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GLOBAL CHANGE AND THREATS TO THE CARIBBEAN:
NEED FOR ADAPTATION SOLUTIONS

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ABSTRACT: The Caribbean consists of 28 insular and coastal states and 10 territories bordering the Caribbean Sea and the Gulf of Mexico, with a combined area of over 5 million square kilometers. The estimated population of the region is about 40 million people, of which an estimated 28 million live in coastal cities, towns, and villages. The average temperature in the area has increased about 2 degrees Celsius over the past century and is projected to increase another 3.5 degrees Celsius during this century. The area is highly vulnerable to hurricane damage. The large population living in coastal towns is vulnerable to sea level rise and runoff from the inland mountains. The governments of the Caribbean established the Caribbean Community Climate Change Centre to focus research efforts on the problems of the region.

Keywords: climate change, Caribbean, coastal zones, hurricanes

1. Introduction

The Caribbean consists of 28 insular and coastal states and 10 territories bordering the Caribbean Sea and the Gulf of Mexico, with a combined area of over 5 million square kilometers. It starts at Surinam and Guyana off the northeastern tip of South America, extending to Trinidad and Tobago, Barbados, the Windward and Leeward Islands, to Jamaica, the Bahamas, and finishes at Belize in the west (see Figure 1). The Caribbean can be considered as a lake bounded on the south by South America and Central America and in the north by the island chain. This paper is in four parts: observed global changes in key climate parameters as they apply to the Caribbean; the projected changes in these parameters; the vulnerability of the Caribbean to these changes; and the need for adaptation. The key parameters are: temperature rise; sea level rise; changes in rainfall patterns; and extreme weather events.

FIGURE 1

The Caribbean

2. Present and Future Climate

Over the past 140 years, and in particular in the last century, the average global temperature has been increasing (IPCC, 2001). In the Caribbean, the overall change in temperature has been about 2 degrees Celsius; however, climate models are projecting that the average temperature for the Caribbean will increase a further 3.5 degrees Celsius over the next hundred years, which is quite significant. The global sea level is expected to rise between 0.09 and 0.9 meters by 2100 (IPCC, 2001). The Caribbean is like a lake, therefore the impact of these changes could be much more severe in this region than would occur in other parts of the world. More importantly are the precipitation patterns. Figure 2 shows changes in precipitation worldwide from 1900 to 2000 (IPCC, 2001). The western part of Africa has experienced a 50 percent reduction in precipitation, while the Caribbean area has recorded a 30 percent decrease. Based on the global climate models under the SRES A2 scenario, different areas of the earth will become wetter or dryer, with an overall global increase in rainfall (see Figure 3). The Caribbean is projected to experience a decrease in rainfall throughout the area.

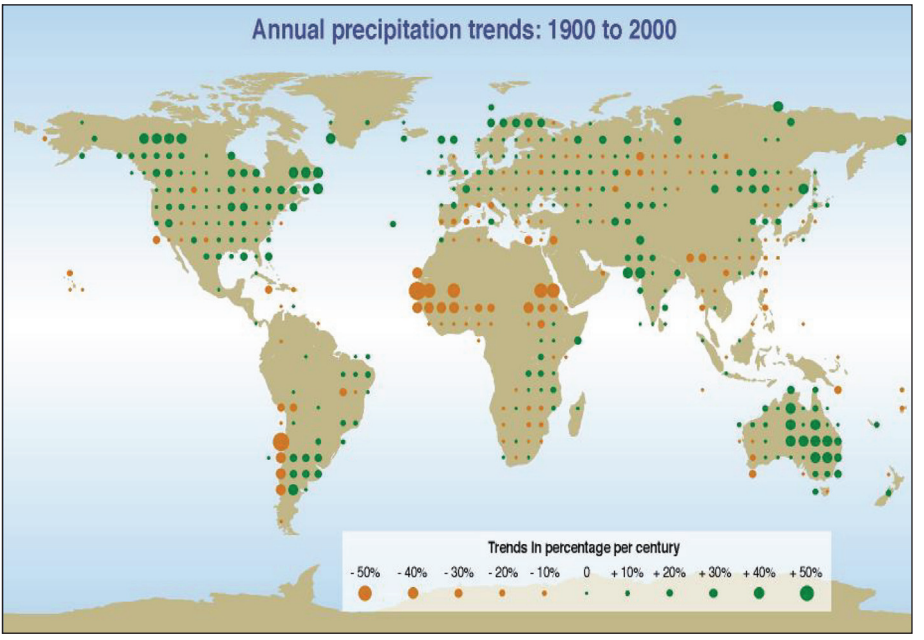

FIGURE 2

Global annual precipitation trends, 1900 to 2000. Source: IPCC, 2001.

What is the likelihood of extreme weather conditions? The projected changes during the 21st century are for higher maximum temperatures, more hot days and heat waves over nearly all land areas. Both the minimum and maximum temperatures would be expected to be higher in the Caribbean area, as well as more intense precipitation (for selected country studies on climate change impacts in the Caribbean region see Anon, 2001a,b,c; CARIBISS, 2001; d'Auvergne *et al.*, 2001; James, 2001; Khan, 2001; Mahlung, 2001; Usher, 2000). Examples of environmental changes as a result of climate change are already occurring in Belize. Belize has a larger land mass than the smaller islands in the Caribbean and there has been a dramatic change in one of its lagoons. The lagoon is on the corridor for birds migrating south for the winter from North America. Normally the lagoon has a depth of about 18 feet, and it gradually decreases during the dry season to about one or two feet by the end of May. The lagoon started to lose water in December, and since February, over 90 percent of it is bone dry, and is being used by cattle in the region for grazing. This is a result of changes in rainfall patterns over the last

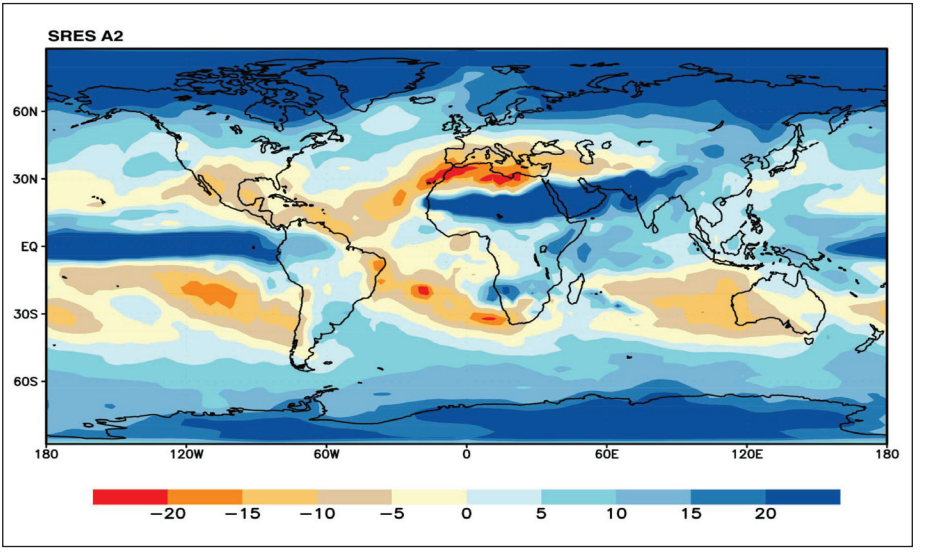

FIGURE 3

Global precipitation patterns under future climate scenario SRES A2. Source: IPCC, 2001.

three years in the area of the lagoon. Examples of the effects of these changes are damage to crops, heat stress on livestock, extended range of pests and diseases (for example, Dengue fever), flooding damage to property, and increasing insurance costs.

3. Climate Vulnerability

What makes the Caribbean vulnerable to the projected global changes? The Caribbean consists of 28 insular and coastal states and 10 territories bordering the Caribbean Sea and the Gulf of Mexico, with a combined area of over 5 million square kilometers. The estimated human population of the region is about 40 million people, of which an estimated 28 million live in coastal cities, towns, and villages. These coastal areas are the very areas that will be most impacted by tropical storms and other climate impacts such as damage to coastal aquifers. Economic growth, frequently dominated by specialized agriculture such as sugar and tourism, has failed to keep pace with the human population growth as 38 percent of the human population of

the Caribbean can be classified as poor. Natural (for example, hurricanes) and anthropogenic activities (for example, land development) have further exacerbated the economic conditions highlighting the need for adaptation in the region.

The Region is subjected to natural climatic hazards that aggravate anthropogenic hazards. For example, there are six months of hurricane activity during times of significant climate variability. These threats to society (see Aiken *et al.,* 1992; FAO, 1989; Stoddart, 1985; Swiadeck, 1997) are further worsened by the conditions introduced by anthropogenic activities, such as poor land-use management, poor marine practices and damage to ecosystems. Future scenarios of climate change call for more severe impacts of tropical storms and hurricanes, more floods, landslides, and changes in rainfall patterns that will generate drought conditions.

In 2004, a unique hurricane named 'Ivan' impacted on the Caribbean (see Figure 4). It was the first hurricane in recorded history that formed at such a low latitude, about 8 degrees north, and so far east of the Lesser Antilles. As Ivan passed over the Caribbean island of Grenada, its cloud structure reached the extreme northern boundary of the Caribbean and extended south to Venezuela in South America. In addition to the cloud structure, the winds and the rains from the hurricane produced severe erosion on the coastal zones of Caribbean islands (see Kjerfve *et al.,* 1986; Letourneur *et al.,* 1993 for this effect). For instance, Hurricane Ivan was far north of Belize, however, the coral reefs suffered from the extreme erosion from the storm. Even though the focus of hurricane impacts tends to concentrate on the particular island over which a hurricane is passing, it also affects all of the islands once inside the Caribbean because the hurricane is land locked at that stage.

To get out of the Caribbean, hurricanes need to cross one of the many islands. In the case of Ivan it went over Jamaica, over the Grand Cayman Islands and over western Cuba before it went off into the Gulf of Mexico and into the United States of America. What is important about a significant hurricane like this? Consider the differences between how the leaders of two nations affected by the hurricane were impacted. At the time, the US Republican convention was being held in New York. The hurricane crisscrossing over Florida, however, did not stop the Republican convention from continuing, and New York was just not affected because of the large size of the United States of America. In the case of the same hurricane over

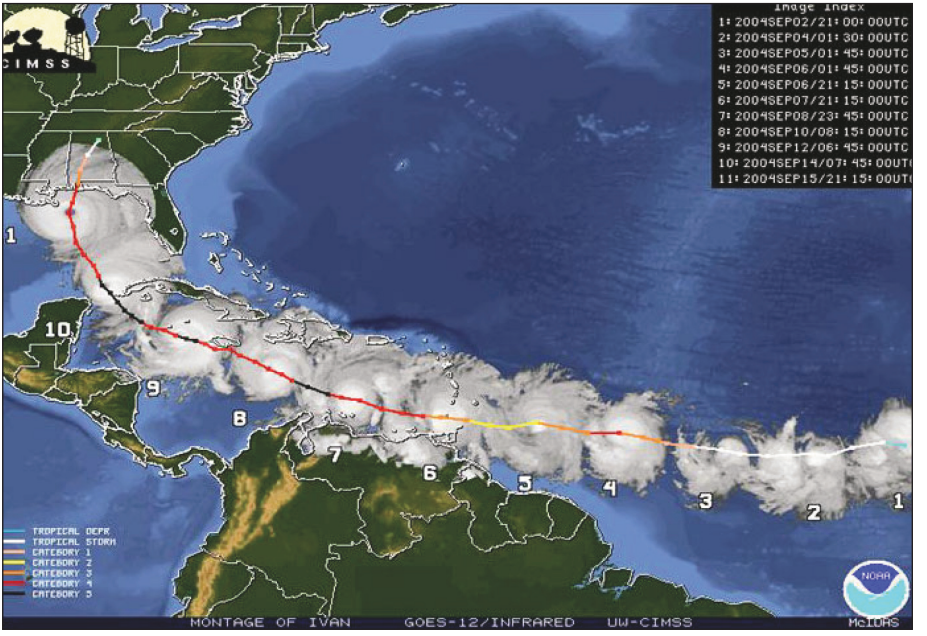

FIGURE 4

Path of Hurricane Ivan through the Caribbean. Source: National Oceanic and Atmospheric Administration (NOAA, 2004).

Granada, it encompassed the entire island including the Prime Minister's residence which was destroyed. The house was washed away from the hillside, and the Prime Minister had to take refuge on a British ship. This example shows the difference between the impact of a hurricane on the islands in the Caribbean and the same hurricane impacting the United States. Adaptation is far more important in the Caribbean than in larger countries such as the USA due their capacity to adapt to the impacts.

There are several other vulnerability consequences of climate change. Beach erosion has important implications not only because of damage to the marine ecosystems but also since most of the island's economy is based on tourism. If the beaches are eroded, livelihoods are destroyed. Most importantly for human survival is the salt water intrusion into aquifers directly affecting the 28 million people living in coastal areas through storm surges caused by the hurricanes. Figure 5 is an example of the effect of rising sea level. It compares a house on the coast during a storm surge in 1997 to what would happen in

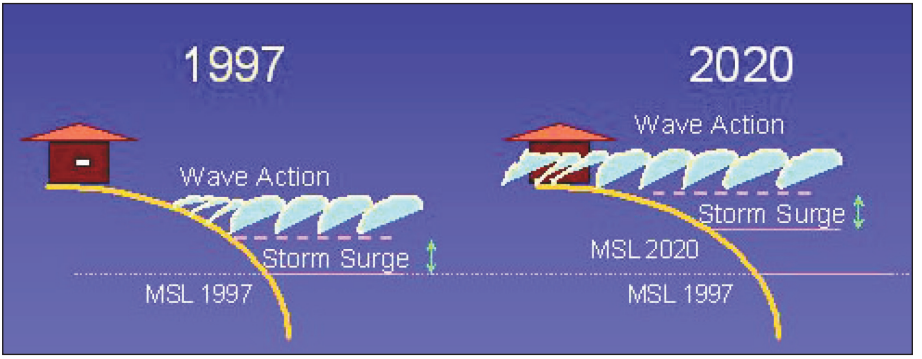

FIGURE 5

Coastal impact of storm surge and wave action under a sea level rise scenario, 1997 and 2020.

2020 with the current projected rise in sea level – the result being the building washed away.

Agriculture, tourism, health, water and human settlements will all suffer. For agriculture, the variability in the climate coupled with the long term climatic change will alter the patterns upon which agriculture depends. The higher temperatures will increase the evaporation rate and, coupled with less rainfall, there will be more desertification. Climate change is projected to decrease agriculture in the tropics far more than it will affect other areas around the globe.

Human settlements will be greatly affected. For instance, the people who live on the coast will need to move further inland. Unfortunately, the islands are mostly mountainous, so the population is faced with a dilemma. While the coastal areas being affected present vulnerable habitats (Anon, 2002), so do the mountains which are vulnerable to hazards such as flash flooding. The fisheries are threatened because of projected warmer sea temperatures in the Caribbean (Mahon and Joseph, 1997) especially in the coral reefs (Ginsburg, 1994; Harmelin-Vivien, 1994) which are the breeding grounds for many fish species. Climate change will impact the mangroves which provide habitat for the early stages of many fish and other marine life (Bossi and Cintron, 1990; Boulon, 1992; Dennis, 1992). One of the most important impacts will be on water security. Salt water intrusion, less rainfall and more evaporation all

influence water supply, and all expect to be negatively impacted under scenarios of future climate changes for the Caribbean.

4. Adaptation Strategies

What is being done in terms of adaptation in the region? The observed and projected climate changes pose major adaptation challenges to the Caribbean. First, realistic climate change projections for the region and credible regional scenarios of future climate change are needed. The global climate models (GCMs) provide valuable information on a global scale, but the Caribbean is extremely small compared to the rest of the globe. Most of the global climate models show Central America as a whole, which includes some of the Caribbean. The islands, however, are worse off because most of them are less than 50 kilometers long - the exceptions are Cuba and the Hispaniola (Cuba has the length, but not the width).

There are needs for vulnerability assessments, impact studies and development of cost-effective adaptation options. In spite of the lack of some vital information, the Caribbean has taken steps to understanding how to adapt to climate change. A project, conducted from 1997 to 2001, developed a plan of action for adaptation to climate change that includes training people and building capacity for adaptation. This was further supported in 2001 to 2004 by a grant from the Canadian International Development Agency to help develop capacity, study climate change impacts on major economic sectors, and risk management approaches to climate risks. The next step is another project where climate change adaptation is being brought into the main stream of national development planning.

The Caribbean countries went one step further by establishing the Caribbean Community Climate Change Centre of which this author is the current director (see CCCCC, 2006). The CCCCC was endorsed by the Caribbean Heads of State in 2002 and became operational in January of 2004 with 2 main programs. One is with the country of Japan applying the Japanese climate model with a 20 kilometer resolution over the smaller islands, starting with St. Lucia, and then other islands such as Dominica, Trinidad, Barbados, and Jamaica. This will allow for adaptation modeling in specific area sectors, such as the management of the watersheds for electricity planning. And, under another program, the CCCCC will develop a plan for adaptation

measures for the coastal areas of three islands: the Commonwealth of Dominica; St. Lucia and St. Vincent; and the Grenadines.

The Centre is also working very closely with two universities in the United States of America: the University of Louisville in Kentucky mapping hazard mitigation for the Caribbean; and the Florida International University examining the design of buildings to make them able to withstand up to at least a category three hurricane. The Caribbean Sea is being studied as a whole in terms of its biodiversity, and considering what steps are needed to ensure that climate change mitigation or adaptation will maintain the sustainability of this biodiversity. The Centre is also working very closely with the government of Italy which is supporting, to a large extent, the operations of the Centre, and to develop other methods for developing alternate uses of energy in a sustainable manner. These are some of the steps taken in terms of adaptation to climate change in the Caribbean.

5. Conclusions

The Caribbean is particularly vulnerable to future climate change due to its coastal human populations; its reliance on climate-sensitive human economies such as tourism; its history of severe and impactful hurricanes; its low capacity to adapt to climate change due to dispersed governmental structures, knowledge and resources. The governments of the Caribbean have recognized climate change as a future threat and have established the Caribbean Community Climate Change Centre in Belize. The Centre is working closely with many countries including Italy, Japan, Canada and the United States of America in order to transfer and build some of the adaptive capacity to climate change that exists around the globe.

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