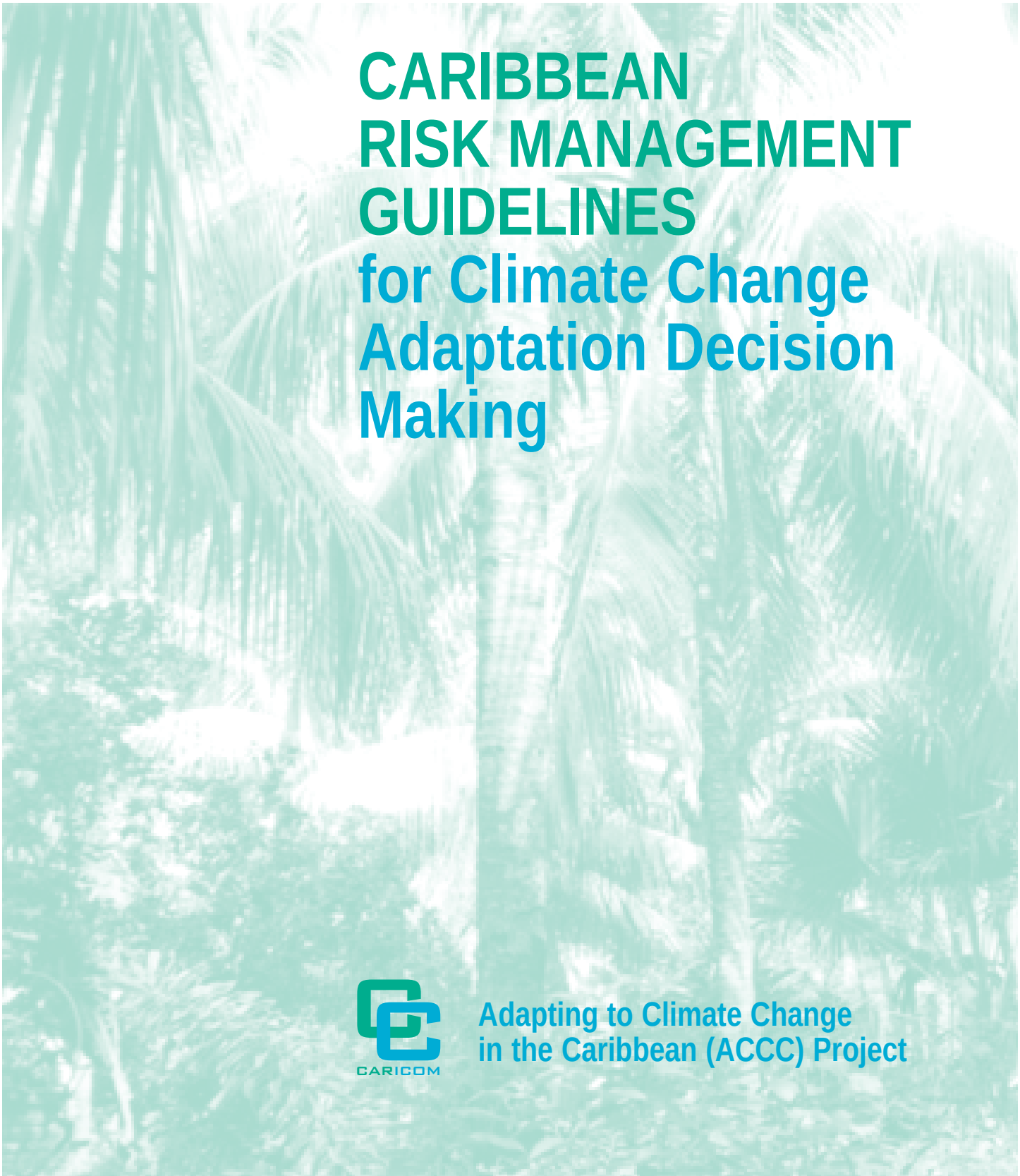
CARIBBEAN RISK MANAGEMENT GUIDELINES for Climate Change Adaptation Decision Making



CARICOM

Adapting to Climate Change in the Caribbean (ACCC) Project

Adapting to Climate Change in the Caribbean (ACCC) Project Overview

Adaptation to climate variations and change, and to sea level rise, is of fundamental economic and social importance to the countries of the Caribbean. The Adapting to Climate Change in the Caribbean (ACCC) project is funded by the Canadian International Development Agency (CIDA) and runs from October 2001 to March 2004. The project builds on the initial experience gained through the Caribbean Planning for Adaptation to Climate Change (CPACC) project, which concluded in December 2001. This US$2.1 million project involves 9 individual components that continue from CPACC in order to consolidate, extend and make sustainable climate change responses. They are also designed to lead into and complement the Global Environment Facility (GEF) program – Mainstreaming Adaptation to Climate Change (MACC). The nine components of the ACCC Project include:

Component 1: Development of Business Plan for Caribbean Climate Change Centre

Component 2: Public Education and Outreach (PEO)

Component 3: Risk Management Approach to Physical Planning

Component 4: Strengthening Regional Technical Capacity

Component 5: Adaptation Planning in Environmental Assessments

Component 6: Strategies for Adaptation in the Water Sector

Component 7: Adaptation Strategies to Protect Human Health

Component 8: Adaptation Strategies for Agriculture and Food

Component 9: Fostering Collaboration with non-CARICOM Countries

The outcomes from this initiative aim to ensure that:

- The Caribbean Community Climate Change Centre (soon to be established) becomes a sustainable institution for coordinating all climate change related activities in the region;
- The region builds climate change adaptation into planning and assessment processes in key economic and social sectors;
- The scientific and technical competence to address climate change issues is strengthened in the region;
- National and regional agencies can constructively engage in international climate change negotiations; and
- Citizens, the private sector and governments of the region have the knowledge to support and conduct appropriate climate change responses.

CARICOM countries participating in the ACCC Project:

Antigua & Barbuda	Dominica	St. Lucia
Bahamas	Grenada	St. Kitts & Nevis
Barbados	Guyana	St. Vincent & the Grenadines
Belize	Jamaica	Trinidad & Tobago

The ACCC project is executed through the Canadian Executing Agency (CEA) which comprises Canadian firms, de Romilly and de Romilly Ltd. and GCSI - Global Change Strategies International Inc. Day-to-day implementation is the responsibility of the Regional Project Implementation Unit (RPIU), based in Barbados that was originally established for the CPACC Project. However, implementation is the full responsibility of the Caribbean Community (CARICOM) Secretariat.

For further information, please visit our website: **http://www.caribbeanclimate.org**

Canadian International Development Agency | Agence canadienne de développement international

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FOREWORD

One of the major environmental challenges facing the Caribbean is that of global climate change and its associated consequences of sea level rise, intensification of storms, and changing weather patterns. Caribbean governments, like those of other Small Island Developing States, have undertaken a strategy to adapt to climate change with the hope that by so doing, their social, economic and environmental systems would be able to withstand the predicted deleterious impacts of climate change.

Although there is certainty that global warming is a physical reality triggered by increased greenhouse gas concentrations in the atmosphere, there is still some measure of uncertainty as to the extent and nature of future climate conditions. Global Coupled Ocean Atmosphere Climate models provide projections that are – at best – approximations, and climate scientists have the daunting challenge to provide climate scenarios which can inform adaptation policy.

In this environment of uncertainty, a risk management approach is considered to be suitable for bringing some precision to the decision-making process involved in developing climate change adaptation options for implementation. These guidelines have been developed to assist CARICOM[1] country risk management practitioners in the decision-making process for the selection and implementation of feasible options for adaptation to climate change. The methodology employed in these guidelines is based on the Canadian National Standard (CAN/CSA-Q850-97): *Risk Management: Guideline for Decision-Makers*, and follows the key steps of this standard.

It is also informed in terms of its approach to dealing specifically with climate change risks by the *Comprehensive Hazard and Risk Management* (CHARM) process developed and utilized by the South Pacific Island countries.

To facilitate its specific use for climate change risks, each step in the risk management process is accompanied by a concrete example of how it is applied to address an actual risk arising from a climate hazard. In the manual, the risk addressed is that of water shortage in the vulnerable tourism industry. The process is illustrated from hazard identification, through risk estimation, risk evaluation and finally the identification of risk control actions (adaptation) that need to be implemented.

The annexes to the manual provide the user with a range of relevant information on climate change hazards, climate scenarios and adaptation choices depending on the specific climate risk being addressed. They also

[1]There are twelve CARICOM member countries participating the Adapting to Climate Change in the Caribbean (ACCC) Project, under which these guidelines have been developed. However, throughout the document, reference is made to the Caribbean region in the context of climate change impacts. Additionally, it is felt that other Caribbean nations may benefit from the use of this document.

provide explanations of some of the basic concepts germaine to the risk management process.

We are grateful to the Canadian International Development Agency (CIDA), through the Climate Change Development Fund, for their generous support to the Adapting to Climate Change in the Caribbean (ACCC) Project under which this activity was implemented. We also extend our appreciation to the Government of Canada for permission to use their national standard as a basis for the development of this regional guide.

Byron Blake
Assistant Secretary-General, CARICOM

TECHNICAL COMMITTEE ON RISK MANAGEMENT

Technical Committee on Risk Management for CARIBBEAN RISK MANAGEMENT GUIDELINES for Climate Change Adaptation Decision Making

Mr. Mark Egener

Mark is an internationally recognised expert in crisis and risk management. As a consultant with Global Change Strategies International Inc. since 1998, he has led many projects related to climate change, adaptation to global warming, disaster preparedness, the management of risk and business planning, including several dealing with emergency preparedness in the agriculture, food and health sectors.

From 1983 to 1995 he was head of an Alberta Government agency responsible for producing strategies for legislation, risk management and hazardous material control programs, model plans, training systems, communications and public affairs protocols, and technological support systems, as well as overseeing their development and implementation. During this period he oversaw the preparation and testing of a number of all-hazard emergency preparedness plans and specific plans relating to foreign animal diseases, food, agriculture and forest threats.

Previously he was a senior manager in a major western Canadian energy and chemical company and was a founding member and chairman (1991-1992) of the Major Industrial Accidents Council of Canada, an organization dedicated to the safe management of dangerous chemicals and a leader in alternative service delivery in regulatory matters.

He is a Mechanical Engineer and has a Master of Arts degree in Strategic Affairs from the Royal Military College of Canada. He is a member of the Association of Professional Engineers, Geologists and Geophysicists of Alberta and the Association of Professional Engineers of Ontario.

Mr. Steve Maximay - *Manager, Business Development Unit, Faculty of Science and Agriculture, University of the West Indies, St. Augustine Campus, Trinidad & Tobago*

Mr. Maximay is the Managing Director of PLANTPRO Associates Ltd., a firm incorporated in 1994 that promotes science-based initiatives across all sectors of the Caribbean regional economy. He has been a long-term consultant to the Caribbean Development Bank and The University of the West Indies. As Manager of the Business Development Unit, Faculty of Science and Agriculture, UWI, St. Augustine, he provided an integrated agricultural perspective to the regional risk management exercise coordinated by the ACCC Project.

A Plant Pathologist by training, he has been a secondary school teacher, development banker, researcher, World Bank certified Training Manager, University lecturer, consultant and entrepreneur. With over twenty years experience in the agricultural, education, health, financial and environmental sectors, he has worked in thirteen (13) Caribbean countries. Coming from a multi-disciplinary background, he actively promotes the mainstreaming of environmental concerns as an integral part of business operations.

Ms. Maureen Shepherd - *Consultant*

Maureen is presently a Consultant, Trainer and Internal Auditor and has over thirty years experience in the financial sector. She has held positions of Risk Manager, in charge of compliance and internal audit; Assistant Manager Administration with responsibilities for operations, projects and reviewing and writing manuals; Officer-in-Charge of Branches, Bank Accountant and Training Officer. She lectures in Elements of Financial Services Practice in the Certificate of Banking at University of the West Indies Centre of Management Development (CMD) and previously lectured in Principles of Banking at Barbados Institute of Management and Productivity (BIMAP). Maureen holds a Masters Degree in Business Administration-International Business (University of Luton UK), a Diploma in Public Administration (UWI) and, Diploma in Management of Human Resources (BIMAP). She is also trained in Pastoral Care and Counseling and holds a certificate in Introduction to Psychology.

A member of the Professional Business Advisory Service (PBAS) group (Division of Small Business Association Enterprise Inc.) as Lead Consultant on the working committee with special responsibility in Human Resource Management and Information Technology. Member of the Curriculum Development Specialist Committee, Caribbean Association of Banking and Finance Institutions (CABFI), to develop and review training programmes in Banking and Finance at the certificate, diploma and degree levels with UWI and internationally. Maureen is Vice-President, Barbados Institute of Banking and Finance Inc.; Governor of the Board of Directors of The Institute of Internal Auditors (Barbados Chapter); Master Course Conductor with the Commonwealth Sports Development Program for the Caribbean Coaching Certificate Accreditation Program.

Mr. Mark Sandiford - *Manager, Risk Management Services, CLICO, Barbados*

Mark started his insurance career approximately nineteen (19) years ago when he joined the Insurance Corporation of Barbados on 01 August, 1984. He spent approximately fifteen and a half years there before moving to his current employer, CLICO International General Insurance Limited in January 2000 as a Risk Management Services Manager. Mark is a Chartered Insurer and in April 2003 was elected a Fellow of the Chartered Insurance Institute (FCII) of the UK. He also holds the Associate in Risk Management (ARM) from the Insurance Institute of America as well as an MBA from the University of the West Indies. Mark is the current President of the Insurance Institute of Barbados Incorporated and the first Vice-President of the Association of Insurance Institutes of the Caribbean (AIIC).

Ms. Elizabeth Riley - *Programme Manager - Mitigation and Research, Caribbean Disaster Emergency Response Agency, Barbados*

Ms. Riley has seven (7) years experience in the fields of disaster management, environmental management, and teaching. She also holds a B.A. (Hons) Geography from the University of the West Indies, and an M.A (Econ) in Environment and Development from the University of Manchester.

Since 2000, she has been attached to the Caribbean Disaster Emergency Response Agency (CDERA) and has held the post of Programme Manager, Mitigation and Research since July 2002. At CDERA she has overall responsibility for the programme area and also directs the implementation of initiatives under this area. Prior to this, Ms. Riley has worked as an Environmental Officer with responsibility for the Sustainable Development Unit at the Ministry of Physical Development and Environment (formerly Ministry of Environment, Energy and Natural Resources) in Barbados. She has also worked in the field of renewable energy and was attached to the Center for Resource Management and Environmental Studies (CERMES), University of the West Indies.

Ms. Riley has contributed to a number of technical environmental studies and policy papers during her tenure at the University of the West Indies and the Ministry of Physical Development and Environment and has written and presented technical papers in disaster management whilst attached to CDERA

Dr. Ulric Trotz - *Project Manager, Adapting to Climate Change in the Caribbean (ACCC) Project, Barbados*

A Scientist by training, Dr. Trotz commenced his University education in Edinburgh, and attained his Doctorate in Organic Chemistry in Toronto, Canada. His career experiences and achievements are wide and varied. He has worked as Director, Science & Technology Division, Commonwealth Secretariat, 1993 to 1997; as Secretary, Commonwealth Science Council and Science Advisor to the Commonwealth Secretary-General, 1991-1997; Secretary-General, National Science Research Council (NSRC), Guyana, 1979-1991; Dean, Faculty of Natural Sciences, University of Guyana 1976- 1979; Director, Institute of Applied Sciences and Technology in Guyana, 1980-1991.

Since 1997, Dr Trotz – in his capacity as Manager for the GEF-funded CPACC, and latterly the CIDA-funded ACCC projects – has been giving direction to the region's efforts to build capacity for climate change adaptation. He has presented more than thirty (30) papers/lectures at a range of regional and international fora on climate change issues. He has been publicly recognised in his country of birth, Guyana with the Golden Arrow of Achievement (AA) in National Honours, 1983 "for long and distinguished service in Science and Research", and more recently in Barbados, being inducted as an Honorary Distinguished Fellow of the University of the West Indies.

Ms. Judi Clarke - *Project Component Manager, Adapting to Climate Change in the Caribbean (ACCC) Project, Barbados*

Ms. Clarke read her B.Sc. in Economics and Management at the University of the West Indies in Barbados, and graduated with honours in 1995. After some time volunteering with an environmental Non-governmental Organization (NGO) whilst engaged in environmental consultancies, she gained employment with the Caribbean Planning for Adaptation to Climate Change (CPACC) project in July 1999. Very good research, writing and organizational skills allowed her to be further contracted to work with the follow-up project, Adapting to Climate Change in the Caribbean (ACCC) with which she presently works. As Project Component Manager, she has technical responsibilities for the Environmental Impact Assessment, Public Education and Outreach (PEO) and Risk Management components of the project.

Whilst involved in both regional climate change projects, Ms. Clarke has contributed to a number of technical and policy papers, and has written articles for the local media and for publications of intergovernmental organizations. In particular, she has co-authored a technical paper on the adaptation policy development experience in the Caribbean which was presented at Seventh Meeting of the Conference of Parties to the United Nations Framework Convention on Climate Change, in Marrakech in 2001. Ms. Clarke is presently conducting research in the use of the Clean Development Mechanism to cost effectively meet growing energy demands in Barbados for her thesis to complete a Master of Science in Natural Resource Management and Climate Change at the University of the West Indies in Barbados.

The following made valuable contributions to the development of these guidelines:

Dr. James Bruce
Senior Associate – **Global Change Strategies International Inc. (A division of Natsource)**

Dr. Richenda Connell
Technical Director – UK Climate Impacts Programme

Mr. John Firth
Strategic Planning Manager – Severn Trent Water

Participants in the three risk management workshops hosted by the Adapting to Climate Change in the Caribbean (ACCC) Project:

Risk Management Approach to Climate Change
– December 11-13, 2001

Risk Management Training Seminar for the Tourism and Finance Sectors
– March 5-7, 2002

Risk Management Training Seminar for the Agriculture and Water Sectors
– July 10-12, 2002

EXECUTIVE SUMMARY

Although Caribbean States generate less than one per cent of global Green House Gas (GHG) emissions, they are most vulnerable to, and stand to be severely impacted by the effects of global warming. Given their present vulnerability to climate-related events, it will be necessary for the Small Island Developing States (SIDS) and low-lying coastal States of the region to intensify the process of adaptation. Adaptation is necessary to avoid, or at least reduce much of the possible damage; and since we need many of the benefits of adaptation today, regardless of climate change in the future, many of the adaptive strategies for climate can be "win-win"[2].

The Caribbean region is characterized by its heavy dependence on economic activities in the coastal zone and a high degree of coastal settlement. These factors are mainly responsible for increased vulnerability to sea level rise and to other climate variability and change impacts. Adaptation to climate variability and climate change is a problem involving risks and choices.

The purpose of this manual is to provide a risk management framework to guide the decision-making process related to the identification and implementation of appropriate climate variability and climate change adaptation options for the Caribbean.

The following guiding principles are utilized throughout the manual and should be fully considered and incorporated in each step within the decision making process:

1. Stakeholder involvement
2. Communication
3. Promotion of sustainable development
4. Documentation
5. Maximization of the use of existing tools, human and technical resources
6. Maximization of the use of local expertise and knowledge
7. Public education and awareness.

The risk management process provides a systematic, informative and science-based tool to help decision makers analyse the risks (and benefits) of climate variability and change, and select optimal courses of action. The following six steps define the process:

1. Getting Started
2. Analysing the Climate Variability or Climate Change (CV/CC) Hazard
3. Estimating the Risk

[2] A "win-win" strategy, also known as a "no regrets" strategy is one whereby there will be net social benefits whether or not anthropogenic climate change becomes a major problem.

4. Evaluating the Risk
5. Adaptation, Risk Control and Financing
6. Implementation and Monitoring.

The process is explained in detail in the following sections of this manual and an example is provided illustrating each step to help you and your risk management team understand the key elements.

The completion of one step leads logically to the next or stops if the process has reached a resolution of the hazard/risk. If new information arises or your group wishes to improve the accuracy of the data or assumptions, they can return to the beginning of the step or go back to a previous step. This manual will lead you through each step in such a way that you and your team will easily follow it. For each step the manual will:

1. Describe the purpose of the step
2. Outline what to do and explain how to do it
3. Describe the expected results
4. Explain how a decision is made at the completion of the step (except for Step 1)
5. Provide a checklist as an *Aide Memoire*
6. Provide an example.

The focus of the example is how changing precipitation patterns in the Caribbean may lead to reduced water availability and how this in turn may affect some aspects of the hotel tourism sector.

A range of relevant information on climate change hazards, climate scenarios and adaptation choices are provided in the annexes to the manual.

TERMS USED IN THESE GUIDELINES

The following definitions apply in this guideline and are taken from the Canadian Standard CAN/CSA-Q850-97 unless otherwise specified. Where it will add to clarity, the definition of a term is included in the text when that term is first used.

ACCC – Adapting to Climate Change in the Caribbean – CIDA-funded program 2001-2004

Adaptation – Adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation (*Climate Change 2001: Impacts, Adaptation and Vulnerability*. IPCC, TAR, 2001).

Adaptation benefits – the avoided damage costs or the accrued benefits following the adoption and implementation of adaptation measures (*Climate Change 2001: Impacts, Adaptation and Vulnerability*. IPCC, TAR, 2001).

Adaptation costs – costs of planning, preparing for, facilitating, and implementing adaptation measures, including transaction costs. (*Climate Change 2001: Impacts, Adaptation and Vulnerability*. IPCC, TAR, 2001)

Adaptive capacity - the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or cope with the consequences. (*Climate Change 2001: Impacts, Adaptation and Vulnerability*. IPCC, TAR, 2001)

CCCCC – Caribbean Community Climate Change Centre (www.caribbeanclimate.org)

Climate change (CC) – a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods (UNFCCC).

Climate scenario – projection of future climatic conditions.

Climate variability (CV) – climate variability refers to fluctuations in climate over a shorter term – the departures from long-term averages or trends, over seasons or a few years, such as those caused by the El Niño Southern Oscillation phenomenon.

Consequences – Risk is often expressed as the product of the consequences flowing from an event and the frequency of the event. In these guidelines, we use the term "impacts" for consistency with the terminology of climate change.

Dialogue – a process for two-way communication that fosters shared understanding. It is supported by information.

Hazard – a source of potential harm, or a situation with a potential for causing harm, in terms of human injury; damage to health, property, the environment, and other things of value; or some combination of these.

Hazard identification – the process of recognizing that a hazard exists and defining its characteristics.

IPCC – Intergovernmental Panel on Climate Change

Impact – Something that logically or naturally follows from an action or condition related to climate change or climate variability.

Loss – an injury or damage to health, property, the environment, or something else of value.

Organization – a company, corporation, firm, enterprise, or institution, or part thereof, whether incorporated or not, public or private, that has its own functions and administration.

Residual risk – the risk remaining after all risk control strategies have been applied.

Risk – the chance of injury or loss as defined as a measure of the probability and severity of an adverse effect to health, property, the environment, or other things of value.

Risk analysis – the systematic use of information to identify hazards and to estimate the chance for, and severity of, injury or loss to individuals or populations, property, the environment, or other things of value.

Risk assessment – the overall process of risk analysis and risk evaluation.

Risk communication – any two-way communication between stakeholders about the existence, nature, form, severity, or acceptability of risks.

Risk control option – an action intended to reduce the frequency and/or severity of injury or loss, including a decision not to pursue the activity.

Risk control strategy – a program which may include the application of several risk control options.

Risk estimation – the activity of estimating the frequency or probability and consequence of risk scenarios, including a consideration of the uncertainty of the estimates.

Risk evaluation – the process by which risks are examined in terms of costs and benefits, and evaluated in terms of acceptability of risk considering the needs, issues, and concerns of stakeholders.

Risk information library – a collection of all information developed through the risk management process. This includes information on the risks, decisions, stakeholder views, meetings and other information that may be of value.

Risk management – the systematic application of management policies, procedures, and practices to the tasks of analysing, evaluating, controlling, and communicating about risk issues.

Risk perception – the significance assigned to risks by stakeholders. This perception is derived from the stakeholders' expressed needs, issues, and concerns.

Risk scenario – a defined sequence of events with an associated frequency and consequences.

Stakeholder – any individual, group, or organisation able to affect, be affected by, or believe it might be affected by a decision or activity. The decision makers are also stakeholders.

Stakeholder analysis – identification of individuals or groups who are likely to have an interest in the risk management issue including a consideration of what their needs, issues and concerns would be and how the stakeholder should be included in the process.

TAR – Third Assessment Report of the IPCC

UNFCCC – United Nations Framework Convention on Climate Change

Vulnerability – the degree to which a system is susceptible to, or unable to cope with adverse effects of climate change, including climate variability and extremes. Vulnerability is the function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity (*Climate Change 2001: Impacts, Adaptation and Vulnerability.* IPCC, TAR, 2001).

INTRODUCTION

The changing climate affects many aspects of Caribbean life and economy – agriculture, water availability, health, the coastal zone, tourism and, of course, the frequency and severity of disasters from storms, floods and droughts. Most of the disasters in the Caribbean region are climate related – hurricanes, floods, drought, landslides – and occur with present-day climate variability. It is anticipated that projected climate change will exacerbate the already disastrous impacts of climate variability and will change the environment in which resources and economy are managed and ecosystems changed. Although Caribbean States generate less than one per cent (1%) of global Green House Gas (GHG) emissions, they are most vulnerable to, and stand to be severely impacted by global warming. Given their present vulnerability to climate-related events, it will be necessary for the Small Island Developing States (SIDS) and low-lying coastal States of the region to intensify the process of adaptation. Adaptation to climate change refers to adjustments in natural and human systems in response to actual or expected climatic stimuli or their effects. Adaptation is necessary to avoid, or at least reduce much of the possible damage; and since we need many of the benefits of adaptation today regardless of climate change in the future. For example, increased protection of agriculture, improved flood defences, more efficient use of water, better malaria control are many of the adaptive strategies for climate can be "win-win".

The Caribbean region is characterized by its heavy dependence on economic activities in the coastal zone and a high degree of coastal settlement. These factors are mainly responsible for increased vulnerability to sea level rise and to other climate variability and change impacts. Studies initiated under the Caribbean Planning for Adaptation to Climate Change (CPACC) project have indicated the need for a suite of adaptation responses in the following categories:

- Legislative (e.g., building codes, setbacks, etc)
- Infrastructure (e.g., adjusted design parameters, coastal protection)
- Behavioural (e.g., water conservation, care of natural ecosystems etc.).

However, it is difficult to convince policy makers to take action due to the rather imprecise nature of the responses identified to date and the projected timeframe within which climate change phenomena are expected to materialise. A useful strategy for encouraging action is to promote activities which contribute to national sustainable development goals and which need to be carried out in any event – the so called "win-win" ("no regrets") approach referred to earlier. There is an urgent need for a more robust approach to the identification of appropriate adaptation responses in the face of limitations in the precision of regional climate change scenarios.

Quantitative projections of the trend and extent of sea level rise (SLR) and other factors related to climate change in the region remain approximate. This means that adaptation planning has to be pursued in an environment of uncertainty. Risk management as a tool has been usefully applied in the design and selection of strategies for coping with areas of uncertainty.

Some of the strengths to this approach are:

- the capacity to integrate multiple factors;
- its possession of some level of predictive capability; and
- if prudently applied it can reduce the level of vulnerability of a given exposure unit.

These guidelines have been developed to serve as a user-friendly risk management framework to assist the process of decision-making concerning the selection and eventual implementation of adaptation options.

The complexity of assessing the optimal course forward – where there are uncertainties about the needs, the objectives, the process or the outcomes or any number of other parameters – often encourages denial, delay or deferral of necessary action. The risk management process provides a framework for managing the selection of adaptation strategies for those aspects of climate variability and change impacts that create or increase a risk to the Caribbean region, its member states, citizens, infrastructure, economies and environment. Risk management is a decision-making tool that assists in the selection of optimal, or the most cost-effective strategies using a systematic, proven process that is open to the public.

The process necessitates the inclusion of a wide variety of concerned stakeholders. This inclusiveness offers opportunities for raising awareness, bringing bright new ideas into the decision-making process and learning about stakeholder perceptions of the potential risks involved. In addition, a carefully managed, informative and science-based process with a secure and accessible document "trail" will benefit all users of the results.

This process moves away from precipitous action toward a more measured regime of strategy development, evaluation, continuous monitoring and results measurement leading to improvements in regional capacities and resilience.

The uncertainties of climate variability and climate change pose a challenging decision-making environment. Additionally, for some aspects a long lead-time exists between the action taken to deal with climate risks and the realisation of the benefits to be derived from such action. This hiatus adds to the uncertainty involved in the process. As such, decision makers must rely to a large extent on informed judgement. Within the Caribbean context, decision-making has traditionally been approached

rationally, based on the availability of technical information and the evaluation of options. This traditional approach often gives insufficient consideration to risk or the acceptability of risk. This risk management approach therefore offers a methodology to refine this process and brings a greater level of objectivity to it.

This manual is consistent with, supports and builds upon the existing international, regional and sub-regional mandates which address sustainable development, the inherent linkages of climate variability and change with disaster management and the specific concerns of Small Island Developing States (SIDS). These include:

- The Barbados Programme of Action for Small Island Developing States
- The St. George's Declaration of Principles for Environmental Sustainability in the Organization of Eastern Caribbean States (OECS)
- Declaration of the World Summit on Sustainable Development
- The Strategy and Results Framework for Comprehensive Disaster Management (CDM) in the Caribbean (developed by CDERA)
- International Strategy for Disaster Reduction.

At the national level, a number of initiatives have taken place or are currently taking place which may be utilized to support capacity-building for adaptation to climate variability and climate change. These present critical opportunities for, and mechanisms by which the integration of the risk management process may be useful.

Vulnerability to the potential impacts of climate variability and change is not equitably distributed across countries within the region or within countries. Interventions that aim to reduce this vulnerability can be designed to support the goals of poverty reduction at the national and regional levels.

To illustrate how the steps of the risk management process may be applied, an example is used throughout these guidelines. Based on climate change projections for the Caribbean region, and studies carried out under the CPACC project, reduced water availability is considered to be a likely effect of climate variability and change. We have therefore, for the purposes of illustrating these guidelines, applied the process to water availability for the hotel tourism sector in one Caribbean country, bearing in mind the linkages to other sectors.

PURPOSE OF THESE GUIDELINES

The purpose of these guidelines is to provide a risk management framework to guide the decision-making process related to the identification and implementation of appropriate climate variability and climate change adaptation options for the Caribbean.

The specific objective of these guidelines is to describe and illustrate the steps of the Caribbean risk management decision-making process for adaptation to climate variability and climate change.

GUIDING PRINCIPLES

The following key principles are utilized throughout these guidelines and should be fully considered and incorporated in each step within the decision-making process.

STAKEHOLDER INVOLVEMENT

Key stakeholders should be identified and involved during the entire process. However, the stakeholder composition may be modified at various stages throughout the process as appropriate to the situation being addressed.

COMMUNICATION

A transparent communication process between the risk management team and stakeholders during the decision-making process should be ongoing to:

- acquire relevant information
- build public awareness of the particular risk and gain support for the process
- facilitate consultation
- evaluate stakeholder acceptance of risks
- serve as a monitoring and review mechanism.

PROMOTION OF SUSTAINABLE DEVELOPMENT

The integration of the outputs of the risk management process into national development planning should assist in achieving sustainable development goals.

DOCUMENTATION

An appropriate standardized method of documentation should be identified and used throughout the risk management process to:

- ensure consistency in execution
- promote accountability and transparency
- develop records for future reference or applications.

MAXIMIZATION OF THE USE OF EXISTING TOOLS, HUMAN AND TECHNICAL RESOURCES

At the national and regional levels stakeholders may provide existing resources including data sets, technical methods and documentation of previous experiences which should be incorporated into the process to the extent possible. This does not preclude the development of new tools where required.

MAXIMIZATION OF THE USE OF LOCAL EXPERTISE AND KNOWLEDGE

Local communities often possess valuable knowledge which should inform the decision-making process. As such, local participation should be ensured.

PUBLIC EDUCATION AND AWARENESS

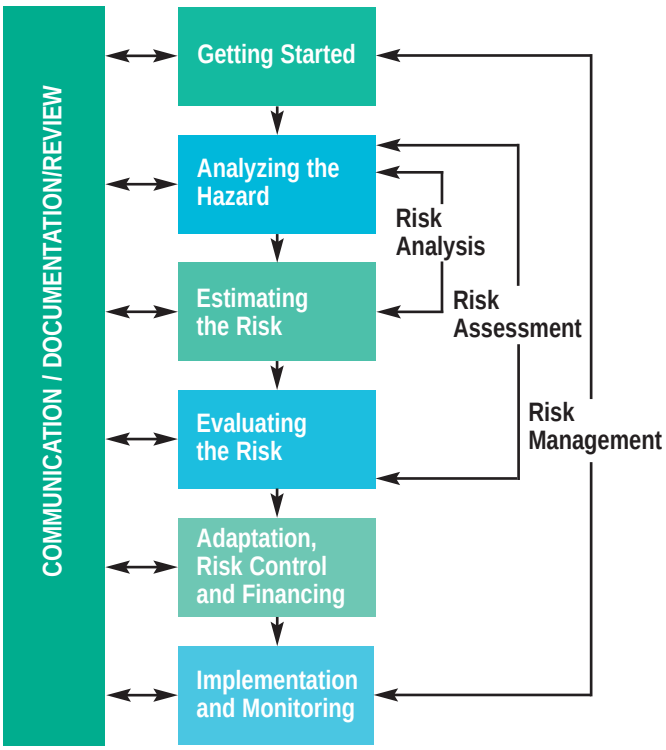
A fundamental activity that should be carried out whilst implementing the risk management process is that of public education and awareness – of climate variability and climate change issues as well as of the risk management process itself. This would ensure wide stakeholder support for implementing the outputs of the process.

OVERVIEW OF THE RISK MANAGEMENT PROCESS

The *hazards* posed by climate variability and climate change create some risk. Activities undertaken by governments, corporations and others to respond to these hazards consider options to accommodate, reduce or control the attendant risks. Additionally, where climate variability and change create beneficial opportunities, these too should be considered. The risk management process provides a systematic, information and science-based tool to help decision makers analyse the risks (and benefits), and select optimal courses of action. The process helps to raise awareness of the importance of identifying and involving stakeholders. It should also help to provide a document trail to support the decisions that are made.

The decision-making process consists of six steps as illustrated below.

FIGURE 1: Steps in the Risk Management Process[3]



These are the main activities in the risk management process. The various feedback loops ensure the process accounts for all information and perspectives.

The figure also shows how the risk communication process with key stakeholders and the public integrates with all stages of the process.

It also shows that records are kept of all significant activities throughout the process.

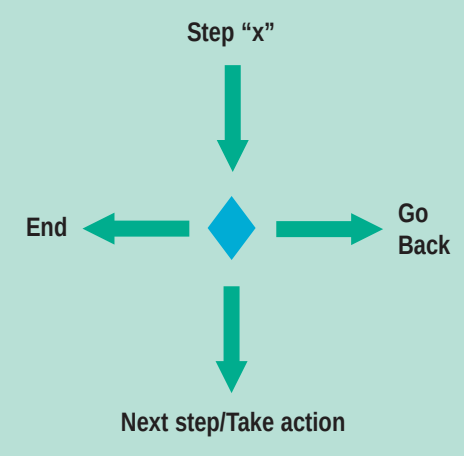
The process is explained in detail in the following sections of this manual and an example is provided illustrating each step to help you and your risk management team understand the key elements.

The completion of one step leads logically to the next or, stops if the process has reached a resolution of the hazard/risk. If new information arises or your group wishes to improve the accuracy of the data or

[3]Adapted from the Canadian Standards Association, 1997, CAN/CSA-Q850-97, *Risk Management Guideline for Decision-Makers.*

assumptions, they can return to the beginning of the step or go back to a previous step. The decision choices to be made at the end of each step are shown in the following illustration.

FIGURE 2:
Decision at Completion of a Step – "Decision Diamond"



This manual will lead you through each step in such a way that you and your team will easily follow it. For each step the manual will:

1. Describe the purpose of the step
2. Outline what to do and explain how to do it
3. Describe the expected results
4. Explain how a decision is made at the completion of the step (except for Step 1)
5. Provide a checklist as an *Aide Memoire*
6. Provide an example.

It is emphasised throughout the risk management process that stakeholder perceptions of the risk – and their acceptability of certain levels of risk – is not always related to the actual measure of impact and frequency with which the event occurs. For example, an individual may perceive the health risk of smoking to be very low whereas the proven risk is very high. The same individual may perceive the danger by being attacked by a shark while swimming at the beach to be very high whereas the proven risk is very low. Frequent interaction and dialogue with all stakeholders should incorporate distorted or sensitive risk perceptions into the process. This stakeholder involvement and dialogue will facilitate education and enlightenment about the true nature of the hazard and risk(s) presented.

To assist the user of this manual in understanding the risk management process, an example based on the impacts of climate variability or change on water availability for the tourism sector is inserted at the end of each step. A list of tools and techniques that may be used at each step is provided in Annex I.

To keep the example simple, a small "slice" of an adaptation issue has been selected. Climate variability or climate change affecting water resource management in the Caribbean includes changes in rainfall, increased evaporation, higher temperatures and higher sea levels. These changes can

have profound effects on water quality and ultimately reduce freshwater availability and can also result in droughts and floods. The focus of the example is how changing precipitation patterns in the Caribbean may lead to reduced water availability and how this in turn may affect some aspects of the hotel tourism sector. The reader should bear in mind that reduced water availability would have indirect impacts on other sectors such as agriculture and health, by reducing food production and causing health and sanitation problems, which can in turn affect the tourism sector.

A risk management approach is therefore adopted to assess the risks of reduced water availability on the hotel tourism sector, since tourism is an important source of revenue in the Caribbean. Tourism earnings represent 21 to 34% of GDP for most countries of the Caribbean. The example is not intended to be a complete in-depth risk management analysis, but instead will provide the reader with an example of how to utilize the risk management approach to help make good decisions about adaptation options.

STEP 1: Getting Started

1. PURPOSE

This step captures the administrative process and identifies the specific problem(s)/hazard(s) and the associated risks. It would also identify the stakeholders and the project team, especially those with the relevant expertise, and list the responsibilities of each member of the project team and the resources needed to complete the risk management framework. The decision makers and the project team are linked in this process by the workplan timeframe and reporting processes. A 'task sheet' template is provided in Annex II to assist in planning this step and in carefully recording information about the team, stakeholders and resource requirements for the entire risk management process. When completed, the task sheet becomes invaluable to the process as it provides the foundation upon which the rest of the risk management framework is constructed.

2. WHAT TO DO AND HOW TO DO IT

2.1 Define the Hazard(s) and Risk(s)

The Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC) predicts that if the present global trend of Green House Gas emissions continues, global sea level is expected to rise by 0.09 to 0.88 metres and global mean temperature to increase by 1.4 to 5.8°C by the end of this century. The TAR also reinforces the observation that impacts of sea level rise and temperature increases are likely to be more severe on Small Island Developing and low-lying coastal States. More detailed, downscaled climate change scenarios for the Caribbean will be provided through the CIDA-funded ACCC project and the GEF-funded Mainstreaming Adaptation to Climate Change (MACC) Project. Studies carried out by the CPACC and ACCC projects in the Caribbean region reveal that countries are very vulnerable to climate change impacts. Specifically, the following sectors were considered to be at risk:

- human settlements
- tourism
- agriculture and food security
- water
- health
- banking/insurance
- infrastructure
- coastal, marine and terrestrial ecosystems.

Potential risks can be identified for each of these sectors. To determine the risks to which sectors are exposed it is necessary to examine their vulnerability to specific hazards. Potential hazards expected from climate variability and climate change include:

- Increased atmospheric and sea-surface temperatures
- Decreased precipitation on average in the rainy season and increased annual evaporation
- More intense storms[4]
- Changing weather patterns
- Sea level rise

Trends in these directions have already been observed in the Caribbean.[5]

2.2 Define the Project Team and Stakeholders

The team should be selected based on the expertise required to address the hazards(s) identified, as well as on the key/focal organization responsible for implementing the adaptation option(s) agreed upon at the end of the process. Additionally, the team members should be very honest about their own capabilities, resources, objectives and timescales. The risk management team may change its composition throughout the process as needed, but its primary function must be maintained: to offer technical expertise to ensure acceptable and informed decisions.

A stakeholder is anyone that effects or can be affected by decisions made in the context of the risk management process. As such, this group can be large and diverse. It is therefore important to engage in stakeholder dialogue early in the process so that needs and concerns are communicated to the risk management team. This group may also evolve throughout the process.

3. EXPECTED RESULTS

- Risks defined.
- Project team established.
- Terms of reference for project team developed and approved.
- Modalities for communication established.
- Collection of documentation begun for the risk information library.
- Stakeholders identified and preliminary analysis of their needs, concerns and probable issues completed.

[4]IPCC projects that tropical cyclones (hurricanes) are unlikely to increase in frequency, but the most severe ones would increase in intensity in a warmer world. For heavy rain events, an increase in frequency is also projected.

[5]IPCC TAR, Peterson, T. C. et al., 2002. Recent changes in climate extremes in the Caribbean region, *J. Geophys. Res-Atmospheres*, 107, #D21 4601.

4. CHECKLIST

The following checklist should be completed to ensure the stated tasks have been accomplished.

Getting Started

1.	Have you defined the problem and the risk issues?
2.	Have you identified the stakeholders and their probable issues, needs and concerns?
3.	Have you identified the project team?
4.	Have you decided on the resources needed and identified the existing capacity that may facilitate the process?
5.	Have you set up the communication mechanism between the project team and stakeholders?
6.	Have you determined the responsibilities of the project team?

Example for STEP 1: Getting Started

a) Defining the Problem

For the purposes of this example we will assume there is the need to address possible impacts of climate change on the hotel tourism sector in a country, and in particular, changed precipitation patterns that have led to reduced water availability.

b) Defining the Risk(s)

It is anticipated that reduced water availability could affect the amount of fresh water directly available to the tourism industry, for example for hotel and resort operations. It could also result in reduced food production, health and sanitation problems, less available water for domestic uses, increased intersectoral conflicts due to competition for water (e.g. agriculture/tourism), land degradation and soil erosion, damage to water infrastructure and dust pollution all of which could impact the tourism sector.

c) Identifying the Stakeholders

This suggests a possible composition of the project risk management team:

- Department of Meteorology
- National water authority
- Hotel Association
- Tourist Board
- Ministry of Health
- National Climate Change Committee
- Ministry of Agriculture
- Department responsible for Sanitation.

d) Defining Project Team (Terms of Reference)

Some activities may include:

i. Review hydro-meteorological data to define past magnitude and future likelihood and potential magnitude of drought, identify potential impacts on water resources, water availability and demand.

ii. Identify and evaluate potential adaptation measures.

iii. Develop draft implementation plan within six months.

iv. Seek approval from relevant body for implementation.

v. Begin thinking about how the key and other stakeholders in this issue (tourism industries, news media, tourists themselves, farmers, utility operators, others) will be communicated with and when.

STEP 2: Analysing the Climate Variability or Climate Change (CV/CC) Hazard

1. PURPOSE

This is a very important step in the risk management approach to decision-making. Having completed the checklist in the "Getting Started" step, we need to begin to define the CV/CC hazard and the potential risks to the community. What is it that will cause harm, in terms of injury, damage to property, the environment or monetary losses? See Annex III for a summary of anticipated impacts resulting from climate variability and change. The potential risks will be the probability (likelihood) and severity of the CV/CC hazard.

What we are attempting to do at this stage is to develop risk scenarios, where each scenario is a sequence of events caused by the CV/CC hazard and the potential impacts that may follow. Each scenario becomes an accounting line item, i.e., a monetary value is established where possible, and/or some qualitative expression is used to define the potential loss; the total risk would be the sum of all these items.

2. WHAT TO DO AND HOW TO DO IT

The risk management team identifies the type of CV/CC hazards that are of concern. For each of these hazards, the team defines a sequence of events and the potential impacts that could occur. For example, a shortage of potable water may cause some tourism facilities to close, could cause adverse health effects, etc. These risk scenarios will form the basis for the more detailed risk estimations and risk evaluations to be conducted in Steps 3 and 4.

In this step, the risk scenarios will be developed or expanded to show the types of losses or impacts that could occur as a result of exposure to the hazard. Losses could include, health losses due to illness, injury or death, property losses, economic losses and environmental losses. The risk management team will decide the level of detail to be included at this stage. Historic records and projections made by subject matter experts will be useful sources for assigning initial estimates of frequency and the magnitude of impact during this preliminary analysis.

Now that the risk scenarios are developed, further work should be done on the analysis of stakeholders and their likely needs, issues and concerns that was started in Step 1. Specific groups and individuals who might be engaged to participate in the risk management process should be identified at this step, along with their contact information.

As work progresses during this step more information will become available that should be kept for the risk information library. The *risk information library*[6] should be made freely available to key stakeholders

[6]Definition: a collection of all information developed through the risk management process. This includes information on the risks, decisions, stakeholder views etc. (CAN/CSA-Q850-97).

(including other project management teams assessing other climate change risks) and the wider public.

This library will become a major mechanism to track concerns, stakeholders, decisions and changes. Properly filed information is the lifeblood of informed decision-making. The risk information library should include:

- baseline data and information on the hazard
- roles and responsibilities of the risk management team (Project Team)
- full listing of the risk scenarios and the completed matrices (See Step 3)
- stakeholder identification and contact information
- decisions taken and the assumptions/ reasons
- scope of decisions to be made and the identity of the decision makers
- stakeholder information and minutes of meetings with stakeholders
- news media reports that have been made to date.

Establishing a baseline for the hazard(s) is essential if plausible scenarios are to be developed. In the context of the example used in this text, the risk management team might source baseline information on the following:

- number of hotels, locations, number of bed spaces
- proposed hotel developments
- water consumption data (average and peak; annual, seasonal, daily)
- water sources
- water quality data for each source
- water-borne diseases
- tourism projections
- leakage
- competing demands for water
- utilisation of existing water infrastructure and resources
- capability of water infrastructure to respond to changes in demand, etc.

It is also important to record the source of the information, date collected, assumptions made and data weaknesses. Additionally, data and information gaps should be identified in the baseline and a plan for undertaking additional information gathering exercises should be

developed. If baseline information is not available at this stage, the risk management team should support research to complete the baseline.

The risk management team should also begin to consider its plan for communicating information about the risks that have been identified and are going to be further examined. The team should determine how open and transparent the process would be. A plan should be developed for providing information to stakeholders, news media outlets, and concerned politicians and so on.

3. EXPECTED RESULTS

- Hazards related to CV/CC identified and documented.
- Baseline established, and/or plans made to collect baseline data.
- Risk scenarios developed and a preliminary analysis completed for each showing the potential losses.
- Important reference material documented and stored.
- Further analysis of stakeholders completed, profiles and contact information documented. Initial communication commenced with key stakeholders.
- Risk information library started and rules for document collection established.
- Outline of risk communications plan completed.

4. MAKING A DECISION

Decisions made between each step are determined by using the "Decision Diamond" in Figure 2 (page 7) There are three possible choices: End, Go Back, or Next Step/Take Action.

End

At this early stage, if the hazard(s) and risk(s) identified are agreed to be acceptable by stakeholders, or they no longer exist, the process can be ended. For instance, if new legislation mandates that all hotels over a certain number of rooms construct a desalination plant, and the government subsequently constructs a similar plant to service the public water supply, then reduced aquifer and surface water availability may not pose a risk; OR

Go Back

This decision may be necessary to improve the completeness of the previous step. With climate change and variability, in particular, data and assumptions may have to be improved upon to give credibility and accountability to the rest of the risk management process; OR

Next Step/Take Action

Going to the next step in the process implies taking action since the identified hazard(s) and risk(s) are assessed to be unacceptable and the risk management process needs to be applied. The team should now proceed to the next step, 'Estimating the Risk'.

5. CHECKLIST

The following checklist should be completed to ensure the stated tasks have been accomplished.

Analysing the CV/CC Hazards

1.	Have you listed all possible hazards?
2.	Have you developed risk scenarios and completed the preliminary analysis?
3.	Have you established the baseline in the context of the hazard and the area of focus?
4.	Have you developed a stakeholder database?
5.	Have you started stakeholder analysis?

Example for STEP 2: Analysing the Climate Variability or Climate Change Hazard (CV/CC Hazard)

During the winter months, a prime tourism period, there is a severe shortage of water due to climatic change.

a) Developing Risk Scenarios

Potential risks arising from this shortage include, but are not limited to:

- lack of potable water
- lack of water for domestic uses (laundry, sanitation)
- lack of water for recreational purpose (swimming pools, golf courses)
- health hazards due to poor sanitation; dust pollution; allergies
- lack of water for agriculture disrupting local food supply to the tourism industry
- loss of livelihoods of small farmers
- others.

Each of these impacts should be expanded to create a “scenario”. For example, if potable water is not available for hotels and resorts, tourists will not come to the country. What will be the economic impacts on shops, restaurants, taxis, etc.

b) Beginning the Stakeholder Analysis

Some of the obvious stakeholders would come from tourism industries, news media, tourists themselves, farmers, utility operators, shops, restaurants, transportation sectors, governments, labour unions etc. What are their issues and concerns likely to be? Who are some of the contacts: industry associations, community groups?

c) Begin the Risk Information Library

Develop a plan for capturing all the reference and other material, such as minutes of meetings, expert advice, studies and other documents that may bear on this risk scenario. Copy and file the documents in such a way that the information and the bases for decisions can be identified and easily retrieved.

d) Making a Decision

Based on the individual scenarios, use the 'decision diamond' to:

i. End the process because the stakeholders agree the possibilities are remote or the impacts immaterial; OR

ii. Go over the first phase to assess whether the baseline and the hazard have been properly identified, and if the present risk management team is the most appropriate; OR

iii. Take action and go on to the next step:

- decide on scenarios to be used; and
- agree on stakeholder listing and communication.

Note: This step should be revisited during project implementation to reflect evolving climate change scenarios and knowledge of likely impacts, new baseline information and changing stakeholder positions.

STEP 3: Estimating the Risk

1. PURPOSE

This step involves estimating the frequency (or probability) and severity of the impact of climate variability and climate change risk scenarios developed in the previous step. It will also include a consideration of the uncertainty of the estimates.

2. WHAT TO DO AND HOW TO DO IT

In this phase of the risk management decision-making process the objective will be to assess the relative frequency and severity of the various risk scenarios identified in the risk analysis phase.

The work team will have to decide on the methods to be used to achieve this objective. For example, they may use historical records of the potential impacts of climate variability or climate change events, technical data such as that obtainable from CPACC, IPCC, statistical and scientific models, and information from experts from both within and outside the Risk Management Team. At this stage, likely climate parameters for the future should be factored into the process of determining potential climate change impacts using climate change scenarios for the region (see Annex IV). The use of outside experts such as universities, government agencies and respected consultants can add significant value by way of lending credibility to, and gaining acceptance for the outcomes of the process.

2.1 Estimating Frequency or Probability of an Event

The purpose of this particular exercise is to determine the relative frequency with which the various risk scenarios can be expected to occur over a given period of time. Typically, this can be based on historical data that can be obtained from a number of sources. These can include: regional and/or country specific scientific studies and research papers, records of extra-regional countries and areas, and insurance company records, to name a few. Such data should indicate how often particular risk scenarios have occurred in the past for use in forming a judgement as to the likelihood of their occurrence in the future, assuming a stable unchanging world. Using climate scenarios, a similar process should be undertaken to determine probable risk scenarios arising from future climate in a changing world. If there is no easy or ready access to credible data, other statistical techniques can be used as part of the iterative process. During this process it is also important to provide a timescale, where possible, showing how the risk arising from an impact may change over time. This can be used as a guide to identifying critical dates for taking action.

2.2 Estimating Severity of the impacts

Estimating severity usually focuses on determining the potential health, environmental or financial impacts of risk scenarios. In the case of commercial enterprises, financial impacts are most important when dealing with a profit-maximizing concern. Wherever possible an attempt should be made to quantify the scale of the impact using auditable data, e.g., increase in unemployment, illness, death rates, etc. However, in the context of climate change adaptation, the work team can choose to include non-financial criteria such as the loss of life, effect on GDP, environmental impacts or any other relevant measure that is suited to best expressing the potential impacts in measurable terms. If possible, some form of common scoring should be used to enable severity to be relatively ranked.

The risk management team develops an impact severity rating scale appropriate to the risk scenarios such as Table 1 shown below.

TABLE 1: Direct Impact Rating Matrix

Impact / Severity	Social Factors			Economic Factors				Environmental Factors			
	Displace-ment	Health	Loss of Livelihood	Cultural Aspects	Property Loss	Financial Loss	GDP Impact	Air	Water	Land	Eco-systems
Very low											
Low											
Moderate											
Major											
Extreme											

It may be necessary to complete several versions of Tables 1 and 2, each relating to a different scenario planning period and climate change scenario. For example, climate change scenarios may cover three timescales for thirty-year periods – the 2020's, 2050's and the 2080's and several alternative scenarios for each period. The frequency and impact ratings for any specific impact will be different depending upon the chosen timescale and climate change scenario.

2.3 Representing Frequency and Severity Estimates

Once these analyses are completed for each of the events in a risk scenario, the results can be presented in the frequency/probability and impact severity rating tables.

TABLE 2: Frequency/Probability Rating

Hazard	Very Unlikely to Happen	Occasional Occurrence	Moderately Frequent	Occurs Often	Virtually Certain to Occur
Hazards from risk scenario (deal with each separately)	Not likely to occur during the planning period	May occur sometime but not often during the planning period	Likely to occur at least once during the planning period	Likely to occur several times during the planning period	Happens often and will happen again during the planning period

Key groups of stakeholders are involved in this step of the process through dialogue. The risk management team decides on the mechanism or mechanisms for involving them, such as focus groups, workshops or meetings. It is expected that stakeholder needs, issues and concerns will change as they become more exposed to the risk management process and the information provided by the risk management team. The team will have to update its stakeholder analysis regularly.

It is almost certain that stakeholders will disagree on the frequency/impact ratings used because of their different perceptions of the risks and the degree of influence they believe they may have over future events. If a consensus cannot be achieved it is important to record the differing views on frequency and impact. At a later stage in the risk management process the sensitivities of the proposed adaptation and risk control measures to the alternative views can be tested and discussed.

At this stage of the process, risk communications will assume a very important role. Trust issues with stakeholders could arise at this juncture if the risk management team and the process are not fully open and transparent (see Annex V, Risk Perceptions and Risk Communications, for more information). The risk communications plan should be revised to take account of this by providing information about the methods used to estimate the frequency and severity of the impacts, assumptions that were used, and what reviews or third party analyses were conducted.

3. EXPECTED RESULTS

In this step the work team decides what the specific scale of the impact and frequency ratings should be to fit the categories of hazard and the risk scenarios developed in Steps 1 and 2. The probability or frequency of the occurrence of the impacts is estimated, as are their likely severity. The results of this risk estimation are rated and displayed in a format such as shown in Table 1.

Perception of the risk scenario impacts and frequency by stakeholders will also have to be taken into consideration at some point. You probably do not want to arbitrarily skew your tables of estimated impacts and

frequency, but should have some mechanism for recognizing the often over-riding perceptions of the risk by some key stakeholders (for example, when children's welfare is involved).

The results of the frequency and severity ratings of the individual impacts for each scenario can be combined to produce an indication of the average or expected value of losses or outcomes for each of the risk scenarios.

The dialogue with stakeholders is maintained and the analysis of their needs, issues and concerns is updated. The risk communications plan is implemented and monitored. The development of the risk information library continues.

4. MAKING A DECISION

At this juncture, it is appropriate to examine the process for deciding whether you should proceed, revisit the previous steps or abort the process. These decisions will relate primarily to such things as the adequacy of data, the methods of analysis and the underlying assumptions, and the weight to be attached to stakeholder perceptions.

End

Is the risk perceived to be lower than estimated? Do the stakeholders agree? If so, then no further action is probably needed, OR

Go Back

a) Have new issues arisen that need to be considered? If so then the team might need to return to the first stage of the risk management process. e.g. input from another project team assessing the risks associated with a related climate change impact

b) Is there a need to consider new or additional risk scenarios?

c) Are there any doubts about the quality of the data used in the analysis? What about the adequacy of the methods employed?

d) Are all stakeholders comfortable with the degree/level of uncertainty associated with the analysis? If not, the work team should revisit the analysis employing better techniques and/or better data, OR

Next Step/Take Action

If all stakeholders are comfortable with the data, assumptions and outcomes of the analysis, the work team can proceed to the next stage of the risk management process, Evaluating the Risk.

5. CHECKLIST

The following checklist should be completed to ensure the stated tasks have been accomplished.

Evalulating the Risks

1.	Are you satisfied with the quality of your data?
2.	Have you analysed and assigned appropriate levels of frequency and severity?
3.	Have you properly established the level of each risk?
4.	Have you adequately taken account of stakeholder perceptions and have they endorsed the analysis?
5.	Have you compared the various risk scenarios in terms of probability and severity of the impacts?
6.	Are all relevant documents and information being stored in the risk information library?

Example for STEP 3: Estimating the Risk

a) Estimate Frequency or Probability Rating

The estimation of the frequency of the occurrence of the hazard should be made using the best advice possible. In the case of water shortages due to lack of rainfall, salinisation of fresh water supplies or other events outlined in the risk scenarios, historical records supplemented by forecasts by the IPCC, universities, government departments or other credible sources would form the basis of the first estimates. The frequency of each particular event in the risk scenario would be made against a frequency rating scale such as is shown in Table 3 below.

TABLE 3: Frequency/Probability Rating

Hazard	Very Unlikely to Happen	Occasional Occurrence	Moderately Frequent	Occurs Often	Virtually Certain to Occur
Hazard 1 (deal with each separately)		X			
Hazard 2 (deal with each separately)				X	

The likely impacts of water shortage (hazard) on the social, economic and environmental factors specific to the tourism industry are assigned varying degrees of severity (from 'very low' to 'extreme') as indicated in the following matrix. A table such as the one shown below could be completed for each of the hazards in the risk scenario.

TABLE 4: Direct Impact Rating Matrix

Impact / Severity	Social Factors			Economic Factors				Environmental Factors			
	Displace-ment	Health	Loss of Livelihood	Cultural Aspects	Property Loss	Financial Loss	GDP Impact	Air	Water	Land	Eco-systems
Very low				X							
Low											X
Moderate		X			X			X		X	
Major			X			X	X				
Extreme											
Not Applicable	X								X		

The risk analysis should be endorsed by the stakeholders before proceeding to the next step. The stakeholder analysis is expanded to include new stakeholders and new issues, needs and concerns that have been brought out through the dialogue on the estimations of the frequency or probability and the impacts of the hazards.

The risk information library is updated with all the studies, interviews and other baseline data that was used for the risk estimation including the working papers of the risk management team.

STEP 4: Evaluating the Risk

Evaluating the Risk is the process by which risks are examined in terms of costs, benefits and acceptability, considering the needs, issues and concerns of stakeholders. Steps 2 and 3, (*The Analysis of Hazards and Risk, the Estimation of the Risks*) and this step, evaluating the risk, together are referred to as 'Risk Assessment' (see Figure 1 on page 6).

1. PURPOSE

This step serves to integrate the overall risk management process. The identification of hazards and attendant risks, and the analysis of these will result in the definition of the entire risk spectrum, encompassing risks that are considered 'least severe to most severe'. In this step, your team will review and validate all the work from the previous steps, such as the identification of hazards, risk scenarios, needs, issues, concerns of stakeholders, the urgency and validity of risk data and estimations, and new issues that have arisen. Particular attention will be paid to the estimations of the levels of risk for the various risk scenarios developed in the previous step.

The purpose of this evaluation is to give consideration to:

- ranking the risks from "least severe" to "most severe" from the analyses completed earlier and the perceptions of the stakeholders
- estimating the costs of potential losses
- assessing the acceptability of the risks.

This leads to and prepares the way for the development of options for reducing the risk to acceptable levels – which will be outlined in the next step.

2. WHAT TO DO AND HOW TO DO IT

2.1 Comparing levels of risk and acceptability of risk scenarios

Review the risk scenarios using the risk estimation tables showing the impact and frequency ratings for each of the risk scenarios from the previous step (Estimating the Risk). One useful technique is to compare risk scenario ratings using an evaluation matrix such as the one shown below. An acceptability value is assigned to each based on the scale used by your risk management team. Your team would decide on the comparative ratings based on the level of risk for the shaded areas, such as in Table 5.

TABLE 5: Risk Assessment Matrix

Impact Severity	Frequency/Probability				
	Very Unlikely to Happen	Occasional Occurrence	Moderately Frequent	Occurs Often	Virtually Certain to Occur
Extreme					
Major					
Moderate					
Low					
Very Low					

Extreme risk: This indicates an unacceptable level of risk that requires immediate controls to move the activity out of the extreme range.

High risk: This level will require high-priority control measures to reduce risk to an acceptable level.

Moderate risk: Some controls will be required to move this risk scenario to lower levels.

Low risk: Probably no controls are needed. However, depending upon stakeholder perceptions, some low-level controls or other actions such as public education and awareness may be desirable.

Negligible risk: Scenarios in this category probably do not need to be considered further.

The following activities may be conducted to assist in this step.

- Estimate the costs of the impacts and any benefits that may be apparent. For example, if reduced water availability may make it too costly to irrigate a golf course, there will be costs in lost tourist patronage of the golf course. If the golf course closes, there may be benefits to the community if the land reverted to residential housing.
- Consider and analyse perceptions of key stakeholders, including the general public.
- Assess the acceptability of risks, cost, benefits, etc., to stakeholders (including governments, communities, economic sectors, etc.). It is important to remember that people who deal regularly with risks view them differently than laypersons. This makes an interactive dialogue with stakeholders very important at

this step to accurately determine the level of acceptability of the risk to the various stakeholder groups.

- Increase the dialogue with key stakeholders and begin identifying various risk control, avoidance or prevention strategies for risks that are unacceptable.
- Ensure that all important information is stored in the risk information library.

3. EXPECTED RESULTS

- Acceptability of risks assessed.
- All unacceptable risks prioritized.
- Costs of potential losses and benefits estimated.
- Dynamic interactive dialogue with stakeholders continued.
- Risk information library updated.

4. MAKING A DECISION

At this stage, the following decisions may be made:

End

a) Have the stakeholders have agreed that the risks are acceptable?

b) Have the stakeholders have agreed that the benefits derived from implementing the adaptation options do not justify the costs of implementing the latter, OR

Go Back

a) Are data and information insufficient to make decisions on the acceptability of risks?

b) Were stakeholder consultations less rigorous than they should have been?

c) Were all stakeholders are party to developing the conclusions?

d) Is relevant frequency/impact information available from another risk management project team, OR

Next Step/Take Action

If there is consensus amongst stakeholders that the risks are unacceptable and that controls or other means for reducing the risk will have to be implemented, then proceed to the next step.

5. CHECKLIST

The following checklist should be completed to ensure the stated tasks have been accomplished.

Evaluating the Risks

1.	Are the risk evaluation criteria accurate and do they include the major issues that should be taken into account?
2.	Have you ranked which risks are acceptable and which are not?
3.	Have you ranked the unacceptable risks in order of priority for adaptive response?
4.	Have you sought and included stakeholder views on risk acceptability/ unacceptability?
5.	Is there consensus among stakeholders and the decision organization that risks can and should be controlled or modified?
6.	Is the risk information library up-to-date?

Example for STEP 4: Evaluating the Risk

Review the data that has been recorded during the risk estimation process in a series of tables such as Table 1 (Direct Impact Rating) and Table 2 (Frequency or Probability Rating) in the previous step. This information is used to discuss the risks with other experts and stakeholders and to arrive at an evaluation of the seriousness of the risk. By aggregating the data from the tables and the perceptions of the risk from stakeholders and experts, a Risk Assessment Matrix can be developed to portray the overall level of risk for each risk scenario. The example of reduced water availability for the hotel industry is shown in Table 6. It can be seen that this exposes the industry to extreme risks which may lead to loss of livelihoods and financial loss to stakeholders and therefore require immediate control. The severity of impact increases from the bottom to the top of the table and the probability or frequency of the event increases from left to right. Risks that are positioned in the upper right of the table are extreme and the severity decreases with risks positioned closer to the bottom left. This graphic display is useful for ranking the risks by severity and in discussing the overall risk levels with participants in the process.

TABLE 6: Risk Assessment Matrix

Impact Severity	Frequency/Probability					
		Very Unlikely to Happen	Occasional Occurrence	Moderately Frequent	Occurs Often	Virtually Certain to Occur
	Extreme					
	Major					
	Moderate					
	Low					
	Very Low					

Extreme Risk – Loss of livelihood, financial loss, GDP Impact

High Risk – Health, Property Loss, Ecosystem degradation (Air Quality, Land Quality)

Moderate Risk – Cultural Aspects

This information can be used to compare the relative importance of risk scenarios, and in the cost/benefit analysis of alternative risk control and risk financing options in the next step.

This aggregated information and the analysis worksheets should be added to the risk information library along with notes from meeting and discussions with stakeholders.

STEP 5: Adaptation, Risk Control and Financing

Since we are in fact, dealing with a natural phenomenon over which we have no control, the appropriate climate change response for the Caribbean region is 'adaptation'. The IPCC defines 'adaptation' as:

> *'… the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.'*

From National Climate Change Adaptation Policies and Implementation Plans developed under the CPACC project, and from First National Communications of CARICOM countries, several adaptation strategies covering the range of vulnerable sectors have been identified and are outlined in Annex VI.

1. PURPOSE

The decision at the previous step, 'Risk Evaluation' predetermines the risk control and financing required at this stage. This step will produce strategies that will result in all risk issues and concerns considered in the process, becoming acceptable. It is extremely important to remember, when considering adaptation and risk control responses, that project teams and key stakeholders take time to review all relevant political, social, economic and environmental action plans. Actions taken elsewhere by governments, organisations and individuals, etc., in response to non-climate change issues will impact both directly and indirectly on the risk management process undertaken here and determine the viability of the proposed responses to climate change. For example, it would be counter-productive to consider recommending wide-scale investment at the national level in securing additional water resources to maintain supply to the tourism industry, if the individual hotels are already intending to undertake their own investment in private desalination plants.

Usually, control strategies will consist of implementing several risk control options. The full range of options should be considered and evaluated. Control measures should be effective in reducing risk and be cost effective. It is important to note that the cost of the control measure should not exceed the value of the potential loss. Therefore an estimate of the cost of implementing the control option must be considered and factored into the evaluation.

2. WHAT TO DO AND HOW TO DO IT

2.1 Identify feasible adaptation strategies

The adaptation option(s) selected at this stage should be in accordance with the ranking developed in the Risk Assessment Matrix, based on the severity of the risk and the need to respond. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation,

private and public adaptation, and autonomous and planned adaptation. The IPCC Third Assessment Report, *Climate Change 2001: Impacts, Adaptation, and Vulnerability* describes each option as follows:

- Anticipatory adaptation – Adaptation that takes place before impacts of climate change are observed. Also referred to as 'proactive adaptation'.
- Reactive adaptation – Adaptation that takes place after the impacts of climate change have been observed.
- Private adaptation – Adaptation that is initiated and implemented by individuals, households or private companies. Private adaptation is usually in the actor's rational self-interest.
- Public adaptation – Adaptation that is initiated and implemented by governments at all levels. Public adaptation is usually directed at collective needs.
- Autonomous adaptation – Adaptation that does not constitute a conscious response to climatic stimuli but is triggered in ecological changes in natural systems and by market or welfare changes in human systems. Also referred to as 'spontaneous adaptation'.
- Planned adaptation – Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change, and that actions are required to return to, maintain, or achieve a desired state.

2.2 Evaluate risk control options in terms of effectiveness, cost and residual risks

Alternative strategies for controlling the risks identified in the previous sections are evaluated in terms of:

- effectiveness in reducing losses
- the cost to implement the option
- the impact of control measures on other stakeholder interests.

Estimate the effectiveness of the proposed options using historical data, climate projections and professional judgement. Assess new residual risk scenarios generated by the control option, which may provide unexpected beneficial/adverse side effects.

2.3 Assess stakeholder acceptance and concerns and consider how these can be addressed

This may be done by:

- communicating with stakeholders on the proposed risk control options
- evaluating any proposed control or financial strategy in terms of needs, issues and concerns of affected stakeholders.

To determine whether or not a risk is acceptable, determine whether the risk is:

- so great or the outcome so unacceptable that it must be refused altogether
- so small as to be negligible or
- falls between the two extremes above and has been reduced to the lowest achievable or practicable level.

2.4 Estimate financial issues and concerns

Risks that cannot be completely controlled or accommodated by adaptation strategies will entail some economic loss. This residual risk will have to be accepted and paid for by the government, business or individuals. An option is to transfer some or all of the residual risk to another body by such mechanisms as the purchase of commercial insurance or by making arrangements with a senior government to bear the risk. Often the costs of residual risks are shared among several organizations. An example would be the recovery costs following a severe storm where governments, insurance, businesses and individuals all bear some of the costs.

Estimates should be made by the risk management team of the costs of the residual risks and the data stored in the risk information library.

3. EXPECTED RESULTS

- Adaptation plan completed based on priority risks/hazards identified in earlier steps.
- Cost and benefits of the adaptation plan are known and documented.
- Decision on the options for financing using retention [financing using own (private sector), State (developmental) funds or borrowed capital] or transfer [primarily using insurance] techniques alone or in combination.
- Stakeholders accept risk levels including estimates of residual risk.
- Update risk information library.

4. MAKING A DECISION

End, if:

a) adaptation options to reduce risks are not feasible, OR

Go Back, if:

a) adequate data is not available for evaluating cost effectiveness of proposed adaptation options

b) key stakeholders have not been consulted

c) assumptions and uncertainties associated with estimates are not acceptable to stakeholders

d) new risks are introduced as a result of implementing the proposed adaptation option

Next Step /Take Action, if:

a) feasible adaptation options are defined and ready for implementation

b) proposed actions are acceptable to stakeholders

c) residual risks are acceptable to stakeholders or can be managed.

5. CHECKLIST

The following checklist should be completed to ensure the stated tasks have been accomplished.

Adaptation and Risk Control

1.	Have you identified feasible adaptation strategies?
2.	Have you evaluated options or strategies (cost effectiveness)?
3.	Have you addressed and assessed stakeholder concerns?
4.	Have you estimated financial issues and concerns of the residual risks?
5.	Have you identified and considered the residual or "leftover" issues, not addressed? During the adaptation process or previously mentioned?
6.	Have you decided how and when "leftover" issues should be handled?
7.	Have you updated the risk information library?
8.	Have you developed a risk communications plan for the residual risk?

Example for STEP 5: Adaptation and Risk Control

From the previous step, reference to the Risk Assessment Matrix reveals that the risks that need to be addressed arise from:

- loss of livelihood, financial loss and GDP impact [major]
- health, property loss, ecosystem degradation (air quality, land degradation) [moderate]

a) Identifying feasible adaptation strategies:

Water shortages are the hazard that we need to deal with. We then select adaptation options (See Annex VI) that would reduce the risks (loss of GDP, loss of income to the industry, loss of jobs resulting from lower hotel occupancy).

b) Possible adaptation options

i. Desalination plant (government, hotel)
ii. Water harvesting (hotel)
iii. Water conservation measures (national, hotel)
iv. Recycling grey water, e.g., for watering golf courses (hotel)

c) Evaluate adaptation strategies (cost-benefit analysis)

For each adaptation option, costs of implementation are assessed and, based on a cost-benefit analysis, a decision is made on the option or options to be pursued. A decision is also made regarding the agency responsible for implementation (finances, management oversight, etc.) and consultation with relevant stakeholders is carried out to ensure agreement and support for proposed course of action.

For the purposes of this example, let us assume that the following three (3) options are selected, full proposals for implementation developed and deemed feasible, and required resources obtained.

i. A desalination plant is built. This is the responsibility of the national water authority that is sensitive to the need for water in other critical sectors.
ii. Water harvesting (rain water capture) techniques are employed. This is carried out by the hotel owners.
iii. Water conservation is also implemented as a joint action between the hotel owners and the regulatory bodies.

Once the options are selected and the risk estimation indicates that the risk will now be within the acceptable range, a dialogue with stakeholders will ensure that their perceptions of risk reduction or control are in harmony with the risk management team.

Residual risks or costs will also have to be estimated and decisions made about who should bear these – insurers, governments, users or a sharing amongst all. At this stage, updating the risk information library with the new estimations of reduced risk and with information about stakeholder acceptance is important.

STEP 6: Implementation and Monitoring

By this time, the adaptation plans or strategies have been chosen and approved for implementation and the key stakeholders have reached a consensus on the actions to be taken. Now they must be put into action, monitored and evaluated.

1. PURPOSE

- To guide the actions to be taken to reduce vulnerability to present day climate variability and projected climate change.
- To monitor and evaluate the implementation process.

2. WHAT TO DO AND HOW TO DO IT

- Develop the implementation plan.
  Before implementing the risk control and/or financing options (from Step 5), we should develop implementation plans for each adaptation project. Such plans should be linked to existing relevant programmes where appropriate. Depending on the size and cost implications of the plans this could be a complex step involving many collaborating agencies.
- Implement the plan – Once resources have been identified and institutional arrangements put in place for implementation, proceed to execute the implementation plans.
- Develop and establish the monitoring process (a number of aspects may have to be monitored such as performance, stakeholder reactions, changing circumstances, costs, effectiveness technological aspects, etc.). In Steps 2 and 3 the process of identifying and analysing the risk may suggest some measurement strategies or tools that could be used in the monitoring phase to ensure that control or adaptation measures are proceeding as planned. As well, the dialogue with stakeholders may have introduced some monitoring or measurement criteria that would be highly visible and credible with stakeholders and the general public.
- In complex adaptation scenarios, the risk management team may decide to continue the process with a second iteration of the whole process, improving and updating the information and methodology used in the first iteration. In the meantime, the action plans for the most urgent risks are underway.
- Decide when implementation of the action plan has to be started. It is possible that the timescale for the impacts may be some time in the future and a decision need not be taken at the present. If this happens, it is important to establish a review date and record in the risk information library.

- Before implementation it is essential that the following reviews are undertaken:
  a) outputs from other risk management project teams, if available and relevant
  b) relevant non-climate social, political, economic and environmental action plans.
- Communications aspects – This may involve outreach and news media fora, community meetings. Record responses and media coverage in the risk information library.

3. EXPECTED RESULTS

- Comprehensive implementation plans that include:
  a) A complete database of experts and expertise in the particular subject areas chosen for adaptation options such as water resources management, climate change, etc.
  b) A database of ongoing activities that could facilitate the implementation of the plans.
  c) Mechanisms to enhance information exchange within the industry and across sectors.
  d) Documentation of the methodology for implementation which can be made available to other vulnerable sectors.
  e) Mechanisms for training and capacity building in required areas.
  f) Mechanisms for extensive public education and outreach.
  g) Indicators of progress – the ultimate indicator is the reduction of vulnerability. This may be assessed by factors such as:
     1) the ratio of public supply water to that supplied by recycling or other means (desalination, for example).
     2) the level of awareness raised in the industry.
  h) Mechanisms for reporting on progress.
- Identification of the factors that may influence implementation of the plan and measures to address these where necessary.
- Identification of areas for opportunity for further actions to address climate change impacts.
- Risk information library updated.

4. CHECKLIST

The following checklist should be completed to ensure the stated tasks have been accomplished.

Implementation and Monitoring

1.	Have you developed a feasible implementation plan?
2.	Have you sought to identify synergies with ongoing activities (national development plans, private sector initiatives, etc.,?
3	Have you ensured that all the necessary resources are in place for implementation of the plan?
4	Have you developed an effective measurement monitoring programme to ensure objectives are being attained?
5	Have you developed an effective communications strategy to support the programme?

Example for STEP 6: Implementation and Monitoring

For the three adaptation options identified in the last step (desalination, water harvesting, water conservation), we assume that everything is in place to proceed with implementation.

For each, an implementation plan must be prepared identifying timelines for the achievement of:

- certain milestones in the project
- resources inputs and flows
- management issues
- a detailed monitoring plan to ensure minimum slippage during implementation.

The implementation plans should also include communications support strategies for key stakeholders – for example, for desalination, the community where the plant will be constructed and the public who might be asked to pay more for their water supply.

In addition, steps should also be taken to identify and lessen the impact of any residual risks arising from the implementation of the selected adaptation options. For instance, storage facilities for water harvesting may provide ample breeding habitat for mosquitoes responsible for dengue. This residual risk can be addressed through the inputs of the Sanitary Engineering Department into the design parameters of the storage facilities and arrangements for constant monitoring of the constructed facilities.

Monitoring and measurement data should also be developed. Previous records of stakeholder concerns may provide some indicators for measurement frameworks.

There may be some unresolved issues or some risks that should be further reduced that would prompt a second iteration of the whole process.

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LIST OF ANNEXES

ANNEX I

A CARICOM Risk Management Guide for Decision-making: Tools and Techniques

	Getting Started	Analyzing the Hazard	Estimating the Risk	Evaluating the Risk	Adaption, Risk Control & Financing	Implementation & Monitoring
Brainstorming	■	■	■	■	■	■
Project & task definition sheets	■	■	■	■	■	■
Consultation exercises	■	■	■	■	■	
Consensus reaching	■	■	■	■	■	■
Focus groups	■	■			■	
Analysis of interconnected decision areas	■	■			■	
Problem mapping tools	■	■			■	
Checklists			■	■		
Screening		■	■	■	■	
Ranking/dominance analysis					■	
Uncertainty radial charts			■	■		
Force field analysis					■	■
Fault/event trees		■	■	■		
Cause and effect diagrams		■	■	■		
Solution and effect diagrams					■	■
Decision/probability trees		■	■	■		
Radar diagrams					■	■
Pareto analysis		■	■			
Expert judgement	■	■	■	■	■	■
Pedigree analysis		■	■	■	■	
Scenario planning	■	■			■	

ANNEX II

Caribbean Risk Management Guidelines for Climate Change Adaptation Decision Making Project Task Sheet

PROJECT:	
PROJECT LEADER:	PROJECT TEAM:
SCOPE/TERMS OF REFERENCE:	
TASKS SUPPORTED:	
MILESTONES:	KEY ACTIVITIES:
STAKEHOLDERS:	
DELIVERABLES/OUTPUTS:	
ASSUMPTIONS/CONSTRAINTS:	
DEPENDENCIES:	RISKS:
START DATE:	COMPLETION DATE:

RESOURCE INPUTS:
HUMAN: FACILITIES:
INFORMATION TECHNOLOGY:
FINANCE:
OTHER:

DATE COMPLETED:

LINKS:

TOOLS & TECHNIQUES:

Getting Started	Analyzing the Hazard	Estimating the Risk	Evaluating the Risk	Adaptation, Risk Control & Financing	Implementation & Monitoring

NOTES

ANNEX III

Summary of Anticipated Impacts Resulting from Climate Change and Climate Variability in the Caribbean Region

BEACH AND SHORELINE STABILITY

The climate change factors that are most likely to impact coastal stability are sea level rise, changes in hurricane patterns and storm surges. In the small-island and low-lying coastal states of the region, the coastal zones usually have a high concentration of critical infrastructure, human settlements and social and economic activity. For example, ninety percent (90%) of the population of Guyana resides in the coastal strip where the main urban centres and commercial activities are found.

Beaches serve as buffer zones between the land and the water and many important birds, reptiles, and other animals nest and breed on the berm and the open beach. Sea turtles use many beaches in the Wider Caribbean to dig their nests and deposit their eggs. The beach also provides habitat for a multitude of burrowing species, such as crabs, clams, and other invertebrates. Beaches also have a significant economic value in the region as beach tourism is one of the major contributors to national economies, this is perhaps why there has already been significant interest and investment in coastal zone management all over the region.

Where coastlines are particularly vulnerable to incident waves (Dominica, Guyana and Belize) or where coastal areas are below sea level, as in the case of Georgetown, Guyana, sea defense structures have been erected. The present state of these structures is rather poor although in the past few years rehabilitation programmes have been developed. Needless to say, increased storm surge activity and sea level rise impacting on inadequate structures and exposed areas can lead to complete inundation and lost lives in some cases, and biodiversity will be affected both directly and indirectly. Lost infrastructure and the consequent effect on economic activity can reduce opportunities for social and economic development.

MARINE ECOSYSTEMS

Marine ecosystems in the Caribbean consist principally of coral reefs, sea-grass beds, mangroves and other wetlands.

Coral Reefs

For coral reefs to grow and remain healthy, the seawater in which they live must be shallow, clear, clean, warm water. Water temperatures must remain between 18 and 30 degrees Celsius throughout the year. A coral reef ecosystem provides a number of natural services and functions that

[1]Summary of stakeholder consultation on potential impacts from climate change and climate variability in the Caribbean Region undertaken for Component 4 of the Caribbean Planning for Adaptation to Climate Change (CPACC) project (1997-2001).

are of economic importance to Caribbean countries. Some of these coral reef functions and services are:

- The generation of the white sand that forms many of the beaches in the Wider Caribbean region;
- Natural attractions and a focus for a number of forms of tourist and local recreation, providing income from these activities;
- Natural breakwaters, protecting beaches, coastlines from erosion and infrastructure (roads, buildings, harbours) from direct exposure to and damage from waves, especially during storms;
- Creatation of natural protected bays and lagoons for recreational activities (swimming, water sports) and safe moorings for fishing and recreational vessels;
- Provision of habitat for economically valuable fishable resources (fish, lobster, crabs) to live and reproduce.

Despite what may seem as ideal conditions coral reefs in the Caribbean continue to exhibit signs of stress and bleaching, particularly during ENSO[2] events. Anticipated sea level rise and increased ocean temperatures are likely to increase incidents or coral damage and mortality, thereby reducing their physiological functions.

Mangrove Communities

Mangroves are expected to respond to rising sea levels and saline intrusion by retreating shoreward[3]. This readjustment of mangroves will result in changing acreage and salinity levels and also affect the fish resources since some of the commercial species have nursery areas in the mangroves. Mangroves also serve as protection against storms, tides, cyclones and storm surges and are used as filters for nutrients and to stabilize substrates. If the mangrove forest has to re-establish itself at a new location then many valuable functions will be lost. At the local level, persons who depend heavily on fish as their main source of protein would be affected when fish stocks are reduced, especially when there is competition by commercial fisheries.

Though adaptable to natural climate variability, storms may damage mangroves severely as was the case of Gilbert in Jamaica[4]. These fragile ecosystems reach maturity in about 25 years and since the average

[2]El Niño – Southern Oscillation (ENSO) phenomenon is a global event arising from large-scale interaction between the ocean and the atmosphere. The Southern Oscillation, a more recent discovery, refers to an oscillation in the surface pressure (atmospheric mass) between the southeastern tropical Pacific and the Australian-Indonesian regions. When the waters of the eastern Pacific are abnormally warm (an El Niño event) sea level pressure drops in the eastern Pacific and rises in the west. The reduction in the pressure gradient is accompanied by a weakening of the low-latitude easterly trades.

[3]Snedaker, 1993, Vicente et al, 1993.

[4]Bacon, 1989.

inter-hurricane period for most of the region is less than that, their biomass is generally considered to be limited by hurricanes[5].

Estuaries, Wetlands and Watersheds

Coastal areas of the Wider Caribbean near major watersheds often contain large lagoons of fresh or brackish water. Estuaries, coastal lagoons, and other inshore marine waters are very fertile and productive ecosystems. They serve as important sources of organic material and nutrients, and also provide feeding, nesting and nursery areas for various birds and fishes. These ecosystems act as sinks of terrestrial run-off, trapping sediments and toxins, which may damage the fragile coral reefs. Fragile ecosystems in these areas are extremely vulnerable to climate change impacts.

HYDROLOGICAL CHARACTERISTICS AND WATER RESOURCES

In most countries, no systematic water monitoring programmes exist and this essentially undermines any attempt to accurately assess vulnerability. However, the impacts of climate change combined with high demand during tourist season may affect the ability of countries to adequately deal with seasonal demand for water in water-scarce regions. Total precipitation as well as temporal distribution, are taken into consideration when assessing climate change effects. Countries in the Caribbean typically experience two distinct seasonal climatic types that can be classified as the rainy or wet season (around June to December) and the dry seasons (around January to May).

Climate change can present additional water management problems. Such problems may arise from increased flooding, impeded drainage and elevated water tables. It is projected that on Andros Island in the Bahamas, where the water table is only 30cm below the surface, high evaporation rates and increasing brackishness will eventuate with continued sea level rise[6]. For many small islands, saline intrusion into the freshwater lens would be of great concern, especially where over-pumping of aquifers is already occurring (e.g., Barbados and the Bahamas). This would further diminish the amount of freshwater available for domestic and economic activity.

Studies have shown a decrease in precipitation in the tropics and sub-tropics. Current climate change-induced models simulate an increase in most equatorial regions but a general decrease in subtropics. Potential changes in intense rainfall frequency are difficult to infer from Global Climate Models (GCMs) largely as a result of coarse spatial resolution, however there are indications that the frequency of heavy rainfall events and consequent flooding is likely to increase as a result of global warming.

[5]Lugo and Snedaker, 1974.

[6]Martin and Bruce, 1999.

All water-related infrastructure can be directly damaged from severe weather events and decreased water availability has implications for health, sanitation, and agriculture. These impacts are expected to be country-specific as various factors will influence the possible effects.

Although a comprehensive watershed management programme has been developed for some Caribbean countries there is a need to undertake an inventory of all water resources to better assess and quantify likely impacts arising from climate change.

All Caribbean countries in their First National Communications to the United Nations Framework Convention on Climate Change (UNFCCC) have highlighted the serious threat posed by global climate change to the region's hydrological resources . Further, they have identified the need to undertake Integrated Water Resources Management as an adaptation response to the projected impacts of climate change on the region's water resources. Under Component 7 of the Adapting to Climate Change in the Caribbean (ACCC) project the Jamaica Water Authority is implementing a pilot project which aims to identify climate change impacts on the water resources in Jamaica . In determining the extent of these impacts the pilot project will utilize climate scenarios generated from the statistical downscaling of global climate models being accomplished under Component 4 of the ACCC project. Adaptation options for mitigating these impacts will be developed utilizing this risk management process, which has been developed. The methodologies developed under the exercise will be disseminated to other regional water authorities and further refined under the GEF funded Mainstreaming Adaptation to Climate Change (MACC) project.[1]

FOOD AND NUTRITION: AGRICULTURE AND FISHERIES

One of the sectors most vulnerable to climate change is agriculture, and hence food security in the Caribbean is a pressing concern. This sector is of considerable importance to many economies in the region, however, the full extent of impacts on this sector are yet to be assessed and quantified. It is expected that climate change will impact food production, by reducing yields and thereby affecting food security, and exacerbate other problems associated with this sector, namely soil erosion, land degradation and soil fertility loss. Soil salinisation will also result in crop failure and reduced arable land acreage. Further work will need to be undertaken to understand the impacts of climate change on the agricultural sector so that appropriate intervention options can be developed.

However, evidence of climate change can be found as persons directly involved in agricultural production have reported that certain pests are still active outside of their typical season and there is an apparent change

[1]This paragraph has been added subsequent to the completion of the document from which this Annex is extracted

in temporal distribution of rainfall (i.e., change in length of wet or dry seasons).

A direct impact of rising sea levels will be inundation and the threat of saline intrusion into cultivation fields. Drainage during the rainy seasons may require additional and more intensive pumping facilities. The possible intrusion of salt water into the water conservancies and estuaries needs to be examined since these are the prime source of irrigation water.

If weather systems become more intense, then the effect of flooding conditions must be addressed. More frequent El Niño/La Niña events can subject the coast to cycles of drought/flood which can have serious effects on the soil and, therefore, on food production. Cattle and other livestock may not be spared because of the severity of the conditions associated with these rainfall extremes. Apart from the effect on rice and sugar, scarcities of cash crops will be a problem and an economic hindrance.

The state of the fisheries is intimately linked to the health and resilience of the coastal ecosystems. Coral reefs showing signs of degradation due to pollution will not support a healthy fishery. The clearance of mangroves removes important nursery areas of many commercially valuable species, which may consequently not survive to see adulthood.

Fish kills in Guyana, Grenada, St. Lucia, St. Vincent and the Grenadines, Barbados and Trinidad and Tobago in 1999 have been linked to the influx of nutrient-rich algae from the Orinoco River into the Caribbean Sea, causing low oxygen content and the consequent proliferation of deadly bacteria. Caribbean scientists also confirmed that the water temperatures were significantly higher that normal. Projected climate change induced flooding and increased ocean temperatures can be expected to result in increased fish kills of this nature.

Under the ACCC project an extensive study has been undertaken to develop a better understanding of the likely impacts of climate change on food security in the region. Using climate projections derived from global models the study identifies critical factors in the regional food supply chain which will be threatened by evolving new climatic conditions in the region. The Caribbean population derives a significant amount of their daily protein intake from marine sources so the study also considers the impacts of climate change on regional fisheries. Another aspect of Caribbean food security is the region's heavy dependence on food importation and the study addresses the likely impacts climate change may have on the availability and prices of food imports. Several adaptation options including policy options are identified and actions recommended to cope with the threats envisaged. The study also identifies gaps in our knowledge in the arena of climate change and regional agriculture, tools needed to refine our approach to quantifying

impacts and recommending feasible adaptation options. Some of the latter are to be addressed under the Mainstreaming Adaptation to Climate Change (MACC) project[2].

SETTLEMENT AND INFRASTRUCTURE

Most settlements in the Caribbean are located in the coastal regions, as this is also the location of much social and economic activity. Pre-existing conditions where coastal development has been approved without consideration of prudent coastal zone management, and decaying sea defense structures make these areas all the more vulnerable to sea level rise and storm surges.

In 1999, the storm surges alone from Hurricane Lenny resulted in the devastation of a significant portion of coastal infrastructure all over the region. Jetties and other facilities were destroyed and houses were washed into the sea. With currently projected rates of sea level rise and flooding, coupled with the possibility of more intense and frequent extreme events such as cyclones (hurricanes) and associated storm surge, critical infrastructure such as social services, airports, port facilities, roads, coastal protection structures, tourism facilities and vital utilities will be at severe risk. Storm surges and sea level rise can result in the dislocation of coastal populations and will cause permanent inundation of the entire coastline in some areas if no response measures are taken.

TOURISM

Tourism is the main foreign exchange earner in the region and the chief contributor to Gross National Product (GNP) for most countries. This sector also makes a significant contribution to employment, as in the Bahamas where tourism provided jobs for 70% of the country's labour force in 1998.

Climate change impacts will affect this industry both directly and indirectly. Sea level rise, storm surges and hurricane activity can result in lost beaches, inundation and degradation of coastal ecosystems and infrastructure. Saline intrusion can affect water supplies thereby reducing the supply of water for domestic, commercial and agricultural purposes. The loss of coral reefs and the biodiversity that they support may also have a negative effect on tourism.

A significant proportion of tourist arrivals in the Caribbean is during the winter months as visitors from the North (the largest market) attempt to escape cold winters. Projected global warming may mean milder winters and thus reduce the appeal of the Caribbean as a destination. It is projected that tourism can be further harmed by increased airfares if airlines are heavily taxed for greenhouse gas emissions.

[2]This paragraph has been added subsequent to the completion of the document from which this Annex is extracted.

To ensure sustainability of the industry, some countries have already invested quite heavily in reinforcing infrastructure and in sound coastal zone management practices, including setback and waste disposal regulations.

HUMAN HEALTH

This sector possibly has the least information in the region as it relates to climate change impacts. Perhaps impacts are too subtle, hence extensive research is not seen as a priority. The Caribbean has a favourable climate for many disease vectors. Therefore, climate-related chronic, contagious, allergic, and vector-borne diseases (e.g., Malaria and dengue fever, asthma and hay fever), linked to plants or fungi whose ranges and life cycles are strongly affected by climate and weather can be expected to increase with global warming.

Cuba has done extensive work on climate change impacts on health. Their national climate change committee, working in conjunction with the Ministry responsible for Health, has the authority to issue warnings to the country when they suspect that there is danger of increased respiratory disorders associated with El Niño events. Their work on health also includes skin disorders resulting from over exposure to solar radiation.

At the southern end of the region, while there is a lack of data in Guyana, there have been reports that skin cancer is on the rise in a region of Guyana inhabited mostly by Amerindians (region 9). This report seems to suggest that Amerindians, who are repeatedly exposed to solar radiation, are being affected by higher incidences of UV-b radiation and possibly higher surface temperatures.

Climate-induced effects on other sectors such as agriculture, fisheries, water and coastal resources, and social and economic conditions might also affect human health. Decreases in food production might result in poorer diets, and rise in sea level and changed precipitation patterns may result in the deterioration of water supplies resulting in contamination. Greater numbers of humans could migrate from one area to another, changing the geographic ranges and susceptibility of human populations to many diseases. In general, any event that reduces standards of living will have an adverse impact on human health.

Recent global studies have focused on the possible impact that changing climate, season, and weather variables might have on the incidence of disease. The more subtle impacts on health may not be readily discernible by the public, thereby making it difficult to mobilize public support for policy changes that may be required.

The Caribbean Environmental Health Institute (CEHI) and SENES Consultants Ltd. of Canada are implementing activities in component 7 of the Adapting to Climate Change in the Caribbean (ACCC) Project "Formulating Adaptation Strategies to Protect Human Health". The objective of this component is to develop analytical tools, methodologies and procedures, which would facilitate a more methodical and systematic identification of climate change impacts on human health so as to ensure that appropriate intervention options can be identified and implemented by authorities in the region. To this end, health and climate data will collected from relevant sources in Barbados and St. Lucia, and subjected to statistical analyses to determine whether or not correlative trends can be detected between climate episodes and incidences of certain types of health problems. The methodology developed by the Institute of Meteorology in Cuba will also be studied to assess its applicability to regional circumstances. Finally, based on what at this stage would be essentially a qualitative perception of climate change impacts on health in the Caribbean region, recommendations for feasible adaptation strategies will be suggested.[3]

FORESTRY AND TERRESTRIAL BIODIVERSITY

The Caribbean has a highly variable incidence of biological diversity, which is already threatened by anthropogenic stresses – human consumption of natural resources and conversion of natural habitats for other purposes; ever increasing populations that result in the encroachment of agricultural and other cultural activities into natural ecosystems, making it difficult for these systems to adapt by moving with natural climate variability; and reduced resilience of many species whose numbers have significantly reduced by hunting or harvesting.

Forest biodiversity in the Caribbean is very sensitive to changes in climate patterns. The removal of indigenous species for development activities or human settlement has caused micro-climates in cleared areas. These micro-climates are impacted by changing weather patterns and it is anticipated that exotic species must be introduced to re-forest such areas. Impacts of climate change on some species will be from physiological stress from loss of habitats.

Increased levels of carbon dioxide in the atmosphere will be beneficial for some plant species but the overall effect will be negative. Other impacts are direct loss of forest cover and other habitats as well as many animal species due to heat stress or storm activity.

[3]This paragraph has been added subsequent to the completion of the document from which this Annex is extracted.

OTHER ECONOMIC AND SOCIO-CULTURAL IMPACTS

Climate change could have direct and indirect impacts on other sectors in the Caribbean region. The insurance industry, for instance, is highly sensitive to the intensity and frequency of disasters – climate change-induced or not. Because insurance premiums are based on assessment of risk of occurrence of a particular event, any indication of an increase in hurricane and storm activity can mean that premiums will increase. Within the past decade the cost of insurance has increased considerably – which is not surprising when insurance companies have had to pay out billions of dollars for damage from hurricanes and other natural disasters which caused widespread socio-economic dislocation, injury and loss of life. In Antigua, following the passage of numerous hurricanes in the 1990's, the cost of insurance for many coastal properties has become prohibitive, with many owners opting not to insure at all. Even in cases where there was no damage in the insular Caribbean itself – as with hurricane Andrew that devastated Florida in 1992 – an increase in insurance premiums in the Caribbean subsequently occurred.

Certain traditional assets will also be at risk from climate change. These assets may include subsistence and traditional technologies (skills and knowledge), community structure and coastal villages and settlements.

ANNEX IV

Summary of Climate Change Scenarios for the Caribbean Region

1.0 Climate Scenarios

As noted, scenarios of future climate are based mainly on the output of atmospheric – ocean General Climate Models (or Global Circulation Models) AOGCM's. These use mathematical descriptions of atmospheric and oceanic motions, energy fluxes and water fluxes to simulate past, present and future climates. Past and present climates are used to validate the models. Future climate is driven primarily by forcing due to greenhouse gases and aerosols, which tend to counteract the greenhouse effect. These human-induced influences now outweigh natural factors that affect global climate such as changes in solar radiation or volcanic emissions.

The greenhouse gas and aerosol forcing is estimated by means of scenarios of future emissions. These can have a very wide range depending on the future evolution of world populations, economies, energy use, the sources of energy used, and extent of deforestation or afforestation. Our present (2002) atmosphere has about 30% more CO2 (the most abundant of the greenhouse gases) than in pre-industrial times. IPCC's range of emission estimates suggest that CO2 concentrations could be as much as triple pre-industrial values by 2100 or could be less than double pre-industrial concentrations by 2100. The outcome depends primarily on the rate of growth of economies and of fossil fuel use and the vigour of measures to reduce the latter. This creates the greatest uncertainty in projections of future climate.

However, most climate model analyses have used simply a projection of greenhouse gas and aerosol forcing that increases at approximately the same rate as during the past decade. This also results in a range of outcomes because of the differences between models. Most of the available literature is based on such climate model analyses, and the following range of outcomes generally reflects these model differences, except as specifically noted. In cases where recent trends are consistent with projections, more confidence can be placed in the model outputs so some recent trends are cited. However where results are available using a broader range of future emission scenarios (the IPCC-SRES scenarios) these have been used (e.g., for sea level rise), and so reflect uncertainties in both future emissions and in the models.

To address the uncertainty associated with future climate change, two climate change scenarios – a 'low case' and a 'high case' scenario – are specified. These two scenarios are estimates of the range of potential economic impacts due to climate change to 2050 and 2080. These scenarios are based on the Third Assessment Report of the IPCC, Climate

Change 2001. In particular, the increase in tropical cyclone (hurricane) peak wind and peak rainfall intensity are considered to be "likely" (65-90% confidence) by IPCC this century.

1.2 Temperature and Precipitation

Temperature increases by season for the two scenarios are shown in Table 2.1. The temperature increase for the low scenario is 2°C and for the high scenario is 3.3°C. Night time temperatures are projected to rise more than daytime temperatures, thus narrowing the daily temperature range by 0.3°C to 0.7°C.

TABLE 2.1: Temperature Increases by Season

	Temperature Increase (°C) Scenario 1 (low)	Temperature Increase (°C) Scenario 2 (high)
Dec. - Feb. 2050 2080	 1.4 2.0	 2.0 3.3
June -August 2050 2080	 1.5 2.0	 1.9 3.3

NOTE: A decrease in the daily temperature range of 0.3°C to 0.7°C is projected with greater warming at night than during the day.

The precipitation scenarios are shown in Table 2.2. The low scenario shows decreases in precipitation throughout the year, with larger reductions during the rainy season. Precipitation is projected to rise under the high scenario, with a smaller increase during the rainy than during the dry season. It should be noted that the low and high values in the case of rainfall do not reflect low and high greenhouse gas emissions – they are simply the range of estimates from various sources.

TABLE 2.2: Precipitation Changes by Season

	Precipitation Change % Scenario 1 (low)	Precipitation Change% Scenario 2 (high)
Dec. - Feb. 2050 2080	 -1.5 -4.4	 +13.1 +24.4
June - August 2050 2080	 -18.4 -25.3	 +17.1 +8.9

NOTE: A decrease in the daily temperature range of 0.3°C to 0.7°C is projected with greater warming at night than during the day.

The variation among model outputs for precipitation as reflected in Table 2.2 is very high. The median values for the scenarios suggest:

- less rain in the rainy season (-6.9% for 2050 and -8.2% for 2080), and
- more rain in the dry season (+5.9% for 2050 and +8.2% for 2080).

Three points tend to reinforce the likelihood of reduced precipitation, in the rainy season at least:

- In general, the Caribbean receives less rain in El Niño years and IPCC suggests that future climate may be more "El Niño-like".
- Trends in rainfall over the past few decades have been mostly downward in the Caribbean except for the northern islands of the Bahamas.
- Increased evaporation losses with higher temperatures will tend to overcome small increases in rainfall, with a net negative moisture balance especially in the rainy season.

1.3 Sea Level Rise

Climate change causes sea levels to rise due to thermal expansion of ocean waters and melting of glaciers and ice on land. The range of mean sea level rise for the period 1990 to 2100 as estimated by five models is 0.18 to 0.77 metres. For the full range of economic and energy development in IPCC's emission scenarios (SRES scenarios), mean sea level rise of 0.16 to 0.87 metres is anticipated by 2100. The mean sea level rise for earlier periods is shown below in Table 2.3.

Table 2.3: Mean Sea Level Rise (Haites, et al.[1])

SRES Mean Sea Level Changes		
	Scenario 1 (low)	Scenario 2 (high)
2050	0.08m	0.44m
2080	0.13m	0.70m
eventual	0.5 m	2.0m

There is a long lag time from greenhouse gas emissions to sea level rise, so that mean sea level would continue to rise for more than 1500 years. If emissions were held constant after 70 years at twice pre-industrial levels, sea level would eventually rise to between 0.5 and 2.0 metres above present levels.

To compare observed sea level rise to date, the longest observed record in the region is from Key West, Florida, where average increases of 0.017 m

[1]Haites, Erik et al. (2002). *Assessment of the Economic impacts of climate change on CARICOM countries, Report for World Bank – Latin America and Caribbean, July 2002.*

per decade have been observed since 1850. This is much more rapid than even the highest of the above projections for the Caribbean. The high projections thus seem more compatible with the observations to date. However, this should be tempered with the note that the northern Caribbean mean sea level increase, during the relatively short Topex/Poseidon satellite mission (1993-1998), was substantially greater than for the Southern Caribbean.

1.4 Extreme Events

1.4.1 Storm Surges

It is not the mean sea level that damages beaches and shorelines and causes major floods, but the extreme high water under storm surges, tides, and waves. Probability analysis shows that for a location about one metre above present mean sea level and a sea level rise of 20 cm, storm surges and tidal flooding which now occur every 10 years on average, would occur twice per year – a twenty-fold increase.

To illustrate the potential magnitude of storm surge inundation, model calculations for a category 5 (most severe) hurricane approaching the Bahamas from the east, indicate a "maximum envelope of water" (MEOW) 5.2 m deep moving on shore in the Nassau area. The observed MEOW in the Bahamas from hurricane Andrew[2] (category 4) was 2.4 to 3.0 m.

1.4.2 Tropical Storms and Hurricanes

Will tropical storms and hurricanes become more frequent or severe in a changing climate?

The historical record indicates that the:

- Number of hurricanes plus tropical storms (that did not reach hurricane intensity) in Atlantic-Caribbean basin has increased from 7 to 10 per year since 1886[3].
- Number of hurricanes alone shows no long-term trend, but annual numbers are affected by the state of ENSO (fewer during El Niño and more during La Nina conditions), so a more "El Niño-like" climate would mean fewer hurricanes and less precipitation.
- Number of hurricanes reached the unprecedented number of 4 during 1999.

The climate change scenarios are presented in Table 2.4. The trend in the number of tropical storms and hurricanes is uncertain, so the number remains at 10 per year for both scenarios. The number of severe hurricanes (category 4 and 5 storms) is assumed to be 2 in the low case and to equal the 1999 level of 4 in the high case. The intensity

[2]Rolle, The Bahamas Meteorological Service, personal communication.

[3]Martin and Weech, 2001.

(maximum wind speed) of the strongest hurricanes is projected to rise by 5% in the low scenario and by 15% in the high scenario[4].

Table 2.4: Tropical Storms and Hurricanes

	Scenario 1 (low)	Scenario 2 (high)
Number of tropical storms and hurricanes per year, 2050 and 2080	10	10
Number of severe hurricanes per year, 2050 and 2080	2	4
Increased wind speed of the strongest hurricanes, 2050 and 2080	5%	15%

Table 2.5 provides an estimate of the increase in insured losses with changes in hurricane intensity (maximum wind speed) for the United States. The losses increase exponentially – a 5% increase in maximum wind increases damages by approximately 35% and a 15% increase in maximum wind speed increases damages by roughly 135%.

Table 2.5: Loss Potential in Future Hurricanes

Storm	Class	Year	Estimated 1990 Insured Losses (000's)	Estimated 1990 Insured Losses if Maximum Wind Speed Increases by		
				5%	10%	15%
Hugo	4	1989	$3,658,887	$4,902,705 34%	$6,514,172 78%	$8,542,428 133%
Alicia	3	1983	$3,658,887	$3,382,775 39%	$4,312,884 77%	$5,685,853 133%
Camille	5	1969	$2,435,589	$4,120,733 34%	$5,438,332 76%	$7,095,008 130%

1.4.3 Heavy Rains

Despite a decline in total rainfall, there has been an increase in rain intensity on rain days in the Caribbean. Such heavy rains are due to tropical waves and upper level troughs in the inter-tropical convergence zone and cause local flooding. There were 46 cases of such events between 1955 and 2000 (46 years) in Barbados, most of which caused floods and a few of which caused wind damage[5].

[4]Houghton, et al., 2001.

[5]Zwiers and Kharin, 1998 and Kharin and Zwiers, 2000.

TABLE 2.6: Heavy Rains

	Scenario 1 (low)	Scenario 2 (high)
One day average rainfall, 2050 and 2080	+0.5 mm	+1.0 mm
20 year return period one-day rainfall 2050 2080	 95mm 110 mm	

The number of flooding events from short duration intense rainfalls and the amount of flooding and erosion per event are thus projected to increase, even though total rainy season rainfall is likely to continue to decline.

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ANNEX V

Risk Perceptions and Risk Communications

INTRODUCTION

An individual or a work team that will be making decisions about risk will have to understand the risk in terms of the needs, issues, and concerns of the affected stakeholders. There will also be a requirement to communicate with a broad variety of individuals, organisations, informal groups, the news media and governments about risk. This Annex provides some insights into the difficulties of understanding perceptions about risk and some thoughts about how to effectively communicate about risks.

RISK PERCEPTION – HOW DIFFERENT PEOPLE VALUE THINGS DIFFERENTLY

The value associated with something that may be lost often differs from one individual to the next. It can also differ for the same individual, depending on his or her circumstances at the time. Consider a very hungry individual. A pizza could be very valuable to that person because it would satisfy his or her hunger. On the other hand, the pizza would offer little immediate value if the individual had just eaten a large dinner. The pizza would be of greater value the next day when the person's hunger returned. The individual perceives the value of the pizza differently, depending on whether the individual is hungry or not; that is, depending on the individual's needs at the time.

A person's sense of value may also be very time dependent. One pizza may be very desirable to a hungry individual, a second pizza may still be a little desirable if that person is still hungry after eating the first, but a third, fourth, or fifth pizza may not be wanted at all. In fact these additional pizzas may generate negative value if the person eats the pizzas anyway and gets sick from overeating as a result.

Now consider the risk of losing the pizza. If very hungry, the individual may find any risk of losing the pizza unacceptable. If, on the other hand, the individual is not at all hungry, he or she may be indifferent to losing the pizza.

The acceptability of the risk depends on the value or utility placed on the item at risk (in the example above, a pizza), which depends on the needs of that individual, at that specific time.

Not all considerations of utility are time-sensitive. For example, if we value honesty in people, we probably always value honesty. If we are concerned about the environment, we are probably always concerned

[1]These short discussions about the perceptions of risk and communicating about risks are taken, with some editorial amendments, from the National Standard of Canada, CAN/CSA Q850-97, *Risk Management: Guideline for Decision-Makers*, Appendices C and D.

about the environment. The terms "needs", "issues", and "concerns" are often used to refer to those factors that affect our perceptions of risk.

Different people can value the same loss differently because the loss may affect their overall satisfaction (or their needs, issues, and concerns) differently.

The issue of perceived value has been often overlooked in dealing with risk situations when the risk is based on the simple equation:

Risk = Probability x Consequence

This equation is inadequate as a practical definition of the concept of risk when the consideration of the perception or acceptability of the risk is included. A more appropriate expression of risk would be:

Risk = Probability x Consequence x Perception

Consider another example related to the acceptability of risk. We wish to determine the acceptability of the risk associated with a game of chance involving the toss of a coin. If it's heads, the player wins $100. If it's tails, the player loses $100.

Most people would say that the risk is that they might lose $100, the item at risk being the $100 itself. The classic definition of risk is expressed using the formula, Risk = Probability x Consequence. This equation gives what is termed the expected value of the loss in the coin toss example; the risk (or expected value of the loss) is $50 – the probability of getting heads or tails and losing (.5), multiplied by the amount of money that would be owed in the case of a loss ($100). So while the expected value of the loss might be $50, most individuals would recognize that the risk, or what they stand to lose, is $100.

How acceptable is the risk and what kinds of actions on the part of decision-makers will this risk generate? The answer, quite simply, is it depends the value placed on the $100. This in turn, depends on the needs, issues, and concerns of the stakeholder bearing the risk. The value associated with the $100 will determine an individual's perception of the risk.

For a sports figure earning $1,000,000 a year, the loss of $100 may be inconsequential. That person would not place a great deal of value or utility on the $100 because the loss or gain of this amount would not materially reduce his or her situation. However, to a single, unemployed parent with four children to support, the loss of $100 may mean not being able to feed the children. The $100 has substantial value, and the risk of losing that $100 may be unacceptable. What the parent, or any stakeholder, is doing is comparing the value gained as a result of winning the $100 with the impacts of losing the $100.

Even though the probability associated with losing is the same, and the consequence of losing is the same ($100), the acceptability of the risk can vary from one individual to the next as illustrated by the rich and the needy persons' different values of the loss of $100. The perceived risk is not the same because the value placed on the potential loss can differ completely from one individual to another. This is because these individuals' needs, issues, and concerns differ widely. Decision-makers often overlook or ignore this difference in perceived value and, as a result, many decisions create controversy.

Risk Communications – How to Talk to People about Risks

General: Risk communication goes beyond simple messages providing information. Risk communication is based on a dialogue that allows stakeholders to participate in the decision-making process.

Risk communication is not simply public relations or one-way public education because:

a) It will not always reduce conflict;

b) It does not guarantee that decisions will be easily made because people do not have the same ability to understand and relate to a particular risk; and

c) Providing people with scientific information alone will not enable them or the decision-maker to resolve important risk issues.

Communicating about risk is important. To avoid communicating about risk is not effective and may be very costly in the long term. Stakeholders resent risks that are imposed on them and risk decisions made without their input. Most people believe that they have a right to be involved in the decisions that affect them. They believe that the decision-making process should be accessible. Involving stakeholders builds acceptance and can bring out constructive ideas.

Effective Risk Communication: Effective risk communication is the responsibility of the decision maker, not the stakeholder. Actions and communications based on dialogue lead to shared understanding, shared goals, and better decisions. Risk communication builds trust and encourages buy-in by sharing decision-making, reducing misperceptions, and improving technical understanding of the science of risk.

Ineffective risk communication may lead to some or all of the following:

- irreplaceable loss of management credibility,
- unnecessary and costly conflicts with government,
- difficult and expensive approval processes for projects,
- bitter and protracted debates and conflicts with stakeholders,

- diversion of management attention from important problems to less important problems,
- non-supportive and critical employees, and
- unnecessary human suffering due to high levels of anxiety and fear.

It is important to provide the information that people may seek.

Credibility: Credibility is a key goal since decisions and behaviour flow from perceptions. Credibility may be defined as the perception of being trustworthy and competent. Personal credibility is described by the use of terms such as candour, capability, commitment, competence, dedication, empathy, expertise, honesty, resolve, respect, and understanding. For messages to be credible, they must be consistent with the facts and with previous statements. These messages need to be framed in stakeholder terms, not self-serving language or jargon, and be consistent with the messages of others. Credibility is very difficult to establish, easy to lose and almost impossible to regain once lost. For this reason some specialised training in risk communications is recommended prior to initiating the risk management process.

Stakeholders: It can be extremely important to include even minor stakeholders in the process if these stakeholders believe that the outcome of the decision is important to them. These "minor" players may be much more influential than the risk management team anticipates. Even a small group of stakeholders may effectively mobilise public opinion and halt an activity they feel presents an unacceptable risk.

> *For example, a local environmental group rallied to stop an incinerator from being built because they believed the residual risk from the facility was not acceptable. The unit was projected to operate at 99.9999% burn efficiency, indicating a very minor risk. However, even though the risk, from a technical point of view, was very small, from the stakeholders' point of view, it was still unacceptable. All the other key stakeholders supported the incinerator project, but this small group effectively mobilised public opinion against it. The company, after spending an enormous amount of time, effort, and money, was forced to withdraw its permit request.*

It is important that stakeholders with the potential to stop a project be identified as early in the process as possible.

Regardless of whether stakeholders might actually be affected by an activity or decision, they must be included as legitimate stakeholders if they believe themselves to be affected. These stakeholders may be able to mobilise public opinion against a proposed project regardless of the scientific risk. They may also choose to leave the decision process if they

receive enough credible information to understand that the activity really does not affect them.

> *For example, a community group believed a proposed change to a chemical company's air emissions permit would expose them to greater risk. However, this belief was based on a number of misconceptions related to some technical aspects of the activity: the composition of the emissions and local wind patterns. Through a dialogue process, the concerns of the stakeholders were addressed, and the misconceptions about the technical issues were corrected. As a result of effective communication efforts, these stakeholders' concerns were alleviated.*

This example stresses the need for an effective communication process to facilitate this transfer of information between the decision-maker and other stakeholders.

It is important that the risk management team clearly decides what the stakeholders needs, issues and concerns are before proceeding with a stakeholder dialogue. There are numerous examples of decision-makers addressing the wrong issue.

> *For example, a chemical company was establishing a new facility and believed that the key issue for the community would be emissions. They spent a great deal of time and money developing a communication strategy around the issue of emissions. However, through dialogue with the community in a town hall meeting, they found out that the primary issue was related to transportation. The community believed that the new facility would result in a dramatic increase in large truck traffic, which would create a risk for their children. They were not so concerned about emissions because they believed, rightly, that the company was utilising a highly effective emission control system.) As a result, the company had wasted a great deal of time and money addressing an issue that was not of concern to stakeholders. The company should have conducted a preliminary dialogue with its key stakeholders to validate what they thought would be their primary issues.*

Trust: Stakeholders often believe that the process of communicating with them about an issue is as important as the eventual resolution of the issue. It is through the communication process that the risk management team has the opportunity to gain stakeholders' trust. If the risk management team fails to communicate to the satisfaction of the stakeholders, trust in the process could be quickly lost.

Research in the area of stakeholder perception has shown that "trust" is a key determinant of stakeholders' acceptance of risk. That is, if stakeholders trust those who are charged with managing the risk, they are more accepting of higher levels of risk. Where this trust is absent, stakeholders demand higher levels of safety, and may refuse to accept any risk at all.

The development of trust between stakeholder and decision-maker is only one of the benefits of an effective communication process. Stakeholders are often the source of information critical to the decision-process.

> *For example, a company warehouse safety officer issued safety glasses to all employees in an attempt to reduce the numbers of on-the-job eye injuries. When a reduction in injuries failed to materialise, the immediate reaction was that the safety glasses were an ineffective safety mechanism and some other risk control strategy should be developed. However, in speaking with the employees, it was discovered that the glasses were quite uncomfortable to wear, and employees removed them when the safety inspectors left. Proper-sized glasses were provided to employees, and the incidence of injuries declined as expected. The employees provided critical information that the decision-maker would not have been able to attain elsewhere.*

The communication process is necessary so that information may be passed from the risk management team to other stakeholders. It is also necessary for evaluating stakeholder acceptance of risk. Sometimes stakeholders just want to be involved in the decision process so that they can monitor the performance of the decision-maker; they just want to see what is going on. Again, involving stakeholders "who just want to watch" provides the decision-maker with the opportunity to build trust with these stakeholders.

ANNEX VI

Recommendations to Reverse Human Impacts on Environmental Degradation in Caribbean Island Nations

For Caribbean countries to effectively stem the impacts of human activities that exacerbate the effects of sea level rise on coastal ecosystems, they will need to develop a coordinated set of actions linked to projected outcomes. These actions will likely include such measures as targeted regulatory policies; land-use planning; economic and market-based incentives; research, monitoring and mapping; and broadscale efforts for improving public awareness and education about the relationships between human activities and environmental health. While nearly all Caribbean countries have implemented an array of different measures, they are rarely coordinated, or comprehensive or, most problematical, enforced. In other words, they are not part of comprehensive strategic plans. In this section, we offer a number of recommendations that Caribbean island nations can evaluate to develop such plans for reversing the impacts of current development practices and protecting coastal resources from future impacts. While these recommendations are generic, they can be adapted by national and local governments.

4.1 Regulatory Recommendations

4.1a Introduce national building codes that account for climate variability and change

Studies conducted worldwide have shown that strict adherence to building codes and standards reduce destruction caused by extreme weather events and climate variability. Revised building codes within individual countries could include instructions to (Vermeiren, 2000):

- Improve construction techniques such as stronger connections (at the ridge board, between the joists and the top plate, between the floor and the foundation, at the foundation footing), long screws/nails, hurricane straps and strong roofing materials;
- Modify engineering designs to include climate change projections, particularly for sea level rise, in addition to historical data typically used;
- Limit the siting of new structures in hazardous areas, restricting siting of any new public buildings in such areas;
- Elevate structures in high hazard areas (e.g., on pilings) through the designation of minimum floor elevations, piling depths and bracing requirements; and
- Add additional specifications to ensure that new buildings are built to better withstand wind and flooding.

It is important to include training programs in code requirements and construction techniques for local builders and carpenters, including the

informal housing community. Strengthened building codes are of little use if they are not properly enforced; therefore, any efforts to revise codes or implement new ones should also include training programs for building inspectors. Table 3 summarizes the current status of Building Codes in each of the CPACC/ACCC countries.

An important first step towards introducing and enforcing revised building codes in individual Caribbean countries has been the introduction of the Caribbean Uniform Building Code (CUBiC), a regional building standard. In the Eastern Caribbean, a model building code, based on CUBiC, has been developed by the Organization of Eastern Caribbean States to facilitate the introduction of national codes (Wason, 1999). However, given current climate change projections, the adequacy of CUBiC should be reassessed – efforts should focus on incorporating these regional standards and the specific instructions listed above into each country's regulations and land use plans. Traditionally, in the Caribbean, existing building and planning statutes do not specifically reference building codes; instead, legislation has focused on safeguarding health and property by proper planning and siting.

TABLE 3: Summary of Building Code Status

Country	Code Status	Building Inspection Capacity
Anguilla	Anguilla Building Code completed. Anguilla Building Ordinance mandates the use of the Anguilla Building Code. Building Code being used administratively. Building regulations mandating the use of the Code will be incorporated into the new Physical Planning Ordinance (administered by the Department of Physical Planning). The Attorney General's office is now discussing the draft legislation with the Public Works and the Physical Planning Departments.	Being developed. Building inspectors being trained At present the Public Works Department employs a Building Inspector
Antigua and Barbuda	Completed, based on OECS model building code. Legislated in 1996 as regulations under the Development Control Ordinance.	Five building inspectors on staff. Training program to be developed.
Bahamas	The Code, which was based generally on the South Florida Building Code, was in operation from the mid 1970s.	Building inspectors in place in adequate numbers and training.
Barbados	Draft Building Code developed in 1993. The Government proceeding with the establishment of a Building Authority and the appointment of Building Inspectors. Technical provisions of the Code based on the standards contained in CUBiC Detailed recommendations for establishing the Building Authority and other mechanisms required for legislative review completed in 1999 with the assistance of the OAS/CDMP. The working papers for the enabling legislation and for the establishment of the Building Authority now being discussed with the Minister responsible prior to submission to Cabinet.	Recommendations made for the engagement of an adequate number of building inspectors for monitoring residential construction. Other buildings will be monitored by professional engineers and architects engaged on a case by case basis.
Belize	Belize City Building Code in place from 1963. Belmopan has building and planning regulations. There is no national building code. The Belize Chamber of Commerce and Industry have completed draft of technical standards for Belize building construction and a residential construction guide with the assistance of OAS/CDMP. Documents completed in December 1999 and being reviewed for legislative approval by the Attorney General's office.	The Ministry of Housing and the Reconstruction and Development Corp. in Belmopan have building inspectors.Consideration has been given to the nature of inspection desired and to the number of building inspectors required and training requirements.
Dominica	Code drafted, based on OECS model building code. Submitted for legislative review. OECS Model Planning Act being used as the basis of a new Dominica Physical Planning Act which will mandate the use of the Building Code.	The Development Control Authority has 5 building inspectors of staff.
Grenada	Currently drafting code, based on OECS model building code.	*No information available*
Jamaica	Jamaica National Building code drafted and distributed for comment in 1984 – not adopted. A revised Code has been drafted and is being discussed. There are building by-laws in each of the Parishes and in Kingston-St. Andrew.	There are building inspectors in each Parish with training in building and in construction. The staffing in some Parishes will have to be augmented to ensure that building plans can be properly reviewed in accordance with the requirements of the new Code.

Country	Code Status	Building Inspection Capacity
St. Kitts and Nevis	Building code approved by Parliament and mandated for use by the Development Control and Planning Bill which was gazetted in 2000. The building regulations include the Building Code and Building Guidelines as the second and third schedules.	Four building inspectors are in place in St. Kitts and one in Nevis.
St Lucia	Code drafted and accepted by the Development Control Authority. Code is based on OECS model building code. Physical Planning Bill drafted and forwarded for legislative approval. This Bill will mandate the use of the Code and Guidelines.	There are twelve building inspectors in the employ of the Development Control Authority. The inspectors are engaged mainly in monitoring residential construction.
Trinidad and Tobago	The Trinidad and Tobago Building Code has been drafted and is submitted for comments by the building fraternity. The enabling legislation has been submitted for legislative approval. Small building code being drafted based on Chapter V of CUBiC. For engineered buildings British, American and Canadian codes are used as standards.	Special committee mandated to prepare building regulations for legislative review.
Turks and Caicos Islands	TCI Building Code included in the building regulations of 1990. Code in regular use in the islands since 1991. The technical requirements of the Code are based generally on CUBiC. The Department of Planning and members of the building fraternity of TCI carry out revisions to the administrative sections of the Code.	There are three building inspectors and one building control engineer on the staff of the Department of Planning. Monitoring of construction of large buildings such as hotels and condominiums is generally carried out by engineers and architects engaged as Special Inspectors.

4.1b Introduce regulations to phase out development in high hazard areas

In addition to revised building codes for the quality and siting of new structures, regulations should be introduced to plan a strategic retreat of existing development located in low-lying coastal floodplains and high hazard areas along the coast. These regulations should consider:

- Prohibiting the construction of protective structures in sensitive high hazard areas;
- Prohibiting the reconstruction of storm-damaged property in high hazard areas; and
- Conditioning land ownership in high hazard areas to expire when a property owner dies or when sea levels reach a particular point along a map.

4.1c Strengthen regulations to protect ecological buffers

While most Caribbean countries have regulations governing the use of wetlands and mangroves, strengthening these measures to ensure that ecological buffers are protected should be a priority. The filling of wetlands, damming rivers, mining coral and beach sands and cutting of mangroves should be prohibited in order to preserve the natural storm abatement functions of these areas.

4.2 Land-Use Planning & Land Protection Tools Recommendations

4.2a Develop comprehensive land-use plans

The most immediate need for reducing island vulnerability to sea level rise is development of comprehensive land-use plans that account for high hazard areas and climate risks. Such plans need to be integrated throughout several government agencies and developed through consultative processes to include public participation. Based on hazard maps and projections of climate change, plans could be designed to limit infrastructure and land uses based on vulnerability to both current climatic conditions and projected changes.

4.2b Develop and implement integrated coastal management plans

While many Caribbean countries have developed or are developing integrated coastal management plans, for example, natural resource management plans that encompass the various sectors impacting the coastal zone, such efforts should be a priority for government agencies charged with land-use planning and natural resource management. Because coastal ecosystems can serve to buffer the impacts of climate variability and change on coastal infrastructure and land uses, national and local level management plans to conserve these ecosystems should be a top priority for adaptation. Ongoing efforts at integrated coastal management should include assessments of the potential impacts of climate change and sea level rise. These plans also provide a framework to balance resource allocation decisions across ministerial lines, because they seek to promote horizontal integration rather than the traditional vertical command and control decision-making process. Similarly, an important aspect of such plans will be the institutionalization of mechanisms for shared management responsibility between government and communities, which will encourage stakeholder participation in decision making processes.

4.2c Develop coordinating mechanisms to ensure that watershed management plans are implemented at both the ministerial and private sector levels

Many land use decisions in watersheds throughout the Caribbean are not coordinated; as a result, land use practices are often a large source of sedimentation in coastal waters, that limits the capacity of the coastal ecosystems to buffer storm surge and inundation. Land-use planning and natural resource management agencies should be encouraged to work with the various stakeholders in individual watersheds to plan uses that protect riparian forests and agricultural areas and to reduce or control sediment loads to coastal waters. Such plans could include zoning protection for vulnerable watershed areas.

4.2d Employ a "retreat approach" to planning and development in high hazard areas along the coastline

Land-use planning should encourage a strategic retreat from development and infrastructures in low-lying coastal floodplains and high hazard areas; planning and development would be based on retreat plans, where new structures are located on setback lines behind these areas. Designating a setback line begins with establishing a baseline, which could be drawn along the dune crest. For armored shorelines, the baseline may be drawn at the theoretical dune crest location – the position where the dune crest was calculated to exist if the shoreline had not been armored. For most erosional beaches with a sand deficit, this theoretical dune crest location may be significantly landward of the seawall or bulkhead. For inlet zones, which are sections of beach in close proximity to tidal inlets, the baseline may be drawn at the most landward shoreline position at any time during the past 30 to 40 years (South Carolina Beachfront Management Act, 1988).

Once the baseline is established a second line of jurisdiction, called the setback line, can be drawn. The setback line is intended to be a projection of where the baseline would be located in 30 to 40 years, landward from the baseline, at a distance equal to the average annual erosion rate multiplied by 30 to 40. For stable or accretion beaches with a zero rate, the setback line should be designed to give property owners reasonable use of their land, while at the same time restricting large commercial structures from the beach.

4.2e Integrate regional disaster mitigation strategies with national/physical planning

Historically development of physical and disaster mitigation plans has been done separately under different ministries with little or no integration. This also has been true in the United States: while the coastal management agency is commonly located in either natural resource management departments or the land-use planning agencies such as the state planning office, the state emergency management agency holds the lead for disaster response. Consequently, coordination and integration of these functions has developed slowly. However, such coordination of functions has facilitated improvements in planning and development by taking into consideration the need for improved building codes to reduce the loss of life and property; discouragement of development in high hazard areas, incorporation of a retreat policy and promotion of the use of soft structures to control erosion and flooding.

4.2f Employ [or Use] land protection tools to maintain, preserve and restore ecological buffers and encourage retreat from high hazard areas

Caribbean countries attempting to maintain ecological buffers against extreme weather events or to encourage retreat approaches from high hazard areas may wish to explore one or more of the following land

protection tools. The most effective approach involves using a combination of tools based on the unique environmental and development conditions on each island. All of these tools should fall within the framework established under a comprehensive land use plan. Land protection tools can then complement zoning and building codes to carryout the goals of the comprehensive plan. These tools, which are summarized in Table 4, include:

- Donated Conservation Easements. Legal agreements undertaken between a landowner and a land trust or government agency that allows landowners to permanently limit or prohibit development on their property. Conservation easements become part of the property title and hence the easement transfers with any change in property ownership.
- Purchased Development Rights (PDRs). Voluntary legal agreements that allow owners to sell the rights to develop their properties to government agencies, or non-profit organizations. As is the case with donated conservation easements, a conservation easement is then placed on the property and recorded as part of the property title. Typically PDRs are used to limit the future use of the property to agricultural, forestry or open space. For example, a government agency might identify several parcels of undeveloped coastal lands in vulnerable areas that serve as buffers between settlements and floodwaters. The agency might then want to approach property owners to purchase the development rights and then limit the future use to open space.
- Transferred Development Rights (TDRs). Established by local ordinances that create "sending areas" (preservation areas) and "receiving areas" (areas where growth and development are encouraged). Property owners in the sending area receive development right credits, which they can sell in exchange for not developing their property. Real estate developers, speculators, or government agencies may purchase the development right credits and use them to increase existing or planned development in receiving areas.
- Land Acquisition. Allows property owners to sell or donate their property to a public agency or land conservation organization, giving the public agency full control over future use to include development or preservation. Government could acquire high hazard areas and convert the lands into natural preserves as ecological buffers. There is a growing trend towards such acquisition in many countries, as it greatly reduces the vulnerability of coastal areas to extreme weather events and the

damages associated with such events. In the U.S., for example, some areas have held public referendums to establish a small "bed tax" to be paid by every tourist staying overnight in hotels, condos, etc. Proceeds from this tax are used to create a land acquisition fund to acquire vulnerable hazard areas and restore their natural buffering capacity. This tool should be used to acquire, restore and preserve wetland and mangrove systems, as well as dune systems that can act as ecological buffers against storm surge and inundation.

TABLE 4: Land Protection Tools

Land Protection Tools	Pro	Con
Demonstrated Conservation Easement	Permanent protection from development; Landowners receive Tax benefits; Little to no cost to the local unit of government; Land remains in private ownership and on the tax rolls	Tax Incentives may not provide sufficient compensation Limited governmental control over which areas are protected
Purchase of Development rights	Permanent protection from development; Property owner paid to protect land; Estate and property tax benefits; Local units of government can target locations; Property remains in private ownership and stays part of tax base;	Costly
Transfer of Development rights	Permanent protection;Landowner paid to protect land; Estate and property tax benefits to landowner; Local units of government can target locations; Low cost to local units of government; Utilizes "free market" approach; Land ownership remains in private hands and on tax roll.	Complex to manage; Receiving area must be willing/able to accept higher densities;
Land Acquisition	Permanent protection from development and full public control for preservation and restoration; Land can be managed for natural ecosystems services including buffering capacity.	Costly

4.2g Enhanced Coastal Protection where Retreat and Accommodation are not possible

For coastal urban areas with high population densities, retreat from, or accommodation of, sea level rise may not be an option. In such cases, hard structures such as sea walls may need to be designed to allow for

future modification to ameliorate sea level rise. Integral to the design of any hard structure, a sand management study should be initiated to assess the impact on beach sand dynamics. It should be noted that hard structures are heavily capital intensive, which may deter their widespread use. Thus, consideration of hard structures should be limited only to those areas where capital development has occurred and the value of existing infrastructure far outweighs the cost of the hard structure approach.

4.3 Economic and Market-Based Incentives Recommendations

4.3a Market-based incentives to promote a sustainable tourism industry

As discussed in Section III, there is a direct linkage between the declining health of coastal ecosystems and the growth of the tourism industry in the Caribbean. The demands on natural resources to service the expanding tourism industry is having detrimental effects on coastal ecosystems, rendering these systems more vulnerable to climate change and reducing their capacity to buffer coastal infrastructure from extreme weather events and floods. To combat these trends, market-based incentives are already being used by Caribbean nations to promote a more sustainable tourism industry (Jamaica Sustainable Development Networking Programme). These incentives are wide-ranging and include:

- Duty and tariff relief and/or tax deductions for environmental resource protection and water-conservation equipment;
- Water and sewage charges for both industrial and domestic users;
- Private sector initiatives such as the Blue Flag Campaign or Green Globe 21 could be used to encourage eco-tourism and environmental resource preservation. The Blue Flag is an eco-label awarded by a non-profit organization to beaches and marinas in countries around the world, based on environmental management criteria. Similarly, Green Globe 21 is a collective body of roughly 1000 travel and tourism companies in over 100 countries, who have committed to specific environmental management standards; and
- Green award programs for hotels that display the best conservation practices or education program.

4.3b Link property insurance with construction quality

The relatively poor quality of many built structures in the coastal zone have increased the vulnerability of these areas to climate variability and sea level rise. Perhaps no market-based tool can be as effective in improving the quality of such structures as insurance incentives. These incentives would include lower deductibles and/or premiums for those who invest in adaptation measures, such as homeowners and businesses

who alter or upgrade properties to better withstand hurricanes-force winds. Reduced insurance premiums for policyholders to make their homes and businesses more hurricane-resistant could be based on available information, such as "Making Your Home Hurricane Resistant" and the "Professional Guide to Performance-Based Design Upgrade for Hurricane Resistant Construction," produced by an engineering firm in Barbados. One key to such incentives is that the insurer is able to ensure the quality of the retrofit work that is done. However, such retrofit work and adaptation measures should benefit the insurance company. After a sufficient number of property owners at risk in the company's portfolio undertake adaptation measures, the company can expect its aggregate catastrophe Probable Maximum Loss (PML) to be lower. The primary insurer should be able to negotiate lower rates from the reinsurer for this effort, which combined with lower incurred claims on the retained risk should more than offset the reduced premium income (Vermeiren, 2000).

4.3c Eliminate subsidies or incentives that continue to promote development in high hazard areas

In many cases, national governments reallocate economic development loans in order to reconstruct and repair structures damaged from extreme weather events. This practice can in fact be considered a government subsidy, which on a long-term basis encourages development and land uses in vulnerable areas, as owners know that government will help repair any damages caused by a hurricane or a similar event. Over the long-term,this practice disrupts national economic development programs, and reinforces a state of underdevelopment in many vulnerable island and low-lying Caribbean states. Governments are forced to borrow more funds from external donors for reconstruction and repairs following an extreme weather event, diverting funds that might have been used on national education programs, for example. This is not to suggest that some level of disaster relief is not necessary after an extreme weather event, but continued reconstruction of buildings and structures that are located in highly vulnerable areas can be considered a subsidy for land uses susceptible to climate variability and change.

4.3d Establish a revolving loan fund for home improvement

Because many of the most vulnerable settlements in coastal zones are low-income, informal housing, countries could encourage the establishment of revolving loan funds to provide families with small loans for home improvement and hurricane-resistant retrofitting.

4.4 Public Awareness and Education

4.4a Improve public awareness and education concerning vulnerability

Much lip service is often given to the importance of public understanding and education in public policy issues. But public awareness and

knowledge is critical in addressing the impacts of climate change and variability and changing attitudes. Governments must embark on a sustained education campaign that is part of a broadscale communications plan designed to demonstrate that key public constituencies understand the impacts of climate variability and change on vulnerable areas, as well as potential adaptation measures they can take. A knowledgeable consumer, for example, should be reluctant to purchase property in high hazard areas. Dissemination of targeted information also helps to ensure that various market sectors take into consideration potential impacts as well as new market growth opportunities. Central to any education program must include the following: promoting awareness of climate change impacts; communicating information about vulnerable and hazardous areas; educating key stakeholders on tools and practices that can be applied to reduce impacts and encouraging participation at all levels in decision-making.

4.5 Research, Monitoring & Hazard Mapping

4.5a Continue to build and expand long-term beach monitoring programs

Through the CPACC project, several countries throughout the region have begun to implement beach-monitoring programs at selected beaches, thereby establishing a series of benchmarks. In existing and future monitoring sites each benchmark, a metal disk set in concrete, has a known vertical elevation that is used as the starting point for the beach survey. In addition, the horizontal coordinates of each benchmark are established, so the benchmark can be replaced in the same location if it is ever destroyed. The information from beach-monitoring programs should be increasingly used in coastal land-use plans and retreat programs, in order to delineate the position of a baseline, set at either the actual dune crest for natural beaches or the theoretical dune crest for armored beaches.

4.5b Promote increased use of GIS and remote-sensing/spatial planning applications

Geographic information systems and databases should be promoted to provide resource managers with information on the state of resources and to assess their vulnerability to climate change. Inventories that quantify and qualify current uses of land, distribution and species diversity provide the baseline information managers need to prepare development scenarios and strategies to assess vulnerabilities to climate change, projected impacts on ecosystems and land-use patterns, and potential land use conflicts. Key to producing and maintaining this information is the development of a local capacity and skilled workforce to design and implement these databases.

4.5c Establish a computer network linking major sea level rise and climate change monitoring institutions

A key deficiency in current climate monitoring is the lack of a capability to provide timely observations to both regional and national forecasters, observers, resource managers and governmental sectors. Coupled with the development of an information-sharing network is the development of databases generated from national and regional projects, observations and other complementary information such as growth and development trends. It should also be noted that paramount to any of the aforementioned actions is the development of national and regional capabilities for display, analysis and reporting of data and information related to climate variability and change. This "local capacity" varies widely from island to island as do hardware and software capabilities. Development of regional or national training centers would be a first step toward promoting growth and development of data and information capabilities among small island nations.

4.5d Expand hazard mapping of coastal zones, based on climate change

A significant need is the identification of areas vulnerable to sea level rise. Government agencies and research institutions should prioritize capacity building for vulnerability assessments to delineate critical hazard areas, particularly as a result of current and projected storm surge and wave action. Whether governments or research institutions perform the mapping, the results can then be integrated into the land-use planning and development process to allow agencies to identify areas for retreat strategies and many of the land protection tools described previously. This process should be coupled with development of data and information clearinghouses to facilitate the exchange of information at local, national and regional levels. In particular, hazard maps based on current and future vulnerability should be a major feature of any education and information program to coastal residents and stakeholders.

Summary Table: Trends in Vulnerability vs. Adaptation Measures to Address Them

In summary, Table 5 depicts the types of adaptation measures that have been recommended to address the negative trends that are increasing the vulnerability of small islands and low-lying Caribbean states to climate variability and change. For each trend, a specific type of adaptation measure is recommended to address that trend. This table can illustrate the connection between these trends and the adaptation measures recommended in this chapter.

TABLE 5: Adaptation Recommendations to Combat Trends that Are Increasing the Vulnerability of Coastal Infrastructure & Land Uses to Climate Variability & Change*

	Regulatory Measures	Land-Use Planning & Land Protection Tools	Economic & Market-Based Incentives	Public Awareness & Education	Research, Monitoring & Hazard Mapping
Growth of Tourism Industry		Develop a comprehensive land use plan	Market-based incentives to promote sustainable tourism	Public awareness & education	
Intensive & Uncontrolled Coastal Development		Develop a comprehensive land use plan Integrate regional disaster mitigation strategies with national/physical planning	Eliminate subsidies that promote development in high hazard areas		Establish a computer network linking major sea level rise and climate change monitoring institutions
Location of Coastal Infrastructure in Hazardous Areas	Introduce regulations to phase out development in high hazard areas	Utilize a retreat approach to development in high hazard areas-Utilize land protection tools to preserve/restore ecological buffers	Eliminate subsidies that promote development in high hazard areas	Public awareness & education	Expand hazard mapping of coastal zones, based on climate change Continue to build and expand long-term beach monitoring programs
Inadequate Waste Disposal Systems	Strengthened regulations to protect ecological buffers		Market-based incentives to promote sustainable tourism		
Quality of Building Construction & Insurance Incentives	Strengthened building codes		Link property insurance with construction quality Establish a revolving fund for home improvement loans	Public awareness & education	
Destruction of Ecological Buffers	Strengthened regulations to protect ecological buffers	Utilize land protection tools to preserve/restore ecological buffers Develop & implement integrated coastal management plans		Public awareness & education	Use of GIS mapping
Continued Reliance on Top-Down Approaches to Land-Use Planning		Develop & implement integrated coastal management plans Implement watershed mgt.			
Destructive Ag. & Forestry		Develop a comprehensive land use plan Implement watershed mgt.		Public awareness & education	

* Adaptation recommendations do not address increasing population densities and growth rates