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Title: **Economic Vulnerability to Climate Change for Tourism-Dependent Nations**

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ABSTRACT

Changes in climate are expected to significantly affect participation in recreation and tourism, as well as the provision of tourism products and services. Since tourism is an important sector for many economies of Caribbean nations, the potential vulnerability of tourism to climate change is of interest. Economic vulnerability may be realized through impacts to tourism revenues, tax revenues, and adaptation costs, all of which affect GDP. Rising surface temperatures may affect visitors' comfort level and attitudes about their stay in the destination. Warmer sea water is associated with coral bleaching and mortality, and may affect visitor perceptions of the quality of coral reef resources for underwater recreation activities. Greater frequency and intensity of tropical cyclones increase the vulnerability of physical infrastructure and capital to storm damage.

This paper proposes a conceptual framework for the assessment of the economic vulnerability to climate change for tourism-dependent nations, and uses the tourism sector in Belize as a case study for demonstration. The conceptual framework is based on an economic model of production and consumption. The analysis has implications for training and outreach for tourism industry professionals and policy makers and for the identification of future research and development priorities at the national and regional scales.

Introduction

Tourism is an important economic sector throughout the Caribbean region for economic growth, tax revenues, and foreign exchange earnings. Tourism was estimated to have generated over $15 billion in economic activity in 2006 and accounted for 16.4% of GDP for the region (WTTC, 2006). Tourism's economic contribution ranges from one-third to one half of GDP for most countries (CGCED, 2000). The tourism economy (including direct and indirect economic impacts) supports more than 2.6 million jobs in the region, or 15.4% of total employment (WTTC, 2006), which underscores its importance to national economies and local communities. However, the tourism sectors in small island developing states (SIDS) are particularly vulnerable to the effects of a changing climate, which is associated with variable weather patterns, rising sea levels, and the frequency of tropical cyclones. This vulnerability is particularly relevant to those SIDS for which tourism systems are dependent on natural resources such as coral reefs and fish. Changes in natural resources resulting from climate change may affect the demand for tourism resources as well as the ability of a region to provide certain services or attractions. Climate vulnerability in SIDS may be futher exacerbated by an economic vulnerability due to their small size and insularity (Briguglio, 2004).

Vulnerability in this context can be understood as the degree of sensitivity to and inability to cope with the negative impacts of climate change (McCarthy *et al*., 2001; Bijlsma *et al*., 1996). Klein and Nicholls (1998) have suggested that vulnerability is multi-dimensional, with biogeophysical, economic, institutional, and socio-cultural elements. The vulnerability of a system to climate change is a function of its exposure to negative effects and its ability to cope with those effects (McCarthy *et al*., 2001). Sterr *et al*. (2003) suggest that biogeophysical effects must be first understood before the vulnerability of socio-economic sectors can be assessed.

Vulnerability assessments enable policy makers to anticipate the consequences of climate change and prioritize adaptation measures in order to minimize exposure to risk (Sterr *et al*., 2003). McCarthy *et al*. (2001) describe three main goals of vulnerability assessments:

1. To identify the degree of future risks induced by climate change and sea-level rise
2. To identify the key vulnerable sectors and areas within a country, and
3. To provide a basis for designing adaptation strategies and their implementation.

Following a discussion of the anticipated effects of climate change, a conceptual framework for the assessment of vulnerability of tourism systems is presented. An economic approach to vulnerability assessment is used, and the conceptual framework addresses both exposure and adaptive capacity.

Climate Change

Climate change is the general term associated with a range of demonstrable changes in global and regional climatic conditions, including temperature, sea levels, precipitation, and extreme weather events such as droughts, flooding, and storms (IPCC, 2001a). It reflects both natural and human-caused variations. The effects of climate change are associated with higher concentrations of anthropogenic greenhouse gases in the atmosphere. A natural greenhouse effect keeps the Earth's surface temperature warm, however, an amplified greenhouse effect where an anthropogenically caused increase in atmospheric concentration of energy-trapping gases is causing rapid global warming (a rise of the Earth's surface temperature). Greenhouse gases include carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), tropospheric ozone (O3); they reached their highest recorded levels in the 1990s, primarily due to combustion of fossil fuels and land-use changes.

The 1900s saw an increase in average surface temperature of 0.6 degrees Celsius, 0.4 of which occurred in the last quarter of the century (Simpson, 2006; McMichael *et al*., 2003). According to the IPCC (2001a), there will be an average temperature rise of 1.4 to 5.8 degrees Celsius in the twenty-first century. In 2001, the Intergovernmental Panel on Climate Change declared that "most of the warming observed over the last 50 years is likely to be attributable to human activities."

Two options exist to deal with climate change: adaptation (policies that aim to reduce vulnerability to the negative effects of climate change) and mitigation (policies that attempt to alter factors that cause climate change). Developing nations and impoverished people are more vulnerable to climate change and will be disproportionately affected, in large part due to their lack of resources and adaptive capacity.

The symptoms of climate change are well documented. These include rising global mean temperatures, rising sea levels (as polar and alpine ice melts), and rising sea surface temperatures (IPCC, 2001b; IPCC, 1997). These symptoms have been associated with several biogeophysical effects, including a loss of coastal land, an increase in the frequency and intensity of tropical cyclones, coral reef bleaching, ocean acidification, and increased risks to human health. These biogeophysical effects are briefly described below:

Loss of Coastal Land

Rising sea levels are expected to significantly affect coastal areas through erosion, increased flooding, and salt water intrusion. This is of particular concern for densely-developed islands and coastal towns, which may experience a loss of land area, greater flood risk, and increased threats to water supplies. A one meter rise in sea level can affect more than 100 million people worldwide (Schmidt, 2005). The options of moving inland or constructing sea walls are difficult and sometimes impossible (Schmidt, 2005).

Increase in the frequency and intensity of tropical cyclones

Scientists are not in general agreement about the possible linkages between climate change and the frequency or intensity of tropical storms and hurricanes. However, a significant increase in the frequency of hurricanes in the North Atlantic has been linked to rising sea surface temperatures, which is associated with the higher concentrations of greenhouse gases (Emanuel, 2006). A Massachusetts Institute of Technology study showed that over the past fifty years, hurricanes have become 50% stronger in both Atlantic and Pacific Oceans, primarily due to an increase in sea surface temperature (Schmidt, 2005). The intensity of hurricanes is measured by wind speed, which has been shown to increase with rising temperatures of tropical ocean waters (Knutson and Tuleya, 2004; Emanuel, 1987). Tropical cyclones are considered to be among the two major geophysical causes of loss of life and property (Anthes, 1982). In a recent statement published by ten climate experts in the USA, scientists warned that the main hurricane problem facing that country is the rapidly-expanding concentration of population and wealth in vulnerable coastal regions (Emanuel *et al*., 2006). Indeed, coastal populations of humans in many countries have been growing at twice the national growth rates (IPCC, 1997). Changes in the frequency, intensity, and timing of tropical storms can have considerable effects on coastal wetlands (in terms of the nutrient cycling, biotic functions, hydrology, etc) (Michener, *et al*., 1997).

Coral reef bleaching

Healthy coral reefs provide valuable ecological benefits including the provision of habitat and nutrients for numerous species and the protection of the coastline from the impact of the ocean, decreasing erosion, property damage and the effects of waves and storms. Healthy reefs also provide numerous economic benefits, generating income from both tourism and fishing and protecting the shoreline. As early as 1990, tourism based on reefs and beaches contributed almost US$90 billion per year to the economy of the Caribbean region (Reaser, *et al*., 2000). While some coral bleaching does occur naturally, the current rate of bleaching has been accelerated by anthropogenic factors, including global warming. Scientists now believe that the connection between increased coral bleaching and global warming is undeniable (Hughes, *et al*., 2003). When coral is bleached, it loses all color, becoming white and brittle. If coral dies, much biodiversity will be lost as other marine life living around it dies as well. This detracts from not only the ecological benefits provided by the reef, but from the economic benefits as well.

Corals have optimal conditions for living, often within a narrow temperature and solar radiation range; thus, variations in those factors (among others) can cause the coral to die. Coral reefs are particularly vulnerable to changes in sea surface temperatures (Reaser, *et al*., 2000). The IPCC (1997) notes that the reefs of the Caribbean Sea already live near their thresholds of temperature tolerance. Higher seawater temperatures impair reproductive functions and growth capacity and lead to increased mortality. Buchheim (1998) concluded that a conservative temperature increase of 1-2 degrees Celsius would cause regions between 20-30 degrees North to experience "sustained warming that falls within the lethal limits of most reef-building coral species". As climate change increases, the extent and severity of coral bleaching is expected to increase (Reaser, *et al*., 2000). Coral reefs and mangroves in some areas are already stressed by factors such as pollution, fragmentation and coastal development, and climate change is expected to exacerbate those stresses (IPCC, 1997; Reaser, *et al*., 2000).

Ocean acidification

The world's oceans absorb carbon dioxide from the atmosphere, increasing the hydrogen ion concentration in the water, lower pH levels, acidification, and higher levels of dissolved carbon dioxide in the water. Should current carbon emissions trends continue, there is the possibility of a 0.5 unit pH decrease by the year 2100, far surpassing the range of natural variability (The Royal Society, 2005). Orr *et al*. (2005) found that acidification will have devastating effects on marine life in the very near term, including additional stresses to already threatened coral reefs; deficiencies of calcium carbonate leads to increased difficulty for key marine organisms to develop skeletons and shells. This acidification may also have physiological and/or reproductive effects. Squid, phytoplankton, zooplankton, and several marine fish may be affected by ocean acidification as well. Tropical and subtropical corals are those most likely to be affected; their long term survival and stability will be compromised (The Royal Society, 2005).

Ocean acidification and subsequent damage to coral reefs can have many negative socio-economic and ecological effects. Currently there is no viable technological way to decrease ocean acidification; rather, carbon dioxide emissions must be reduced to stem ocean acidification, a process which will take thousands of years.

Risks to human health

In addition to the implications for malnourishment, other health effects have been associated with climate change, including an expansion of the geographical distribution, in terms of both altitude and latitude, of vector-borne diseases (*e.g.*, malaria, West Nile, dengue fever, Chagas), water-borne diseases, and food-borne infections (*e.g.*, salmonellosis). Changes in sea level, temperature, humidity, and rainfall are among the factors that can influence the distribution of these diseases. The season and timing of disease transmission may be affected as well

(Haines and Kovats, 2006). Climate change is also projected to increase the incidence of heat-related illnesses (particularly among the young, elderly and sick population), cholera, biotoxin poisoning, asthma, allergies, diarrhea, and other diseases (Simpson, 2006; McMichael *et al.*, 2006; IPCC, 1997). Increased concentrations of air pollutants and allergens often accompany warmer weather, adversely affecting respiratory health (Simpson, 2006). Natural disasters occurring as a result of climate change (*e.g.*, storms, floods and droughts) also have harmful effects such as increased injuries, infectious diseases, and death, as well as decreased nutrition and mental health (Haines and Kovats, 2006; McMichael *et al.*, 2006). Food and water shortages and population displacement resulting from events associated with climate change will also impact health (McMichael *et al.*, 2006). In 2000, it was estimated that climate change was responsible for roughly 150,000 deaths per year (Haines and Kovats, 2006).

While climate change may have some beneficial effects on human health such as a decrease in cold-related deaths, the majority of effects will be negative (Haines and Kovats, 2006; McMichael, *et al.*, 2006). Nations with sub-standard sanitation and public health systems are most likely to see the greatest impacts of climate change on human health. Lower income countries in tropical and sub-tropical regions are expected to be hit the hardest (IPCC, 2001a; Haines and Kovats, 2006).

Climate Change and Tourism

Several studies have considered the potential impacts of climate change on recreation and tourism. Mendelsohn and Markowski (1999) identified three ways in which climate is expected to affect recreation. First, changes in the lengths of seasons will affect the availability of particular recreation activities. Second, changes in climate may affect the overall comfort and enjoyment of outdoor recreation. Finally, climate change may impact the ecological systems of an area, ultimately affecting the quality of the recreation experience.

Nature-based tourism is resource-dependent, and as such, may be particularly vulnerable to climate change. For example, Loomis and Crespi (1999) studied the economic effects of climate change on specific recreation activities. Losses to downhill and cross-country skiing were offset by gains to reservoir, beach, golf, and stream recreation. Anticipated effects of climate change on tourism depend on the relationship between climate and specific recreation activities. A longer summer season in alpine national parks was found to have a positive effect on tourism (Richardson and Loomis, 2004); by contrast, warmer temperatures and reduced snowfall were found to have negative effects on winter recreation activities (Scott *et al*., 2003). Optimal air temperature for water based activities ranges from 15-35 degrees Celsius, while optimal water temperatures are between 10 and 20 degrees for water skiing and sailing, less than 18 for fishing, and between 15 and 20 for swimming and sunbathing (Hall and Higham, 2005). Warmer temperatures would make these activities uncomfortable.

The IPCC (1997) has identified a range of anticipated effects of climate change that threaten the long-term sustainability of tourism in coastal areas and tropical islands. These effects include the loss of beaches to erosion and inundation, salinization of freshwater aquifers, added stress to coastal ecosystems, damage to infrastructure from tropical storms, and an overall loss of environmental amenities.

Smith (1990) concluded that summer precipitation in the UK influenced the number of people traveling to the Mediterranean. Giles and Perry's (1998) work indicated that a pleasant summer in the UK in 1995 led to a decrease in outbound tourism and demand for packaged vacations to the Mediterranean. Perry (2006) studied the impact of climate on tourists to the

Mediterranean region in the summer of 2003 and found that the region could become less attractive to tourists in the future, both for health (due to skin cancer, food-related diseases, and possible vector-borne diseases) and comfort (heat) reasons. Repeated heat waves may lead to bad publicity, further discouraging tourists. Increased temperatures may cause peak tourism seasons to shift. Tourist expectations for air-conditioned facilities would strain energy resources. Perry (2006) concluded that changes in the amount and severity of extreme weather events (*e.g.*, heat waves, droughts) will most likely be more important than the gradual average temperature rise.

Regarding the tourism flow from North America to the Caribbean, (Mather, Viner and Todd, 2005) believe that global warming may reduce the appeal of tropical destinations because of heat, beach erosion, decline in reef quality, and increased health risks. In the year 2000, approximately eight million North Americans traveled to the Caribbean and each arrival generated expenditure of approximately US$1,000. If climate change causes even half a percentage point slowdown in growth rate (using 2.5 and 2% as an example) by the year 2050, the region will have lost between eight and thirteen tourist arrivals equaling between eight and thirteen billion dollars of generated expenditure.

In a study regarding the implications of climate change on tourism in Oceania, it was found that small island states will not only be impacted first, but also hardest (Craig-Smith and Ruhanen, 2005). Like the Caribbean, tourism in this region is reliant on a pleasant climate and environmental quality. The authors cite the World Tourism Organization's main concerns of coral bleaching, erosion or submersion of coastal areas from rising sea levels, and a higher incidence of storms.

Vulnerability of Tourism: A Conceptual Framework

The concept of vulnerability has been associated with several related terms, including risk, hazard, and exposure (Patwardhan *et al*., 2003; Shukla *et al*., 2003; IPCC, 2001b). The IPCC (2001b) describes vulnerability as the degree to which as system is susceptible to or unable to cope with the adverse effects of climate change including climate variability and extremes. McCarthy *et al*., (2001) defined vulnerability as the residual impacts of climate change after implementation of adaptation measures. Therefore, vulnerability can be generally understood to be a function of climate-related hazards, socio-economic exposure, and adaptive capacity. Patwardhan *et al*. (2003) describe vulnerability as systemic, and they suggest that the focus of adaptive capacity should be to reduce exposure, according to the following framework:

Risk = Hazard (climate) x Vulnerability (exposure)

The IPCC (1997) recommends a fully-integrated approach to assessing vulnerability to climate change, where biophysical attributes (e.g., land area) are integrated with economic, social, and cultural characteristics, including non-market goods and services. Pulwarty (2006) recommends an integrated approach to vulnerability and capacity assessment that is based on input from a country advisory panel as to the vulnerability of a particular sector. The Pulwarty approach suggests the development of a conceptual model that is relevant to the sector and the country.

Sterr *et al*. (2003) indicated that vulnerability assessments of socio-economic sectors depend on an understanding of the extent to which biogeophysical effects will occur in the study area. They highlight flood frequency, erosion, inundation, and biological effects as the direct biogeophysical impacts of climate change on the tourism sector.

The conceptual framework presented in Figure XX is based on an economic approach and considers tourism as an economic sector. In this framework, sources of vulnerability to climate are either supply- or demand-based. Climate influences the tourism sector either in the *production* (supply) of tourism services (through the quality and availability of infrastructure, resources, or materials) or in the consumption or *consumption* (demand) of tourism services (through tourist perceptions of weather, resources, amenities, or costs). Sources of vulnerability are rated as high, medium, or low based on risk, exposure, or adaptive capacity. Where applicable, vulnerability responses are categorized as related to either mitigation or adaptation strategies. An overview of the conceptual framework is provided below in Figure 1.

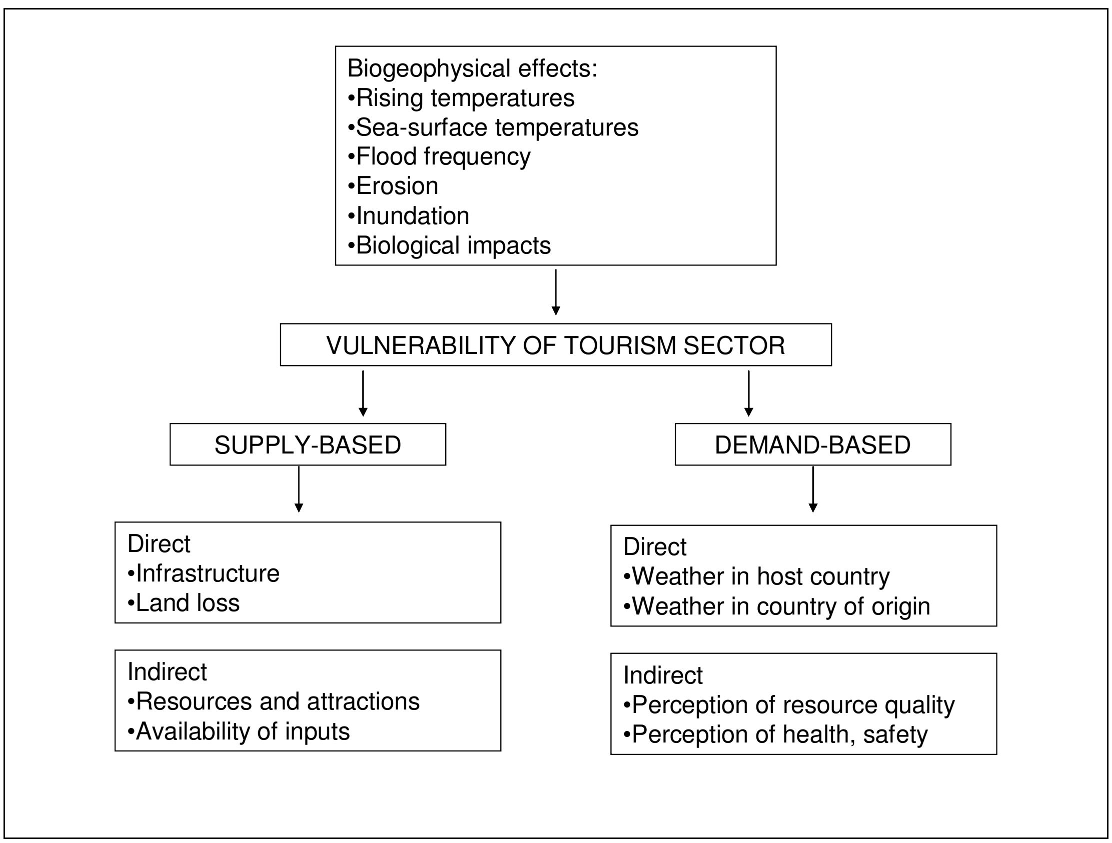

Figure 1: Conceptual framework for tourism vulnerability assessment

Impacts are categorized as either direct or indirect, depending on whether the effect is a physical function of climate change or a socio-economic function the tourism system. The vulnerability of the supply (or production) of tourism services may be directly affected by impacts to infrastructure and land loss. The vulnerability of infrastructure relates to transportation systems (e.g., port, airport, highways), telecommunications, and tourism-related business (e.g., hotels, restaurants, tour operators). The vulnerability of land loss relates to the risks of flooding, inundation, and erosion, which has significant implications for islands and coastal areas. Indirect sources of supply-based vulnerability include impacts to resources (e.g., coral reef, beaches, forests, wildlife), attractions (e.g., natural, manufactured), and the availability of inputs (e.g., accommodations, food, beverages, labor). Dependence on imports may increase the supply-based vulnerabilities.

The vulnerability of the demand for tourism services may be directly affected by weather in the host country as well as the country of origin. Warming temperatures and changes in precipitation in the host country may affect visitor preferences and the overall comfort and enjoyment of activities. Warmer temperatures in the country of origin may reduce demand for trips to tropical countries. Indirect sources of demand-based vulnerability include tourist perceptions of the quality of resources (e.g., coral reefs, beaches, wildlife, other natural resources) as well as perceptions about health and safety conditions (e.g., risk of vector-borne diseases, tropical cyclones). Demand may also be influenced by rising costs of transportation, attractions, accommodations, and food, particularly if mitigation measures include emissions charges.

Vulnerability of Tourism in Belize

Belize is considered a small island developing state (SIDS) because of its low-lying coast, its coastal communities, and its open vulnerable economy (UNDESA, 2005; NAR, 2003). Small island states are considered "extremely vulnerable" to climate change and rising sea levels (IPCC, 1997). Like other SIDS, Belize faces economic, social, and physical exposure to the impacts climate change. As a small, open economy, Belize depends on imports for many basic goods, and relies heavily on tourism for foreign-exchange earnings to meet the demand for imported goods. Due to its small size, land resources are constrained. SIDS are often already at risk from other environmental hazards such as flooding, tropical storms, and deforestation; the effects of climate change are expected to exacerbate these risks and introduce new ones (Tompkins *et al*., 2005).

The tourism sector in Belize is young relative to the agricultural and forestry industries that contributed to the early economic growth of the country. Tourism in Belize was originally developed around small-scale, nature-based recreation activities, and the development of tourism infrastructure reflected an ecotourism niche. Belize is endowed with abundant tourism resources, including the second-largest barrier reef system in the world, hundreds of islands (or "cayes"), numerous limestone caves, and millions of acres of tropical rainforests. The barrier reef was one of the earliest tourist attractions, and the coasts and nearby cayes provided accessibility for snorkeling, diving, fishing, and other water-based recreation activities. Since the 1980s, tourism has expanded rapidly in the Cayo District in western Belize, where tropical rainforests, medicinal plant trails, Mayan archaeological sites, and limestone cave tours attract visitors for adventure and cultural tourism. Numerous national parks and protected areas throughout the country attract wildlife enthusiasts and birders.

The vulnerability of tourism in Belize to climate change is further exacerbated by a general economic vulnerability, which is common among SIDS. Economic vulnerability stems from a narrow range of agricultural exports, a high level of dependence on strategic imports (such as energy), and a degree of economic integration that renders states susceptible to economic fluctuations in other parts of the world (Briguglio, 2004).

The vulnerability of the tourism sector is assessed using the conceptual framework presented in Figure 1.

Supply-based vulnerability

The vulnerability of the supply of tourism is a function of the sector's exposure to climate hazards as well as its capacity for adaptation. The supply or production of tourism services is directly affected by climate in terms of risks to infrastructure (from tropical cyclones and flooding) and the loss of coastal land (from rising sea levels). Seventy per cent of respondents to a survey of tourism businesses in Belize rated their businesses as highly or moderately vulnerable.

More than forty documented hurricanes and tropical storms have passed over Belize in the 20th century. Of the seven hurricanes designated as Category 3 or higher, six have occurred since 1950. Since most tourism development has occurred on off-shore cayes and in coastal areas, the sector faces significant exposure to the risks of increasing storm frequency and intensity. A statement by climate experts called upon leaders of government and industry to respond with immediate and sustained action to evaluate building practices, land use, insurance, and disaster relief policies that have served to exacerbate vulnerability to hurricanes (Emanuel *et al*., 2006). This same problem poses serious threats for Belize; a survey of tourism businesses for this study found that more than a quarter of respondents on Ambergris Caye and nearly half of respondents in the Cayo District lack insurance protection against natural disasters.

Low-lying islands such as the offshore cayes and atolls of Belize are especially vulnerable to rising sea levels associated with climate change because the land area rarely exceeds 3-4 meters above sea level (IPCC, 1997). Small-island developing states (SIDS), as Belize is characterized, are highly susceptible to the impacts of sea level rise, which could possibly be the most “catastrophic” danger they face (Schmidt, 2005). The vulnerability of coastal areas is exacerbated where mangroves have been removed for development. This threat has been identified as highest along the barrier reef, near Belize City, and near Placencia in southern Belize (WRI, 2005).

The supply or production of tourism services is indirect vulnerable to the effects of climate change in terms of risks to natural resources and attractions and the availability of inputs. The vulnerability of coral reefs is among the most significant threats to the tourism sector in Belize, as reef-based activities attract more than 80 per cent of tourists who visit Belize. Coral bleaching has been associated with increasing sea surface temperatures. The first recorded bleaching event in Belize occurred in 1995, and was followed shortly thereafter by a mass bleaching event in 1998, with the bleaching of some individual colonies by more than 90 per cent (WRI, 2005). Coral reefs have also been significantly affected by tropical cyclones in 1998, 2000, and 2001, which reduced coral cover at numerous locations along the barrier reef. Coral reefs are also threatened by dredging, over-fishing, gill netting, trawling, and physical damages from recreation.

Availability of inputs represents another source of indirect vulnerability of climate change to the tourism sector in Belize. Much of the building materials, food, beverages, and energy supporting the sector are imported from overseas (primarily the USA and UK), and rising fuel costs have already forced increases to many products and services. Rising sea levels threaten the viability of coastal and island real estate, which has the potential to escalate housing costs and strain the supply of labor.

Demand-based vulnerability

The vulnerability of the demand for tourism depends on the tastes and preferences of tourists and the price elasticity of demand for tourism products and services. People will continue to travel, however the activities and destinations they choose will most likely change. Perry (2006) points out that while tourists are flexible, but tour operators and local tourism managers are less flexible. An assessment of demand-based vulnerability of tourism would be enhanced by a contingent visitation analysis, where a visitor survey would be used to elicit responses from tourists about their visitation behavior contingent upon various climate scenarios (Richardson, 2007). A general discussion of the vulnerability of the demand for tourism in Belize is presented below.

Tourism demand in Belize may be directly affected by climate change in terms of changes in the weather of the host country and the country of origin. Maximum temperatures during the peak tourist season in Belize average about 30º Celsius (or 85º Fahrenheit), which is within the range of optimal air temperatures for water-based activities (Hall and Higham, 2005), but may be at the upper bound for comfort in the inland forested regions of the Cayo District, where the stagnant heat is not tempered by sea breezes.

Weather in country of origin may also affect the demand for tourism in Belize. More than 80% of overnight visitors to Belize come from the USA, Canada, and Europe (BTB, 2004), and there is concern that rising temperatures and milder winters in those countries may reduce the appeal of Belize as a tourist destination.

Tourism demand in Belize may be indirectly affected by visitor perceptions of the quality of tourism resources as well as perceptions about risks to health and personal safety. The vulnerability of the tourism sector in Belize is underscored by its dependence on coastal resources. Reef-based activities attract the greatest level of participation among tourists in

Belize, according to the Visitor Expenditure and Motivation Survey, administered by the Belize Tourism Board (2004). Snorkeling and diving attract 57.2 and 24.3 per cent of tourists, respectively, while river trips, caving, and birding attract 23.7, 19.6, and 12.9 per cent of tourists, respectively. In terms of sites, the cayes attract 70.3 per cent of tourists, while archaeological sites and national parks attracted only 37.4 and 29.5 per cent, respectively. These statistics suggest that the perceptions of reef quality may be an important factor in the assessment of the vulnerability of tourism demand to climate change.

Incidence of tropical diseases such as malaria and dengue fever are relatively rare in Belize, but an increase in prevalence would be costly in terms of reduced demand from wary travelers. The geographical distribution of these vector-borne diseases, along with water-borne, heat-related, and food-borne diseases is expected to expand as a result of warming temperatures. Risks of personal safety related to tropical storms are a potential factor for vulnerability, although the peak tourism season presently does not coincide with the hurricane season.

Conclusions

Tourism-dependent nations such as small island developing states in the Caribbean are vulnerable to the effects of climate change. This paper presents a conceptual framework for assessing the economic vulnerability of the tourism sector to effects such as rising sea levels, loss of coastal land, and warming sea temperatures. An assessment of economic vulnerability should consider the exposure of the supply of and demand for tourism resources to the hazards of climate change as well as the adaptive capacity of states and communities. Climate effects will vary based on behavioral responses; lower income countries have much less capital to invest in adaptation and mitigation measures, and this condition intensifies the existing risks.

The application of this conceptual framework to the tourism sector of Belize highlights several areas of supply- and demand-based economic vulnerability to climate change, including the risks to coastal land and infrastructure, exposure to resource damages such as coral bleaching, and an associated reduction in demand because of resource changes or risks to personal health and safety. Adaptation measures that reflect these specific sources of vulnerability should be considered in light of the country’s limited capacity to moderate the harmful effects of climate change.

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