for decision-making in integrated coastal zone management.

Public awareness efforts to date have been directed at the regional media and regional private sector. As a result, there is more visibility of climate change issues in the regional press, and the regional private sector have expressed interest in supporting activities addressing the question of risk assessment and climate change.

The project has achieved a fair degree of country ownership as well as support from key regional institutions. At the national level, representatives from government agencies, private sector and non-governmental organizations actively participate in the project through the National Implementation Coordinating Units (NICUs). At the regional level, a Regional Project Implementation Unit (RPIU) has been established at the Cave Hill campus of the University of the West Indies in Barbados under the aegis of UWICED. Other centres of the University participate directly in the project, as do regional institutions charged with meteorology and marine affairs.

Mindful of the absence of any regional coordinating mechanism or institution dealing with GCC, the First Ministerial Meeting to consider progress of the implementation of the Barbados Programme of Action, called for the establishment of a permanent mechanism to ensure the sustainability of climate change activities after the completion of the CPACC project. Accordingly, plans for the establishment of Caribbean Community Climate Change Centre (CCCCC) have been completed. This initiative has been endorsed by CARICOM Heads of Government as well as by the OAS General Assembly and the Inter-American Commission for Sustainable Development.

CPACC has also succeeded in generating interest in climate change issues within the University of the West Indies. It has spearheaded the development of a Climate Change Masters of Science Program at the UWI – Cave Hill, Barbados, and has established a sea level and climate data management centre at the University of the West Indies, St. Augustine, Trinidad and Tobago. CPACC also supports a network of researchers working on downscaling the global climate models at the UWI campuses in Jamaica, Barbados and the Caribbean Institute for Meteorology and Hydrology (CIMH) in Barbados.

ANNEX 2

ELEMENTS OF A PROGRAMME OF ACTION

The main Action Recommendations emerging from the Fiji (SOPAC) and Dominica Consultations include enabling small island countries in collaboration with WMO, UNESCO and regional partners (e.g. SOPAC, CEHI, OAS etc.) to develop and enhance capacity in the following areas:

A. RESEARCH

- Strengthen the application of climate information and to strengthen the links between meteorological and hydrological services;
- Strengthening institutional capacity for data generation;
- Develop rainfall and drought prediction schemes based on existing models;
- Enable regional support to develop water application of climate information and prediction;
- Implement a programme of climate analysis for assessment of extreme weather events;
- Developing minimum standards for risk assessments;
- Implement actions to strengthen national capacity (equipment, training, etc.) using the model outlined in the Pacific Hydrological Cycle Observation System (HYCOS) proposal and recommendations regarding water quality;
- Implement a programme of targeted applied research projects to address knowledge gaps in line with recommendations and priorities presented;
- Develop and/or implement minimum standards for conducting island water resources assessment and monitoring;
- Implement appropriate water quality testing capability and associated training at local, national and regional level;

- Strengthen and enhance communication and information exchange between national agencies involved with meteorological, hydrological and water quality data collection programmes (including water supply agencies and health departments); and
- Utilise the research capabilities at UWI, CIMH, the Universities of Guyana, Suriname, and Cuba and other regional science institutions.

B. PUBLIC EDUCATION, AWARENESS AND OUTREACH

- Provide high-level briefings on the value of hazard assessment and risk management tools;
- Support community participation in appropriate water quality testing programmes targeted at environmental education and awareness of communities, using existing and proposed programmes as models;
- Recognize the value of informal community groups; and
- Including the media as a specific institution.

C. EDUCATION AND TRAINING

- Enhance education and career development opportunities in the water sector; and
- Implement hydrological training for technicians in line with the recommendations presented in a proposal to meet training needs.

D. POLICY/INSTITUTIONAL DEVELOPMENT

- Build environment to facilitate the emergence of an IWRM framework;
- Incorporate the community in policy development at the ground level;
- Develop a generic model for integrated community based planning;
- Build capacity in use of risk management approach to integrated resource management, in areas such as GIS development, hazard mapping, EIAs and SIAs;
- Develop appropriate policy/legislative instruments;
- Enforce zoning of risk areas;
- Enforce building regulations;
- Offer incentives for risk mitigation measures incentives; and
- Harmonize legislation, regulations and policy.

LIST OF REFERENCES

1. AGRICO Ltd.: Draft Report on National Water Situation and Assessment of National Water Profile, Saint Lucia – December 2001.

2. CIDA/ACCC: Proceedings of a MACC Workshop held in Dominica in July 2002

3. Commonwealth Secretariat: Vulnerability: Small States in the Global Society – Report of a Commonwealth Consultative Group – 1985.

4. CPACC/RPIU: Final report of the Caribbean Planning for Adaptation to Climate Change Project – July 2002.

5. Department for International Development (DFID): Addressing the Water Crisis – Strategies for Achieving the International Water Targets – March 2001.

6. Global Water Partnership: Policy Guidance and Operational Tools – Version 1 – March 2002.

7. IICA: A Synthesis of Country Reports on Water Resources Management in the Caribbean – April 1999.

8. IICA: Policy Framework for Sustainable Water Resources Management in the Caribbean – 2000.

9. Impact Consultancy Services Inc: Toward a National Water Policy for Saint Lucia (Draft) – October 2002.

10. IPCC: Climate Change 2001 – Impacts, Adaptation and Vulnerability.

11. Mahon Robin (Dr.) : Adaptation of Fisheries and Fishing Communities to the Impacts of Climate Change – Paper Presented at Consultation on Adaptation of Fisheries and Fishing Communities in CARICOM to the Impacts of Climate Change in Trinidad and Tobago, April 2002.

12. Simmons, I: The Ecology of Natural Resources (second edition). 1981.

13. SOPAC: Island Vulnerability and Dialogue on water and Climate - Paper presented at the Pacific Regional Consultation on Water in Small Island Countries – Sigatoka – Fiji Islands 29 July – 3 August 2002.

14. UNDP: Vulnerability in Small Island Developing States – Draft Report of a Team of Experts, 2002

15. World Bank: The Catastrophe Insurance Market in the Caribbean Region – June 2002.