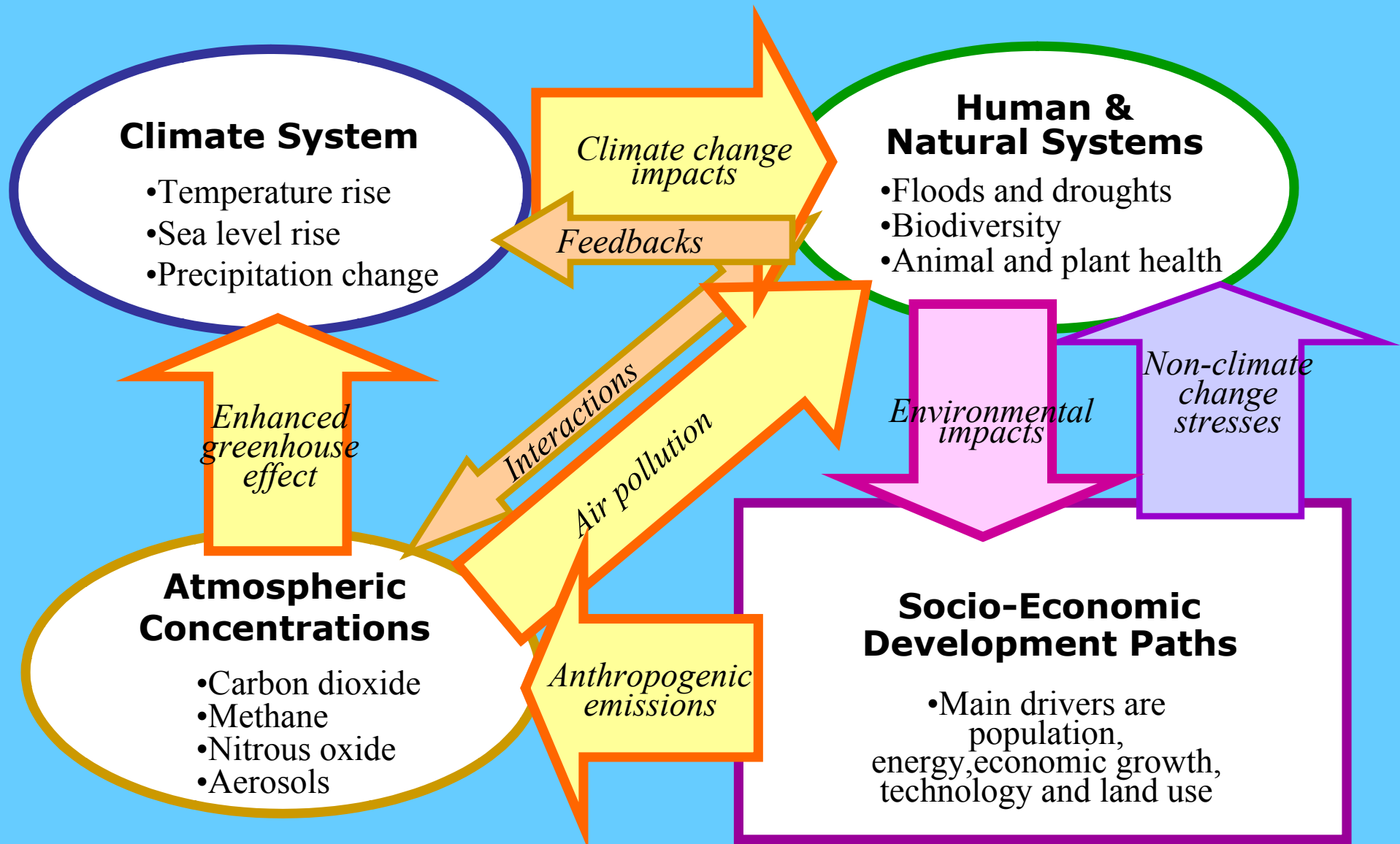


Summary of Key Climate Change Impacts on Small
islands and the Caribbean Region

Findings of the
IPCC Fourth Assessment Report

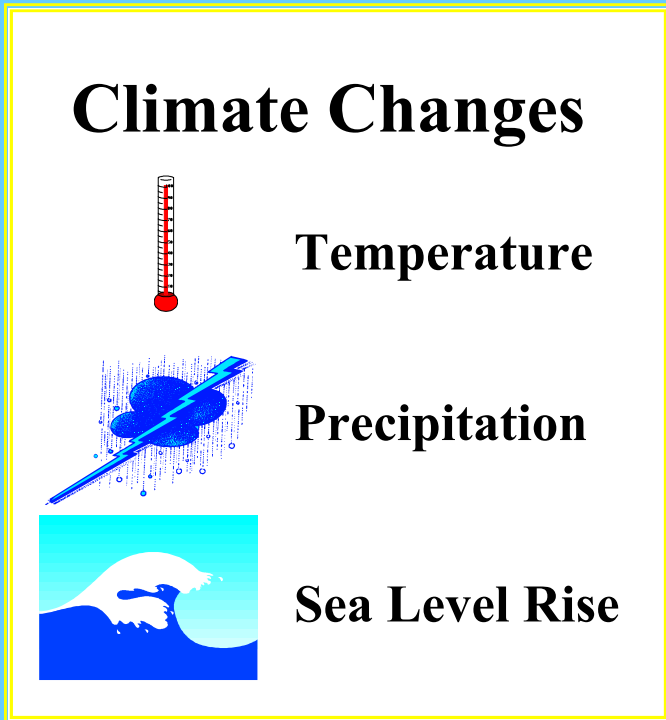
CONCEPTUAL FRAMEWORK FOR THE COMPLEX FEEDBACKS BETWEEN THE CLIMATE SYSTEM AND SOCIETY



Conclusions IPCC WG1 about projected climate change for Caribbean region:

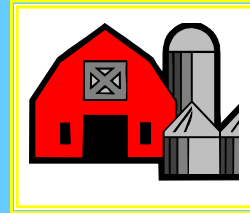
- Sea level will likely continue to rise on average during the century around the islands of the Caribbean Sea. (Models indicate that the rise will not be geographically uniform globally but large deviations among models make estimates of distribution across the Caribbean, uncertain.)
- All Caribbean islands are very likely to warm during this century. The warming is likely to be somewhat smaller than the global, annual mean warming in all seasons.
- Rainfall in the vicinity of the Greater Antilles is likely to decrease in JJA but changes elsewhere and in DJF are uncertain.

Potential Climate Change Impacts



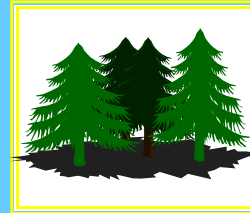
Health

Weather-related mortality
Infectious diseases
Air-quality respiratory illnesses



Agriculture

Crop yields
Irrigation demands



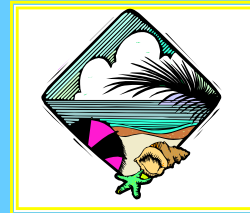
Forests

Change in forest composition
Shift geographic range of forests
Forest health and productivity



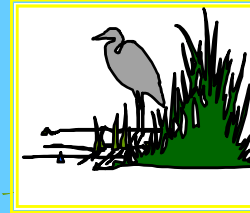
Water Resources

Changes in water supply
Water quality
Increased competition for water



Coastal Areas

Erosion of beaches
Inundation of coastal lands
Costs to protect coastal communities



Species and Natural Areas

Shift in ecological zones
Loss of habitat and species

General Findings

- Small islands are especially vulnerable to climate change and that the impacts will be largely adverse.
- Many islands are already experiencing some negative effects of global warming, sea-level rise and increased sea surface temperature, which are affecting both natural ecosystems and socio-economic conditions.
- Small islands, including those in the Caribbean, have a low capacity to adapt to the negative impacts of climate change.
- On small islands adaptation costs are high relative to GDP, and regrettably some traditional strategies and technologies for coping with past climate variability and extreme climate events (e.g. building on stilts to avoid flood waters; use of grey water from kitchen etc. for irrigating small plots) are being lost with 'modernization'.

Model Projections

- Climate projections (based on modeling) suggest a consistent increase in surface air temperature for the Caribbean, over the next several decades, as shown in the adjacent table.
- Although rainfall projections (models) show no consistent pattern, the observational records suggest that mean annual totals are decreasing in many parts of the region.
- Sea level rise is projected to increase at a rate of between 1 -7 mm/yr. While this rate of rise may appear to be small, the effect is disproportionately great when combined with tidal and storm surge components.
- While the models do not show a clear trend in frequency of tropical cyclones (hurricanes), an increase in maximum wind intensities of at least 5-10 % by the 2050s.

2010-2039 (°C)	2040-2069 (°C)	2070-2099 (°C)
0.48 – 1.06	0.79 – 2.45	0.94 – 4.8

Water Resources

- Water resources in small islands are especially vulnerable to future changes in rainfall distribution. Any reduction in average rainfall will have serious impacts on water supply and island economies. Low rainfall typically leads to (a) reduction in the amount of water that can be physically harvested (b) reduction in river flow, and (c) a slower rate of recharge of the freshwater lens, which can result in prolonged drought.
- Recent modeling of the current and future water resource availability on several small islands in the Caribbean, using a *macro-scale hydrological model* (Arnell, 2004) found that many of these islands would be exposed to severe water stress. Since most of the islands are dependent upon surface water catchments for water supply, it is highly likely that demand would not be met during low rainfall periods.
- Recognizing the vulnerable nature of water supplies, several countries (e.g. The Bahamas, Antigua and Barbuda, Barbados) have begun to invest in the implementation of adaptation strategies, including desalination and rainwater harvesting, to offset current and projected water shortages.

Impact of sea-level rise

- Sea-level rise will exacerbate inundation, erosion and other coastal hazards, threatening vital infrastructure, settlements and facilities that are predominantly situated along the coast.
- Sea-level rise will also negatively impact coastal ecosystems such as coral reefs and mangrove forests, and commercial and artisanal fisheries based on those systems. These adverse effects are likely to manifest themselves through reduced abundance, loss of diversity and possibly shifts in distribution as a result of migration.
- Since fisheries contribute significantly to GDP in many island states, the socio-economic implications of the impact of climate change on fisheries will be important.

Agriculture and Food Security

- Projected impacts of climate change include extended periods of drought and reduced soil quality through increasing soil salinization especially near coastal areas.
- Reduced crop productivity in traditional markets, will drive prices up as food importation costs will inevitably rise, in response to market forces.
- Extreme events, such as hurricanes, floods and droughts can also cause severe damage to food and commercial crops. The case of Grenada after hurricane Ivan is an excellent example. Nutmeg, Grenada's most important agricultural crop, was devastated in a mere few hours by the hurricane. Since the plant does not reach commercial production status under 7-8 years, Grenada will earn no foreign exchange from this source for almost a decade.

Infrastructure and Housing

- In the Caribbean, more than half of the population lives within 1.5 km of the shoreline. In locations such as the north coast of Jamaica and the west and south coasts of Barbados, continuous corridors of development occupy practically all of the prime coastal lands. Other facilities such as fishing villages, government offices, hospitals and critical utilities are frequently located close to the shore. Changes in sea level, and the characteristics of storm events, are likely to have serious consequences for these settlements and infrastructure.
- Almost without exception, international airports are sited on or within a few km. of the coast. Similarly, the main road arteries often parallel the coast. With projected sea-level rise, much of this infrastructure would be at risk from flooding and physical damage, although the degree of risk will obviously vary from country to country.
- The threat from sea-level rise to infrastructure is amplified with the passage of tropical cyclones (hurricanes). In the Caribbean, damage to coastal infrastructure from storm surge alone is often significant. In November 1999, surge damage in St. Lucia associated with Hurricane Lenny exceeded US\$ 6.0 million, although the storm was many kilometres offshore.

Human Health

- Climate change is also likely to result in an increase in the incidence of vector-borne diseases such as dengue fever and malaria. The various mosquitoes that transmit these diseases, as well as other environmental factors in disease transmission, are clearly influenced by climate. In the Caribbean, a retrospective review of dengue fever cases (1980-2002) was carried out in relation to ENSO events (Rawlins *et al.*, 2005). This showed there were greater occurrences of dengue fever in the warmer drier period of the first and second years of El Niño events. Normally, however, it is in the wet season that Caribbean countries are at greatest risk to dengue fever transmission, suggesting that vector mitigation programs should be targeted at this time of year to reduce mosquito production and dengue fever transmission (Rawlins *et al.*, 2005).
- Shortages of fresh water and poor water quality during periods of drought, as well as contamination of fresh water supplies during floods and storms appear to lead to an increased risk of disease including cholera, diarrhoea, and dengue fever. Ciguatera fish poisoning is also common in marine waters, especially reefal waters. Although multiple factors contribute to outbreaks of ciguatera poisoning, including pollution, and other forms of reef degradation, warmer sea surface temperatures during El Niño events have also been linked to ciguatera outbreaks.

Tourism

- Tourism is a major economic sector in many islands, and the effects of climate change will be both direct and indirect. Sea-level rise and increased ocean temperature are projected to accelerate beach erosion, cause degradation of coral reefs including bleaching, and degrade the overall asset value of the coast. Such impacts will in turn reduce the attractiveness of these destinations for coastal tourism. Warmer climates in the higher latitude, especially in winter, may also reduce the number of people who want to visit small islands in tropical and subtropical regions.
- Climate change will also affect vital environmental components of holiday destinations, which could have repercussions for tourism-dependent economies. The importance of environmental attributes in determining the choice and enjoyment of tourists visiting Bonaire and Barbados, two Caribbean islands with markedly different tourism markets and infrastructure, and possible changes resulting from climate change (coral bleaching and beach erosion respectively) have been investigated by Uyarra *et al.*, (2005). They concluded that such changes would have significant impacts on destination selection by visitors, and that island-specific strategies, such as focussing resources on the protection of key tourist assets, may provide a means of reducing the environmental impacts and economic costs of climate change.

Adaptation Strategies

- Under all climate change scenarios considered, small islands including those in the Caribbean will have no choice but to implement adaptation strategies, due to the unprecedented magnitude of the potential impacts. Regional Governments can respond effectively to the threat of climate change by integrating adaptation strategies with existing policies of socioeconomic development and environmental conservation, in order to facilitate sustainable development
- Natural and human-use systems will continue to face pressures that are not climate-related, including population growth, ecosystem degradation, social change and economic transformation. Therefore, Caribbean communities may wish to consider integrated approaches toward sustainable development in which multiple stresses and enhancement of resilience are taken into consideration, and framed as climate risk management. Continued development of climate-friendly and environmentally sound energy services, including renewable energy and energy-saving policies, are appropriate strategies for consideration.
- There is a need to investigate the feasibility and merits of accessing mitigation mechanisms such as the Clean Development Mechanism (CDM) of the Kyoto Protocol. Attention should also be paid to the traditional knowledge and skills that have helped our vulnerable communities to cope successfully with climate variability in the past.