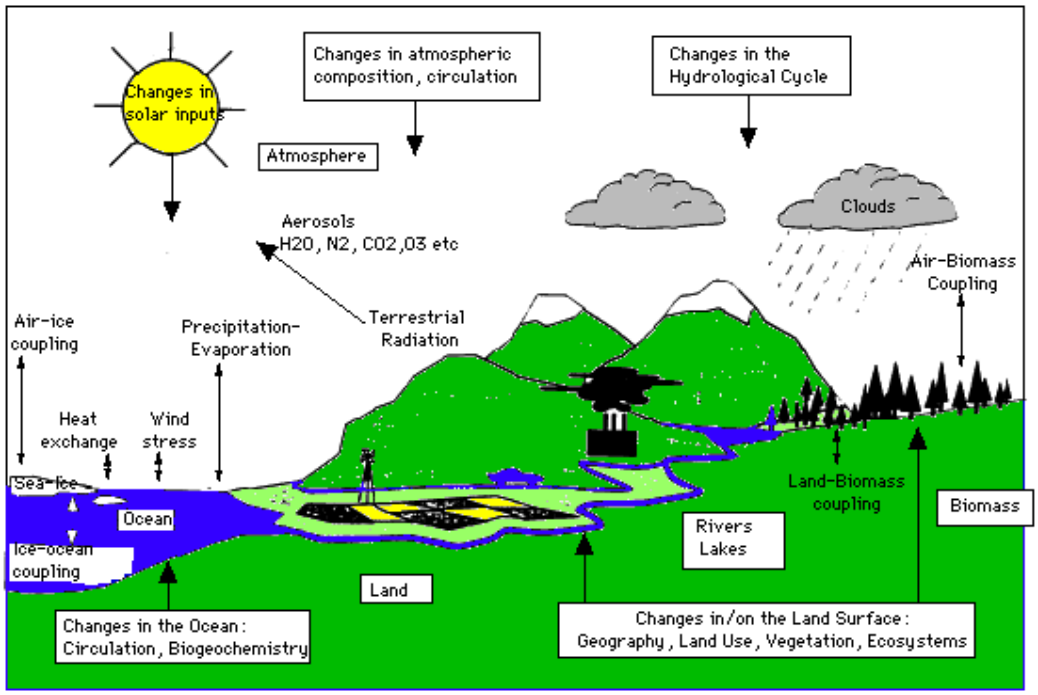
Climate Change: A Global Challenge

Global Climate Change (GCC) has emerged in the past few years as one of the world's major long-term challenges. Anticipated global warming and consequent changes (in precipitation patterns, temperatures, sea level) will seriously impact on all life on earth.

The earth, like all living entities, evolves naturally. Continents drift, land is pushed upwards as well as eroded. These changes are a result of natural forces beyond human influence or control. But over the past century, there have been significant changes in the earth's atmosphere.



Climate Change Processes
Source: 1995 IPCC Scientific Assessment

Global temperatures have risen (Studies suggest that the average land surface temperature has risen 0.45°-0.6°C (0.8-1°F) in the last century).

Precipitation has increased by approximately 1% over the world's continents (high latitude areas have seen a more significant increase in rainfall while precipitation has actually declined in many tropical areas)

Sea level has risen worldwide by approximately 15-20 cm (6-8 inches). 2-5cm (1-2 inches) of the rise has resulted from melting of mountain glaciers, another 2-7cm has resulted from the expansion of sea water associated with a rise in temperature).

Scientists believe that these unnatural changes in the earth's environment have been caused by human factors. With an increasing world population, an expanding global economy and the development of new technologies, the human impact on the environment is severe.

The direct result of these human activities has been the build up of Greenhouse gases (GHG's) in the earth's atmosphere. These gases are primarily Carbon dioxide (CO_2), Methane (MH_4) and Nitrous oxide (N_2O). However, there are 35 trace gases and non-methane hydrocarbons also produced by human activities.

Some GHG's occur naturally in the atmosphere. These are water vapour, carbon dioxide, methane, nitrous oxide and ozone. Under normal conditions the gases trap some of the heat that is radiated back into space, providing a favourable temperature and thus making possible all life on earth.

Because of human activity, excess amounts of these gases are released into the atmosphere and can not be reabsorbed by natural process, hence causing a net increase in temperature. This is known as the **"enhanced greenhouse effect"**.

The international community is tackling this challenge through a number of agreements: namely the **United Nations Framework Convention on Climate Change (UNFCCC), the Intergovernmental Panel on Climate Change (IPCC) and The Kyoto Protocol.**

The UNFCCC is at the centre of international efforts to combat global warming. It was adopted in 1992 at the Rio Earth Summit and its objective is to stabilize greenhouse gas concentrations in the atmosphere at a level that would

Climate Change: A Global Challenge

prevent human interference with the climate system. It is hoped that such a level will be achieved in a time such that ecosystems are able to adapt naturally to climate change.

The overarching body of the Convention is the Conference of Parties (COP), which consists of all states that have ratified the UNFCCC. The COP's role is to promote and review the implementation of the Convention.

The IPCC was established in 1988 by the Unitied Nations Environment Programme, (UNEP) and the World Meteorological Organization, (WMO). It was given the mandate to assess the state of existing knowledge about the climate system and climate change including the environmental, economic and social impacts of GCC and the possible response strategies.

The IPCC released its first report in 1990. The report confirmed scientific evidence for GCC. This had an effect on both policy-makers and the general public and provided the basis for negotiations on the UNFCCC.

The Kyoto Protocol was adopted at the Third Conference of Parties (COP-3), and under this, industrialized countries have a legally binding commitment to reduce their collective greenhouse gas emissions by at least 5% of 1990 levels by the period 2008-2012. The original target that was determined to be desirable if present trends are to be arrested, called for a reduction of GHG emissions to the 1990 level by the year 2000! The compromise agreement negotiated under the Kyoto Protocol falls short of this original target.

ACTION ITEMS

- Reduce CO_2 emissions
- **Car-pool or use public transport.** Transport is one of the more significant sources of GHG emissions
- Implement **Clean Air Policies**
- **Reduce and restrict coastal development**
- **Planting Trees** may help with extracting emitted carbon
- **Encourage the use of other fuels. Fossil fuels are carbon-intensive**

Climate Change: A Caribbean Priority

Climate Change damages will initially be unevenly distributed. Although developed countries are responsible for more than 2/3 of GHG emissions, their strong economies and institutions leave them in a better position than other countries to cope with climate change.

Caribbean Small Island Developing States (SIDS) like other SIDS share many socio-economic challenges. These are mainly heavy dependence upon narrow resource bases, susceptibility to the vagaries of international trade, lack of economies of scale, high transportation and communication costs, grave vulnerability to natural disasters, scarce land resources, limited availability of human capacity and the means to manage and use natural resources on a sustainable basis end ever-increasing pressures on coastal and marine environments and resources. Vulnerability indices show that developing countries are on average two times more vulnerable to negative climate change impacts than developed countries.

CPACC countries

SMALL ISLAND STATES ARE APPROXIMATELY THREE TIMES AS VULNERABLE!!

In recognition of these challenges the United Nations convened a global conference for Small Island Developing States (SIDS) in Barbados in 1994 in an effort to encourage policies, actions and measures to enable SIDS to achieve sustainable development. It is at this conference that Caribbean leaders were made aware of the likely consequences of Global Climate Change (GCC) in the region. It had been concluded that SIDS have specific environmental and development needs because they are ecologically fragile and vulnerable. And as a result Caribbean States collaborated with the OAS to assist in developing a project that would assist the region in coping with these changes.

Extensive national and regional consultations and strong support from the OAS, led to the birth of the Caribbean Planning for Adaptation to Global Climate Change Project (CPACC) in 1994. The overall objective of CPACC is to ***support Caribbean countries in preparing to cope with the adverse effects of GCC, particularly sea-level rise in coastal areas, through vulnerability assessment, adaptation planning and capacity building***.

The project is implemented through a Regional Planning Implementation Unit (RPIU) in Barbados. It is funded by the Global Environment Facility (GEF) and the implementing agency is the World Bank (WB). The twelve countries participating in this initiative are; Antigua and Barbuda, Bahamas, Belize, Barbados, Dominica, Grenada, Guyana, Jamaica, St. Lucia, St. Kitts and Nevis, St. Vincent and the Grenadines and Trinidad and Tobago.

Impacts In the Caribbean

Perhaps the most serious environmental challenge facing Caribbean SIDS as a result of global climate change is sea-level rise, with associated coastal erosion and salt water intrusion into estuaries and aquifers, an escalation in the frequency and intensity of hurricanes and typhoons, and disruptions in precipitation and fresh water supply.

Eroded coastlines place our coastal infrastructure at a greater risk to flooding and submerged coastal wetlands during storms. Warming of our oceans may result in coral reef bleaching. The most severe coral bleaching event in the Caribbean was experienced in 1987. Evidence has shown that this was related to high ocean temperatures. The El Niño Southern Oscillation (ENSO) has already been associated with extensive coral bleaching in the Caribbean in the 1990's.

Climate Change: A Caribbean Priority

Direct damage from storms could be the destruction of hotels and associated infrastructures. This, coupled with beach erosion could result in the devastation of the tourism industry, especially because our beaches are our "crown jewels".

River deltas are also vulnerable to erosion enhanced by sea level rise because the sediments are unconsolidated muds that are subject to compaction and subsistence. It can be expected that the shoreline retreat up to several metres horizontally for each centimeter relative sea level.

Saline intrusion is expected to have a considerably negative impact on agriculture along coastal plains. This effect is expected to be greater than that caused by higher temperatures. Rice production along the coasts of Guyana is particularly vulnerable.

Are we seeing signs already?

Recent predictions using global models have predicted that the Caribbean will experience drier periods. There are signs of this already. In March 2000, Jamaica has been experiencing reduced rainfall resulting in drought conditions across the island. The present amount of rainfall is significantly less than normal.

It has been stated that hurricanes are more likely to occur when there is a warming of sea surface temperatures. Although not the direct result of GCC, we must reflect on the increasing frequency of hurricanes in the 1990s and their intensity. The four warmest years on record since 1860 have all occurred since 1990. Can we forget so easily the destruction caused by Gilbert (1988), Hugo (1989), Georges (1998), Mitch (1999), Floyd (1999)? The loss, of property, experienced on the Florida Coast has often been estimated in *the billions of dollars* after hurricanes such as these.

We in the Caribbean **cannot** recover from losses of this magnitude! If hurricane frequencies and intensity increase we can expect more of the same or worse.

According to Red Cross International, each year more than **480, 000 persons** are affected by disasters in the region – more than 1 ½ times the population of Barbados! These natural disasters have resulted in losses in the Caribbean in excess of **US$ 9 billion dollars.**

Are we experiencing GCC effects already?

- Historical data for the Caribbean Sea indicates that an increase of 1.5°C has been associated with the increased hurricane frequency.
- The four warmest years on record since 1860 have all occurred since 1990!
- Fish kills in Guyana, Grenada, St. Lucia, St. Vincent & the Grenadines, Barbados, Trinidad & Tobago last year
- Coral bleaching events – the most severe occurred in 1987
- Prolonged wet or dry seasons
- Changing rainfall patterns
- Hurricane "Lenny" in 1999! This was the first of its kind, having approached the Caribbean from the West and affecting every country in the region in some way.

Action for policy makers

- **Reduce $C0_2$ emissions**
- **Be prepared**
- **Reduce** dumping into our oceans
- **Preserve** beaches and natural defenses

For more information about the CPACC project, please contact our RPIU office in Barbados at:
Tel: (246) 417 4580
Fax: (246) 417 0461
Email: cpacc@sunbeach.net or visit our website at: http://www.cpacc.org
Website: http://www.cpacc.org

Climate Change and Public Health

The prevalence of particular diseases and other threats to human health depend largely on local climate. The major effects of climate change on health are caused by: heat stress, air pollution, alterations in the incidence of communicable diseases, undernutrition and inundation.

In much of the world, life expectancy is increasing and infant mortality in developing nations is decreasing, but conversely there appears to be a widespread increase in new and resurgent vector-borne diseases like malaria, dengue fever, hantavirus, yellow fever, encephalitis, cholera and salmonellosis.

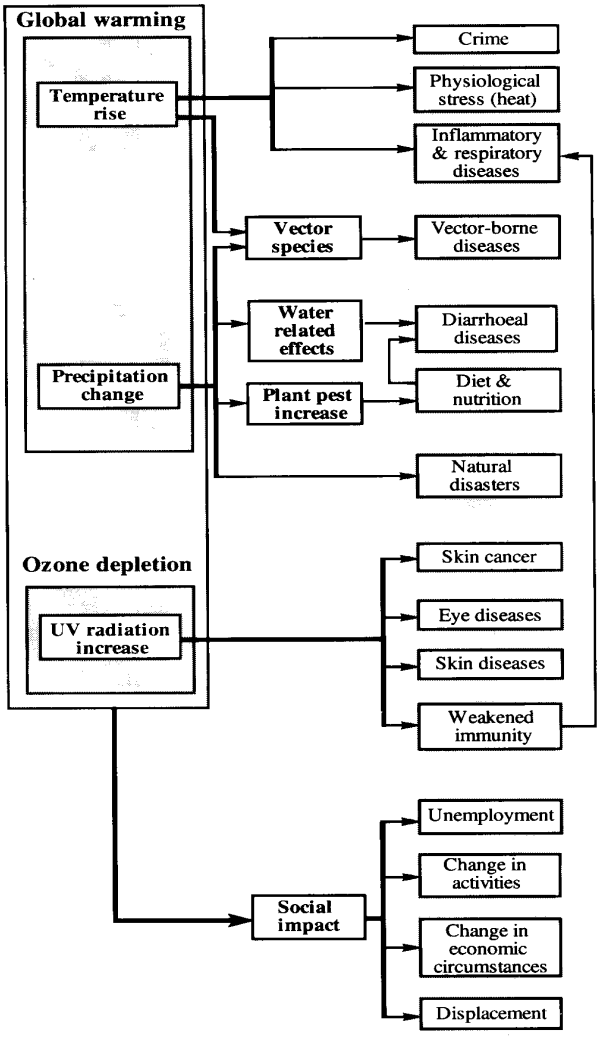
The most direct impact of climate change would be the hotter temperatures themselves. Extreme temperatures can cause loss of life – directly and indirectly. Particularly vulnerable groups are children, older people and those with heart problems. Warm temperatures can increase air and water pollution which in turn affect human health. High temperatures increase ground-level ozone which damages the lung tissue, and the potential for the spread of diseases (like malaria, dengue fever, yellow fever, encephalitis, cholera and salmonellosis)

Additionally, growing populations and changing lifestylesput a strain on social services such as health, sanitation and water, and cause environmental problems.

Exposure to high temperatures and high UV levels are leading factors in the development of skin cancer, cataracts and immunosuppression.

However, there are some possible positive effects to exposure to UV radiation. Vitamin D deficiency that leads to rickets, is still frequently occurring in children north of latitude 60 degrees N. There are also other systemic effects like improvement of the body's tolerance to toxic agents, lowering blood pressure. Thus an increase in ambient ultra violet rays could have some positive effects, particularly on populations that live in regions near the poles. High temperatures can also reduce the number of cold-related illnesses.

On a more local scale, an increase in rainfall may cause flooding with contamination of wells, pits, and surface water.



***Climate Change Process and Change*, Edward Bryant, 1997**

However, quantifying the projected health impacts is difficult because they depend on other variables – migration, provision of clean urban environments, improved nutrition, increased availability of potable water,

Climate Change and Public Health

improvements in sanitation, the extent of disease control measures, changes in resistance of vector organisms to insecticides, and more widespread availability of heath care. Human health is particularly vulnerable in areas where there is little access to space conditioning i.e. built-up and urban areas, and where basic and health care services are not easily accessible.

When discussing the various health effects potentially related to climatic change, it is necessary to put them in a population context. Many of the effects mentioned have quite specific distribution patterns in the population with regard to their occurrence and effects. Age, level of hygiene and socioeconomic status, skin pigmentation, and health status will all be determinants of the net effects of climatic change on public health.

To date, there is no documented evidence in the Caribbean on health problems that are specifically related to climate change.

A summary of health-related climate effects.

Disease/condition	*Climate variables controlling disease*	*Degree of in (1 = most,*
Asthma	increased rain, temperature	1*
Australian encephalitis	increased rain	5*
Bushfires	increased warming, rain, drought	5
Cataracts	increased UVB	4
Cholera	increased rain	1
Crime -violent	increased warming	5*
Crime -property	increased warming	5*
Dengue	increased warming, rain	2*
Diarrhoeal diseases	increased rain	3*
Drought	decreased rain	1
Epidemic polyarthritis	increased rain, warming	2*
Epidemic typhus	increased cooling	5
Floods	increased rain	1*
Haemorrhagic fever viruses	increased rain?	4
Heat exhaustion, stroke	increased warming	3*
Hypothermia	increased cooling, wind	5
Immunity	increased UVB	4
Japanese encephalitis	increased warming	2
Legionnaires' disease	increased warming	5*
Lyme disease	increased rain, warming	1*
Malaria	increased warming, rain	1*
Pterygium	increased UVB	4
Q fever	increased drought	5
Rocky Mountain spotted fever	increased warming, rain	3
Schistosomiasis or bilharzia	increased rain	2*
Skin cancers	increased UVB	4
Typhoid	increased rain	4
Trypanosomiasis	increased rain, warming	4*
Tuberculosis	increased cooling	1
Yellow fever	increased warming, rain	2*

*signature of enhanced 'greenhouse' warming

Bryant, 1997

Actions for policy makers

- Develop a comprehensive health care policy
- Upgrade and maintain facilities
- Strengthen emergency response systems
- Develop public education and outreach programmes
- Consider water purification systems
- Support water purification technologies
- Develop emergency health protocols including supplies
- Develop and Implement Clean Air Policies and monitoring programmes

Climate Change and Potable Water

Given the fact that the availability of many Caribbean islands depends on the amount of rainfall, changing rainfall patterns will invariably impact on water supplies.

The availability of potable water is an essential component of welfare. Currently, 1.3 billion people do not have access to adequate supplies of drinking water, and 2 billion people do not have access to adequate sanitation.

Developing countries are most vulnerable because they derive most of the potable water from single-point systems like reservoirs. These systems, by nature, are vulnerable because the system does not provide other resources should the primary supply fail, and because the small size of the aquifers means that they respond quickly to changes. However, recently, there have been other sources of potable water through desalination. There is also strong encouragement for individual households to have water collection tanks, and recycle water for irrigation purposes (Grey water systems).

The impacts of climate change on water supplies will depend on the conditions of the existing system, as well as
the ability of water resources managers and related institutions to respond not only to climate change, but to population growth and changes in demands, technology, and social, economic and legislative conditions.

Health impacts are a likely consequence particularly the spread of water-borne diseases. Cholera, typhoid and diarrhoeal diseases are health issues usually associated with floods.

Sea-level rise affects water quality by inducing saltwater intrusion in coastal aquifers that are often a major source of potable water on islands in the Caribbean.

Actions for policy makers

- Develop policy to increase water efficiency
- Commission engineering and structural improvements to water supply infrastructure
- Develop long-term integrated water resource management
- Develop water quality programmes with the Ministry of Health particularly related to emergency response
- Encourage storage of water as part of domestic disaster preparedness

Climate Change and Risk Management

Deforestation, chemical contamination, destructive agricultural and land-use patterns, and ineffective waste management are environmental threats that may compound any impact of climate change. Heavily dependent on revenues from tourism, many Caribbean nations have heavily developed their fragile coastal areas. Aggressive coastal developments, over-fishing, pollution and the leaching of phosphate fertilizers into sea water, play a major role in the destruction of valuable marine ecosystems.

The Caribbean is particularly vulnerable because of its location in earthquake and hurricane belts, as well as because of its inability to "pool" the large resources needed to recover from serious devastation. (In the period 1960-1994, natural disasters in the region have resulted in losses of over US$9 billion dollars!)

CPACC's main concern is that of sea level rise and how it affects low lying coasts in the region. There are not only biological and geological consequences, however. Islands are characterized by the concentration of infrastructure along their coastlines, for example, essential resources, hospitals, emergency services, power generation plants as well as income earners such as tourism, manufacturing and shipping. Therefore, if the sea reclaims these coastal lands, economies can be devastated.

CPACC has been working with colleagues in Canada to expose the region to the use of a risk management approach in addressing climate change issues in agriculture, energy, health and other sectors. Such an approach should lead to a reduction of losses from natural disasters such as hurricanes, other storms, floods and droughts.

GCC does not only affect our lands and seas, the corporate world is part of the chain and hopefully part of the solution. Increasingly alarmed by threats to their financial security posed by an escalating number of weather-related catastrophes, major insurance companies in developed countries are starting to support a variety of measures that would slow the production of greenhouse gases worldwide.

The insurance industry's interest in climate change stems from its sense of vulnerability. Franklin Nutter, president of the Reinsurance Association of America has said "*The insurance business is the first in line to be affected by climate change...it could bankrupt the industry.*" In 1992 Hurricane Andrew destroyed 85,000 homes in Florida and inflicted damages estimated at US$30 billion. People want insurance because of the threats from natural events, yet it is the same threat of future increases in natural catastrophes that could sink the insurance industry.

Individuals in the international financial arena are presently drawing attention to the potential risk factors facing investments in fossil fuels. Why? Because the value of assets that are evidently under threat now from an enhanced greenhouse effect are so huge that enormous numbers of long-term debt and equity investments by the banking sector are at risk.

As the most powerful players in any economy, the insurance and the banking industries are in a position to offer a counterweight to the influence of other industries in the climate change decision. Not only can they throw their weight, but their experience in risk management as well. If bankers' and insurers' involvement continues to grow, policy changes as well as market impetus in favour of energy-efficient and renewable energy technologies are likely.

In 1998 hurricane Georges devastated large parts of the Caribbean and Central America resulting in lost lives, damaged property and significant changes in landscape. In the last ten years, the region has suffered an onslaught of tropical storms and hurricanes, sixteen of which were in categories four and five. In the last year alone we have experienced four category four and five hurricanes that caused severe damage (see table). In real terms, this has meant the displacement of hundreds of thousands of people and losses of **US$9 billion**!

Climate Change and Risk Management

These types of events lead to a surge in reinsurance rates, or some properties and fixtures being uninsurable. This is the case in the region. The Barbados Light and Power company cannot get insurance for its poles!

Federal Emergency Management Agency in the United States reports that damage from more frequent and severe weather calamities and other natural phenomena during the past decade required 460 major disasters to be declared, nearly double the 237 declarations for the previous ten-year period and more than any other decade on record. Financially, comparing a three-year period of 1989 through 1991, and 1997 through 1999, the federal costs of severe weather disasters rose a dramatic 337 % in the latter part of the decade.

Possible scenarios of GCC effects for Barbados are the loss of hotels, Barbados Light and Power powerplants, Police Stations and Fire Stations, which are mostly located on the coasts. Due to the lack of building codes or the disregard for them, development has not been undertaken with a view to the future. Only when the threat is apparent are we putting measures of adaptation and / or mitigation in place.

To avoid this reactive response to climate change effects, the financial sectors should to reassess its role in the economy. Insurance can be tied to the country's building code.

United Insurance is already doing this. Other insurers and banks do the same for domestic and commercial buildings.

Table showing strong hurricanes and their intensities for the Caribbean Region, 1988 – 1999

Year	Name	Maximum sustained wind speed		Central Pressure (Millibars)	Category, Saffir-Simpson Scale
		Knots	Miles per hour		
1988	Gilbert	160	184	888	5
1988	Helene	125	144	938	4
1988	Joan	125	144	932	4
1989	Gabrielle	125	144	941	4
1989	Hugo	140	161	918	5
1991	Claudette	115	132	956	4
1992	Andrew	135	155	922	5
1995	Felix	120	138	929	4
1995	Luis	130	150	940	4
1995	Opal	130	150	919	4
1996	Edouard	125	144	933	4
1996	Hortense	120	138	935	4
1998	Georges	135	155	937	5
1998	Mitch	155	178	905	5
1999	Floyd	134	154	927	4
1999	Gert	131	150	930	4

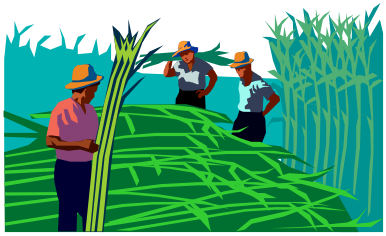
Source: Address by Professor Oliver Headley, CERMES/UWI at the Fifth Annual Conference of Head of State of CARICOM, 10-15th October 1999, Sherbourne Conference Centre.

Actions for policy makers

- Establish and enforce building codes and standards
- Adopt the integrated Coastal Area Management (ICAM) framework
- Integrate land-use planning
- Commission training programmes
- Develop resettlement policies
- Develop public awareness / education programmes
- Develop appropriate maintenance legislation
- Enforce legislation to control sand mining
- Solicit support of Insurance sector

Climate Change and Agriculture

Analyses of potential influences of climate change on agricultural ecosystems typically ignore regionally important specialty crops that may be especially sensitive to geographic shifts in climate. Impacts of climate change on agriculture will vary from crop to crop, location to location, and system to system. Adaptation may be constrained by factors other than climate and crop genetic capability, including availability of suitable soils and adequate supplies of water.



According to the International Panel on Climate Change (IPCC), global agriculture faces the prospect of a changing climate as well as the known challenge of feeding the world's growing population. Climate change could have far-reaching effects on patterns of trade among nations, development, and food security. Despite technological advances such as improved crop varieties and irrigation systems, weather and climate are still key factors in agricultural productivity.

Undoubtedly, most of the world's population depends on agricultural activities. The continued dependence of agricultural production on climatic factors, and the significant magnitude and rapid rates of possible climate changes combine to create the need for a comprehensive consideration of the potential impacts of climate on global agriculture.

Higher temperatures in general hasten plant maturity in annual species, thus shortening the growth stages. This is one reason yields are lower in the tropics.

Too much precipitation can cause disease infestation in crops, while too little can be detrimental to crop yields, especially if the dry periods occur during critical development stages.

Climate change will also have an impact on the soil, a vital element in agricultural ecosystems. Higher air temperatures will cause higher soil temperatures, which should generally increase solution chemical reaction rates and diffusion-controlled reactions. Soluabilities of solid and gaseous components may either increase or decrease, but the consequences of these changes may take many years to become significant. Furthermore, higher temperatures will accelerate the decay of soil organic matter, resulting in release of carbon dioxide to the atmosphere and decrease in carbon/nitrogen ratios, although these two effects should be offset somewhat by the greater root biomass and crop residues resulting from plant responses to higher carbon dioxide.

Sea level rise, another predicted effect of global warming, will cause increased flooding, salt-water intrusion, and rising water tables in agricultural soils located near coastlines. This is particularly crucial in the Caribbean.

Actions for policy makers

- Reduce activities which weaken and degrade the soil such as intensive fertilizer use and sheep-grazing
- Reduce deforestation. Trees, shrubs and even grasses help soil stability
- Allow land time to recover, utilize crop rotation measures where possible
- Plant a tree! The right species! Trees capture some of the carbon emitted through farming practices.
- Do not farm or graze on weak soils. We increase the impact of landslides in this way.

Climate Change and Coral Reefs

What are Coral Reefs & Where are they found?

Corals are colonial animals. They may range in size from an inch in diameter to the size of a car. Shapes range from golf-ball, to pillar, to plate, and to branching forms that look like the antlers of a moose or a deer. The bulk of the mass of a coral colony is the calcium carbonate, or limestone skeleton that is secreted by the thin layer of living tissue that is the coral colony. Over millennia, individual coral colonies grow, reproduce, and die. The accumulation of the calcium carbonate skeletons of these massive corals forms the foundation of the coral reef that may extend from the sea surface to depths of over 100 feet, and stretch along a coast for tens or hundreds of miles.

For coral reefs to grow and remain healthy the seawater in which they live must be shallow, clear, clean, warm water. Water temperatures must remain between 18 and 30 degrees Celsius through out the year. This combination of water conditions is found on the eastern margins of continents between latitudes 30 degrees north and 30 degrees south. In the Atlantic Basin coral reefs are found from Brazil in the south, through out the Caribbean, to Florida in the USA, the Bahamas and Bermuda in the north.

Global Climate Changes

INCREASE IN ...	EFFECTS
• Atmospheric Carbon Dioxide Concentrations.	• Carbonate Balance
• Sea Surface Temperature	• Increases coral bleaching and mortality
• Ultra-violet B Radiation (due to ozone loss)	• More coral bleaching and mortality
• Sea Level	• Increased coastal erosion causing increased turbidity of coastal waters. • Landward shift of zones • Upward growth of reef flats
• Intensity and frequency of Storms	• Physical damage especially to branching corals
• Cloudiness	• Reduced growth
• Changes in Ocean Circulation Patterns	• Effects on growth if cooler/warmer
• **Increased Rainfall Terrestrial Run Off**	• More sedimentation & turbidity causing coral decline

What do coral reefs do for us?

Coral reefs have been called" the rain forests of the oceans". Like the trees in a forest, corals provide a living framework, on, in, and between which animals and plants can live, grow, feed, reproduce and die. The coral reefs, the plants and animals associated with the reefs; and the non-living materials (water, sand, dissolved chemicals) form the coral reef ecosystem.

A coral reef ecosystem provides a number of natural services and functions that are of economic importance to local and national economies. Some of these coral reef functions and services are:

- The generation of the white sand that forms many of the beaches in the Wider Caribbean region.
- Serves as a natural attraction and a focus for a number of forms of tourist and local recreation.
- Serve as natural breakwaters, protecting beaches, coastlines from erosion and infrastructure` (roads, buildings, harbors) from direct exposure to and damage from damage waves, especially during storms.

Creates natural protected bays and lagoons for recreational activities (swimming, water sports) and safe moorings for fishing and recreational vessels.

Indirectly provide income from tourism and recreation activities that focus on water sports and beach recreation. Provides habitat for economically valuable fishable resources (fish, lobster, crabs) to live and reproduce.

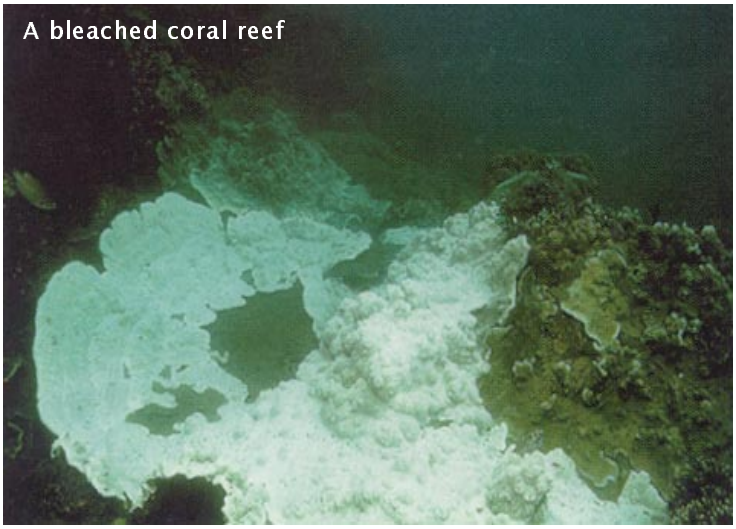
The best way to protect coral reefs from the impacts of global climate change is to ensure that they are not damaged by human activities. Measures that protect coral reefs translate directly into the conservation of the functions and services that coral reefs provide, and stream of economic benefits that arise from the provision of these services and functions.

Climate Change and Coral Reefs

A number of land based activities, especially pollution currently contribute to the degradation and destruction of coral reefs. Measures must be put in place to manage these land-based activities and protect the coral reefs so that they are better able to cope with and survive the anticipated climate change impacts. Measures include, but are not limited to the following:

- Conserve coastal mangrove and sea grass ecosystems
- Maintain the high levels of coastal water quality necessary for healthy reefs by:
  - ✓ reducing upland deforestation in watersheds,
  - ✓ reducing the destruction of mangroves and coastal wetlands
  - ✓ planning and managing coastal land conversion and the expansion of coastal infrastructure
  - ✓ ensuring that all sewage and industrial effluent discharged into in-shore waters is treated to internationally accepted standards for tropical waters.
- Provide resources to support monitoring activities in the coastal zone to provide information for decision and policy making.
- Provide legislative backing for dealing with non-point sources of pollution.
- Adopt the ICZM process for planning and resource management in coastal areas that incorporates
  - ✓ watershed management
  - ✓ capacity building
  - ✓ adequate funding to implement ICZM
  - ✓ effective coordination among implementing agencies.
- Support marine protected area, forestry and fishery management programmes that can focus resources at the site level for :
  - ✓ the conservation management of watersheds and reefs
  - ✓ the coordination and management of resource use and user activities.

The extensive coral bleaching event in 1987 throughout the Caribbean emphasized the need for in situ water temperature data on reefs to establish any link between this phenomenon and GCC. CPACC has established a network of coral reef monitoring stations for measuring climate change impacts in the Bahamas, Belize and Jamaica. This network will be expanded incrementally to cover the entire region. While data collected over the long term will be used to assess the impacts of climate change on the regions coral reefs, this same data is of immediate use for coastal resource management and planning.


A bleached coral reef

Sea level data from the wider Caribbean region has been collected over the past century. But the data is patchy and does not form the type of comprehensive baseline on which trends and changes can be defined. In order to improve the quality of baseline data on which to base decisions, CPACC has established a network of 18 monitoring stations throughout the Caribbean which allow the access to real time data on certain climate and sea level parameters via the internet.

Actions for policy makers

- Reduce destruction of mangroves and wetlands
- Reduce marine pollution and agricultural and land-based runoff
- Protect reefs! They are nature's defense from heavy wave action.
- Admire! Do not touch! Leave them for the next person to enjoy!
- Already weakened reefs are more vulnerable to Climate Change

International Responses to Climate Change

The United Nations Framework convention on Climate Change

In recognition of the fact that the Industrial Revolution has significantly altered the relationship between man and nature, and that continued human activities are likely to change the conditions that make life on earth possible, the international community have engaged in some 'soul-searching' .

The United Nations Framework Convention on Climate Change (UNFCCC) was signed by 154 states (plus the European Community) at Rio de Janeiro in 1992, and is one of a series of agreements through which countries around the globe are collaborating to meet this challenge. The ultimate objective of the UNFCCC is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system. Such a level should be achieved within a time frame sufficient enough to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."

Both developed and developing countries accept a number of commitments. All Parties will develop and submit "national communications" that contain inventories of greenhouse gas emissions by source and greenhouse-gas removals by "sinks". National strategies for adaptation and mitigation will be adopted. Technology transfer and sustainable management, conservation, and enhancement of greenhouse sinks are also promoted. In addition, the Parties will take climate change into consideration in their relevant social, economic, and environmental policies; cooperate in scientific, technical, and educational matters; and promote education, public awareness, and the exchange of information related to climate change.

The Kyoto Protocol

The Kyoto Protocol (KP) was adopted at the Conference of Parties Third meeting (COP3) in 1997. Under the protocol which was adopted by consensus, industrialized countries have a legally binding commitment to reduce their collective GHG emissions by at least 5% compared to 1990 levels by the period 2008-2012. In the mean time Parties will continue to carry out their commitments under the Climate Change Convention and prepare for the future implementation of the Protocol.
The initial agreement was to reduce GHG's to 1990 levels by 2000, but not every Party could meet this commitment. Countries would make different commitments based on their economic circumstances.

Countries undergoing transition to market economies have differing baseline years (other than 1990). These base years would be more recent than 1990 and they would be allowed a certain degree of flexibility.

There have been no commitments made by developing countries.

International Responses to Climate Change

The Global Environment facility (GEF)

The GEF is an independent international financial entity and the United Nations Development Programme and the World Bank are its implementing agencies. It provides the cost financing to developing countries and those with economies in transition to defray the added costs of making planned projects environmentally friendly, as well as finances regional approaches to multinational problems.

Since its creation in 1991, GEF as funded more than 500 projects in 120 countries.

GEF Projects in four programme areas are:

- Biodiversity. GEF is the leading multilateral entity responding to the global threat to biodiversity, and the financial mechanism of the Convention on Biological Diversity. Since 1991 GEF has provided over $775 million for nearly 250 biodiversity projects, and generated an additional $1.2billion in co-financing.

- Energy. GEF is the leading multilateral entity promoting energy efficiency and sustainable energy technologies in developing countries and industrialized nations transitioning to market economies. As a financial mechanism of the UNFCCC, GEF has allocated about $753 million to these projects and matched more than $4.3 billion in co-financing.

- International Waters. GEF is the leading multilateral entity working to reverse the degradation of aquifers, basin, lakes, oceans, rivers, and wetlands of international significance. GEF has thus far allocated $242 million to international water initiatives that help address shared problems in a coordinated, cost effective manner.

- Ozone. GEF is the multilateral entity helping the nations of Eastern Europe and the former Soviet Union phase out ozone depleting substances. GEF's ozone layer programme will help eliminate more than 30,000 metric tonnes annually at an overall cost effectiveness better than $4 per kilogramme.

The GEF and Climate Change

The GEF Project is the funding agency behind the four year US$ 6.3 million dollar Caribbean Planning for Adaptation to Climate Change (CPACC) Project. The Project which was borne out of the 1994 Global Conference on the Sustainable Development of Small Island Developing States in Barbados aims to "***assist Caribbean states to cope with the adverse effects of global climate change (GCC)".***

The Project is being implemented in twelve CARICOM countries in the English-speaking Caribbean and aims to address the challenges facing small developing states. The Project focuses on both adaptation and mitigation and seeks through policy development, installation of appropriate technology, development of monitoring protocols and information systems and the experimentation with new techniques to prepare these countries for climate change impacts and the management of their coastal and marine resources.

The GEF Project is the first of its kind in the Caribbean and has been a model for regional collaboration and implementation. GEF continues to consider climate change a critical issue.

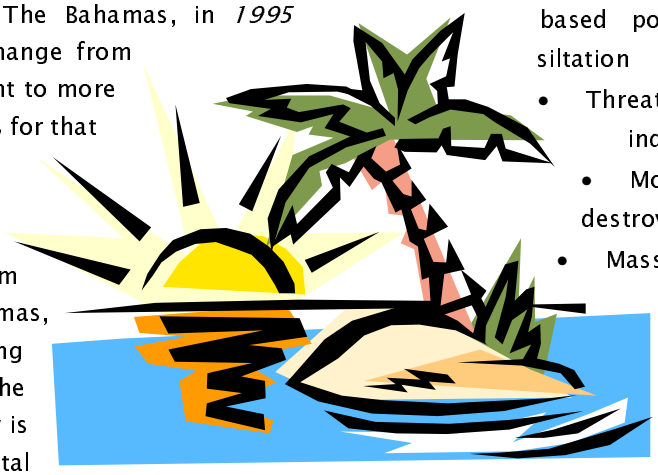
GEF has along with the United Nations Developing Programme (UNDP) established the Enabling Activities Project. This Project implemented through UNDP and the University of the West Indies will assist countries in preparing and maintaining a system of national communications. It should also develop capacity in a number of areas including vulnerability assessment.

Continue support from the GEF in supporting Climate Change Mitigation and Adaptation will be key. Governments in the region should also commit financial and human resources to this effort.

Further opportunities exist through the GEF in assisting countries in the region with National Communications as well as assessing the Clean Development Mechanism. We must take advantage of these opportunities.

Climate Change and Tourism

Tourism is the dominant economic sector in the region, and is the single largest contributor to the Gross National Product (GNP) for many Caribbean countries. In *1995,* for example, the sector accounted for 69%, *56%* and 53% of the Gross National Product of Antigua, Jamaica and the Bahamas respectively. Tourism also earns valuable foreign exchange for the region and provides employment opportunities in many islands. The Bahamas, in *1995* earned US$1.3 b in foreign exchange from the industry, which was equivalent to more than *50%* of Government revenues for that year.



Cruise shipping is one of the major planks of the tourism industry in the region. Bahamas, Jamaica, and St. Lucia are among the premier ports of call. The continued viability of this industry is however threatened due to coastal degradation, pollution and visitor harassment at some ports of call.

As the lead sector for many countries in the region, any dislocation within the tourism industry is likely to produce ripple effects. Reduced earnings from the industry would affect budgetary allocations for other important sectors such as health and education. The industry is particularly vulnerable to global climate change in the following ways:

- It is highly dependent on natural resources of the region
- Encroachment of tourism infrastructure on beach zone in some areas
- Concentration of tourism-related infrastructure in
- selected sections of the coast inmost territories
- Uncontrolled and often ill-conceived development projects

GCC can result in:

- Further loss of beach to accelerated erosion and inundation
- Loss of amenity value
- Salinization of freshwater aquifers
- Increased stress on coastal ecosystems from land-based pollution, storm water runoff and siltation
- Threat to long-term sustainability of industry
- More intense weather activities destroying coastal zones
- Massive losses from infrastructure damage
- Increased costs for reinsurance and other cost-recovery methods
- Structural damage to cruise ship ports
- Loss of coral reefs to bleaching, hurricane damage

Actions for policy makers

- Enforce beach protection policy
- Develop eco-tourism policy
- Reinforce legislation governing cruise shipping
- Develop initiatives to diversify the tourism industry
- Develop integrated and participatory approach to tourism
- Enhance environmental policy for hotels / attractions
- Reduce and discourage development on the immediate coastline
- Enforce setback policies
- Encourage environmental action in tourism through economic incentives
- Develop incentive-based programmes for the tourism industry
- Value coastal and marine resources

REMEMBER!

- Once lost, it is almost impossible to get them back! Save our coastal and marine environment for local as well as visitor enjoyment!
- Energy Efficiency will be a key contribution by this sector.