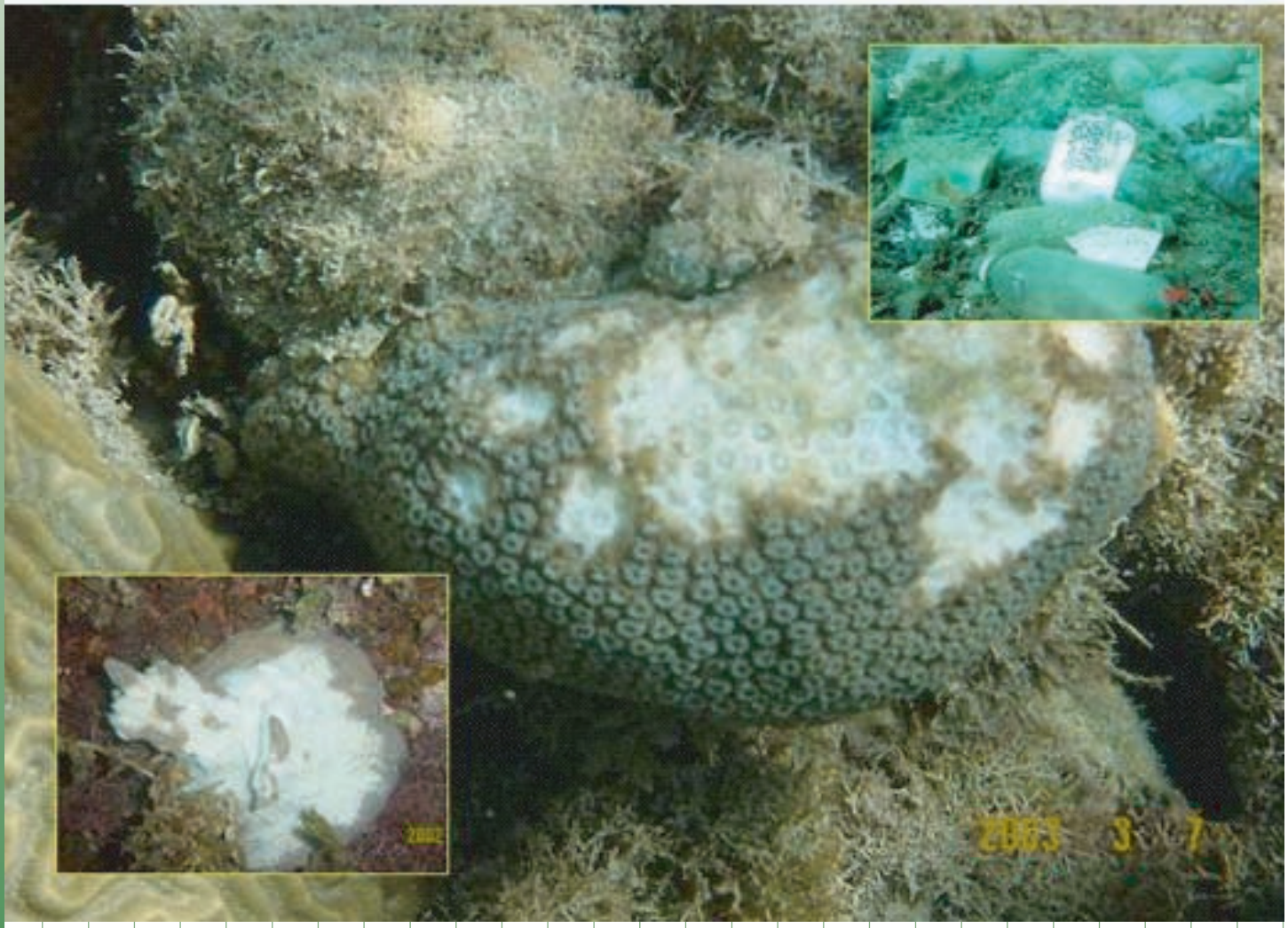
Mainstreaming Adaptation to Climate Change (MACC) Project

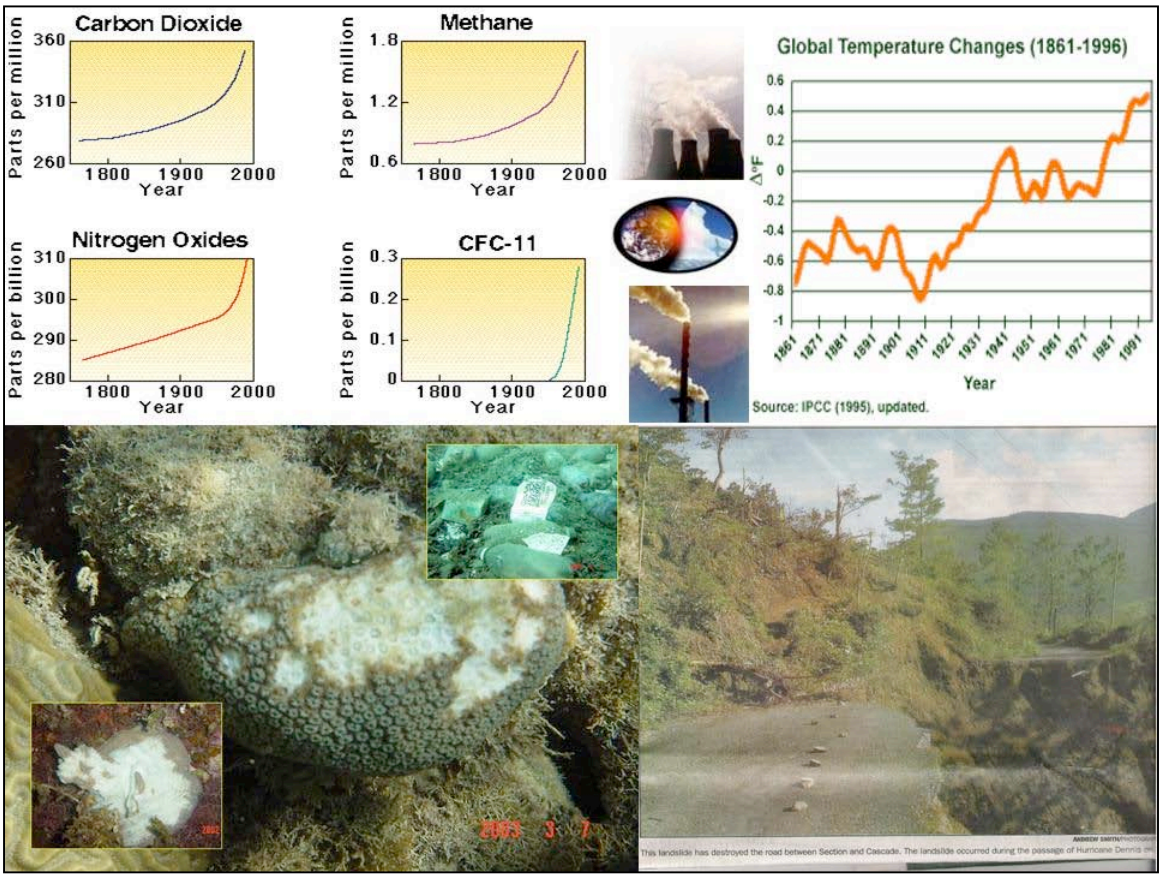


Climate Change Handbook for Caribbean Journalists

Mainstreaming Adaptation to Climate Change (MACC) Project

A Handbook for Concepts and Issues in Climate Change:

Global and Regional Perspectives



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List of Abbreviations and Acronyms

ACCC	Adapting to Climate Change in the Caribbean
ACM	Association of Caribbean MediaWorkers
BPOA	Barbados Programme of Action
CARICOM	Caribbean Community, H.Q., Guyana
CCCCC	Caribbean Community Climate Change Centre H.Q., Belize
CCCDF	Canadian Climate Change Development Fund
CDM	Clean Development Mechanism
CERMES	Centre for Resource Management and Environmental Studies
CIDA	Canadian International Development Agency
CIMH	Caribbean Institute for Meteorology and Hydrology
CPACC	Caribbean Planning for Adaptation to Global Climate Change
CO_2	Carbon Dioxide
COP	Conference of the Parties
COP/MOP	Conference of the Parties Serving as the Meeting of the Parties to the Kyoto Protocol
EIT	Economies in Transition
EU	European Union
GEF	Global Environmental Facility
GHGs	Greenhouse Gases
G77 & China	Group of 77 and China
HFCs	Hydrofluorocarbons
IET	International Emissions Trading
IPCC	Intergovernmental Panel on Climate Change

JI	Joint Implementation
KP	Kyoto Protocol
MACC	Mainstreaming Adaptation to Climate Change
NEPA	National Environment and Planning Agency
NMIA	Norman Manley International Airport
NOAA	National Oceanic and Atmospheric Administration
OAS	Organisation of American States
OECS	Organisation of Eastern Caribbean States
OPEC	Organisation of Petroleum Exporting Countries
PEO	Public Education and Outreach
PFCs	Perfluorocarbons
PICCAP	Pacific Islands Climate Change Assistance Programme
RPIU	Regional Project Implementation Unit
SIDS	Small Island Developing States
SPREP	South Pacific Regional Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNCED	United Nations Council for Environment and Development
UNEP	United Nations Environment Programme
USA	United States of America
UWI	University of the West Indies
UWICED	University of the West Indies Centre for Environment and Development
WMO	World Meteorological Organisation

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FOREWORD

By Dr. Ulric O.D. Trotz, MACC Project Manager

Caribbean journalists, as a group, are more committed to regionalism and generally more devoted to our enduring and sometimes frustrating dream of a West Indian nation than any other stakeholder segment of our society.

While political issues have long tended to dominate the national and regional media landscape, increasingly new features are looming into prominence. Perspectives are changing, albeit slowly, but there is room for optimism. Climate change is the one emerging issue with the greatest capacity to decimate and destroy the lives and livelihoods, as well as the structures, both physical and institutional, of our fragile nation states and our even more tenuous regional bonds.

This is the purpose of the handbook – to inform, to educate and to warn Caribbean society of the clear and present danger posed by the extreme weather events that we are now experiencing, and the long-term impact of climate change on our present attempts at sustainable development.

This handbook will allow you to understand the deeply-rooted issues behind the events that we are now experiencing – hurricanes, droughts, floods, sea-level rise and their negative effects on our countries. It will provide you with the background that you need to go beyond the mere narration of events to providing a context or frame-of-reference for your readers and audience. In fact, inaction by any stakeholder, and that includes you, my media colleagues, also has a cost.

Increasingly we are trying to put a value on the cost of inaction or, to put it bluntly, if we don't do what needs to be done, what will it cost our country and our region. There is a cost, and it could be an extremely high cost, for not taking the actions in the present that will safeguard our futures. Our colleague, Dr Kenrick Leslie, Director of the Caribbean Community Climate Change Centre, refers to this as "the day before tomorrow" or today. If we are to avert the major cataclysms predicted for the day after tomorrow we need to use today and approach tomorrow with a sense of extreme urgency.

The Handbook has to be a work in progress. Every day we are learning more and more from our research about the specific impacts of climate change on our region. This is the first and vital step in developing adaptation measures that are appropriate and sustainable. We will continue to update this booklet in the years to come, ensuring that all times, you, the journalists of the region, are very aware of the issues that confront the region as we struggle against time, tides and tomorrow's challenges, to adapt to climate change.

Dr. Ulric O.D. Trotz
Project Manager
Mainstreaming Adaptation to Climate Change (MACC) Project
Belmopan, Belize

PREFACE

Why do journalists need this handbook? Journalists need this important resource because climate change is one of the most compelling stories of the 21st Century.

Caribbean journalists, in particular, need this volume because climate variability and climate change present an overwhelming challenge to the long-term viability of our civilisation.

The phenomena associated with climate change are also as multi-faceted as they are difficult to engage – both as science and as journalistic challenge.

Their major characteristics span the full spectrum of public affairs and ought to be of concern to reporters with an interest in everything from the environment to health, economics and finance, education, development and community life.

This handbook attempts to clarify areas of doubt, identify sources of immediate and long-term concern and examine existing strategies being designed by the region to adapt to the prospect of climate change.

It provides practical direction on matters of language, central concepts and possible story angles.

It is hoped that in time this handbook will assist in lifting the quality of Caribbean journalism and play a role in shaping more informed public awareness and opinion in an area of increasingly critical concern.

The Association of Caribbean MediaWorkers (ACM) is thankful to the Mainstreaming Adaptation to Climate Change (MACC) Project for expressing its confidence in the regional journalistic community in the development of this important resource.

We also pay special tribute to Dale Rankine for his outstanding role in researching and writing the original version of this document and his invaluable assistance in fine-tuning it in keeping with feedback from other climate change experts, professional communicators and journalists.

Wesley Gibbings
President
Association of Caribbean MediaWorkers

Climate Change Handbook

For

Caribbean Journalists

1.0 What is Climate Change?

Before attempting to give a definition of climate change, it is worth clarifying a few terms, which are used in everyday life, but often misinterpreted. The authors believe that a clear knowledge of these key definitions is essential to understanding the basics of climate change.

1.1 Weather and Climate Defined

Weather is the state of the atmosphere at a specific time and place. It defines the physical conditions of the atmosphere with respect to wind, temperature cloudiness, moisture and pressure (among other parameters). **Climate**, on the other hand, is the general pattern of weather conditions for a region over a long period of time (at least 30 years). It characterises the average weather conditions over time and space. In sum, the difference can be stated as: "Climate is what you expect (e.g. dry spell in February); weather is what you get (a very wet February)." **Climate variability** is described as a fluctuation in climate, which lasts for a specified period of time, usually measured in seasons to years to decades.

1.2 Climate Change Defined

Energy from the sun drives the earth's weather and climate, and heats the earth's surface; in turn, the earth radiates energy back into space (see Figure 1). Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the outgoing energy, retaining heat somewhat like the glass panels of a greenhouse. Without this natural "greenhouse effect[1]," temperatures would be much lower than they are now, and life as known today would not be possible (www.epa.gov).

The emissions of greenhouse gases (GHGs) have increased greatly over the last two centuries as a result of certain economic activities and demographic growth. The principal activities associated with the increased emissions include the burning of large quantities of oil, gasoline, and coal; the cutting of forests; and certain farming methods. Furthermore, new GHGs have been added in the last century (see Figure 2).

The increased concentration of GHGs as a result of human activities has increased the heat-trapping ability of the atmosphere, resulting in marked increases in global surface temperatures (over 0.5°C in the last century). This has led to noted alterations in climate, including changes in cloud and snow covers, rainfall, wind patterns, ocean currents, and the distribution of plant and animal species.

[1] The greenhouse effect keeps the earth's average temperature at a more hospitable 15°C (60°F).

According to the United Nations Framework Convention on Climate Change (UNFCCC), the term **climate change** is used to define a change in climate that is attributable directly or indirectly to human activity that alters atmospheric composition (UNFCCC, 2002). Another definition regards climate change as any systematic change in the long-term statistics of climate elements (such as temperature, pressure, or wind) sustained over several decades or longer (see http://www.ilrdss.sws.uiuc.edu).

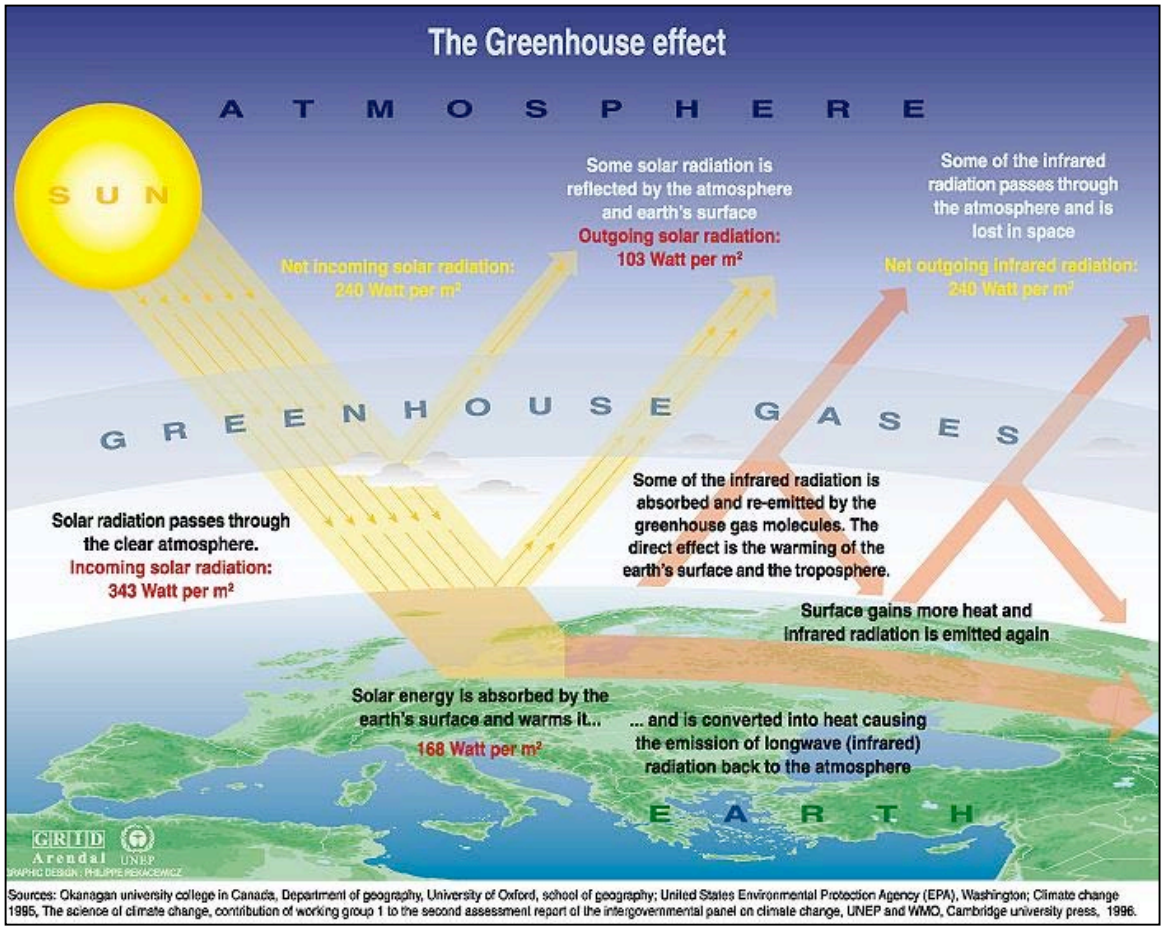

Figure 1: The Atmospheric Greenhouse Effect

The world's climate has always varied naturally. However the changes that have been noted in the last century have outpaced the natural variations, which occur over longer timescales. The majority of scientists now believe that current manifestations of global warming are the signals that climate change has begun. As expressed by a quotation in National Geographic magazine: "The changes are happening largely out of sight. But they shouldn't be out of mind, because they are omens of what's in store for the rest of the planet."

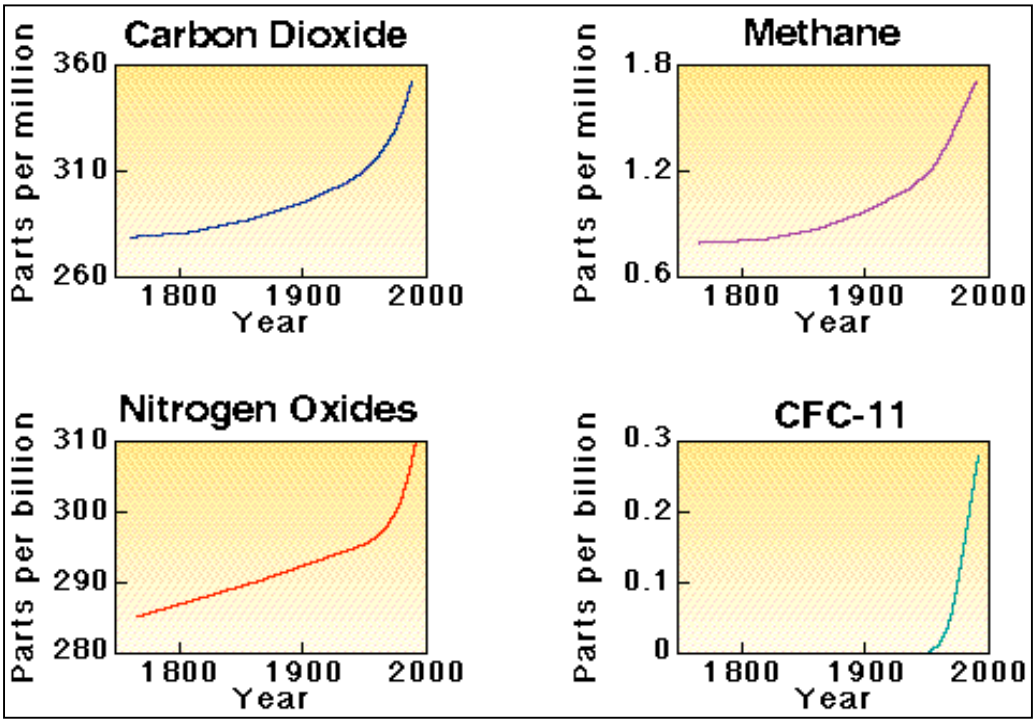

Figure 2: Rising Concentration of Greenhouse Gases

Note that chlorofluorocarbons (CFCs) were not present before the 1900s.

1.3 Contentions about Climate Change

There are a number of disagreements regarding climate change. Some doubt the very science of climate change, claiming that there is no proof that global warming result from human activities. There is, however, an increasing body of evidence[2] pointing to the contrary. The International Panel on Climate Change (IPCC) noted that in the light of new evidence and taking into account the remaining uncertainties, most of the observed warming over the last 50 years is likely to have been due to the increase in GHG concentration (IPCC, 2001a).

Figure 3 (a, b and c) show the observed and simulated temperature variations from 1850-2000. The last graph, Figure 3c, shows that observed measurements (red line) and simulated global surface temperatures (grey shading) are only in sync when both the natural and human-induced effects on global temperatures are combined. This affirms that natural variability alone cannot account for the observed global warming.

[2] On July 21, 2004, New York Attorney General Eliot Spitzer and lawyers from seven other states sued the nation's largest utility companies, demanding that they reduce emissions of the gases thought to be warming the earth (Business Week, August 16, 2004).

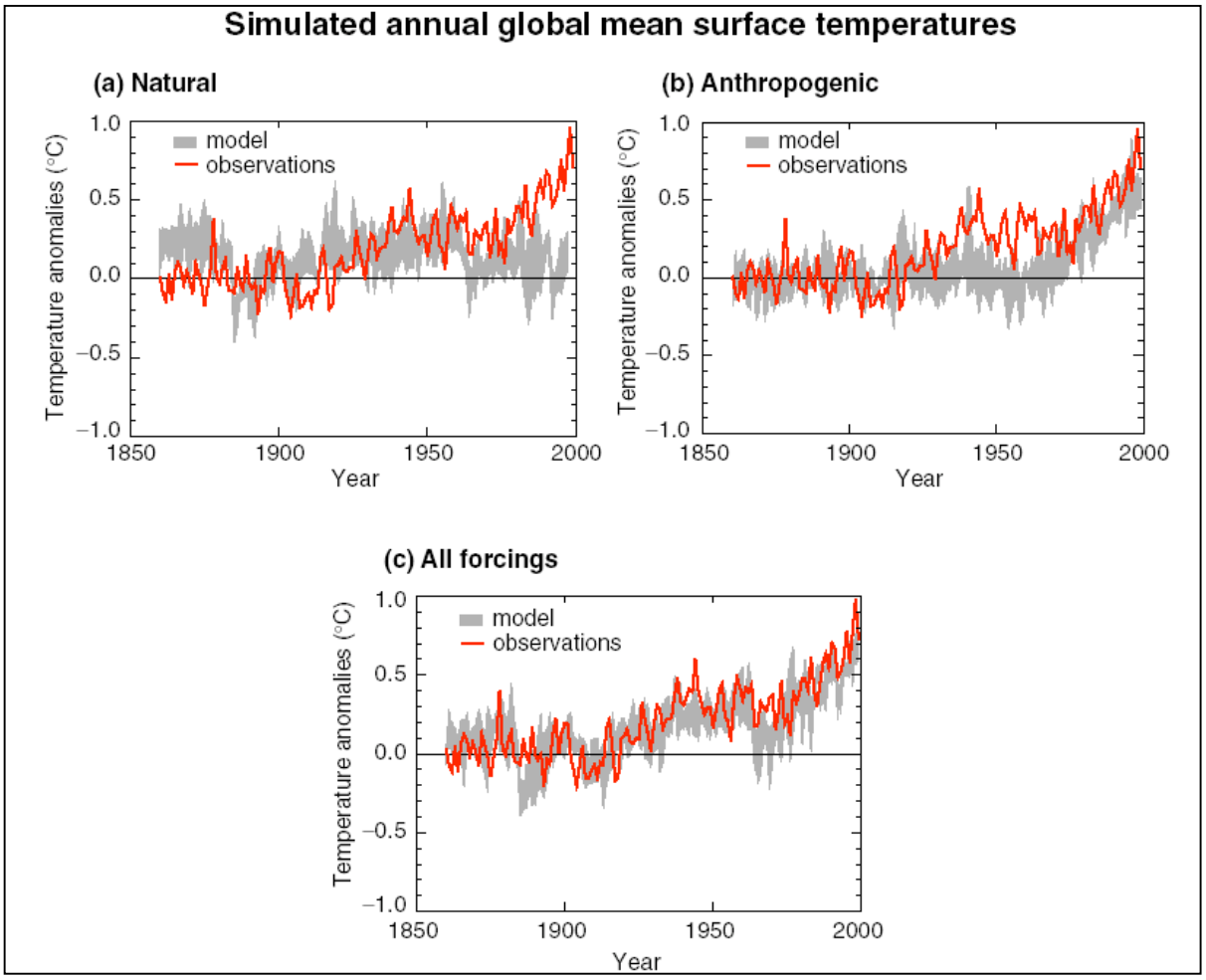

Figure 3: Natural and Simulated Annual Global Mean Temperatures

Others contend that selective data is used to support the claim that climate change is a reality. However, evidence to the contrary is becoming more compelling. In the word of the National Geographic: “From Alaska to the snowy peaks of the Andes the world is heating up right now and fast…these aren’t projections; they are facts on the ground.

The matter of uncertainty of has also been raised. While it is true that there is disagreement in some projections of climate, the majority of the climate change models have projected adverse impacts. Regional projections have been regarded with some degree of skepticism, due to greater reliance on expert judgment, than on empirical scientific data and evidence. The advent of regional climate models, along with the availability of more data, has resulted in new findings at the regional scale that support previous conclusions” (see section 2).

2.0 Examples of How Climate Change is Manifesting Itself

An increasing body of observation gives a collective picture of a warming world and other changes in the climate system. The third assessment reports (TAR) (2001) of the IPCC and the UNFCCC have both reported numerous manifestations of climate change.

2.1 Global surface temperatures have increased over the 20th century

The global average surface temperature (the average of near surface air temperature over land and sea surface temperature) has increased since 1861. Over the 20th century, the increase has been 0.6°C (see comparison of global temperatures with 1961-90 mean in Figure 1) (IPCC, 2001a). Of particular note was the Arctic region. Here temperatures increased by 5°C, nearly 10 times faster the global average increase (www.unfccc.int).

The IPCC reported that, globally, the 1990s was the warmest decade and 1998 the warmest year in the instrumental record since 1861 (IPCC, 2001a). New data analyses of the Northern Hemisphere indicate that the increase in temperature in the 20th century is likely to have been the largest of any century during the past 1,000 years. On average, between 1950 and 1993, nighttime daily minimum air temperatures over land increased by about 0.2°C per decade. This rate of increase exceeds the rate of increase in daytime daily maximum air temperatures (0.1°C per decade). One result of this is the lengthening of the freeze-free season in many mid- and high latitude regions.

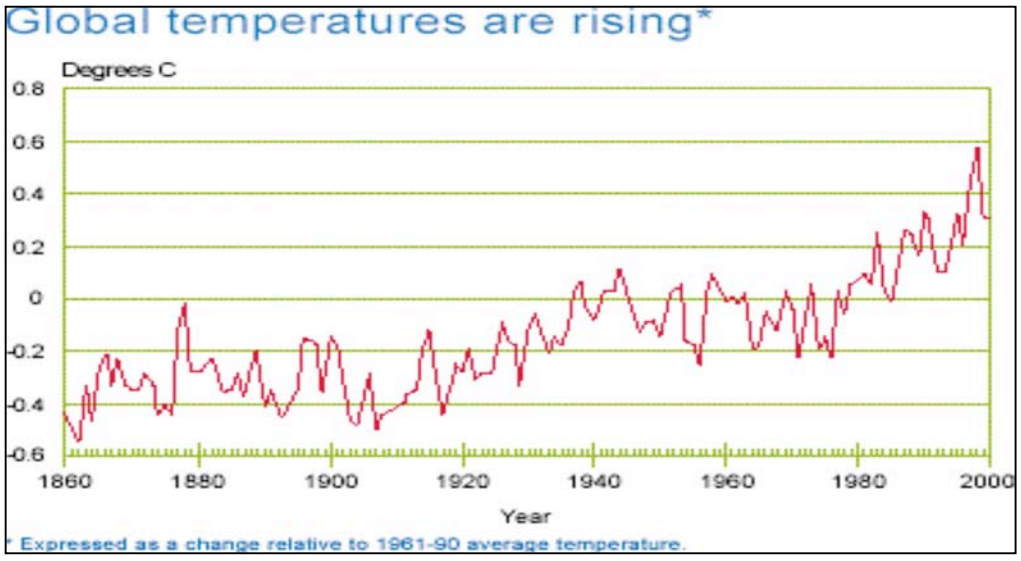

Figure 4: Increasing Global Temperatures: 1860-2000
Source: www.ec.gc.ca

2.2 The decline of winter – snow cover and ice extent have decreased

Satellite data show that there have been decreases of up to 10 per cent in the extent of snow cover since the late 1960s, and ground-based observations show that there has also been a reduction of close to two weeks in annual duration of lake and river ice in mid- and high[3] latitudes of the Northern Hemisphere.

Over the 20th century, there has been a widespread retreat of mountain glaciers in non-polar regions. In the Northern Hemisphere, spring and summer sea-ice extent has decreased by about 10 to 15 per cent since the 1950s, with an approximate 40 per cent decrease in summer Arctic sea-ice extent.

2.3 Global average sea level has risen and ocean heat content has increased

Data shows that global average sea level rose between 20 and 30 centimeters during the 20th century. This has been attributed to the melting snow and ice covers and to the thermal expansion of warmer ocean waters. In addition, ocean heat content has shown increases since the late 1950s.

Figure 5 shows the observed rise in sea level over the interlude 1880 to 1980, and projections of sea level rise under different climate change scenarios for 2100. It can be seen that under all scenarios, sea level is projected to rise well beyond current levels.

2.4 More frequent and intense extreme weather events

The recent increase (in frequency and intensity) of “extreme weather events” has been too pronounced to explain away as random (www.unfccc.int). In fact, all Category 5 hurricanes on record in the Atlantic Basin have occurred since 1928[4].

Scientists have also reported that the mean number of hurricanes in the Caribbean has increased from eight to 14 since 1995. In 2004, 15 tropical cyclones were recorded in the Atlantic Basin, including nine hurricanes, six of which were classified as major on the Saffir-Simpson Scale of hurricane intensity (Category 3 or higher). Four of the six hurricanes affected Florida, making it the only U.S. state[5] since 1886 to experience the impact of four hurricanes in one season (NOAA, 2004).

[3] The mid-latitudes generally refer to regions between 30° to 60°. High latitudes are regions above 60°.
[4] In the interlude 1928 and 1998, the Atlantic Basin, Gulf of Mexico and the Caribbean have witnessed 22 Category 5 hurricanes (i.e. hurricanes with maximum sustained winds exceeding 135 knots). Of note, Hurricane Ivan 2004 was also a Category 5 hurricane.
[5] The other state was Texas, which was also hit by 4 hurricanes in 1886.

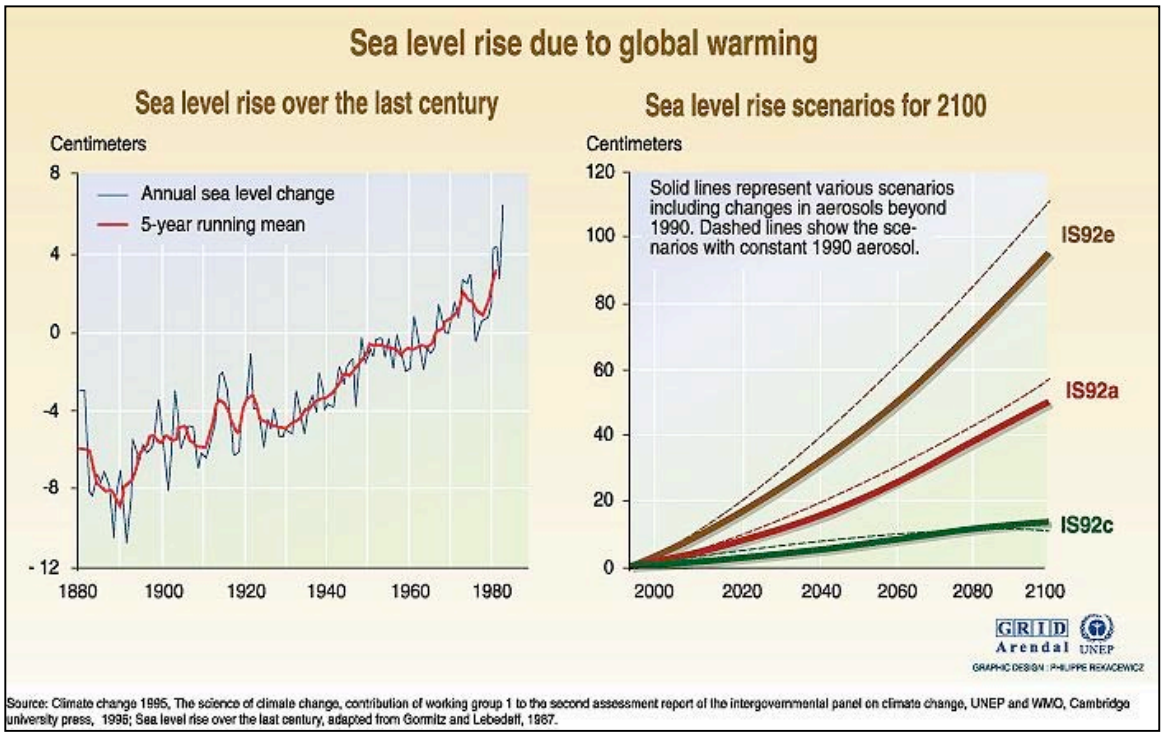

Figure 5: Sea Level Rise due to Global Warming and Projections for 2100

Scientists concur that the increase in extreme events could be an indication that climate change has already begun. The trend toward more powerful storms and hotter, longer dry periods is predicted by computer models and reflects common sense.

In Africa's large catchment basins of Niger, Lake Chad, and Senegal, total available water has decreased by 40 to 60 per cent, and desertification has been worsened by lower average annual rainfall, runoff, and soil moisture, especially in southern, northern, and western Africa (www.unfccc.int).

To the other extreme, recent floods and major events such as the 2004 monsoon-based flooding of Bangladesh (which left 60 per cent of the country underwater) and the Hurricane Katrina catastrophe in the Gulf Coast of the United States, described as one of the worst natural disasters in the country's history, are an indication that storms indeed are growing more powerful (www.unfccc.int).

Other incidents of flooding include the 1996-7 Rhine floods, the 1998 Chinese floods, the 1998 and 2002 East European floods, the 2000 floods in Mozambique and Europe, and the 2005 floods in Europe (which left 38 people dead).

2.5 Evidence in small island developing states

Evidence of climate change has also been experienced in small island developing states (SIDS).

A prime example is Tuvalu, a tiny island country in the Pacific Ocean midway between Hawaii and Australia. Its leaders have conceded defeat in their battle with the rising sea, announcing that they will abandon their homeland. In 2001, Tuvaluans asked New Zealand to accept its 11,000 citizens, but New Zealand has not agreed to do so. As sea level has risen, Tuvalu has experienced lowland flooding. Saltwater intrusion is adversely affecting its drinking water and food production. Coastal erosion is eating away at the nine islands that make up the country (www.earth-policy.org). Projections are that the country could be totally inundated by 2050.

In the Caribbean, recent studies (2002) have indicated that the number of very warm days and nights is increasing dramatically and the number of very cool days and nights is decreasing, while extreme inter-annual temperature range is decreasing. It has also been found that maximum number of consecutive dry days is decreasing, while the number of heavy rainfall events is increasing (Taylor et al, 2002). Overall rainfall has decreased in the Caribbean in the last century (see Figure 6).

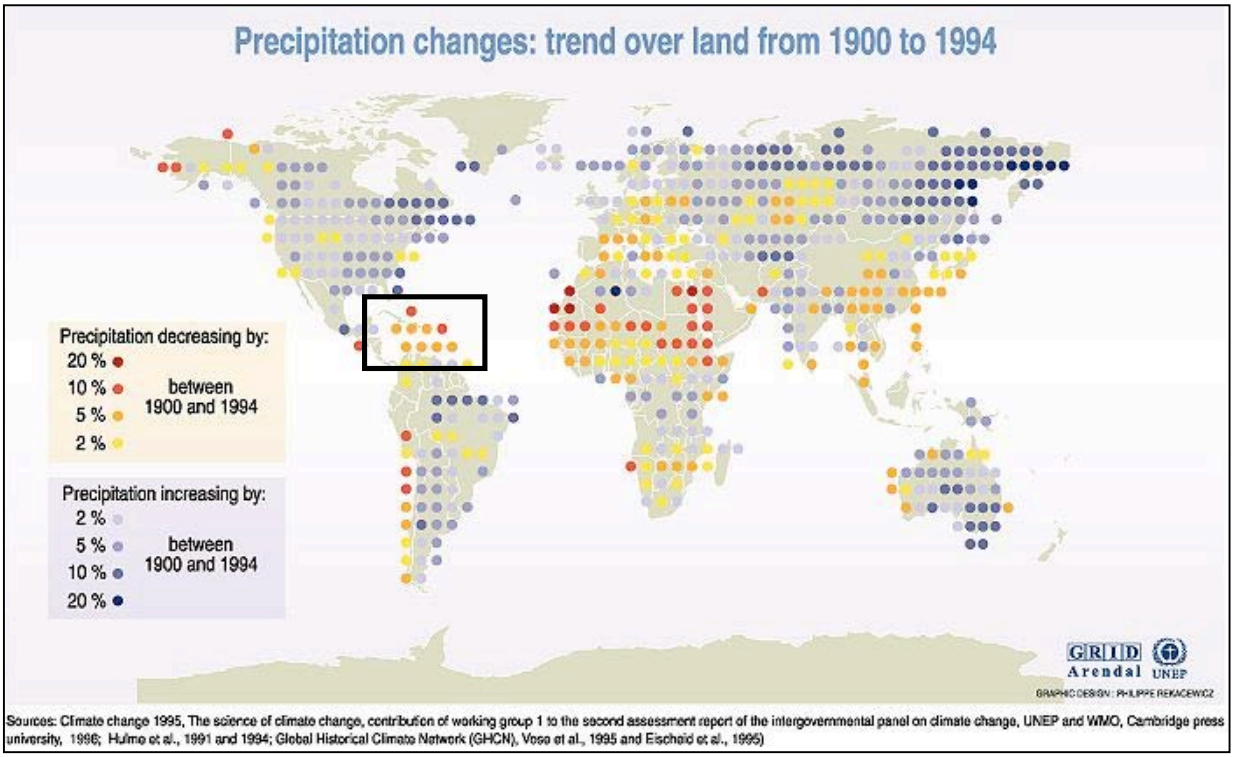

Figure 6: Precipitation changes: 1900-1994.
The delineated area shows that rainfall has decreased in the Caribbean during this period.

2.6 Other noteworthy changes in aspects of climate

There have been increases in precipitation of at least 0.2 per cent per decade in all latitudes of the Northern Hemisphere. The highest increases (0.5 to 1 per cent per decade) occurred in mid- to high latitudes, where there has been an observed increase in the frequency of heavy precipitation events.

These latitudes have also witnessed an increase in cloud cover of about 2 per cent, with a related decrease in daily temperature range. The National Oceanic and Atmospheric Administration (NOAA) reported that 2004 ranked among the top 10 wettest years on record for the contiguous United States.

2.7 Climate-induced changes

Scientists have observed climate-related changes in at least 420 physical processes and biological species or communities. In the Alps in Europe, some plant species have been migrating upward by one to four metres per decade. In other cases, some plants previously found only on mountaintops have disappeared.

In Europe, mating and egg-laying of some bird species have occurred earlier in the season. For example, egg-laying by 20 of 65 species in the United Kingdom, including long-distance migrants, advanced by an average of eight days between 1971 and 1995.

Across Europe, the growing season in controlled, mixed-species gardens lengthened by 10.8 days from 1959 to 1993. Butterflies, dragonflies, moths, beetles, and other insects are now living at higher latitudes and altitudes, where previously it was too cold to survive (www.unfcc.int).

3.0 Anthropogenic Issues Compounding the Climate Change Crisis

There are a number of human activities and practices (besides the burning of fossil fuels) that are exacerbating the crisis posed by climate change. These include deforestation, pollution, unplanned development, social pressures, and unsustainable farming practices. These are briefly elaborated in this section.

3.1 Deforestation

Deforestation refers to the removal of forest stands by cutting and burning to provide land for other purposes. Such purposes include agriculture, the construction of residential or industrial building sites and roads, and the harvest of trees for building materials or fuel without replanting new trees.

Deforestation is often cited as one of the major causes of the enhanced greenhouse effect for two reasons: 1) the burning or decomposition of the wood releases carbon dioxide (a major GHG); and 2) trees that once removed carbon dioxide from the atmosphere through the process of photosynthesis are no longer present to serve as a carbon sink.

Furthermore, trees root systems are essential for keeping topsoil in place. Deforestation can bring about soil erosion and landslides, especially during periods of high rainfall.

3.2 Pollution

The indiscriminate dumping of industrial and domestic wastes into water bodies compounds the problem posed by climate change. Organic waste has resulted in degradation of important marine ecosystems, such as coral reefs and mangroves.

Coral reefs, in addition to providing a sanctuary and spawning ground for many fish species and invertebrates, also offer coastal protection from storm surge. Coral reefs are already facing the stress of coral bleaching associated with warmer sea surface temperatures (as a result of global warming).

Pollution also affects freshwater systems, thereby reducing available water supplies.

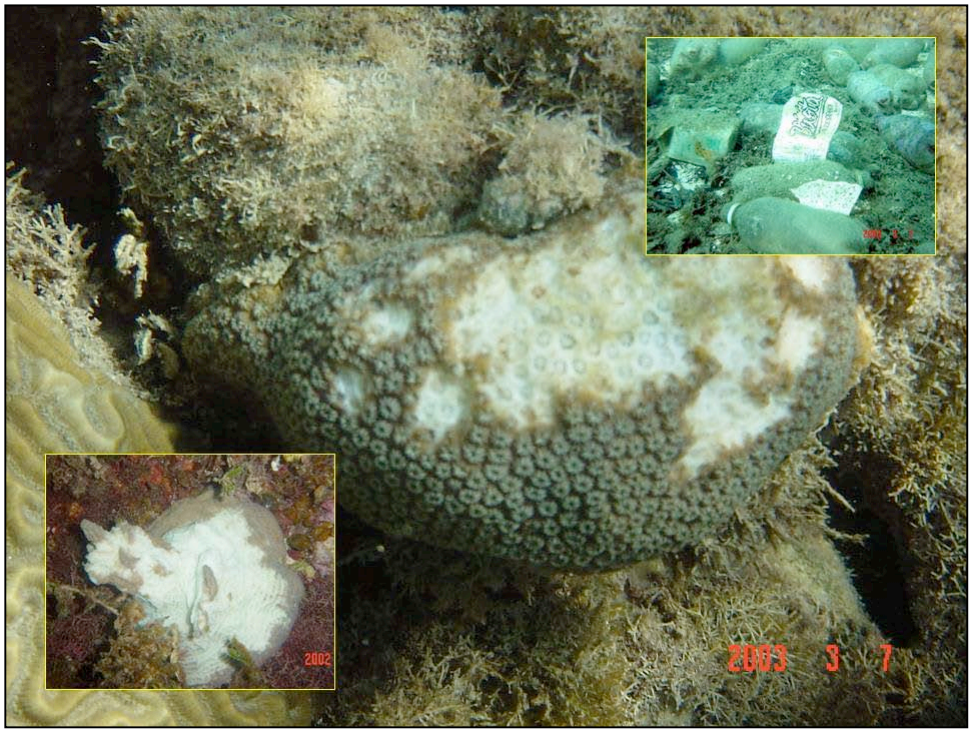

Figure 7: Evidence of coral degradation due to pollution in Montego Bay Marine Park, Jamaica
Source: Montego Bay Marine Park

3.3 Unplanned Development and Social Pressures

Rapid population growth and industrialisation have resulted in a number of unplanned developments. These are often sited in vulnerable or low-lying areas, making them susceptible to flooding, storm surge, and sea level rise. This is often the case with coastal settlements and key infrastructure, which are also prone to damage from severe weather events such as hurricanes.

Additionally, in cases where the integrity of wetlands, such as mangroves, is compromised by unplanned coastal developments, natural processes such as water exchanges are disrupted and often lead to enhanced coastal deterioration such as beach erosion.

3.4 Unsustainable Farming Practices

These practices include slash and burn agriculture, misuse and overuse of fertilisers, and over-cultivation (over-cropping) on marginal farm lands. Among other undesirable outcomes, these actions lead to soil erosion, soil loss, and the deposition of fertile soil into lakes and other water bodies.

In turn, this can cause eutrophication of water bodies. Eutrophication refers to the accumulation of nutrients in a lake or landlocked body of water, resulting in algal blooms. When these algal blooms decay, they remove dissolved oxygen and thus eliminate aerobic organisms such as fish and potentially cause the accumulation of sulphide in the water (www.bio.hw.ac.uk).

These consequences collectively result in decreased food outputs and water availability, and thus bear serious implications for food security. Unsustainable farming practices are a leading cause of famine in Kenya.

4.0 Global Climate Change Projections

One of the great challenges of global climatology is the prediction of future climate changes with adequate details and which is sufficiently far advanced to allow humanity to adjust its behaviour in time to avert the worst consequences of such changes. The assessment of climate change is done on global and regional scales that cover periods of at least a century (IPCC, 2000).

The IPCC makes projections of global climate based on simulations made with global climate computer models, applying them to spatial scales of hundreds of kilometres and larger. Current climate change simulations have been assessed for the period 1990 to

2100 and are based on a range of climate change scenarios. The IPCC has developed a group of six scenarios based on four so-called "storylines." Each storyline represents different demographic, social, economic, technological, and environmental paths to development (for more detailed information, refer to storyline and SRES scenarios in the glossary).

Some of the major global projections of the climate change by the IPCC (2001) are summarised in below:

- *Global temperatures* – Mid-century (2021-2050) projections of surface air temperatures (SAT) indicate that there could be an increase between 0.8°C and 2.1°C compared to 1961-1990 values. Near the end of the century (2071-2100), the corresponding figures range between +0.9°C and +4.5°C. Surface temperature increases will be smaller in the North Atlantic and Southern Ocean Regions compared to the global mean.
- *Snow cover and sea-ice extent* – As the climate warms, further decreases in Northern Hemisphere snow cover and sea-ice extent will result.
- *Precipitation* – The globally averaged mean water vapour, evaporation, and precipitation levels are projected to increase. Most tropical areas (i.e. areas between 0° and 30° N and S) are expected to see increases in mean precipitation. Most subtropical areas are likely to experience decreases in mean precipitation. In the high latitudes (above 60° latitude), mean precipitation will increase. Overall, the intensity of rainfall events is expected to increase.
- *Dryness:* Due to increased evaporation and reduced precipitation in mid-continental areas, projections indicate the drying of such areas during summer, resulting in decreases in soil moisture.
- *Monsoon precipitation:* Available studies indicate enhanced inter-annual variability of northern summer monsoon precipitation.
- *Sea level rise:* Global sea level rise is projected to between 0.11 and 0.77 metres during the interlude 1990 to 2100. The wide range reflects uncertainties in modeling.

5.0 Caribbean Challenges to Climate Change

The combined area of the Caribbean Sea and Gulf of Mexico is 5,326,000 km^2. This area comprises a total of 28 insular and coastal states and 10 territories bordering the Caribbean Sea and the Gulf of Mexico. The estimated population is 40 million people, of which some 70 per cent live in coastal cities, towns and villages and of which approximately 38 per cent can be classified as poor.

The Caribbean countries, like other small island and coastal areas, face difficult decisions in confronting the adverse effects of global climate change and the associated sea level rise (www.cpacc.org, 1998).

This is so for a number of reasons, not least among which is the fact that the region contributes minimally to the emissions of greenhouse gases and in turn to the attendant global warming. Taken collectively, all the small island states of the Caribbean Sea and the Atlantic, Pacific and Indian Oceans contribute less than 1 per cent of global emissions (IPCC, 2001b) (see Table 1 below).

This means that attempts in the Caribbean to mitigate climate change, which involve reducing the sources of greenhouse gases or enhancing their removal (by sinks), would not contribute substantially to the reduction of global emissions on the scale required to address the underlying problem.

Further, even an immediate and dramatic cut in global greenhouse gas emissions would not fully prevent the realisation of climate change impacts in the future (www.unfccc.int). The climate system responds to changes in GHG levels with a time lag. Past and present emissions have already committed the earth to at least some climate change in the 21st century. Natural ecosystems and human societies will be sensitive to both the magnitude and the rate of this change.

Although the full extent of climate change impacts in the Caribbean is far from certain, mostly adverse consequences are projected. Climate change impacts, including sea level rise, intensified storms, and associated storm surge, should be matters of concern for the Caribbean and particularly coastal areas.

Greenhouse Gas Emissions: The Caribbean Compared with Latin America and the Caribbean and the World-2000 Data

Rank	Country	MtC	% of regional total (594.9 MtC)	Tons of C per person
8	Cuba	13.62	1.96%	1.2
11	Dominican Republic	8.23	1.19%	1
15	Trinidad & Tobago	5.86	0.85%	4.5
17	Jamaica	3.54	0.51%	1.4
23	Guyana	1.05	0.15%	1.4
25	Bahamas	0.54	0.08%	1.8
26	Barbados	0.42	0.06%	1.6
27	Antigua & Barbuda	0.37	0.05%	5.4
28	Belize	0.35	0.05%	1.4
29	Saint Lucia	0.16	0.02%	1
30	Saint Vincent & Grenadines	0.07	0.01%	0.6
31	Dominica	0.05	0.01%	0.6
32	Grenada	0.03	0.00%	0.3
33	Saint Kitts & Nevis	0.03	0.00%	0.6

Total Emissions for Caribbean= **33.98 MtC** which equates to **4.89%** of the Regional total or **0.48%** of the global total

Total Global Emissions=**7157.96 MtC**

Legend: MtC=million metric tonnes of carbon equivalent; Tons C=metric tons of carbon equivalent. Rank and % of **Regional total** are based on figures for Latin America and the Caribbean.

Table 1. Total Greenhouse Gas Emissions by Caribbean Countries for 2000
Source: Adapted from Climate Analysis Indicators Tool (http://www.cait.wri.org) comparative data for 2000.

5.1 Inherent Vulnerabilities to Climate Change

There are a number of inherent circumstances that make the Caribbean particularly vulnerable to climate change. Among the chief ones are:

- *Limited physical size and isolation of islands* – This effectively reduces some adaptation options to climate change and sea level rise. Retreat is often difficult, and in some cases entire islands could be eliminated, with abandonment as the only option. Protection costs for human settlements and critical infrastructure are too burdensome for individual states.

- *Generally limited natural resources* – Many resources are already heavily stressed from unsustainable human activities. Financial and human resources are also inadequate.

- *High susceptibility to natural hazards* – Hazards include tropical cyclones (hurricanes) and associated storm surge, droughts, tsunamis, and volcanic eruptions. This is especially important given that most key infrastructure (tourism, transport, and communications) and major economic activities are concentrated within the coastal zone and, in some cases, low-lying floodplains. Lack of planning policies and/or failure to enact such policies can lead to large expanses of unplanned developments.

- *Low economic resilience* – This is due to the extreme openness of small economies and high sensitivity to external market shocks over which they exert little or no control.

- *Generally high population densities* – In some cases, high population densities is also compounded by high population growth rates. Often, large population settlements are located in coastal areas where they are very susceptible to flooding and storm surge. The prospect of sea level rise thus poses a serious threat for these coastal populations and the supporting infrastructure.

- *Frequently poorly developed infrastructure* – The exception is major foreign exchange-earning sectors, such as tourism.

- *Insurance* – Organisations and individuals alike often experience difficulty in securing requisite levels of insurance or re-insurance due to the perceived proneness to natural disasters.

Besides these, sea level rise bears other potential consequences such as coastal erosion and land loss, flooding, soil salinisation, and intrusion of saltwater into groundwater aquifers. The quantity and quality of available water supplies can affect agricultural production and human health. Similarly, changes in sea surface temperature

(SST), ocean circulation, and upwelling[6] could affect marine organisms such as corals, sea grasses, and fish stocks (IPCC, 2001a).

5.2 Regional Projections of Climate Change – The Caribbean

Obtaining accurate regional climate projections is difficult. This is primarily due to the fact that most of the climate models operate at resolutions (spatial scales) much too large to provide detail of Caribbean countries.

Attempts are currently underway to downscale global models (i.e. to reduce the spatial resolution) to generate more precise regional projections. Under the Mainstreaming Adaptation to Climate Change (MACC) Project (refer to section 8.3 of this handbook), regional downscaling is currently being undertaken on two campuses of the University of the West Indies (Cave Hill – Barbados and Mona – Jamaica). As well, two regional scientists have been sent to Japan (July 2005) for further training in this field.

The IPCC has made regional projections for four regions: the Atlantic Ocean and Caribbean Sea, the Indian Ocean, the Pacific Ocean, and the Mediterranean Sea. The time period of 30 years (1961-1990) is used as the basis for comparison for climate change scenarios in these island regions. Two future time periods centered on the 2050s (2040-2069) and the 2080s (2070-2099) were used. The projections stated in Table 2 are based on the IPCC projections for the Atlantic and Caribbean region.

Parameter	Projections
Temperature	Increases between 2.0° and 2.8°C for the 2050s and 3.1° to 4.3°C for the 2080s.
Rainfall	Marginal increases expected.
Sea level rise	Increase of about 38 cm between 1990 and 2080s (Nicholls et al, (1999). IPCC estimates indicate an increase of 18 cm per 100 years.
Tropical Cyclone and Peak wind intensity	Likely to increase (66-90% chance).
Health Impacts	Vector-borne diseases (such as dengue and malaria) are likely to increase with higher temperatures.
Coastal Resources	Coral reefs will experience a higher incidence of bleaching and die-out due to higher temperatures.

Table 2: Regional Projections of Climate Change

[6] This is the upward flow of cold ocean waters from great depths below the water surface. These waters are rich in nutrients and thus support abundant fish and marine populations.

6.0 Country-by-Country Guide to Climate Change Issues and Concerns

Although climate change poses many common problems for countries of the Caribbean, individual challenges will differ between islands. These will vary according to physical characteristics, natural and financial resources, and population density and distribution, among other factors.

This section provides a country-by-country analysis of the major climate change concerns as well as the key vulnerability issues of selected islands. The concerns highlighted were obtained from the Initial National Communications of the respective countries and from a synthesis report authored by Moore (2002). A summary of the geographic and socio-economic characteristic of the 12 participating countries in the MACC Project is also given in Table 3, at the end of this section.

6.1 Antigua and Barbuda

The main concerns of Antigua and Barbuda include:

- *The increase in tropical cyclones*[7]*:* As much as 60 per cent of Antigua's population lives along the coast. The coast also houses the island's major tourism infrastructure. Hurricanes cause major disruptions to activities, lives, and livelihoods within the coastal zone, as proven by recent hurricanes such as Marilyn (1995) Jose (1998), Georges (1998), and Lenny (1999). Resulting landslides and flooding inflicted damage to houses and infrastructure alike. This has had negative effects on the economy. Increased tropical cyclone activity thus poses a major threat to the country.
- *Decreased rainfall:* Antigua is regarded as a water-scarce country. Much of the country's fresh water is derived from desalination. During periods of prolonged drought, water has to be imported via barges from regional islands (UNEP, 2000). Decreased rainfall will therefore exacerbate the water scarcity problem and will have adverse impacts on public health, agriculture, and tourism.
- *Sea level rise and storm surge:* These pose serious challenges for the large concentration of human settlement and economic infrastructure within the coastal zone. Sea level rise, in particular, could result in saline intrusion into groundwater aquifers. This will further compromise fragile fresh water supplies.

[7] Tropical cyclone is the generic term used for a number of weather systems that occur over tropical oceans. These systems may take the form of tropical depressions, tropical storms, and hurricanes.

6.2. The Bahamas

Over 80 per cent of the landmass that makes up the Bahamas is within 1.5 metres of mean sea level. The entire island system is considered to be in the coastal zone as inland locations are always within 16 kilometres of the coast. Sea level rise thus poses major threats and could result in major dislocations. The islands' rounded hills with porous young limestone formations are particularly susceptible to erosion and the devastating impacts of hurricanes.

The Bahamas is renowned for its diverse and extensive coral reef systems. With an area of over 2,300 square kilometres of coral reefs, the islands boast the third most extensive coral reef system in the world. It supports a thriving tourism industry that contributes to about 50 per cent of the islands' gross domestic product (GDP). Higher temperatures due to global warming will lead to a higher incidence of coral bleaching and silting due to erosion could have major deleterious consequences for the reefs. Beach loss due to erosion could also occur. The tourism industry could thus be severely impacted, especially with the large concentration of hotels along coastlines.

As well, most of the islands' fresh water is extracted from shallow freshwater lenses. This means that saline intrusion due to sea level rise could significantly reduce freshwater supplies, especially in the wake of increasing demands.

6.3 Barbados

This country's main concerns include:

- *Sea level rise and coastal zone issues:* Assessment of sea level rise scenarios in Barbados under the CPACC Project (see section 8.1) showed that a 1-metre rise could result in beach losses between 5 and 30 metres. These losses could have significant economic impacts on the island since most important infrastructure is along the coast, including the Barbados Light and Power Company and the Port Authority. The tourism industry could also be significantly affected, since the island's hotels are also mainly concentrated within the coastal zone. Sea level rise, through the intrusion of saline water, can also have adverse impacts on the island's water supplies. It is estimated that nearly 51,000 people could be affected by water shortages.
- *Risk of flooding:* The island's last direct hit from a hurricane occurred in 1955 (Hurricane Janet). Since 1955, however, the country has counted 58 events of heavy rains, flooding, and wind. Two tropical systems, Hurricane Allen (1980) and a tropical wave (1995), cost the country over BDS $11 million. Flooding from these events was a major problem. Projections calling for an increase in rainfall intensity, which could increase flooding events, could have serious consequences for the island.
- *Damage to coral reef and fisheries*: Temperature increases projected for the region could prove deadly to coral reefs and fisheries, which they nurture. This

was shown during the 1999 inflow of fresh waters from the Orinoco River of South America, occasioned by the unseasonably high precipitation in the Orinoco basin, resulting in conditions in the Caribbean Sea which were conducive to the survival of certain species of freshwater bacteria that led to massive fish kills. Loss of beaches, a major tourist attraction, could also result, since reefs create and maintain the beaches.

6.4 Belize

Belize has been identified by the UNFCCC as one of the countries most vulnerable to the impacts of hurricanes and climate change (www.iadb.org). This was further borne out by the effects of recent hurricanes. Keith (October 2000) left a rail of damage in San Pedro; Category 4 Iris (2001) damaged many houses and flattened coastal towns; and Ivan (September 2004) split Caye Caulker Island (northeast of Belize City) into two parts.

The impacts of temperature rise on climate change in coastal areas of Belize can be expected to lead to an increase in the frequency of storms throughout this century, which could have significant environmental impacts on the country's coastal habitats.

Aside from storms, other risks to reefs and coastal wetlands include changes in sea level, water temperature, and salinity. Sea level rise also poses threats of flooding to coastal communities. Coral reefs, sea grass beds, mangroves, and littoral forest constitute the basis of the thriving Belize fishing industry. Activities in the fisheries sector may therefore be considerably diminished, resulting in significant socio-economic hardship to fishermen, their dependents, and coastal communities in general.

6.5 Dominica

Dominica has considerable forestry reserves, and its range of forest species may be affected by climate change. Stronger hurricanes and sea level rise could be particularly costly for the island, as up to 90 per cent of the population and critical infrastructure is found in coastal areas.

Dominica is renowned for its vast number of rivers (365), which could experience a reduction in base flow due to decreased rainfall. This could also result in reduced water availability for domestic and commercial uses, including the generation of hydro-electricity. Variations in rainfall could also negatively affect the island's chief cash crop, bananas. Further, increased and irregular rainfall patterns would have severe implications on agriculture, which is practised along slopes, resulting in erosion and siltation of water sources.

6.6 Grenada

The recent impacts of Hurricane Ivan (September 2004) and Hurricane Emily (July 2005) emphasised this country's vulnerability to extreme weather events. It was reported that 80 per cent of the country had been demolished, with at least 89 per cent of the housing stock destroyed. This prompted the need for a review of building codes (OECS, 2004).

The major export crop, nutmegs, was significantly damaged. The nutmeg sub-sector employed over 30,000 people and caused significant loss of livelihood. Ivan took the lives of 28 people, with half the number of casualties occurring in the capital city of St Georges on the island's west coast. Following Ivan, the government's fiscal position deteriorated from a surplus of $17 million to a deficit of $54 million, or 4.5 per cent of GDP. This reflects the fall-off in revenues, particularly from taxes on international trade and transactions (OECS, 2004).

Stronger hurricanes could thus prove catastrophic, especially if recovery efforts are impeded by other extreme events. Since all the major commercial centres and key infrastructure including airports, hotels, and hospitals are in the coastal zone, sea level rise also poses another serious challenge for the country.

6.7 Guyana

Coastal erosion of natural and estuarine sea defenses, sea level rise, reduced rainfall, and higher temperatures are among Guyana's key climate change concerns. Erosion and sea level rise will increase the likelihood of severe flooding in the coastal zone, where 90 per cent of the population lives. A number of communities could also be marooned by flood waters, since most of the highways and secondary roads are concentrated in a narrow coastal strip.

Temperature increases could affect different species of trees in the country's vast forests reserves. Over time, this could affect the lucrative lumber industry. The higher temperatures along with reductions in rainfall could affect the inland waterways, which are a chief means of transportation. Significant reductions in rainfall could also affect the generation of hydropower at a time when energy demand could be higher due to higher temperatures.

6.8 Jamaica

Jamaica's chief concerns include coastal inundation, sea level rise, and damage by extreme weather events. The country's two international airports lie along the coast, one at sea level and the other less than 2 metres above sea level. The central business

districts, key infrastructure, and major tourist accommodations and attractions are all in the coastal zone. In many cases, relocation or abandonment are not realistic options.

Heavy rainfall associated with tropical cyclones results in coastal flooding, which causes severe inconvenience and loss of revenues. Hurricane Ivan in 2004 dumped nearly 2 metres of sand along the entire roadway leading to the Norman Manley International Airport, rendering it impassable for nearly one week. Should there be a major climate disaster, overseas aid may have to be shipped rather than airlifted since both airports could be inundated.

Sea-level rise bears significant concerns for saline intrusion into the country's ground water. Estimates are that up to 80 per cent of the island's fresh water is supplied by ground water. Since the country also supplies water to a number of cruise ships that dock in its harbours, loss of revenues could also result.

The community of Portmore in Southeastern Jamaica is an example of Jamaica's vulnerability to climate change. Home to over 250,000 people, Portmore accounts for nearly 10 per cent of the country's population. Several neighbourhoods in Portmore are in low-lying areas, prompting time-consuming evacuation exercises once a major climate hazard threatens.

Damage by Hurricane Ivan amounted to over US$500 million with significant losses to the agriculture and tourism industries. Interestingly, the hurricane did not make landfall over Jamaica, indicating that future direct systems of similar magnitude could cause even more catastrophic damage.

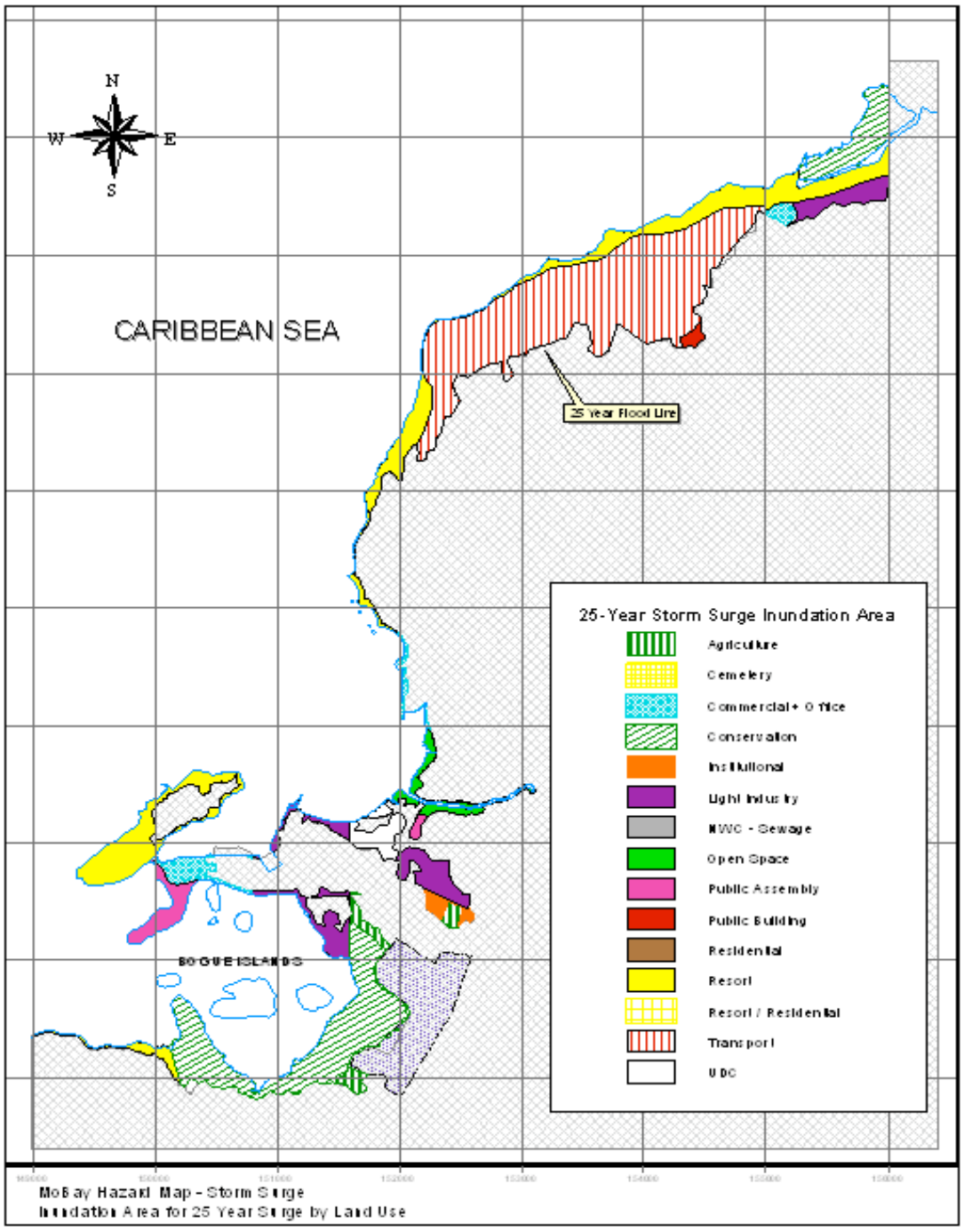

Figure 8 Montego Bay Inundation Area for 1 in 25-year Hurricane Surge
Source: www.oas.org

Figure 9: Hurricane Ivan's Disruption of Shoreline at Eastern End of Runway, NMIA
Source: Cowill Lyn, NEPA, Jamaica

6.9 Saint Lucia

Tropical cyclone activity and sea level rise pose major challenges for Saint Lucia. Increased beach erosion damage to coastal infrastructure and major coastal settlements could result from enhanced storm activity. Beach loss could damage key tourism infrastructure. Tourism contributes significantly to the Saint Lucian economy, so that dislocations would affect national economic growth.

Approximately 50 per cent of the total population lives in the Castries/Gros-Islet corridor, located along the northwestern coast of the island. Much of the capital, Castries, is built on low-lying reclaimed land, making the city centre prone to flooding during periods of heavy rain.

The agricultural sector could also be adversely affected by more intense climate extremes. Bananas, the principal crop, is sensitive to variations in rainfall and temperature. Projected decreases in rainfall and increased temperatures could increase heat stress and result in reduced yields.

6.10 St Kitts and Nevis

Coastal erosion and flooding, which could increase with more intense hurricanes, pose a major threat to this country's key infrastructure, population, and thriving tourism industry. The passage of Hurricanes Luis and Marilyn (1995) and George (1998), for example, significantly reduced tourist traffic to the island. As well, Hurricane Lenny destroyed a recently constructed cruise ship pier in St Kitts and decimated a five-star hotel in Nevis. Some residential coastal locations are deemed so vulnerable to hurricanes and flooding that securing insurance coverage is very difficult.

As well, saltwater intrusion due to sea level rise is likely to affect agricultural soils, resulting in reduced production. Increased temperatures will have negative impacts on the fisheries, particularly the conch and lobster industries.

6.11 St Vincent and the Grenadines

About 85 per cent of this country's population lives on a narrow coastal strip that is less than 5 metres above sea level and less than 5 kilometres away from the high water mark. Also sited on his strip is the main built-up area, which accounts for 90 per cent of the country's economic investment. Sea level rise thus presents serious and costly adverse impacts, especially for areas built on reclaimed lands.

Rapid rates of coastal erosion have been noted in areas in the southwestern tip of the island (Campden Park), which could be enhanced by more intense hurricanes. Hurricanes Lenny (1999) and Emily (2005), neither of whom made direct hits, caused significant damage to the island. In the case of the latter, estimates were that damage amounted to over 2 per cent of current GDP.

The offshore coral reefs that surround the cayes of the Grenadines are also at risk. Studies have shown that extensive coral bleaching could result with rising temperatures. In addition to damage to the natural environment, this could result in damage to the tourism industry.

6.12 Trinidad and Tobago

The densest population settlement in Trinidad and Tobago is located in the Caroni Basin. This basin is situated between the northern range and central range in Trinidad. The area is considered vulnerable to climate change and sea level rise because it is home to many species of wildlife, critical life-sustaining facilities, and main reserves of surface and groundwater. As well, large population settlements are located just at the foothills of the northern fringe in Trinidad. A combination of erodible soils and

inadequately constructed homes makes these areas particularly vulnerable to storm activity.

The island is not frequently impacted by hurricanes, but projections for more intense systems could pose a serious threat. Other large settlements are located on low-lying flood plains, where frequent flooding has already led residents to commence relocation efforts. Point Lisas, an industrial estate on the west coast of Trinidad, lies primarily on low-lying reclaimed land. This area is an important contributor to the country's GDP. Sea level rise thus threatens to realise seriously adverse consequences for the main socio-economic sectors of Trinidad and Tobago.

STATISTICS	Ant. & Barb.	Bahamas	Barbados	Belize	Dominica	Grenada
Capital	Saint John's	Nassau	Bridgetown	Belmopan	Roseau	Saint George's
Area (km sq)	443	13,940	431	22,966	754	344
Coastline (km)	153	3542	97	386	148	121
Climate	Tropical maritime	Tropical maritime	Tropical, rainy season	Tropical, hot/humid, rainy/dry season	Tropical, heavy rainfall	Tropical
Terrain	Low-lying dryland, no inland water	Flat, low rounded hills, no rivers	Flat, central highland, no inland water	Flat swampy plains, low mtns, inland water and rivers	Rugged mtns, no inland water	Volcanic, central mtns, no inland water
Highest point (m)	402	63	336	1,160	1,447	840
Natural resources	Negligible	Salt, aragonite, timber, arable land	Petroleum, fish, natural gas	Arable land, timber, fish, hydropower	Timber, hydropower, arable land	Timber, fruit, harbours
Natural hazards	Hurricanes, tropical storms, droughts	Hurricanes, tropical storms	Hurricanes, landslides	Hurricanes, coastal flooding	Flash floods, hurricanes	Hurricanes
Environmental issues	Limited fresh water, deforestation, rainfall runoff	Coral reef decay, solid waste disposal	Ship pollution, soil erosion, solid waste disposal, contamination of aquifers	Deforestation, water pollution, industrial waste, agricultural runoff, solid/sewage waste disposal	Crops vulnerable to climate change	NA
Population	68,722	301,790	279,254	279,457	69,029	89,502
Density	155	22	648	12	92	260
Literacy rate	89.0%	95.6%	97.4%	94.1%	94.0%	98.0%
Economy notes	Tourism half of GDP	Tourism 60%+ of GDP	Tourism, light industry, sugar (traditionally)	Tourism, marine products, crops	Agriculture (bananas), tourism	Tourism
GDP	$750,000,000	$5,295,000,000	$4,569,000,000	$1,778,000,000	$384,000,000	$440,000,000
GDP growth rate	3.0%	3.0%	2.3%	3.5%	-1.0%	2.5%
GDP per capita	11,000	17,700	16,400	6,500	5,500	5,000
Unemp. rate	11.0%	10.2%	10.7%	12.9%	23.0%	12.5%
Economic aid	$2,300,000	$9,800,000	$9,100,000	NA	$22,800,000	$8,300,000

STATISTICS	Guyana	Jamaica	St Kitts & Nevis	Saint Lucia	St Vincent & the Grenadines	Trinidad & Tobago
Capital	Georgetown	Kingston	Basseterre	Castries	Kingstown	Port-of-Spain
Area (km sq)	214,970	10,991	261	616	389	5,128
Coastline (km)	459	1022	135	158	84	362
Climate	Tropical, hot/humid, two rainy seasons	Tropical, hot/humid	Tropical, rainy season	Tropical, dry/rainy season	Tropical, rainy season	Tropical, rainy season
Terrain	Highlands, coastal plains, savanna, inland water & rivers	Mtns, coastal plain, inland water	Volcanic, mtns, no inland water	Mtns, fertile valleys, little inland water	Volcanic, mtns, no inland water	Plains, hills, low mtns, no inland water
Highest point (m)	2,835	2,256	1,156	950	1,234	940
Natural resources	Minerals, timber, fish	Bauxite, gypsum, limestone	Arable land	Forests, minerals, geothermal potential	Hydropower, cropland	Petroleum, natural gas, asphalt
Natural hazards	Flash floods	Hurricanes	Hurricanes	Hurricanes, volcanic activity	Hurricanes, volcanic activity	Hurricanes, tropical storms (outside usual path)
Environmental issues	Water pollution (sewage, agri/industrial chemicals), deforestation	Deforestation, water pollution (waste, sewage, oil spills), coral reef damage, air pollution (vehicle emissions)	NA	Deforestation, soil erosion	Water pollution (effluents)	Water pollution (chemical industrial waste, sewage), beach pollution (oil), deforestation, soil erosion
Population	765,283	2,731,832	38,958	166,312	117,534	1,088,644
Density	4	249	149	270	302	212
Literacy rate	98.8%	87.9%	97.0%	67.0%	96.0%	98.6%
Economy notes	Agriculture, mining	Services 60% of GDP, tourism, high debt	Sugar, tourism	Mfgr diverse, tourism, bananas	Agriculture (crop wipeout), tourism (seasonal)	Leader in oil & gas, tourism not as important
GDP	$2,899,000,000	$11,130,000,000	$339,000,000	$866,000,000	$342,000,000	$11,480,000,000
GDP growth rate	1.9%	1.9%	-1.9%	3.3%	0.7%	5.7%
GDP per capita	3,800	4,100	8,800	5,400	2,900	10,500
Unemp. Rate	9.1%+	15.0%	4.5%	20.0%	15.0%	10.4%

Table 3: Summary of Socio-economic, Geographic characteristics of Caribbean Countries

Source: www.cia.gov

7.0 Global Conventions and Responses

7.1 The Evolution of the Climate Change Convention

Increasing scientific evidence of human interference with the climate system, coupled with growing public concern over global environmental issues, forced climate change onto the international political agenda in the mid-1980s.

Recognising the needs of policymakers for authoritative, credible and up-to-date scientific information, the Intergovernmental Panel on Climate Change (IPCC) was jointly established by the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP) in 1988.

Two years later, the IPCC issued its First Assessment Report, confirming that human-induced climate change was indeed a threat and calling for a global treaty to address the problem (UNFCCC, 2002). This call was also echoed by the Ministerial Declaration of the Second World Climate Conference held in Geneva in October/ November 1990.

In December 1990, this sequence of events culminated in a formal response by the United Nations General Assembly with the launching of negotiations on a framework convention on climate change. These negotiations were conducted by the Intergovernmental Negotiating Committee (INC). After 15 months, the INC adopted, by consensus, the United Nations Framework Convention on Climate Change (UNFCCC). This Convention was opened for signature at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil, on June 4, 1992. It came into force on March 21, 1994.

Since the Convention's entry into force, parties have met annually in the Conference of the Parties (COP) to monitor its implementation and continue talks on how to tackle climate change (UNFCCC, 2002). Table 4 below gives a chronology of the COPS 1-10 (1995-2004).

Chronology of Conference of the Parties (COP 1-10): 1995-2004

Date of Commencement	Venue	Event: Major Outcome
April 7, 1995	Berlin, Germany	**COP 1**: Berlin Mandate launched a new round of negotiations on a protocol or other legal instrument
July 19, 1996	Geneva, Switzerland	**COP 2**: Geneva Declaration adds impetus to ongoing negotiations
December 11, 1997	Kyoto, Japan	**COP 3**: Kyoto Protocol adopted to the UNFCCC
November 14, 1998	Buenos Aires, Argentina	**COP 4**: Buenos Aires Plan of Action established
October 25, 1999	Bonn, Germany	**COP 5**: Call made for urgent ratification of KP
November 13, 2000	Hague, Netherlands	**COP 6(a):** No decision on Buenos Aires Programme of Action
July 16, 2001	Bonn, Germany	**COP 6(b)**: Some political consensus on the Buenos Aires Programme of Action
October 29, 2001	Marrakesh, Morrocco	**COP 7**: The "Marrakesh Accords" adopted
October 23, 2002	New Delhi, India	**COP 8**: Established the Delhi Ministerial Declaration on Sustainable Development
December 1, 2003	Milan, Italy	**COP 9**: Ministerial call for urgent and coordinated action on climate change
December 6, 2004	Buenos Aires, Argentina	**COP 10**: 10th Anniversary of UNFCCC, achievements highlighted

Table 4: Chronology of Conference of the Parties (COP) Held 1995-2004

7.2 The Provisions of the United Nations Framework Convention on Climate Change (UNFCCC)

The ultimate objective of the Convention is "the stabilising of atmospheric concentrations of GHGs at levels that would prevent dangerous human interference with the climate system." Such levels, which are not specified by the Convention, should be achieved within a sufficient time frame to allow ecosystems to adapt naturally to climate change, to ensure that food security is not threatened, and to enable economic development to proceed in a sustainable manner (UNFCCC, 2002).

In the pursuit of this objective, all parties that have ratified, accepted, approved, or acceded to the treaty are obliged to take steps to respond to climate change. The Convention divides countries into two main groups: those that are listed in its Annex I, known as ***Annex I Parties,*** and those that are not, known as ***non-Annex I Parties.*** The members of the Organisation for Economic Co-operation and Development (OECD) are also listed in the Annex II of the Convention.

Annex I parties include industrialised countries that have historically contributed the most to global GHG emissions and the resulting climate change. Table 5 below shows those parties listed in Annex I of the Convention.

Australia	**Austria**	Belarus
Belgium	Bulgaria	**Canada**
Croatia	Czech Republic	**Denmark**
Estonia	**European Community**	**Finland**
France	**Germany**	**Greece**
Hungary	**Iceland**	**Ireland**
Italy	**Japan**	Latvia
Liechtenstein	Lithuania	**Luxembourg**
Monaco	**Netherlands**	**New Zealand**
Norway	Poland	**Portugal**
Romania	Russian Federation	Slovakia
Slovenia	**Spain**	**Sweden**
Switzerland	Turkey	Ukraine
United Kingdom	**United States of America**	

Table 5: Annex I Parties of the UNFCCC.
Countries in bold are also listed in Annex II.

Given the historical contribution to emissions by Annex I parties and their greater financial and institutional capacity to address climate change, the Convention mandates that these parties should take the lead in so doing. Two principles are enshrined in the Convention – equity and "common but differentiated responsibility," requiring that Annex I parties take steps to modify longer-term trends in emissions (UNFCCC, 2002).

Annex I parties were committed to reducing their emissions of greenhouse gases to 1990 levels by the year 2000. This was a non-legally-binding target. All Annex I parties must also submit regular reports, known as National Communications, which give details of climate change policy and measures that have been implemented. These parties must also submit an annual inventory of GHGs. Additionally, Annex II parties have an obligation to provide "new and additional financial resources" to developing countries to help them cope with climate change, as well as to facilitate the transfer of climate-friendly technologies to both developing countries and countries with Economies in Transition[1] (UNFCCC, 2002).

All non-Annex I parties, essentially developing countries, do not have emission reduction targets. They are, however, required to report in general terms on actions taken to address climate change and adapt to its effects. Subject to the availability of funds, these parties are also required to submit National Communications, but are not obliged to tender annual GHG inventories.

The Convention is served by a secretariat and two subsidiary bodies: the Subsidiary Body for Scientific and Technological Advice (SBSTA) and the Subsidiary Body for Implementation (SBI). Provisions exist within the framework convention for the adoption of protocols by parties that serve to enhance its objectives.

7.3 Climate Change Negotiating Groups

Current climate change negotiations take place among 194 countries. As it is impossible to negotiate with each country individually, countries try to develop coalitions with each other. Such coalitions are necessary to make the negotiations manageable and to reduce the complexity of the issues and the numbers of negotiating groups. They can also reduce transaction costs for countries by helping them pool their resources and increase their negotiation leverage (Gupta, 2000).

Different groupings exist within Annex I and non-Annex I countries. In the Annex I group of countries, the most permanent group is the European Union. The countries with Economies in Transition (CEITs) are not very organised as a coalition and some, such as those aspiring to EU membership, tend to align themselves with the EU. Others, such as Ukraine and Russia, align themselves with other Annex I Parties.

[1] These are chiefly members of the former Soviet Union.

The USA and other Annex I Parties occasionally operate in a group known as JUSSCANNZ (an acronym of their country names). There is also an umbrella group that has members from JUSSCANNZ and some CEITs. Table 6 shows the groups within Annex I.

European Union (25)	JUSSCANNZ (7)	CEIT (changes with admission to EU)	Umbrella group	Rest of Annex I (4)
Austria	Australia	Belarus	Japan	Iceland
Belgium	Canada	Bulgaria	USA	Liechtenstein
Cyprus	Japan.	Croatia	Iceland	Monaco
Czech Republic	Norway	Romania	Canada	Turkey
Denmark	New Zealand	Russian Federation	Australia	
Estonia	Switzerland		Norway	
Findland	U.S.A.		New Zealand	
France			Russian Federation	
Germany			Ukraine	
Grece				
Hungary				
Iceland				
Ireland				
Italy				
Latvia				
Lithuania				
Luxemburg				
Netherlands				
Poland				
Portugal				
Slovakia				
Slovenia				
Spain				
Sweden				
UK				

Table 6: Division with Annex I Countries
Source: Adopted from Gupta, 2000

Non-Annex I countries are also categorised into diverse groups. As in the case with Annex I, some countries fall into more than one group. The major group is the Group of 77 (G-77) and China, which comprises over 130 countries – essentially all the developing countries. The composites of G-77 and China include the Africa Group, the Group of Latin America and the Caribbean (GRULAC), the Alliance of Small Island States (AOSIS), and the Organisation of Petroleum Exporting Countries (OPEC). The African Group consists of 53 countries, GRULAC has 33 members, AOSIS[2] has 42 members (of which 4 are not independent states), and OPEC has 11 members in Asia, Africa, and Latin America (see table 7a). Asia does not have an active regional group in the negotiations.

The non-G-77 non-Annex I countries consist of 23 countries. Given the diversity of the respective groups, arriving at consensus positions is often difficult, and on different issues there are alliances across blocs. Developed countries and other key players within Annex I who do not support emission reduction commitments tend to find support from OPEC countries. This is in stark contrast to the position of the AOSIS, which wants to see a speedy solution to the climate change problem.

[2]AOSIS has five member states that are not members of the G-77.

Non-Annex I Groupings		
Group	**Members**	**Number**
AOSIS	American Samoa*, Antigua and Barbuda, Bahamas, Barbados, Belize, Cape Verde, Comoros, Cook Islands**, Cuba, Cyprus, Dominica, Fed. States of Micronesia, Fiji, Grenada, Guam*, Guinea-Bissau, Guyana, Jamaica, Kiribati, Maldives, Malta, Marshall Islands, Mauritius, Nauru**, Netherlands Antilles*, Niue**, Palau**, Papua New Guinea, Samoa, Sao Tome and Principe, Seychelles, Singapore, Solomon Islands, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Surinam, Tonga, Trinidad and Tobago, Tuvalu**, U.S. Virgin Islands*, Vanuatu.	42 - 4=38
GRILA (Informal group)	Argentina, Bolivia, Chile, Colombia, costa Rica, Cuba, Guatemala, Dominican Republic, Euador, El Salvador, Honduras, Mexico**, Nicaragua, Panama, Paraguay, Uruguay	16
OPEC	Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, UAE, Venezuela	11
Environmental Integrity Group	Mexico**, Korea (Rep.)**, Switzerland[9]**	3
*Note: * not independent States; ** non-G77 countries*		

Table 7a. Non-Annex I Negotiating Groups
Source: Gupta, 2000

Continent	Countries	Total G-77	Total Non G-77
Europe	Albania*, Andorra*, Bosnia Herzegovina, Hole See* Macedonia (former Yugoslav Republic of)*, Malta, Moldova*, San Marino*, Yugoslavia (Federal Rep.)*	2	7
Oceania	Cook Islands*, Fiji, Kiribati*, Marshal Islands, Micronesia (Federal States of), Nauru*, Niue*, Palau*, Samoa, Solomon Islands, Tonga, Tuvalu* Vanuatu	7	6
Total G-77	All the above countries minus the * ones, i.e. those mentioned below	130	
Non-G77	Albania, Andorra, Armenia, Azerbaijan, Cook Islands, Georgia, Holy See, Israel, Kazakhstan, Kiribati, Korea (rep.), Kyrgyzstan, Macedonia (former Yugoslav Republic of), Mexico, Nauru, Niue, Palau, Moldova, san Marino, Tajikistan, Tuvalu, Uzbekistan, Yugoslavia (Federal Rep.)		

Table 7b. Other Non-Annex I Groupings

7.4 The Kyoto Protocol

The Kyoto Protocol was adopted at the third Conference of the Parties (COP-3) to the UNFCCC in Kyoto, Japan, on December 11, 1997. The Protocol shares the objectives, principles, and institutions of the Convention, but significantly strengthens it by committing Annex I parties to individual legally-binding targets to limit GHG emissions (UNFCCC, 2002). The Kyoto Protocol thereby serves as an important first step toward long-term and concrete measures to reducing greenhouse gas emissions (ISC, 2004).

The targets add to give a reduction in emissions of GHGs of 5 per cent below 1990 levels, to be accomplished in the first commitment period of 2008 to 2012 (see Table 8). The targets cover emission of the six main GHGs, namely:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perlfuorocarbons (PFCs)
- Sulphur hexafluoride (SF_6)

In calculating emissions, the warming potential of each of these gases is compared with that of carbon dioxide. In this way, emissions are reported in one unit: “carbon equivalent.” This circumvents any problems associated with reporting in multiple units of the different GHGs.

Country	**Target Relative to 1990 level**
European Union-25 Member Countries	-8% (Reduction of 8%)
United States	-7%
Canada, Hungary, Japan, Poland	-6%
Croatia	-5%
New Zealand, Russian Federation, Ukraine	0% (Meaning no reduction is target is given for the first commitment period)
Norway	+1% (An increase in emissions above 1990 levels allowable)
Australia	+8%
Iceland	+10 %

Table 8: Emission targets of Annex I parties.

The Protocol entered into force on February 16, 2005, the same year in which parties should have exhibited demonstrable progress toward meeting their targets. Negotiations on targets for the second commitment period are also due to commence in 2005.

Reducing emissions can be accomplished by either decreasing the sources of emissions, or enhancing processes that remove emissions from the atmosphere (referred to as increasing carbon sinks). In the case of emission reduction, initiatives include the use of energy-efficient techniques, less carbon-intensive sources of energy, renewable energy or cleaner technologies, or any combination thereof.

Enhancing the removal of carbon is regarded by the Protocol as activities in land use, land-use change and forestry (LULUCF). The activities eligible under LULUCF are expressly defined by the Protocol. They include afforestation, reforestation, deforestation, forest management, cropland management, grazing land management, and re-vegetation. Credits generated by LULUCF are termed *removal units* (RMUs).

The Protocol has a number of mechanisms designed to help parties achieve compliance with their emission targets. Listed in this are three so-called “flexibility mechanisms” known as: Joint Implementation, Clean Development Mechanism, and (International) Emissions Trading. These are briefly elaborated below.

1. **Joint Implementation:** Under this arrangement, an Annex I party may implement a project that reduces emissions, or increases carbon sinks, in the territory of another Annex I Party, and apply the resulting *emission reduction units (ERUs)* against its own target.

2. **Clean Development Mechanism (CDM):** Annex I parties may implement projects in non-Annex I countries that reduce emissions. The resulting reductions, termed *certified emission reductions (CERs)*, can be used to help the Annex I party meet its target. The process has a very detailed rule book outlining requirements, registration, monitoring, and a certification programme. Recent amendments to the modalities of the CDM allow non-Annex I parties to develop their own projects (termed unilateral CDMs) and trade its credits with other parties.

3. **Emissions Trading:** This allows for trading of carbon credits between Annex I parties. The trade can involve a transfer of units of a party’s allowable emission limit, termed its Assigned Amount Unit (AAU), or credits generated by the CDM (CERs) or joint implementation (ERUs). It may also involve the trade of credits generated by LULUCF RMUs. No party is allowed to trade all its credits; it must reserve a quantity to meet its own target. Additionally, no party is allowed to meet its target exclusively by trading; it must implement measures of its own.

Besides these mechanisms, there is a scheme known as the “Bubble.” This is an option in the Kyoto Protocol that allows a group of countries to meet their targets jointly by aggregating their total emissions. Under this arrangement, targets can be redistributed

among members of the group in order to attain an overall regional target. This method is being used by the European Union (EU) in an attempt to meet its target of reducing emissions to 8 per cent below 1990 levels by 2012.

The Protocol has a compliance system composed of a plenary, a bureau, a facilitative branch, and an enforcement branch. If a party fails to meet its emissions target, it must make up the difference in the second commitment period in addition to a penalty of an extra 30 per cent of its emissions target for the first commitment period. It is also required to develop a compliance action plan and is suspended from selling carbon credits under the emissions trading regime.

7.5 The Concerns and Issues with the Kyoto Protocol

While the entry into force of the Kyoto Protocol marks a major milestone for addressing climate change, it has always been regarded only as the first step. In fact, given the level of current emissions, it would not be possible for the Protocol alone to create major reversals of the warming trend. At the time of Kyoto negotiations in 1997, it was estimated that a 60 per cent cut in emissions relative to 1990 levels was needed to significantly reduce and reverse the warming trend. Negotiations have been tense and there is considerable debate surrounding the current exclusion of some leading development countries (mainly India and China) from individual binding targets.

The ultimate solution to climate change requires a drastic reduction in emission of GHGs to about half of current levels (ISC, 2004). If left unchecked, emissions could double current levels by 2050 (ISC, 2004). To reach desirable levels, both developed and developing counties must take action to reduce emissions. In its current form, however, the Protocol determines emission reduction of developed countries alone, and only up to the year 2012.

Another concern surrounds the difficulties in negotiating. The United States of America (see Figure 10) has seceded the Protocol and reiterated its decision not to participate in it. Currently the world's largest emitter, the USA is concerned that accepting the Protocol will damage the economy, resulting in lost jobs. The USA and other countries have also expressed aversion to take on legally-binding emission reductions unless developing countries are involved as well. As previously mentioned, China and India are particular targets in this debate.

Projections indicate that before the middle of this century (between 2020 and 2030), the emissions of developing countries will surpass those of developed countries. However, it is argued that developed countries such as the United States should not absolve themselves from taking action now, since they bear historical responsibility for the present level of global emissions and have benefited from the development path that generated these emissions.

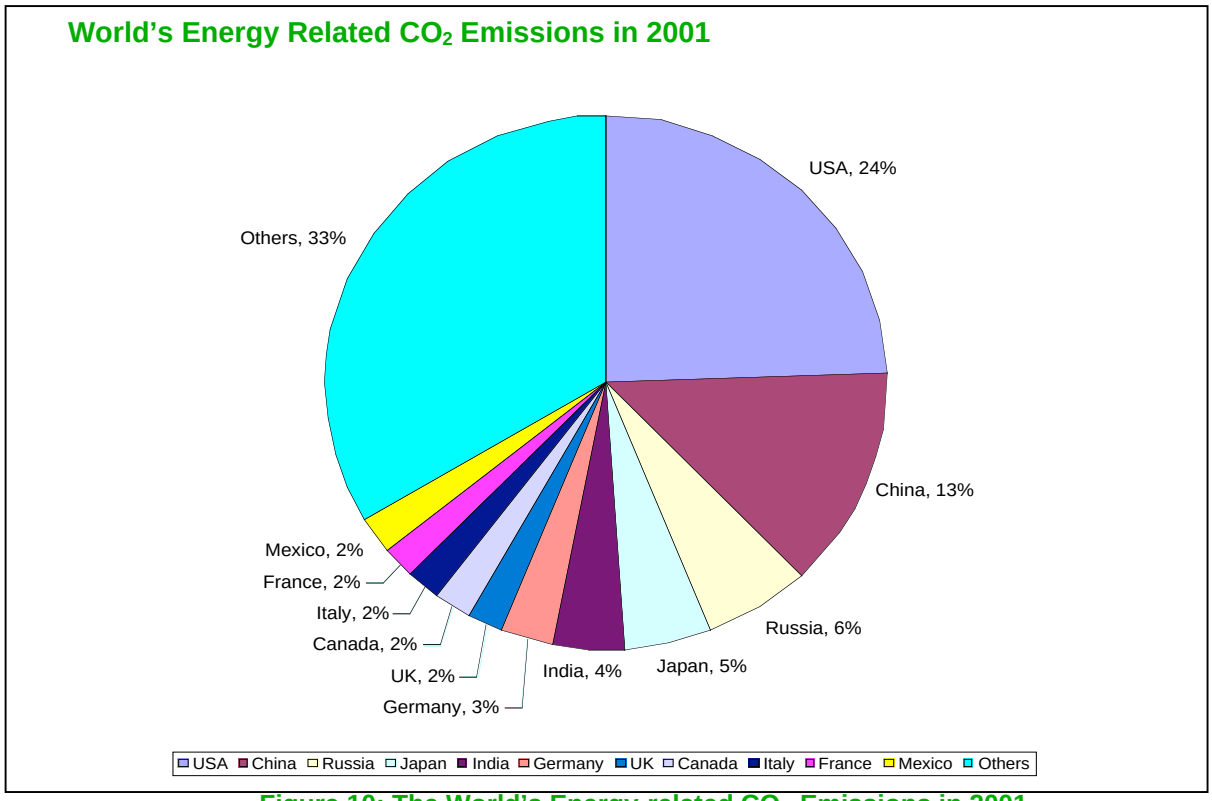

Figure 10: The World's Energy-related CO_2 Emissions in 2001
Source: Adopted from ISC, 2004

Given these and other concerns, it is evident that other measures will be needed to supplement Kyoto. A future framework would have to ensure that all major countries, whether developed or developing, take effective measures to address climate change on both a short- and long-term basis.

Some experts have suggested that any future framework should aim at creating incentives for participation, since parties are engaged on a voluntary basis and it is difficult to introduce disincentives for non-participation such as trade sanctions. It is anticipated that by the end of 2005, parties will initiate considerations beyond Kyoto (i.e. beyond 2012).

7.6 The Asia-Pacific Partnership on Clean Development and Climate

On July 27, 2005, the USA and Australia announced that they had joined with China, India, Japan, and South Korea to create the new Asia-Pacific Partnership on Clean Development and Climate. The partnership is based on the development and deployment of clean and more efficient technologies and energy sources (www.usinfo.state.gov; www.pm.gov.au), which is expected to lead to significant reductions in GHG emissions.

The countries involved will collaborate on innovations such as clean coal, liquefied natural gas, and hydropower. They will also cooperate on the development of longer-term technologies that will promote economic growth, such as nanotechnologies. The partnership states that it is interested in including other like-minded countries.

Unlike the Kyoto Protocol, this partnership is non-binding – it imposes neither targets nor deadlines. Also unlike Kyoto, it is voluntary, and there are no enforcement mechanisms. However, according to the partnership, it is not meant to be a substitute for Kyoto. As outlined in the partnership's vision statement, "the partnership will be consistent with and contribute to our efforts under the UNFCCC and will complement, but not replace, the Kyoto Protocol" (www.pm.gov.au). Despite this, there is concern from developing countries that this initiative, coming at a time when the debate on the second commitment for the Protocol is about to proceed, may prejudice the outcome of that debate.

The first meeting of the Asia-Pacific Partnership on Clean Development and Climate will be held in Adelaide, Australia, in November of 2005.

8.0 Caribbean Response to Adaptation: Planning and Policy

Caribbean countries, like other small island states, are very vulnerable to the adverse impacts of present-day climate extremes. As shown by Hurricane Ivan, one event can cause economic displacements, loss of life and loss of key infrastructure.

The ability of Caribbean countries to cope with a number of extreme events occurring in quick succession or simultaneously is small. This means that the recurrence of extreme events can severely impede development. Furthermore, there are projections (though arguable) that the region could face more intense and frequent extreme events.

Given this, and the urgent need to improve the capacity to cope with extreme events, most of the region's initiatives have been geared towards adapting to climate change. Adaptation refers to adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It entails any changes in processes, practices, and structures designed to moderate potential damages or to benefit from opportunities associated with climate change (IPCC, 2001b).

Many adaptation policies would make good sense even without climate change. Present-day climatic variability, including extreme climatic events such as droughts and floods, already causes a great deal of destruction. Greater efforts to adapt to these events could help to reduce damage in the short term, regardless of any longer-term changes in climate. More generally, many policies that promote adaptation – for example, by improving natural resource management or social conditions – are also vital for promoting sustainable development (IPCC, 2001b). Despite such synergies, however, it is clear that adaptation will also involve real costs and will not prevent all of the expected damage.

A number of regional projects and initiatives in adaptation have been undertaken since 1994. Listed among these are the Caribbean Planning for Adaptation to Climate Change (CPACC) Project, the Adaptation to Climate Change in the Caribbean (ACCC) Project, and Mainstreaming Adaptation to Climate Change (MACC) Project. Recently, the Caribbean Community Climate Change Centre (CCCCC) was established in Belize. Each of these is now looked at in brief.

8.1 Caribbean Planning for Adaptation to Global Climate Change (CPACC)

Background

The CPACC Project has its origin in the Global Conference on the Sustainable Development of Small Island Developing States, which took place in Barbados in April/May 1994. During this conference, the small island developing states of the Caribbean requested assistance in developing a project on adaptation to climate change for submission to the Global Environmental Facility (GEF).

The resulting project, CPACC, received US$6.5 million in funding from the Global Environmental Facility (GEF) and lasted four years (1997 to 2001). It was implemented by the World Bank, executed by the Organisation of the American States (OAS), and managed in day-to-day implementation by the CPACC Regional Implementation Project Unit (RPIU) located in Barbados (Trotz et al, 2001).

The participating countries were all members of CARICOM. They include: Antigua and Barbuda, the Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, Saint Lucia, St Kitts and Nevis, St Vincent, and Trinidad and Tobago.

Project Elements

The CPACC Project supported Caribbean countries in preparing to cope with the adverse effects of global climate change, particularly sea level rise. It did so through

vulnerability assessments in coastal and marine areas, adaptation planning, and capacity building linked to adaptation planning (cpacc.org, 1998). CPACC consisted of four regional projects and five pilot projects. The regional projects were:

1. Design and establishment of a sea level/climate monitoring network;
2. Establishment of databases and information systems;
3. Inventory of coastal resources; and
4. Use and formulation of initial adaptation policies.

The five pilot projects were:

1. Coral reef monitoring for climate change (Bahamas, Belize, and Jamaica);
2. Coastal vulnerability and risk assessment (Barbados, Guyana, and Grenada);
3. Economic valuation of coastal and marine resources (Dominica, Saint Lucia, and Trinidad and Tobago);
4. Formation of economic/regulatory proposals (Antigua and Barbuda, and St Kitts and Nevis); and
5. National communications (St Vincent and the Grenadines) (Moore, 2002).

Project Outcomes of CPACC

The CPACC initiative was intended as the first stage of a comprehensive, long-term program of adaptation to global climate change. It served as the basis for further capacity building, preparation of national climate change adaptation policies and implementation plans, and the formulation of technical assistance and investment projects (CIDA, 2005). Specific project achievements included:

- *Establishment of a sea level and climate monitoring system:* A total of 18 monitoring systems, along with the related data management and information networks, were installed in 12 countries.
- *Improved access and availability of data:* An integrated database for the monitoring of climate change effects was established through the Inventory for Coastal Resources and the institutionalisation of coral reef monitoring.
- *Increased appreciation of climate change issues at the policy-making level:* CPACC enabled more unification among regional parties and better articulation of regional positions for negotiations under the United Nations Framework Convention on Climate Change (UNFCCCC) and the Kyoto Protocol.
- *Meeting country needs for expanded vulnerability assessment:* Pilot vulnerability studies were carried out in Grenada, Guyana, and Barbados.
- *Establishment of coral reef monitoring protocols:* This resulted in a significant increase in monitoring and early warning capabilities.
- *Articulation of national climate change adaptation policies and implementation plans:* Such policies and plans were formulated in 11 participating countries.
- *Creation of a network for regional harmonisation:* CPACC developed initial collaborative efforts with a number of existing regional agencies. Partners include PetroTrin of Trinidad and Tobago, as well as key players in the insurance and banking sectors.

8.2 Adapting to Climate Change in the Caribbean (ACCC)

Background

Adapting to Climate Change in the Caribbean (ACCC) was a project funded by the Canadian International Development Agency (CIDA). ACCC was designed to sustain activities initiated under CPACC, to address issues of adaptation and capacity building not undertaken by CPACC, and, in part, to bridge the time gap between CPACC and its successor project, Mainstreaming Adaptation to Climate Change (MACC) (CIDA, 2005).

ACCC was also meant to facilitate the transformation of the Regional Project Implementation Unit (RPIU) into a legal regional entity, the Caribbean Community Climate Change Centre (CCCCC). This entity was intended to serve as the executing agency for the MACC Project.

Project Components

The ACCC Project had nine main components. There were:

1. Project design and business plan development for a regional climate change centre;
2. Public education and outreach;
3. Integration of climate change into a physical planning process using a risk management approach to adaptation to climate change;
4. Strengthening of regional technical capacity, in partnership with the Caribbean Institute for Meteorology and Hydrology (CIMH), the University of the West Indies (Scenario Projection and Establishment of Climate Change Master's Programme), and the Caribbean Environmental Health Institute, in order to enhance association between Caribbean and South Pacific small island States;
5. Integration of adaptation planning in environmental assessments for national and regional development projects;
6. Implementation strategies for adaptation in the water sector;
7. Formulation of adaptation strategies to protect human health;
8. Adaptation strategies for agriculture and food; and
9. Fostering of collaboration/cooperation with non-CARICOM countries.

Project Outcomes and Achievements of ACCC

Among the outcomes of the project were:

- Development and distribution of risk management guidelines for climate change adaptation decision making; Political endorsement (by CARICOM) of the business plan and establishment of the basis of financial self-sustainability for the Caribbean Community Climate Change Centre (CCCCC);

- Development of a guide to assist environmental impact assessment (EIA) practitioners in CARICOM countries to integrate climate change in the EIA process;
- A draft regional public education and outreach (PEO) strategy;
- Development and handover to MACC (see below) of the organisation's website (www.caribbeanclimate.org);
- Successful launch of a Master's Programme in climate change (the first set of graduates, in 2003, included eight students);
- Statistically downscaled climate scenarios development for Jamaica, Trinidad and Tobago, and Barbados;
- Staff training and development at the Caribbean Institute for Meteorology and Hydrology (CIMH) in climate trend analysis in order to strengthen climate change capacity;
- Dialogue established with the South Pacific Regional Environment Programme (SPREP) and the Pacific Islands Climate Change Assistance Programme (PICCAP) for collaboration on issues related to climate change; and
- Implementation of pilot projects on adaptation studies in the water health and agricultural sectors.

8.3 Mainstreaming Adaptation to Climate Change (MACC)

Background

The GEF-World Bank programme Mainstreaming Adaptation to Climate Change (MACC) is a four-year project (2003 to 2007) with US$5.0 million in funding from GEF.

Participating governments (in-kind) are the Government of Canada and the Government of the United States of America through the National Oceanic and Atmospheric Administration (NOAA) (Fisher, 2004). The implementing agency is the World Bank. The executing agency is the CARICOM Secretariat, located in Georgetown, Guyana.

The MACC project will build capacity and knowledge base, consolidating the achievements of CPACC and adopting a "learning-by-doing" approach to capacity building. The objective of the project is to mainstream climate change adaptation strategies into the sustainable development agendas of the small island and low-lying states in CARICOM.

The participating countries are: Antigua and Barbuda, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, Saint Lucia, St Kitts and Nevis, St Vincent and the Grenadines, and Trinidad and Tobago.

Project Components

The project has five major components; however, the first three components include a number of related sub-components. The components are:

1. Building capacity to identify climate change risks – Among other things, this will include strengthening networks to monitor impacts on regional climate, downscaling global climate models, and developing impact scenarios;
2. Building capacity to reduce vulnerability to climate change;
3. Building capacity to effectively access and utilise resources to minimise the costs of climate change;
4. Public education and outreach; and
5. Project management.

Expected Outcomes

Each component carries a full set of deliverables, the accomplishment of which will be monitored and evaluated. More generally, the MACC Project will seek to build capacity in a cost-effective way. This will contribute to the sustainability of project activities and objectives, enabling participant countries to benefit from the project once it is completed. Additionally, the capacity to formulate a regional agenda and adaptation strategy to climate change will be developed at the regional level.

Among the general expected outcomes are:

- The mainstreaming of adaptation to climate change into national and sectoral planning and policies through the use of climate models developed and customised through the project;
- A strong public education and outreach (PEO) program and a comprehensive communications strategy including all stakeholders in the Caribbean mass media; and
- The creation of an environment conducive to the implementation of measures for adaptation to climate change.

The project will build on the progress achieved under CPACC, further building institutional capacity, strengthening the knowledge base, and deepening awareness and participation.

8.4 The Caribbean Community Climate Change Centre (CCCCC)

The concept of a regional climate change centre was envisioned right from the start of climate change initiatives in the Caribbean. The establishment of the CCCCC was endorsed by the CARICOM Heads of Government in July 2002 (CCCCC, 2005). The CCCCC was officially opened in Belmopan, Belize on August 2, 2005.

This Centre of Excellence is expected to coordinate the regional response to climate change and acts as the key node for information on climate change issues and the Caribbean's efforts to manage and adapt to climate change. The stated mission of the Centre is:

"Through its role as a Centre of Excellence, the Centre will support the people of the Caribbean as they address the impact of climate variability and change on all aspects of economic development through the provision of timely forecasts and analyses of potentially hazardous impacts of both natural and man-induced climatic changes on the environment, and the development of special programmes which create opportunities for sustainable development."

Operations of the Centre

The centre will offer a number of services to countries of the region. In particular, it will:

- Operate as a clearing house for the exchange of information;
- Facilitate the participation of communities-at-risk in local-based projects;
- Monitor and executes new and emerging programmes;
- Provide ready partnership for the execution of climate change projects with other regional and international agencies;
- Identify climate-related threats and assistance to develop regional early-warning systems and adaptation strategies in partnership with all stakeholders;
- Provide specialised training and consultancy services; and
- Establish a trust fund to provide financial assistance when external (international) funding is inaccessible or to support the drafting of proposals for financial assistance.

Unique Role of the Centre

In its role as the agency for regional climate change projects and programmes, the CCCCC is recognised by the UNFCCC, the UNEP, and other international agencies as the focal point for regional climate change issues.

It is the official repository and clearing house for regional climate change data, and it provides policy advice and guidelines to the CARICOM Member States through the Secretariat. The CCCCC has access to considerable expertise in climate change and related areas centralised within the region (CCCCC, 2005).

9.0 Regional and National Success Stories and Actions

There are a number of initiatives that have been undertaken in the region to reduce current vulnerabilities and improve coping ability for potential impacts of climate change. Such initiatives include:

- *Fuel Switching:* Attempts have been made to use cleaner fuels (i.e. fuels lower in carbon content) in some Caribbean countries. In Trinidad, natural gas is used extensively. In Jamaica, efforts are currently ongoing to move away from the use of 90 octane to 87 octane fuel and to switch to diesel powered vehicles. These efforts will reduce emissions of GHGs.

- *Renewable Energy:* High oil import costs and escalating oil prices are increasing the economic vulnerability of Caribbean states. Efforts have been made to invest in renewable energy in some Caribbean states. In Barbados, nearly 20 per cent of the population uses solar water heaters. In Jamaica, the Wigton wind farm has been used to supply electricity to the Jamaica Public Service Company, the island's light and power company.

- *Green Globe Certification:* This initiative, aimed at resource conservation, has been implemented in a number of regional hotels. It targets, among other things, the attitudes and behaviours of guests towards energy and water usage and care for the environment. Sandals and Half Moon Montego Bay in Jamaica, for example, have made important gains in resource reduction through this programme. Ecotourism has also been actively promoted in Dominica.

- *Planning and Development Policy:* Efforts have also been made to improve building and development standards to cope with potential threats posed by climate change. There has been a review of building codes and attempts to have a standardised Caribbean building code. The Petroleum Company of Trinidad and Tobago (Petrotrin) has incorporated climate change considerations into its Environmental Impact Assessment (EIA) process. The granting of a Certificate of Environmental Clearance for developments by the Environmental Management Authority of Trinidad and Tobago also requires the incorporation of climate change considerations in the EIA process for project development approval.

10.0 Remedial Actions: What Can We Do - Individual and Collective Good Practices

Beside what has already been done, there are a number of individual and collective actions that can be taken to cope with the challenges posed by climate change.

The reduction in use of chlorofluorocarbons (CFCs) should be especially targeted since this is both a GHG and an ozone-depleting substance. Wider use of alternative energies and renewable resources will have the dual effect of economic savings and reduced emissions and pollution. Caribbean governments may also need to set emission and fuel efficiency standards for imported new and used vehicles. This could go a long way to reducing soaring energy consumption.

Additionally, every member of the Caribbean public should make attempts to be educated about threats of climate change, which is the first step towards changing behaviours and attitudes.

The following are other adaptation options for socio-economic sectors that can be to cope with the adverse effects of climate variability and change.

Water resources

- More efficient use by consumers through new standards for showers and toilets;
- Recycling of water for lower-quality use such as treated water from households and hotels for agriculture, horticulture, and lawns; and
- Development of drought management plans and formulation of water quality standards.

Agriculture

- Implementation of integrated land-use planning that provides incentives for sound use of agricultural lands;
- Development and testing of crop varieties which are more tolerant to adverse weather conditions such as droughts, high winds, and floods; and
- More efficient use of water (e.g. through use of drip irrigation technology).

Coastal zone protection

Adaptation options in the coastal zone usually take three forms: protect, accommodate, and retreat. Some measures that may be undertaken under these headings are listed below.

Protect:

- 'Hard' protection, including the building of structures such as dykes, bulkheads, seawalls, and other defenses;

- 'Soft' protection, such as beach nourishment and wetland protection and conservation; and
- Integrated coastal zone management.

Accommodate:

- Land use regulations to identify planning and development zones and prohibit development in vulnerable and low-lying areas; and
- Building codes to withstand more extreme weather events and accommodate the anticipated sea level rise.

Retreat:

- Restriction of development (set-back zones), such as constructing buildings away from high water marks; and
- Resettlement of affected and vulnerable people.

Infrastructure development

- Development of new legal tools that make for a more responsive insurance industry; and
- Restriction of construction in areas susceptible to coastal flooding, land slippage, or tidal surges.

Human health

- Construction of shelters that are able to withstand storms and hurricanes; and
- Improvement in health standards and application of pre-emptive policies such as public awareness and education, increasing vaccination programmes, etc.

Natural resource conservation

- Review of existing land use policies to include incentives for sound environmental practices and penalties for unsustainable practices;
- Promotion of wetland and watershed management; and
- Protection of forests by using fire prevention practices.

11.0 Frequently Asked Questions about Climate Change

The following are among some of the frequently asked questions on the issue of climate change. Answers proposed to these questions reflect general consensus among climate change scientists.

1. **Is our climate really changing?**

Yes. In the last century, our planet's average temperature has risen by over half a degree Celsius. Earlier springs, melting ice, and rising sea levels give a collective picture of a changing climate. Most scientists now agree that the earth's climate is changing, and it is not just because of better measurements or data collection. The

changes have been seen for long enough to satisfy temporal timescales over which climate is observed.

2. Does the climate vary naturally?

Yes – the Earth's climate swings naturally, in a slow process. Current human activities are resulting in accelerated changes in the climate system.

3. Can we stop climate change from occurring?

We can't easily change the climate or stop it from changing in the future. It's too late to stop the climate change that's now occurring as a result of increased carbon dioxide emissions in the 20th century. But if we change our fuel-thirsty lifestyles now, we may be able to slow down the effects and learn to adapt better to change in the future.

4. If climate changes, impacts will be felt some time in the future. Why should I care?

The climate affects the lives of all people, and will continue to do so in the future. We have a moral responsibility to pass on to future generation (by the principle of intergenerational equity) an environment that is no more degraded that we received it. Besides, actions we now take could reduce our vulnerability to current extreme events and natural hazards.

5. What are greenhouse gases?

Carbon dioxide, methane, nitrous oxides, ozone and water vapour, chlorofluorocarbons (CFC) and perfluorocarbons, and sulfur hexafluoride are all greenhouse gases (GHGs) found in our atmosphere. They trap heat and redirect it towards the earth's surface (the greenhouse effect). The concentration of GHGs is rising rapidly by burning fossil fuels to sustain our modern lifestyle. This is increasing the warming in the atmosphere and leading to higher surface temperatures (global warming).

6. What is the Kyoto Protocol?

The Kyoto Protocol was adopted in 1997. For industrialised countries – those countries which have been mostly responsible for increases in greenhouse gases since the mid-1800s (Industrial Revolution) – the Protocol establishes legally binding targets to reduce emissions. These targets relate to six greenhouse gases over a five-year period from 2008 to 2012 (known as the first commitment period). The Protocol requires developed countries and countries with economies in transition to reduce their emission of greenhouse gases to about 5 per cent below 1990 levels.

7. Which nations are the worst polluters?

The chief emitter of greenhouse gases is the United States. It has 5 per cent of the world's population, but accounts for 24 per cent of global carbon dioxide emissions. Other industrialised nations are also major emitters.

8. Why is America not participating in the Kyoto Protocol?

The U.S. government feels that the country's economy will be unfairly hit by Kyoto commitments. It also maintains that Kyoto is flawed in that it excludes some greenhouse gases such as ozone and does not impose emission reduction targets on large developing countries (such as India and China). However, it has recently announced its participation in the Asia-Pacific Partnership on Clean Development and Climate.

9. How much do developing countries contribute to global emissions?

The developing world has until now been responsible for only 25 per cent of global emissions. But a few highly populated countries in the developing world, including India and China, are now in the top 10 of global emitters.

10. Without the United States on board, how much impact will Kyoto have?

Kyoto sets emission targets for industrialised countries for the years 2008-2012, with the expectation of more stringent targets in the future. Kyoto's initial targets aim to reduce industrialised country emissions about 5 per cent below 1990 levels. Industrialised countries account for roughly half of global greenhouse gas emissions. Without the United States (the world's largest emitter) and Australia, Kyoto's limits apply to countries accounting for 32 per cent of global emissions. Most experts and governments believe that much steeper emission reductions, 60 per cent or greater, will ultimately be needed to avert serious climate change impacts.

11. Has climate change caused more frequent and intense extreme weather events?

Based on current evidence, it would be fair to say that there has been an increase in extreme weather events coincident with the changing climate. All other things being equal, a warmer world (with warmer oceans) could favour the development of more frequent or intense systems.

12. Can climate induced changes be caused by occurrences other than those to which we now attribute climate change?

Yes. Unsustainable practices such as pollution and deforestation can negatively affect ecosystems and, in turn, climate.

13. The Caribbean has made a negligible contribution of 1 per cent of greenhouse gases, so what can we do?

We are very vulnerable to current climate and weather extremes and are even more so to the potential impacts of climate change and sea level rise. We must therefore take steps to adapt to the changes (section 10 above lists a number of adaptation options). We can also commit to a less carbon-intensive path for future development through the use of renewable energy and the implementation of energy-efficient measures. We must also promote the use of best practices and educate ourselves about the threats and remedial actions that can be taken.

14. Are El Niños related to global warming?

El Niño refers to the above-normal warming that occurs on a three- to seven-year cycle along the western coast of South America (Peru and Ecuador). The phenomenon is so named because the warming occurs around Christmas time and El Niño is the Spanish term for the Christ child. El Niños are not caused by global warming. Clear evidence exists from a variety of sources (including archaeological studies) that El Niños have been present for hundreds, and some indicators suggest maybe millions, of years. However, it has been hypothesised that warmer global sea surface temperatures can enhance the El Niño phenomenon, and it is also true that El Niños have been more frequent and intense in recent decades. Recent climate model results that simulate the 21st century with increased greenhouse gas concentrations in the atmosphere suggest that El Niño-like sea surface temperature patterns in the tropical Pacific are likely to be more persistent.

15. Is sea level rising?

Global mean sea level has been rising at an average rate of 1 to 2 millimetres per year over the past 100 years, which is significantly larger than the rate averaged over the last several thousand years. Projected increase from 1990-2100 is anywhere from 0.09-0.88 metres, depending on which greenhouse gas scenario is used and many physical uncertainties in contributions to sea level rise from a variety of frozen and unfrozen water sources.

16. Is ozone depletion a cause of global warming?

No. Ozone depletion occurs in the upper levels of the atmosphere, where certain gases break down the ozone layer that protects the earth from the harmful ultraviolet radiation from the sun. Global warming occurs as a result of the trapping of heat by greenhouse gases in the lower atmosphere. Of note, however, is the fact that at least one family of greenhouse gases (CFCs) is also an ozone-depleting gas.

17. What's the Intergovernmental Panel on Climate Change?

The IPCC was formed jointly in 1988 by the United Nations Environment Program and World Meteorological Organisation. The IPCC brings together the world's top scientists in all relevant fields, synthesises peer-reviewed scientific literature on global warming studies, and produces authoritative assessments of the current state of knowledge of climate change. So far the IPCC has produced three assessment reports.

12.0 Regional Climate Change Resource Centre

The following is a listing of key institutions and resource persons involved in climate change in the region.

12.1 Climate Change Resource Persons

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Mr. Clifford Mahlung	Jamaica	Climate Branch Head (acting) CDM Executive Board Alternate Member	c/o Meteorological Service, Jamaica 65 _ Half Way Tree Road Kingston 10 Tel: (876) 929-3700 E-mail: cmahlung@hotmail.com
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Table 9. Climate Change Resource Persons

12.2 Regional Institutions

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Caribbean Community (CARICOM) Secretariat	54 High Street, Kingston Georgetown, Guyana Tel: (592) 226-7952 Fax: (592) 227-4537
Caribbean Community Climate Change Centre (CCCCC)	2nd Floor, Lawrence Nicholas Building P.O. Box 563, Bliss Parade Belmopan, Belize
Caribbean Environmental Health Institute (CEHI)	P.O. Box 1111, Castries, Saint Lucia Tel: (758) 453-2931 (Direct); (758) 452-2501 Fax: (758) 453-2721 http://www.cehi.org.lc
Caribbean Institute of Meteorology & Hydrology (CIMH)	Husbands, Barbados Tel: (246) 425-1365
Centre for Resource Management and Environmental Studies (CERMES)	University of the West Indies Cave Hill Campus P.O. Box 64, Bridgetown, St Michael, Barbados Tel: (246) 417-4568
Centre for Marine Sciences	UWI Mona Jamaica Jamaica Tel: 1-876-935-8328; Fax: 1-876-977-1033 Email: gfwarner@uwimona.edu.jm
Climate Studies Group	University of the West Indies, Mona Campus Kingston 7, Jamaica Tel: 876-927-2480 Fax: 876-977-1595
Organisation of Eastern Caribbean States (OECS)	P O Box 1383 Castries, Saint Lucia Tel: (758) 453-6208 ext. 29 Fax: (758) 452-2194 Web: http://www.oecsesdu.org
United Nations Development Programme (UNDP)	Barbados and the OECS UN House Christ Church Barbados Tel: (246) 467-6014, (246) 465-2521
United Nations Development Programme (UNDP)	1-3 Lady Musgrave Road Kingston 5, Jamaica Tel: (876) 978-2392, (876) 978-2393

Table 10: Regional Resource Agencies

12.3 Important Websites

Agency/Project/Entity	Website
Caribbean Planning for Adaptation to Global Climate Change (CPACC) Project	www.cpacc.org
Caribbean Community Climate Change Centre (CCCCC), Mainstreaming Adaptation to Climate Change (MACC)	www.caribbeanclimate.org
Government of Canada-Climate Change	www.climatechange.gc.ca
Earth Policy Institute	www.earth-policy.org
European Union-Environment –Climate Change	www.europa.eu.int
Global Environmental Facility (GEF)	www.gefweb.org
Illinois Rivers Decision Support Systems (Ilrdss)	www.ilrdss.sws.uiuc.edu
Intergovernmental Panel on Climate Change (IPCC)	www.ipcc.ch
Intergovernmental Panel on Climate Change (IPCC)	www.girda.no/climate/vitsl/trends.htm
Pew Centre (The)	www.pewclimate.org
Physical Geography (online text)	www.physicalgeography.net
United Nations Development Programme (UNDP)	www.undp.org
United Nations Framework Convention on Climate Change (UNFCCC)	www.unfccc.int
World Meteorological Organisation (WMO)	www.wmo.ch
World Resources Institute Climate Analysis Indicator tools	www.cait.org

Table 11: Important Climate Change Websites

References

CCCCC, 2005 — Caribbean Community Climate Change Centre (CCCCC): Brochure, Belize, February, 2005

CIDA, 2005 — Adapting to Climate Change in the Caribbean (ACCC), Final Report, prepared for the Canadian International Development Agency (CIDA), Global Climate Change Strategies International (GCSI) and de Romilly and de Romilly Ltd., January , 2005

Fisher, E — Stocktaking Report prepared for the National Capacity Self Assessment (NCSA) Project. **3**, 11-13, Fisher, Elaine, Kingston, October 2004

Gupta, J. — "On Behalf of My Delegation" A Survival Guide for Developing Country Climate Negotiators. Institute for Environmental Studies. Vrje Unisersiteit Amsterdam. The Netherlands, Gupta, Joyeeta, 2000

IPCC, 2000 — Special Reports on Emission Scenarios 2nd Edition, Intergovernmental Panel on Climate Change, 2000

IPCC, 2001a — Climate Change 2001: The Scientific Basis, Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge 2001.

IPCC, 2001b — Climate Change 2001: Impacts, Adaptation and Vulnerability, the Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge 2001.

ISC, 2004 — Sustainable Future Framework on Climate Change. Draft Interim report. Special Committee on Future Framework for addressing Climate Change. Global Enrionmental Sub-Committee. Industrial Structure Council, Japan, October 2004

MACC, 2005 — Mainstreaming Adaptation to Climate Change (MACC) Project: Project Implementation Plan (Draft) Rev.2 Latin America and Caribbean Region LCSES, July 2005

Moore, R. — Vulnerability and Adaptation – A Regional Synthesis of the Vulnerability and Adaptation Components of Caribbean National Communications. Caribbean Planning for Adaptation to Global Climate Change (CPACC). Moore, Rawleston, April, 2002.

Nicholls, R.J.,et al Increasing flood risk and wetland losses due to global sea-level rise: Regional and Global analyses. Global Environmental Change, **9**, 69-87. Nicholls, R.J.; F.M.J. Hoozemans, and M. Marchand, 1999

NOAA, 2004 NOAA Reports Wet, Warm Year for the US in 2004-Hurricanes, wildfires, droughts, snowpack and flooding all notable. National Oceanic and Atmospheric Administration, December 16, 2004

OAS, 1999. Storm Surge Mapping for Montego Bay, USAID-OAS Caribbean Disaster Mitigation Project, Smith Warner International, September 1999.

OECS, 2004 Organisation of Eastern Caribbean States (OECS). Grenada: Macro-Economic Assessment of the damage caused by hurricane Ivan, September 2004.

Taylor, M, et al Recent changes in climate extremes in the Caribbean region, *Journal of Geophysical Research*, Vol. 107, No. D21, 4601, doi:10.1029/2002JD002251 Taylor M. and Peterson et al, 2002

UNEP, 2000 Developing Strategies for Climate Change: The United Nations Environment Programme (UNEP) Country Studies on: Climate Change Impacts and Adaptations Assessment Report 2000:2.

UNFCCC, 2002 A Guide to the Climate Change Convention Process, United Nations Framework Convention on Climate Change, Climate Change Secretariat, Bonn, 2002.

Other References

National Geographic, September 2004 – GLOBAL WARNING (Bulletins from a Warmer World)

Cited Websites:

http://www.cpacc.org

http://www.ec.gc.ca/water/en/info/gloss/e_gloss.htm

http://www.ipcc.ch

http://ww.lwfncdc.noaa.gov

http://www.noaanews.noaa.gov

http://www.pewclimate.org

http://www.pm.gov.au

http://www.unfccc.int

http://www.usinfo.state.gov

Glossary of Terms

(Terms mainly obtained from the Pew Centre: www.pewclimate.org.)

Abrupt Climate Change: A change in climate over a widespread area that takes place so rapidly and unexpectedly that human and natural systems have difficulty adapting. An abrupt climate change occurs on the scale of decades, rather than centuries, and persists for years.

Aerosols: Solid or liquid particles suspended within the atmosphere (see "sulfate aerosols" and "black carbon aerosols").

Afforestation: Planting of new forests on lands that have not been recently forested.

Albedo: Refers to the ratio of light from the sun that is reflected by the Earth's surface to the light received by it. Unreflected light is converted to infrared radiation (i.e. heat), which causes atmospheric warming (see "radiative forcing"). Thus, surfaces with a high albedo (e.g. snow and ice) generally contribute to cooling, whereas surfaces with a low albedo (e.g. forests) generally contribute to warming. Changes in land use that significantly alter the characteristics of land surfaces can therefore influence the climate through changes in albedo.

Alliance of Small Island States (AOSIS): A coalition of some 43 low-lying and small island countries, most of which are members of the G-77, which are particularly vulnerable to the potential adverse consequences of climate change such as sea-level rise, coral bleaching, and increased frequency and intensity of tropical storms.

Allocation: Under an emissions trading scheme, permits to emit can initially either be given away for free, usually under a 'grandfathering' approach based on past emissions in a base year or an 'updating' approach based on the more recent emissions. The alternative is to auction permits in an initial market offering.

Ancillary Benefits: Complementary benefits of a climate policy including improvements in local air quality and reduced reliance of imported fossil fuels.

Assigned Amount: In the Kyoto Protocol, the permitted emissions, in CO_2 equivalents, during a commitment period. It is calculated using the Quantified Emission Limitation and Reduction Commitment (QELRC), together with rules specifying how and what emissions are to be counted.

Anthropogenic Emissions: Emissions of greenhouse gases resulting from human activities.

Annex I Parties: The 40 countries plus the European Economic Community listed in Annex I of the UNFCCC that agreed to try to limit their greenhouse gas emissions: Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, European Economic Community, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Monaco, The Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, and the United States.

Annex A: A list in the Kyoto Protocol of the six greenhouse gases and the sources of emissions covered under the Kyoto Protocol. See also "Basket of Gases."

Annex B: A list in the Kyoto Protocol of 38 countries plus the European Community that agreed to QELRCs (emission targets), along with the QELRCs they accepted. The list is nearly identical to the Annex I Parties listed in the Convention except that it does not include Belarus or Turkey.

Baselines: The baseline estimates of population, GDP, energy use and hence resultant greenhouse gas emissions without climate policies that determine how big a reduction is required, and also what the impacts of climate change without policy will be.

Base Year: Targets for reducing greenhouse gas (GHG) emissions are often defined in relation to a base year. In the Kyoto Protocol, 1990 is the base year for most countries for the major GHGs; 1995 can be used as the base year for some of the minor GHGs.

Basket of Gases: This refers to the group six of greenhouse gases regulated under the Kyoto Protocol. They are listed in Annex A of the Kyoto Protocol and include: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6).

Berlin Mandate: Decision of the Parties reached at the first session of the Conference of the Parties to the UNFCCC (COP-1) in 1995 in Berlin that the commitments made by Annex I countries were inadequate and thus needed to be strengthened.

Black Carbon Aerosols: Particles of carbon in the atmosphere produced by inefficient combustion of fossil fuels or biomass. Black carbon aerosols absorb light from the sun, shading and cooling the Earth's surface, but contribute to significant warming of the atmosphere (see "radiative forcing").

Bryd-Hagel Resolution: In June 1997, anticipating the December 1997 meeting in Kyoto, Senator Robert C. Byrd (D-WV) introduced, with Sen. Chuck Hagel (R-NE) and 44 other cosponsors, a resolution stating that the impending Kyoto Protocol (or any subsequent international climate change agreement) should not –
"(A) mandate new commitments to limit or reduce GHG emissions for the Annex I Parties [i.e. industrialised countries], unless the protocol or other agreement also mandates new specific scheduled commitments to limit or reduce GHG emissions for Developing Country Parties within the same compliance period, or
(B) would result in serious harm to the economy of the United States..."

Bubble: An option in the Kyoto Protocol that allows a group of countries to meet their targets jointly by aggregating their total emissions. The member states of the European Union are utilising this option.

Biodiversity: The variety of organisms found within a specified geographic region.

Capital Stock: Existing investments in energy plant and equipment that may or may not be modified once installed.

Carbon Dioxide (CO_2): CO_2 is a colorless, odorless, non-poisonous gas that is a normal part of the ambient air. Of the six greenhouse gases (GHGs) normally targeted, CO_2 contributes the

most to human-induced global warming. Human activities such as fossil fuel combustion and deforestation have increased atmospheric concentrations of CO_2 by approximately 30 per cent since the industrial revolution. CO_2 is the standard used to determine the "global warming potentials" (GWPs) of other gases. CO_2 has been assigned a 100-year GWP of 1 (i.e. the warming effects over a 100-year time frame relative to other GHGs).

Carbon Dioxide Equivalent (CO_2e): The emissions of a gas, by weight, multiplied by its "global warming potential."

Carbon Sinks: Processes that remove more carbon dioxide from the atmosphere than they release. Both the terrestrial biosphere and oceans can act as carbon sinks.

Carbon Taxes: A surcharge on the carbon content of oil, coal, and gas that discourages the use of fossil fuels and aims to reduce carbon dioxide emissions.

Certified Emissions Reduction (CER): Reductions of greenhouse gases achieved by a Clean Development Mechanism (CDM) project. A CER can be sold or counted toward Annex I countries' emissions commitments. Reductions must be additional to any that would otherwise occur.

Chlorofluorocarbons (CFCs): CFCs are synthetic industrial gases composed of chlorine, fluorine, and carbon. They have been used as refrigerants, aerosol propellants, cleaning solvents, and in the manufacture of plastic foam. There are no natural sources of CFCs. CFCs have an atmospheric lifetime of decades to centuries, and they have 100-year "global warming potentials" thousands of times that of CO_2, depending on the gas. In addition to being greenhouse gases (GHGs), CFCs also contribute to ozone depletion in the stratosphere and are controlled under the Montreal Protocol.

Clean Development Mechanism (CDM): One of the three market mechanisms established by the Kyoto Protocol. The CDM is designed to promote sustainable development in developing countries and assist Annex I Parties in meeting their greenhouse gas (GHG) emissions reduction commitments. It enables industrialised countries to invest in emission reduction projects in developing countries and to receive credits for reductions achieved.

Climate: The long-term average weather of a region including typical weather patterns, the frequency and intensity of storms, cold spells, and heat waves. Climate is not the same as weather.

Climate change: In UNFCCC usage, climate change refers to a change in climate that is attributable directly or indirectly to human activity that alters atmospheric composition. In IPCC usage, climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity. Other references regard climate change as changes in long-term trends in the average climate, such as changes in average temperatures.

Climate Sensitivity: The average global air surface temperature change resulting from a doubling of pre-industrial atmospheric CO_2 concentrations. The IPCC estimates climate sensitivity at 1.5-4.5°C (2.7-8.1°F).

Climate Variability: Refers to changes in patterns, such as precipitation patterns, in the weather and climate.

Commitment Period: The period under the Kyoto Protocol during which Annex I Parties' GHG emissions, averaged over the period, must be within their emission targets. The first commitment period runs from January 1, 2008 to December 31, 2012.

Conference of the Parties (COP): The supreme decision-making body comprised of the parties that have ratified the United Nations Framework Convention on Climate Change (UNFCCC). It meets on an annual basis. As of February 2003, it is comprised of 188 countries.

Discounting: The process that reduces future costs and benefits to reflect the time value of money and the common preference of consumption now rather than later.

Early Crediting: A provision that allows crediting of emission reductions achieved prior to the start of a legally imposed emission control period. These credits can then be used to assist in achieving compliance once a legally imposed system begins.

Ecosystem: A community of organisms and its physical environment.

Emissions: The release of substances (e.g. greenhouse gases) into the atmosphere.

Emissions Cap: A mandated restraint in a scheduled timeframe that puts a "ceiling" on the total amount of anthropogenic greenhouse gas (GHG) emissions that can be released into the atmosphere. This can be measured as gross emissions or as net emissions (emissions minus gases that are sequestered).

Emissions Reduction Unit (ERU): Emissions reductions generated by projects in Annex B countries that can be used by another Annex B country to help meet its commitments under the Kyoto Protocol. Reductions must be additional to those that would otherwise occur.

Emissions Trading: A market mechanism that allows emitters (countries, companies or facilities) to buy emissions from or sell emissions to other emitters. Emissions trading is expected to bring down the costs of meeting emission targets by allowing those who can achieve reductions less expensively to sell excess reductions (e.g. reductions in excess of those required under some regulation) to those for whom achieving reductions is more costly.

Energy Resources: The available supply and price of fossil and alternative resources will play a huge role in estimating how much a greenhouse gas (GHG) constraint will cost. In the U.S. context, natural gas supply (and thus price) is particularly important, as it is expected to be a transition fuel to a lower carbon economy.

Enhanced Greenhouse Effect: The increase in the natural greenhouse effect resulting from increases in atmospheric concentrations of greenhouse gases (GHGs) due to emissions from human activities.

Entry Into Force: The point at which international climate change agreements become binding. The United Nations Framework Convention on Climate Change (UNFCCC) has entered into force. In order for the Kyoto Protocol to do so as well, 55 Parties to the Convention must ratify (approve, accept, or accede) the Protocol, including Annex I Parties accounting for 55 per cent of that group's carbon dioxide emissions in 1990. As of June 2003, 110 countries had ratified the Protocol, representing 43.9 per cent of Annex I emissions.

European Community: As a regional economic integration organisation, the European Community can be and is a party to the UNFCCC; however, it does not have a separate vote from its members (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom).

Evapotranspiration: The process by which water re-enters the atmosphere through evaporation from the ground and transpiration by plants.

GDP: Gross Domestic Product, a measure of overall economic activity.

General Circulation Model (GCM): A computer model of the basic dynamics and physics of the components of the global climate system (including the atmosphere and oceans) and their interactions which can be used to simulate climate variability and change.

Global Warming: The progressive gradual rise of the Earth's average surface temperature thought to be caused in part by increased concentrations of greenhouse gases (GHGs) in the atmosphere.

Global Warming Potential (GWP): A system of multipliers devised to enable warming effects of different gases to be compared. The cumulative warming effect, over a specified time period, of an emission of a mass unit of CO_2 is assigned the value of 1. Effects of emissions of a mass unit of non-CO_2 greenhouse gases (GHGs) are estimated as multiples. For example, over the next 100 years, a gram of methane (CH_4) in the atmosphere is currently estimated as having 23 times the warming effect as a gram of carbon dioxide; methane's 100-year GWP is thus 23. Estimates of GWP vary depending on the time-scale considered (e.g., 20-, 50-, or 100-year GWP), because the effects of some GHGs are more persistent than others.

Greenhouse Effect: The insulating effect of atmospheric greenhouse gases (e.g., water vapor, carbon dioxide, methane, etc.) that keeps the Earth's temperature about 15°C (60°F) warmer than it would be otherwise.

Greenhouse Gas (GHG): Any gas that contributes to the "greenhouse effect."

Group of 77 and China, or G77/China: An international organisation established in 1964 by 77 developing countries; membership has now increased to 133 countries. The group acts as a major negotiating bloc on some issues including climate change.

HGWP (High Global Warming Potential): Some industrially produced gases such as sulfur hexafluoride (SF_6), perfluorocarbons (PFCs), and hydrofluorocarbons (HFCs) have extremely high GWPs. Emissions of these gases have a much greater effect on global warming than an equal emission (by weight) of the naturally occurring gases. Most of these gases have GWPs 1,300 to 23,900 times that of CO_2. These GWPs can be compared to the GWPs of CO_2, CH_4, and N_2O which are presently estimated to be 1, 23 and 296, respectively.

"Hot Air": A situation in which emissions (of a country, sector, company or facility) are well below a target due to the target being above emissions that materialised under the normal course of events (i.e. without deliberate emission reduction efforts). Hot air can result from over-optimistic projections of growth. Emissions are often projected to grow roughly in proportion to GDP, and GDP is often projected to grow at historic rates. If a recession occurs and fuel use declines, emissions may be well below targets since targets are generally set in relation to emission projections. If emissions trading is allowed, an emitter could sell the difference between actual emissions and emission targets. Such emissions are considered hot air because they do not represent reductions from what would have occurred in the normal course of events. An example of this is the breakup of the United Soviet Russian Republic Federation (USSR).

Hydrofluorocarbons (HFCs): HFCs are synthetic industrial gases, primarily used in refrigeration and semi-conductor manufacturing as commercial substitutes for chlorofluorocarbons (CFCs). There are no natural sources of HFCs. The atmospheric lifetime of HFCs is decades to centuries, and they have 100-year "global warming potentials" thousands of times that of CO_2, depending on the gas. HFCs are among the six greenhouse gases (GHGs) to be curbed under the Kyoto Protocol.

Incentive-based Regulation: A regulation that uses the economic behavior of firms and households to attain desired environmental goals. Incentive-based programs involve taxes on emissions or tradable emission permits. The primary strength of incentive-based regulation is the flexibility it provides the polluter to find the least costly way to reduce emissions.

Intergenerational Equity: The fairness of the distribution of the costs and benefits of a policy when costs and benefits are borne by different generations. In the case of a climate change policy, the impacts of inaction in the present will be felt in future generations.

Intergovernmental Panel on Climate Change (IPCC): The IPCC was established in 1988 by the World Meteorological Organisation and the UN Environment Programme. The IPCC is responsible for providing the scientific and technical foundation for the United Nations Framework Convention on Climate Change (UNFCCC), primarily through the publication of periodic assessment reports (see "Second Assessment Report" and "Third Assessment Report").

Joint Implementation (JI): One of the three market mechanisms established by the Kyoto Protocol. Joint Implementation occurs when an Annex B country invests in an emissions reduction or sink enhancement project in another Annex B country to earn emission reduction units (ERUs).

Kyoto Mechanisms: The Kyoto Protocol creates three market-based mechanisms that have the potential to help countries reduce the cost of meeting their emissions reduction targets. These mechanisms are Joint Implementation (Article 6), the Clean Development Mechanisms (Article 12), and Emissions Trading (Article 17).

Kyoto Protocol: An international agreement adopted in December 1997 in Kyoto, Japan. The Protocol sets binding emission targets for developed countries that would reduce their emissions on average 5.2 per cent below 1990 levels.

Land Use, Land-Use Change and Forestry (LULUCF): Land uses and land-use changes can act either as carbon sinks or as emission sources. It is estimated that approximately one-fifth of global emissions result from LULUCF activities. The Kyoto Protocol allows parties to receive emissions credit for certain LULUCF activities that reduce net emissions.

Market Benefits: Benefits of a climate policy that can be measured in terms of avoided market impacts, such as changes in resource productivity (e.g., lower agricultural yields, scarcer water resources) and damages to human-built environment (e.g., coastal flooding due to sea-level rise).

Mauna Loa Record: The record of measurement of atmospheric CO_2 concentrations taken at Mauna Loa Observatory, Mauna Loa, Hawaii, since March 1958. This record shows the continuing increase in average annual atmospheric CO_2 concentrations.

Methane (CH_4): CH_4 is among the six greenhouse gases (GHGs) to be curbed under the Kyoto Protocol. Atmospheric CH_4 is produced by natural processes, but there are also substantial emissions from human activities such as landfills, livestock and livestock wastes, natural gas and petroleum systems, coalmines, rice fields, and wastewater treatment. CH_4 has a relatively short atmospheric lifetime of approximately 10 years, but its 100-year GWP is currently estimated to be approximately 23 times that of CO_2.

Microwave Sounding Units (MSU): Sensors carried aboard Earth orbiting satellites that have been used since 1979 to monitor tropospheric (lower atmospheric) temperatures.

Mitigation: Actions to cut net emissions of greenhouse gases and so reduce climate change. Examples include using fossil fuels more efficiently for industrial processes or electricity generation, switching to solar energy or wind power, improving the insulation of buildings, and expanding forests and other “sinks” to remove greater amounts of carbon dioxide from the atmosphere.

Montreal Protocol on Substances that Deplete the Ozone Layer: An international agreement that entered into force in January 1989 to phase out the use of ozone-depleting compounds such as methyl chloroform, carbon tetrachloride, and CFCs. CFCs are potent greenhouse gases (GHGs) that are not regulated by the Kyoto Protocol since they are covered by the Montreal Protocol.

National Action Plans: Plans submitted to the Conference of the Parties (COP) by all Parties outlining the steps that they have adopted to limit their anthropogenic greenhouse gas (GHG)

emissions. Countries must submit these plans as a condition of participating in the United Nations Framework Convention on Climate Change (UNFCCC) and, subsequently, must communicate their progress to the COP regularly.

Negative Feedback: A process that results in a reduction in the response of a system to an external influence. For example, increased plant productivity in response to global warming would be a negative feedback on warming, because the additional growth would act as a sink for CO_2, reducing the atmospheric CO_2 concentration.

Nitrous Oxide (N_2O): N_2O is among the six greenhouse gases to be curbed under the Kyoto Protocol. N_2O is produced by natural processes, but there are also substantial emissions from human activities such as agriculture and fossil fuel combustion. The atmospheric lifetime of N_2O is approximately 100 years, and its 100-year GWP is currently estimated to be 296 times that of CO_2.

Non-Annex I Parties: Countries that have ratified or acceded to the United Nations Framework Convention on Climate Change (UNFCCC) that are listed in Annex I of the UNFCCC.

Non-Annex B Parties: Countries that are not listed in Annex B of the Kyoto Protocol.

Non-Market Benefits: Benefits of a climate policy that can be measured in terms of avoided non-market impacts such as human-health impacts (e.g. increased incidence of tropical diseases) and damages to ecosystems (e.g. loss of biodiversity).

Non-Party: A state that has not ratified the United Nations Framework Convention on Climate Change (UNFCCC). Non-parties may attend talks as observers.

Perfluorocarbons (PFCs): PFCs are among the six types of greenhouse gases (GHGs) to be curbed under the Kyoto Protocol. PFCs are synthetic industrial gases generated as a by-product of aluminum smelting and uranium enrichment. They also are used as substitutes for CFCs in the manufacture of semiconductors. There are no natural sources of PFCs. PFCs have atmospheric lifetimes of thousands to tens of thousands of years and 100-year GWPs thousands of times that of CO_2, depending on the gas.

"Polluter Pays" Principle (PPP): The principle that countries should in some way compensate others for the effects of pollution that they (or their citizens) generate or have generated.

ppm or ppb: Abbreviations for "parts per million" and "parts per billion," respectively - the units in which concentrations of greenhouse gases (GHGs) are commonly presented. For example, since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased from 270 ppm to 370 ppm.

Positive Feedback: A process that results in an amplification of the response of a system to an external influence. For example, increased atmospheric water vapor in response to global warming would be a positive feedback on warming, because water vapor is a greenhouse gas (GHG) and thus increases in water vapor in association with increases in GHGs would cause greater warming than would occur if water vapor remained constant.

QELRC (Quantified Emission Limitation and Reduction Commitment): Also known as QELRO (Quantified Emission Limitation and Reduction Objective). The quantified commitments for GHG emissions listed in Annex B of the Kyoto Protocol. QELRCs are specified in percentages relative to 1990 emissions.

Radiative Forcing: The term radiative forcing refers to changes in the energy balance of the earth-atmosphere system in response to a change in factors such as greenhouse gas emissions, land-use change, or solar radiation. The climate system inherently attempts to balance incoming (e.g., light) and outgoing (e.g., heat) radiation. Positive radiative forcings increase the temperature of the lower atmosphere, which in turn increases temperatures at the Earth's surface. Negative radiative forcings cool the lower atmosphere. Radiative forcing is most commonly measured in units of watts per square meter (W/m^2).

Radiosondes: Sensors carried aboard weather balloons that have been in continuous use since 1979 for the monitoring of tropospheric temperatures.

Ratification: After signing the United Nations Framework Convention on Climate Change (UNFCCC) or the Kyoto Protocol, a country must ratify it, often with the approval of its parliament or other legislature. In the case of the Kyoto Protocol, a party must deposit its instrument of ratification with the United Nations Secretary General in New York.

Reforestation: Replanting of forests on lands that have recently been harvested.

Regional Groups: The five regional groups that meet privately to discuss issues and nominate bureau members and other officials. They are Africa, Asia, Central and Eastern Europe (CEE), Latin America and the Caribbean (GRULAC), and the Western Europe and Others Group (WEOG).

Renewable Energy: Energy obtained from sources such as geothermal, wind, photovoltaic, solar, and biomass.

Revenue Recycling: If permits are auctioned, this gives considerable sums of money to be recycled back into the economy, either through a lump sum payment of offsetting other taxes. If the existing taxes that are correspondingly reduced were very inefficient, this allows the possibility of both environmental and economic benefits from the trading system, commonly called the 'double dividend.'

Reservoirs: A component or components of the climate system where a greenhouse gas or a precursor of a greenhouse gas is stored. Trees are “reservoirs” for carbon dioxide.

Rio Conventions: Three environmental conventions adopted at the 1992 “Earth Summit” in Rio de Janeiro: the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Convention to Combat Desertification (UNCCD), and the Convention on Biodiversity (CBD). The issues addressed by the three treaties are related – in particular, climate change can have adverse effects on desertification and biodiversity – and through a Joint Liaison Group, the secretariats of the three conventions take steps to coordinate activities to achieve common progress.

Second Assessment Report (SAR): The Second Assessment Report, prepared by the Intergovernmental Panel on Climate Change (IPCC), reviewed the existing scientific literature on climate change. Finalised in 1995, it is comprised of three volumes: Science; Impacts, Adaptations and Mitigation; and Economic and Social Dimensions of Climate Change.

Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC): The United Nations staff assigned the responsibility of conducting the affairs of the UNFCCC. In 1996, the Secretariat moved from Geneva, Switzerland, to Bonn, Germany.

Sequestration: Opportunities to remove atmospheric CO_2, either through biological processes (e.g. plants and trees), or geological processes through storage of CO_2 in underground reservoirs.

Sinks: Any process, activity, or mechanism that results in the net removal of greenhouse gases (GHGs), aerosols, or precursors of GHGs from the atmosphere.

Source: Any process or activity that results in the net release of greenhouse gases (GHGs), aerosols, or precursors of GHGs into the atmosphere.

SRES Scenarios: A suite of emissions scenarios developed by the Intergovernmental Panel on Climate Change (IPCC) in its Special Report on Emissions Scenarios (SRES). These scenarios were developed to explore a range of potential future greenhouse gas (GHG) emissions pathways over the 21st century and their subsequent implications for global climate change.

Storyline: The narrative on which climate scenarios are based. Storylines represent different demographic, social, economic, technological and environmental developments. Each storyline is numbered to avoid interpretations that may reflect value judgment. The Intergovernmental Panel on Climate Change (IPCC) uses four storylines: A1, A2, B1, and B2. From these six scenarios, groups are developed, one each for A2, B1, and B2, and three for A1 (A1F-Fossil fuel intensive, A1B-Balanced – i.e. equal reliance on fossil fuels and non-fossil fuel; and A1T-predominantly non-fossil fuel).

Stratosphere: The region of the Earth's atmosphere 10 to 50 km above the surface of the planet.

Subsidiary Body for Implementation (SBI): A permanent body established by the United Nations Framework Convention on Climate Change (UNFCCC) that makes recommendations to the Convention of Parties (COP) on policy and implementation issues. It is open to participation by all parties and is composed of government representatives.

Subsidiary Body for Scientific and Technological Advice (SBSTA): A permanent body established by the United Nations Framework Convention on Climate Change (UNFCCC) that serves as a link between expert information sources such as the Intergovernmental Panel on Climate Change (IPCC) and the Conference of Parties (COP).

Substitution: The economic process of trading off inputs and consumption due to changes in prices arising from a constraint on greenhouse gas emissions. How the extremely flexible

United States economy adapts to available substitutes and/or finds new methods of production under a greenhouse gas constraint will be critical in minimising overall costs of reducing emissions.

Sulfate Aerosols: Sulfur-based particles derived from emissions of sulfur dioxide (SO_2) from the burning of fossil fuels (particularly coal). Sulfate aerosols reflect incoming light from the sun, shading and cooling the Earth's surface (see "radiative forcing") and thus offset some of the warming historically caused by greenhouse gases (GHGs).

Sulfur Hexafluoride (SF_6): SF_6 is among the six types of greenhouse gases (GHGs) to be curbed under the Kyoto Protocol. SF_6 is a synthetic industrial gas largely used in heavy industry to insulate high-voltage equipment and to assist in the manufacturing of cable-cooling systems. There are no natural sources of SF_6. SF_6 has an atmospheric lifetime of 3,200 years. Its 100-year GWP is currently estimated to be 22,200 times that of CO_2.

Supplementarity: The Kyoto Protocol does not allow Annex I parties to meet their emission targets entirely through use of emissions trading and the other Kyoto Mechanisms; use of the mechanisms must be supplemental to domestic actions to limit or reduce their emissions.

Targets and Timetables: Targets refer to the emission levels or emission rates set as goals for countries, sectors, companies, or facilities. When these goals are to be reached by specified years, the years at which goals are to be met are referred to as the timetables. In the Kyoto Protocol, a target is the per cent reduction from the 1990 emissions baseline that the country has agreed to. On average, developed countries agreed to reduce emissions by 5.2 per cent below 1990 emissions during the period 2008-2012, the first commitment period.

Technological Change: How much technological change will be additionally induced by climate policies is a crucial, but not well quantified, factor in assessing the costs of long-term mitigation of greenhouse gas (GHG) emissions.

Thermal expansion: Expansion of a substance as a result of the addition of heat. In the context of climate change, thermal expansion of the world's oceans in response to global warming is considered the predominant driver of current and future sea-level rise.

Thermohaline Circulation (THC): A three-dimensional pattern of ocean circulation driven by wind, heat and salinity that is an important component of the ocean-atmosphere climate system. In the Atlantic, winds transport warm tropical surface water northward where it cools, becomes denser, and sinks into the deep ocean, at which point it reverses direction and migrates back to the tropics, where it eventually warms and returns to the surface. This cycle or "conveyor belt" is a major mechanism for the global transport of heat, and thus has an important influence on the climate. Global warming is projected to increase sea-surface temperatures, which may slow the THC by reducing the sinking of cold water in the North Atlantic. In addition, ocean salinity also influences water density, and thus decreases in sea-surface salinity from the melting of ice caps and glaciers may also slow the THC.

Third Assessment Report (TAR): The most recent Assessment Report prepared by the Intergovernmental Panel on Climate Change (IPCC), which reviewed the existing scientific literature on climate change, including new information acquired since the completion of the

Second Assessment report (SAR). Finalised in 2001, it is comprised of three volumes: Science; Impacts and Adaptation; and Mitigation.

Trace Gas: A term used to refer to gases found in the Earth's atmosphere other than nitrogen, oxygen, argon and water vapor. When this terminology is used, carbon dioxide, methane, and nitrous oxide are classified as trace gases. Although trace gases taken together make up less than one per cent of the atmosphere, carbon dioxide, methane and nitrous oxide are important in the climate system. Water vapor also plays an important role in the climate system; its concentrations in the lower atmosphere vary considerably from essentially zero in cold dry air masses to perhaps four per cent by volume in humid tropical air masses.

Troposphere: The region of the Earth's atmosphere 0 to 10 kilometres above the planet's surface.

Umbrella Group: Negotiating group within the United Nations Framework Convention on Climate Change (UNFCCC) process comprising the United States, Canada, Japan, Australia, New Zealand, Norway, Iceland, Russia, and Ukraine.

Uncertainty: Uncertainty is a prominent feature of the benefits and costs of climate change. Decision makers need to compare risk of premature or unnecessary actions with risk of failing to take actions that subsequently prove to be warranted. This is complicated by potential irreversibilities in climate impacts and long term investments.

United Nations Framework Convention on Climate Change (UNFCCC): A treaty signed at the 1992 Earth Summit in Rio de Janeiro that calls for the "stabilisation of greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." The treaty includes a non-binding call for developed countries to return their emissions to 1990 levels by the year 2000. The treaty took effect in March 1994 upon ratification by more than 50 countries. The United States was the first industrialised nation to ratify the Convention.

Urban Heat Island (UHI): Refers to the tendency for urban areas to have warmer air temperatures than the surrounding rural landscape, due to the low albedo of streets, sidewalks, parking lots, and buildings. These surfaces absorb solar radiation during the day and release it at night, resulting in higher night temperatures.

Vector-borne disease: Disease that results from an infection transmitted to humans and other animals by blood-feeding arthropods, such as mosquitoes, ticks, and fleas. Examples of vector-borne diseases include Dengue fever, viral encephalitis, Lyme disease, and malaria.

Water Vapor (H_2O): Water vapor is the primary gas responsible for the greenhouse effect. It is believed that increases in temperature caused by anthropogenic emissions of greenhouse gases (GHGs) will increase the amount of water vapor in the atmosphere, resulting in additional warming (see "positive feedback").

Weather: Describes the short-term (i.e. hourly and daily) state of the atmosphere. Weather is not the same as climate.

Voluntary Commitments: A draft article considered during the negotiation of the Kyoto Protocol that would have permitted developing countries to voluntarily adhere to legally binding emissions targets. The proposed language was dropped in the final phase of the negotiations. The issue remains important for some negotiators and may be discussed at upcoming sessions of the Conference of the Parties.