Caribbean Regional Headquarters
Hastings House
Balmoral Gap
Christ Church
Barbados
West Indies
Tel: +1 246 426 2042

UK Office
Almond House
Betteshanger Business Park
Deal
Kent CT14 0LX
United Kingdom
Tel: +44 (0) 1304 619 929

admin@caribsave.org ~ www.caribsave.org

Protecting and enhancing the livelihoods, environments and economies of the Caribbean Basin

CARIBSAVE Climate Change Risk Profile for Antigua and Barbuda

Summary Document

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THE CARIBSAVE CLIMATE CHANGE RISK ATLAS (CCCRA)

A practical evidence-based approach to building resilience and capacity to address the challenges of climate change in the Caribbean

Climate change is a serious and substantial threat to the economies of Caribbean nations, the livelihoods of communities and the environments and infrastructure across the region. The CARIBSAVE Climate Change Risk Atlas (CCCRA) Phase I, funded by the UK Department for International Development (DFID/UKaid) and the Australian Agency for International Development (AusAID), was conducted from 2009 – 2011 and successfully used evidence-based, inter-sectoral approaches to examine climate change risks, vulnerabilities and adaptive capacities; and develop pragmatic response strategies to reduce vulnerability and enhance resilience in 15 countries across the Caribbean (*Anguilla, Antigua & Barbuda, The Bahamas, Barbados, Belize, Dominica, The Dominican Republic, Grenada, Jamaica, Nevis, Saint Lucia, St. Kitts, St. Vincent & the Grenadines, Suriname and the Turks & Caicos Islands*).

The CCCRA provides robust and meaningful new work in the key sectors and focal areas of: Community Livelihoods, Gender, Poverty and Development; Agriculture and Food security; Energy; Water Quality and Availability; Sea Level Rise and Storm Surge Impacts on Coastal Infrastructure and Settlements; Comprehensive Disaster Management; Human Health; and Marine and Terrestrial Biodiversity and Fisheries. This work was conducted through the lens of the tourism sector; the most significant socio-economic sector to the livelihoods, national economies and environments of the Caribbean and its people.

SELECTED POLICY POINTS

- Regional Climate Models, downscaled to national level in the Risk Atlas, have provided projections for Caribbean SIDS and coastal states with enough confidence to support decision-making for immediate adaptive action.
- Planned adaptation must be an absolute priority. New science and observations should be incorporated into existing sustainable development efforts.
- Economic investment and livelihoods, particularly those related to tourism, in the coastal zone of Caribbean countries are at risk from sea level rise and storm surge impacts. These risks can encourage innovative alternatives to the way of doing business and mainstreaming of disaster risk reduction across many areas of policy and practice.
- Climate change adaptation will come at a cost but the financial and human costs of inaction will be much greater.
- Tourism is the main economic driver in the Caribbean. Primary and secondary climate change impacts on this sector must both be considered seriously. Climate change is affecting related sectors such as health, agriculture, biodiversity and water resources that in turn impact on tourism resources and revenue in ways that are comparable to direct impacts on tourism alone.
- Continued learning is a necessary part of adaptation and building resilience and capacity. There are many areas in which action can and must be taken immediately.
- Learning from past experiences and applying new knowledge is essential in order to avoid maladaptation and further losses.

OVERVIEW OF CLIMATE CHANGE ISSUES IN ANTIGUA & BARBUDA

Antigua and Barbuda is already experiencing some of the effects of climate variability and change through damage from severe weather systems and other extreme events, as well as more subtle changes in temperature and rainfall patterns.

Detailed climate modelling projections for Antigua and Barbuda predict:

- an increase in average atmospheric temperature;
- reduced average annual rainfall;
- increased Sea Surface Temperatures (SST); and
- the potential for an increase in the intensity of tropical storms.

And the extent of such changes is expected to be worse than what is being experienced now.

To capture local experiences and observations; and to determine the risks to coastal properties and infrastructure, selected sites were analysed to:

1. assess the vulnerability of the livelihoods of community residents in the **Old Road** area to climate change; and
2. project sea level rise and storm surge impacts on **Dickenson Bay, Fort Bay, and Runaway Bay in Antigua; and on Cocoa Point, Low Bay and Palmetto Point in Barbuda** (Low Bay being at the greatest risk).

The sites were selected by national stakeholders and represent areas of the country which are important to the tourism sector and the economy as a whole, and are already experiencing adverse impacts from climate-related events.

Vulnerable community livelihoods

- The unemployment rate of those surveyed in Old Road town is 34%. This high figure is cause for concern since a stable source of income is an important component of adaptive capacity.
- Few households (and almost all female headed households) have insurance.
- Low-income households tend to sacrifice preparation activities for the sake of using money for other urgent priorities and risk last minute preparations when they are certain that a hurricane system *will* impact the country.

Vulnerable coastlines

- 1 m SLR places 10% of the major tourism properties at risk, along with 2% of road networks and 100% of sea port lands.
- With 2 m SLR, 18% of major tourism resorts will be impacted and 100% of airport lands.
- Annual reductions in the contribution of tourism to Antigua and Barbuda's national GDP as a result of the reduced amenity value from beach loss is estimated to be between US $102 million in 2050 to over US $340 million in 2080 (based on a mid-range SLR scenario).

Climate change effects are evident in the decline of some coastal tourism resources, but also in the socioeconomic sectors which support tourism, such as agriculture, water resources, health and biodiversity.

CLIMATE CHANGE PROJECTIONS FOR ANTIGUA AND BARBUDA

The projections of *temperature, precipitation, sea surface temperatures;* and *tropical storms and hurricanes* for Antigua and Barbuda are indicated in Box 1 and have been used in making expert judgements on the impacts on various socio-economic sectors and natural systems, and their further implications for the tourism industry.

Stakeholders consulted in the CCCRA have shared their experiences and understanding about climate-related events, and this was generally consistent with observational data.

Box 1: Climate Modelling Projections for Antigua and Barbuda

Temperature: Regional Climate Model (RCM) projections indicate an increase in mean annual temperatures spanning 2.4˚C and 3.2˚C by the 2080s, in higher emissions scenario.

Precipitation: General Circulation Model (GCM) projections of rainfall span both overall increases and decreases, ranging from of -31 to +13 mm per month by 2080 under the higher emissions scenario. Most projections tend toward decreases. The RCM projections, driven by HadCM3 boundary conditions, indicate large decrease in annual rainfall (-18%) when compared to simulations based on ECHAM4 (-5%).

Sea Surface Temperatures (SST): GCM projections indicate increases in SST throughout the year. Projected increases range from +0.7˚C and +2.8˚C by the 2080s across all three emissions scenarios.

Tropical Storms and Hurricanes: North Atlantic hurricanes and tropical storms appear to have increased in intensity over the last 30 years. Observed and projected increases in SSTs indicate potential for continuing increases in hurricane activity, and model projections indicate that this may occur through increases in intensity of events but not necessarily through increases in frequency of storms.

SEA LEVEL RISE AND STORM SURGE IMPACTS ON COASTAL INFRASTRUCTURE AND SETTLEMENTS

The majority of infrastructure and settlements in Antigua and Barbuda, like most SIDS, are located on, or near the coast, including government, health, commercial and transportation facilities. The high-density tourism development on the coast is particularly vulnerable to climate change and SLR and increases the risk of degradation of coastal and marine biodiversity thereby reducing its resilience to climate change impacts such as SLR and storm surge.

The CARIBSAVE Partnership coordinated a field research team with members from the University of Waterloo (Canada) and the staff from the Ministry of Agriculture, Lands and the Environment to complete detailed coastal profile surveying, therefore contributing to capacity building in Antigua and Barbuda with regard to coastal survey methodology and survey equipment. Areas at greatest risk in Antigua are Dickenson Bay, Fort Bay, and Runaway Bay and in Barbuda, Cocoa Point, Low Bay and Palmetto Point, with Low Bay at greatest risk in Barbuda. These areas include notable resorts, ports and an airport that lies less than 6 m above sea level and will therefore be affected.

This study revealed the geographic areas that will be impacted by SLR (see Figure 2 and Figure 3), but the calculation of actual costs associated with this inundation must include impacts on insurance costs, destination competitiveness and the spill over impacts that lost coastal activities/industries will have in other sectors, for example changes in agriculture and energy demand or fluctuations in employment in construction etc.

Figure 1: Beach erosion at Runaway Bay

Figure 2: Total land and beach loss due to SLR at Sandals Resort, Antigua

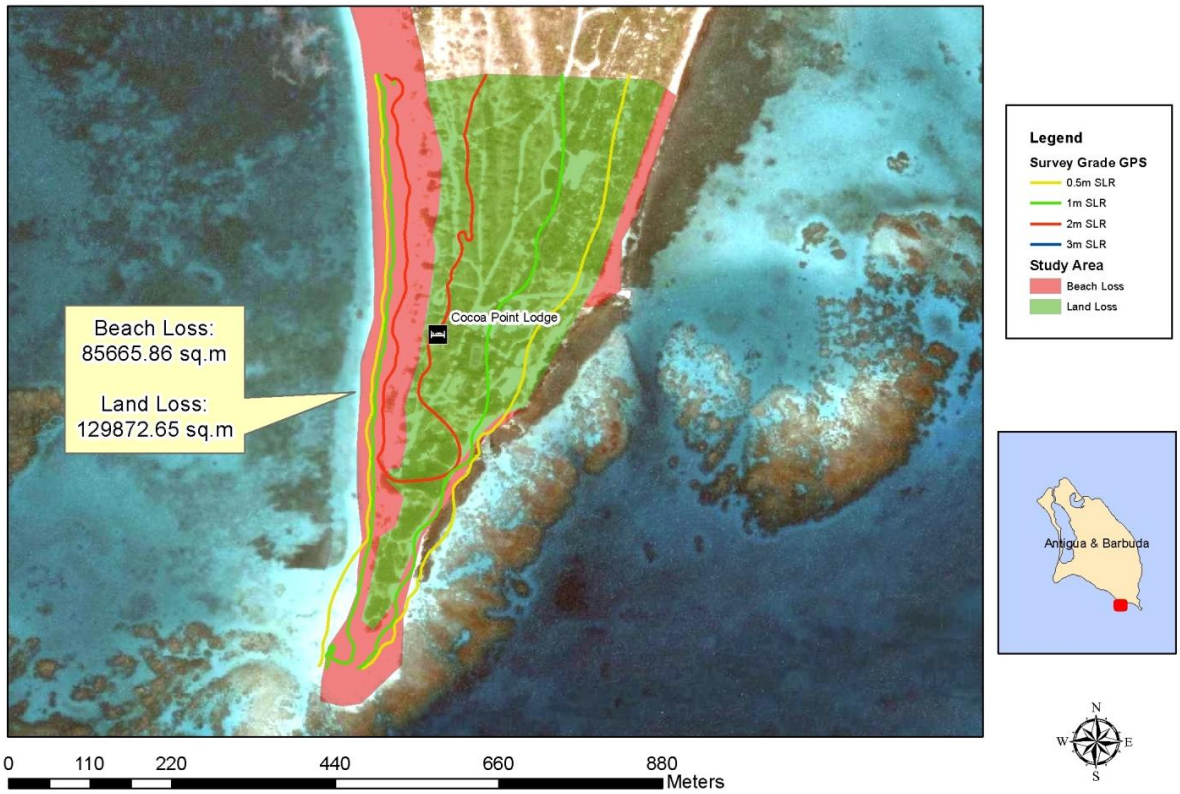


Figure 3: Total land and beach loss due to SLR at Cocoa Point, Barbuda

One meter and two meter SLR scenarios, and beach erosion scenarios of 50 m and 100 m, were used to assess the potential vulnerability of major tourism resources. Results of these surveys (Table 1) indicate that 1 m SLR places 10% of the major tourism properties at risk, along with 2% of road networks and 100% of sea ports. With 2 m SLR, 18% of major tourism resorts will be impacted and 100% of airports. Critical beach assets will be affected much earlier than SLR-induced erosion damages to infrastructure; indeed, once erosion is damaging infrastructure, it means the beach, a vital tourism asset, has essentially disappeared. The Ministry of Tourism is seeking market the country in a way that reaches beyond the notion of 'sun, sea and sand' and is encapsulated in the catch phrase 'the beach is just the beginning' in recognition of the fact that the country has to diversify its product.

As Table 1 shows, with 100 m of erosion (resulting from approx. 1 m SLR), 44% of the major tourism resorts will be impacted, and 65% of sea turtle nesting sites will be impacted. Engineered structures and natural environments (e.g. mangroves) can protect against some of these impacts to coastal regions, but the dynamics of these erosion processes will demand some adaptation of coastal infrastructure and settlements.

Table 1: Impacts associated with 1 m and 2 m SLR and 50m and 100m beach erosion in Antigua and Barbuda

		Tourism Attractions		Transportation Infrastructure		
		Major Tourism Resorts	Sea Turtle Nesting Sites	Airport Lands	Major Road Networks	Seaport Land
SLR	1.0m	10%	12%	0%	2%	100%
	2.0m	18%	18%	100%	6%	-
Erosion	50m	34%	50%	-	-	-
	100m	44%	65%	-	-	-

Annual reductions in the contribution of tourism to Antigua and Barbuda's national GDP as a result of the reduced amenity value from beach loss is estimated to be between US $102 million in 2050 to over US $340 million in 2080 (based on a mid-range SLR scenario). The costs of rebuilding the infrastructure are estimated to be over US $668 million in 2050, up to US $1.57 billion in 2080 for tourism resorts and an additional US $19 million by 2050 to US $46 million by 2080 for re-building ports and $1 million in 2050 to $2 million by 2080 for major roadways[i]. As the CCCRA reveals, projected impacts from climate change involve much more than those from SLR and therefore losses to national economies will be greater than the figures mentioned.

This SLR work provides Antigua and Barbuda with new, high resolution geospatial data of coastal areas and a quantification of the extent of SLR impacts projected for the islands and reinforces that serious, comprehensive and urgent action that addresses the challenges of adapting to SLR is needed. One priority area is to build a full inventory of existing coastal protective defences so that structural protection can be optimised now and into the future, for example, existing seawalls that are in disrepair do not serve their anticipated erosion protection purpose. Only when the current conditions are known can adaptation planning begin in earnest with SLR integrated into government insurance policies, design of coastal structures and most importantly land use development plans and Tourism Master plans.

COMMUNITY LIVELIHOODS, GENDER, POVERTY AND DEVELOPMENT

Figure 4: Old Road with a view of Curtain Bluff Bay

More than 50 residents and workers from the Old Road community participated in CARIBSAVE's vulnerability assessment which included a vulnerability mapping exercise, focus groups and household surveys which were developed according to a sustainable livelihoods framework. This research an understanding of: how the main tourism related activities, including fishing, vending and other micro and medium-sized commercial activities located along the coast and have been affected by climate related events; the community's adaptive capacity and the complex factors that influence their livelihood choices; and the differences in the vulnerability of men and women.

The Old Road community is located to the south of Antigua, and can be classified as a low-middle income area. It is fishing and farming community with numerous tourism facilities and attractions along the coastline and was formerly described as the "bread basket" of Antigua and Barbuda. A few fishermen land their boats in Curtain Bluff Bay, but there is no formal fisheries infrastructure. Farmlands are located in the Claremont area, on the outskirts of the Old Road area.

Community Characteristics and Experiences

Households in the community are mostly headed by men, but the female employment rate is higher, possibly reflecting the higher levels of education pursued by women. Female-headed households also have higher monthly income. A source of concern is the fairly high (34%) unemployment rate, since a stable source of income is an important component of adaptive capacity. The tourism sector is a major employer, employing 38% of the residents sampled, and approximately 63% of the employed respondents. Few households (and almost all female headed households) have insurance, which translates into a very limited capacity to rebuild or restore property in the event of damage or loss. The sea, coral reefs, mangroves and forests play vital roles in the lives of many respondents for subsistence, livelihood and recreational purposes. The different perspectives of risk and vulnerability that are seen between genders means that the comprehensive integration of gender, poverty and livelihood issues into climate change impact and vulnerability assessment and planning processes is essential to developing appropriate adaptation strategies.

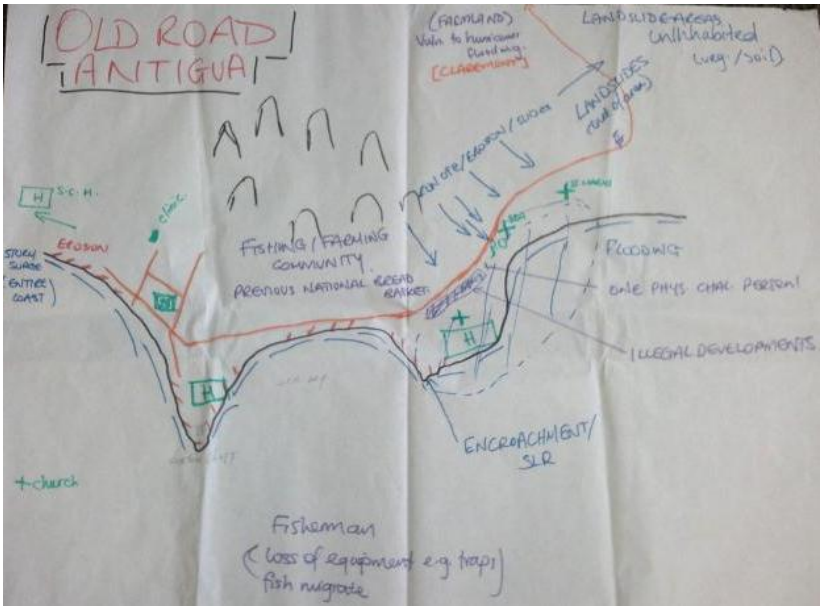


Figure 5: Participatory vulnerability mapping exercise

As a community that has experienced several hurricane systems over the last two decades, participants are all too aware of the severity of these systems, and the imminent threat of increasingly intense hurricanes. Residents therefore place major emphasis on preparation, but low-income households will sacrifice preparation activities for the sake of using money for other urgent priorities and risk last minute preparations when they know a hurricane system *will* impact the country.

However, knowledge of climate change within the community is average with some residents who never heard of the term “climate change” and others who have pursued studies and/or are currently working in professions which involve climate or natural resource research. For members that are aware of it, there is little doubt about the consequences that climate change is having and will have on their lives and all of the main livelihoods in the community are already being impacted to some degree by climate related changes.

Hurricanes Luis (1995), George (1998), Lenny and Jose (1999), Omar (2008) and Earl (2010) have caused severe damage and disruption in the community, especially in earlier years when properties were less structurally sound. Although Hurricane Omar and Hurricane Earl were less impactful systems, farmers were significantly affected with banana crops lost to wind damage. Fishers are affected when there is infrastructural damage or loss of boats, but once the storm has passed they can usually return to work with little impact. Particularly vulnerable livelihood groups include low to middle level hotel and restaurant employees, taxi operators, farmers and roadside and beach vendors; those employed by government or in other private sector establishments do not usually suffer from income loss. Tourism is often impacted by port and airport closures for a few days and even after schedules are restored, there can be a noticeable decline of long stay passengers, a decline in the duration of their stay and/or a decline in tourist

expenditure immediately following the passage of a hurricane, with significant consequences for the tourism sector and the wider economy.

Survey respondents revealed a low level of financial security in the event of job loss or a natural disaster; households that are unable to sustain themselves after one month, and unable to source any external help, are at significantly greater risk. Other events of concern include drought, flooding and storm surge, which mainly affect properties, infrastructure and the natural environment. Some of the practical recommendations put forward by the community to improve resilience include: implementing a water catchment and conservation project; establishing a community disaster management group; establishing a dedicated hurricane shelter in the community; assessing the feasibility of establishing emergency and health services and encouraging activities that would mitigate and manage flood events to reduce their impacts.

AGRICULTURE AND FOOD SECURITY

Agriculture in Antigua and Barbuda is mainly directed to the domestic market with carrots, onions, sweet potato, cucurbits, cabbage and cotton among the major crops grown in Antigua and melons, corn and beans more popular in Barbuda. Agricultural areas in are socially vulnerable due to the fact that there are very few full time commercial farmers, and local businessmen lack the incentive to invest in the sector. The high cost of labour, small size of the local market, lack of marketing structures and infrastructure, and competition from imported foodstuffs makes income generation from farming particularly difficult.

Figure 6: Agriculture in Old Road, Antigua

The sector is highly vulnerable to climate related events and low annual rainfall and high evaporation and transpiration rates make irrigation necessary for sustained yields and moderate levels of production, especially in drought years. January to April 2010 brought severe drought conditions which contributed to substantial crop losses. This was followed by excessive rainfall from April to August causing soil saturation and leaching which hampered land preparation and resulted in retarded crop growth. On 29th August 2010 Hurricane Earl hit the country causing damages to agricultural infrastructure in the amount of EC $12.3 million and incurring losses to the crop sector totalling EC $2.7 million[ii]. Some farmers have switched to higher yielding varieties, or used hot season varieties of cultivars during hot and dry periods. Others have invested in drip irrigation, greenhouse technology, or water storage devices, such as mini dams and ponds. A Climate Resilient Water Management for Agriculture project would make Antigua's agriculture sector less vulnerable to limited water availability resulting from climate change. The project will necessitate support from the Ministry of Agriculture and technical assistance from agricultural agencies such as IICA and FAO to develop capacity in both Government agencies and at the farm level to understand climate change impacts on irrigation systems and agricultural production.

The mismanagement of excessive levels of livestock that are left to roam unrestrained in fallow agricultural lands, as well as other sensitive areas is the main vulnerability enhancing factor for land use and soil degradation in Antigua and Barbuda. This should be addressed by implementing a Livestock Grazing

Management project that looks at habitat management and herd or population management to ensure that the livestock are raised sustainably.

ENERGY AND TOURISM

Current tourism related energy use and associated emissions in Antigua and Barbuda are estimated to be the equivalent of 50 - 80% of estimated national emissions of CO_2, depending on the source of the national emissions statistic used. Antigua and Barbuda is emitting higher levels of CO_2 than the global annual average of 4.3 t CO_2 per capita (5.06 t CO_2). Energy audits will help to identify major energy consuming sub-sectors, and to develop appropriate strategies for energy and emissions reductions. Aviation (38%), cruise ships (29%) and accommodation (17%) were identified as the major direct consumers of energy and emissions in the tourism sector. Electricity is entirely produced from fossil fuels by the Antigua Public Utilities Authority (APUA) and a private power producer, Antigua Power Company (40% of generation needs), which sells electricity to APUA. One plant is a dual purpose (desalination and electricity) steam plant, supplying 30% of the electricity on Antigua.

Antigua and Barbuda is in the process of finalising a National Energy Policy (NEP) and the draft is ready for adoption. The document elaborates potential measures to be taken and calls for a comprehensive assessment of the renewable energy sector to determine what environmentally sound, culturally acceptable and economically viable renewable energy solutions exist. Key areas highlighted for action are: energy cost reduction; diversification and efficient use of energy sources; electricity reliability; environmental protection; and stimulate new economic/business opportunities. There is only brief reference to the need for the tourism sector to address energy conservation. Developing a Sustainable Energy Action Plan and a Policy Framework that supports the ideas and guidelines of the draft NEP should be a high priority.

Figure 7: Desalination plant which also produces electricity - in a vulnerable area in Antigua

Source: http://www.365antigua.com

Climate change can have both direct and indirect impacts on energy generation, distribution and transmission infrastructure, with implications for existing traditional (fossil fuel based) energy systems, as well as proposed renewable energy initiatives. Hurricanes impact transmission lines, poles and other infrastructure and Hurricane Jose resulted in 90% power outages in Antigua and Barbuda. Power generating stations and other major infrastructure located on the coastline are highly vulnerable to damage from flooding and inundation resulting from SLR and storm induced surges. Temperature increases reduce the efficiency of energy generation at thermal power plants and reduced precipitation may affect water availability for non-contact cooling. Alternative energy sources, while they are environmentally more sustainable, also face challenges from physical climate change impacts and these must be considered in energy sector planning.

The anticipation of continued rising oil prices, as well as international emissions reduction polices, will make both the tourism sector and the wider economy of Antigua and Barbuda highly vulnerable. Energy costs in Antigua and Barbuda is disproportionately high compared to the rest of the Caribbean and following several years of subsidised fuel prices the Government announced a partial pass-through pricing system in August 2009. Rising oil prices will affect tourism in particular since aviation has limited options for using alternative fuels and increases in fuel costs will inevitably be passed on to the passengers. In order to ensure that fuel imports are maintained at an affordable and sustainable level, demand side management, technological innovation and politics that allow restructuring of tourism systems will be needed. Carbon pricing is the most efficient tool to stimulate behaviour change and change in production, thus while it will be difficult at first, such a price structure will encourage the creation of a more sustainable energy sector; and by extension, a more sustainable tourism sector in Antigua and Barbuda. The introduction of many technologies is economically feasible in tourism, while new financing mechanisms such as the Clean Development Mechanism and voluntary carbon offsetting schemes can make contributions to implementing new and innovative, but not economical technical solutions.

A number of tourism management models that focus on market structure and average length of stay are available that can be used to address the high emissions associated with international travel. Some markets are economically more beneficial because of higher spending, while having lower emissions because of proximity to the destination. Similarly, it is preferable to increase the length of stay of a few visitors rather than increase the number of short stays by many visitors. According to the UNWTO in its 2010 report, Antigua & Barbuda has been experiencing an increasing trend in average length of stay from 9.4 to 10.0 nights in the period 2004 -2008. This is a positive trend and efforts to further support this development need to be encouraged.

WATER QUALITY AND AVAILABILITY

The water withdrawal rate per capita in Antigua and Barbuda is estimated to be 80 m^3 per year and, as such, Antigua and Barbuda is a water stressed country, particularly in the north[iii]. Water in Antigua comes from surface sources via dams and multiple small ponds, from groundwater sources and desalination plants (75% of drinking water). In Barbuda, groundwater is the main water source for the domestic sector, while the private sector utilises desalination plants. The tourism sector, combined with industry, accounts for 20% of water demand in the country, with cruise ships accounting for approximately 1%[iv]. Some hotels have their own desalination plants. Corrosion problems in the pipe network and illegal connections result in substantial losses (30 to 35% from leakage)[v] that must be addressed through pipe replacement and improved management. Desalination plants are heavy users of electricity and therefore expensive to run, hence the combination desalination and power plant on Antigua. The feasibility of operating reverse osmosis desalination systems using renewable energy should be assessed as well as alternative water generation technologies such as atmospheric water generation (water-from-air) systems.

Availability of water is clearly impacted by climate signals with low average rainfall and high rainfall variability being the two key factors. Heavy rainfall erodes soils and can result in landslides that damage water intakes. Hurricane Omar in 2008 caused extensive flooding that significantly impacted the agricultural sector. Observations have shown:

- there appears to be a decline in June precipitation;
- there has been a shift in the driest month from February to March;
- there has been a flattening of the rainfall peak in September;
- there continues to be a consistent but minor peak in rainfall in May.

Antigua and Barbuda has a long history of droughts with Barbuda usually worse affected, and consequently there have been calls for improved forecasting for floods and droughts.

Between 1983 and 1984 water had to be brought via barges from neighbouring islands and in Barbuda, drought conditions affect wells leaving them prone to over pumping and salt water intrusion. Ground water resources in some areas of Barbuda are less than 1.5 m from the surface making the risk of intrusion from SLR extremely high[vi]. The country's main aquifers and other groundwater abstraction points are located along the coast[v] and occurrences of poor water quality have resulted in well water being used for flushing toilets and washing only.

Investments have been made in developing dams in the country and the increased use of rainwater harvesting has been identified as a possible option to satisfy irrigation needs. However, challenges associated with this option include flooding and employing suitable flood control measures[iv]. New reservoirs must include the appropriate infrastructure for prevention of flooding from overflows. Another option involves recycling treated sewage.

Figure 8: Potworks Reservoir, Antigua - believed to be the largest body of freshwater in the Eastern Caribbean

Source: www.antiguanice.com

Water storage is an important adaptation measure that is already widely used with 46% of poor households owning water tanks and as many as 13% of households reliant on public standpipes. The widespread nature of water collection is partly because of issues of water availability, but in very poor households is often related to the high cost of water in Antigua and Barbuda. The overall policy direction concerning water resources in Antigua and Barbuda has been one which aims to improve access to water resources and to make buildings more self-reliant where water production is concerned. The Town and Country Planning Act requires that all new buildings have enough water storage for three to four days; approximately 18 m^3 of water is averaged to be stored per bedroom per day[iv]. The viability of additional storage facilities at the community level should also be assessed, but should be combined with public education on water conservation and the safe use of rainwater harvesting systems.

A *Draft Integrated Water Resource Management Strategy* and a *Draft Drought Management Plan* have been prepared, but robust land management policies are needed to reduce the discharge of pollutants, rehabilitate watersheds and establish watershed protection. The implementation of Integrated Water Resources Management (IWRM) has encountered several issues, including the lack of political will and commitment, the lack of an IWRM policy, and the lack of stakeholder participation[v]. This situation should be re-visited because the basis of IWRM is that different users of water are interdependent: IWRM encourages a move away from a uni-sectoral water management approach to one which allows participatory decision-making including different user groups. Such an approach allows an equitable

management of water resources, which will be particularly important with declining water resources under climate change.

The establishment of any water management policies and programmes would be strengthened by improved data collection. In addition, an in-depth water monitoring programme that includes monitoring of ground and surface water quantity and quality should be developed. A baseline assessment of water quality should be established using mapping of water quality problems in a Geographical Information System (GIS) database, allowing the characterisation of water contamination risks. The data collected could then contribute to the development of computer models of groundwater flow to account for the impact of SLR on groundwater levels. Due to the particular vulnerability of aquifers in Antigua and Barbuda, these models should be developed urgently in order to effectively mitigate the effects of climate change on freshwater resources.

COMPREHENSIVE NATURAL DISASTER MANAGEMENT

Antigua and Barbuda is a country with 100% of its land and population exposed to two or more hazards[vi], thus making it highly vulnerable to the impacts of extreme weather events and climate change. A strong disaster and emergency management system is important not only to safety and security but also to the socio-economic performance of the country.

Hurricanes and tropical storms, with the associated flooding and storm surge have been the most damaging hazards to Antigua and Barbuda in recent years because of the large, low-lying bays and the low elevation of these two islands. In 2010 Hurricane Earl caused significant flooding, downed trees and caused power outages across the islands. The uncertainty of Earl's path resulted in a late response by the National Office of Disaster Services (NODS) and although there were no deaths or injuries, Earl did disrupt a number of industries from power outages, the closed airport, damaged crop lands and significant loss of equipment (14%) by fisher folk.

It is clear that vulnerability to such hazards has been reduced between 1999 (when Jose and Lenny hit the same communities within a short period of time) and now (2011), as a result of greater awareness and sensitisation of Antiguans. Nevertheless, physical structures and public utilities are still vulnerable to damages from high winds and flood waters so vulnerability persists on the twin islands. The National Office of Disaster Services (NODS) Director called for stronger, supportive legislation, specifically for shelters, following the passage of Hurricane Earl even though the response and reconstruction efforts helped save lives and provided Antiguans the necessary food and shelter. The Disaster Relief Emergency Fund (DREF) mission was also successful and allowed the national Red Cross society to better assist those persons in need of assistance with shelter and food.

Antigua and Barbuda has taken on the Comprehensive Disaster Management (CDM) Strategy of the Caribbean Disaster Emergency Management Agency (CDEMA) in their recent policy development and planning and they are also a sub-regional focal point for response activities under CDEMA.

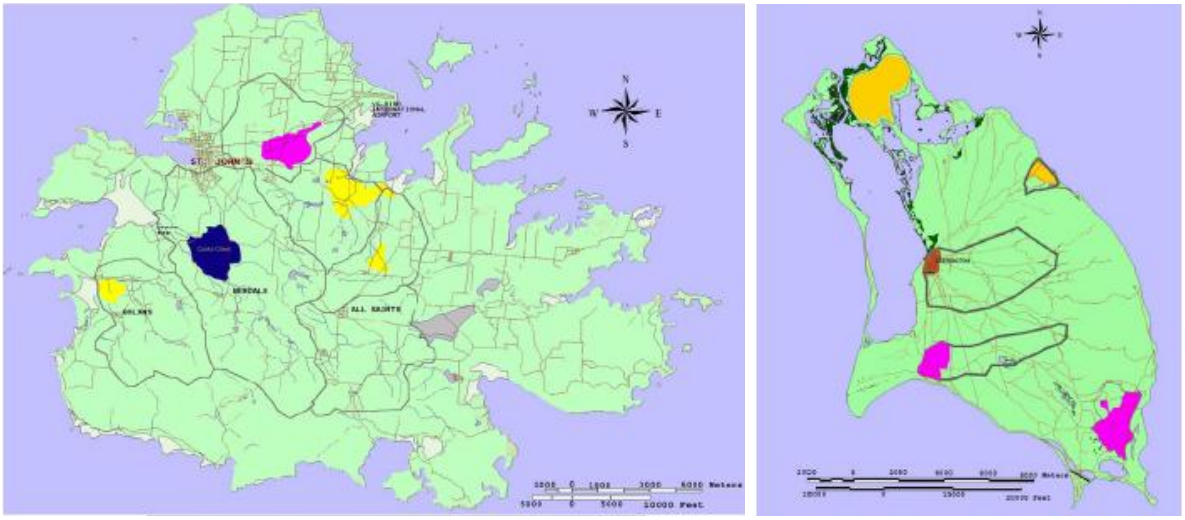
Since the implementation of CDM in Antigua and Barbuda, disaster management has had a greater focus on identifying hazards and working on community-level interventions, with committees representing 16 different geographical units. NODS activities are supported by the Disaster Management Act, Disaster Management Plan (under review for incorporation of CDM) and the Natural Hazard Mitigation Policy and Plan. An interactive and innovative community education and capacity building initiative designed to reach all levels of Antiguan society would enable individuals to manage their own risk levels and build resilience to natural hazard events. Media and communications technology offer fast, effective ways to reach a large

portion of the population; NODS has a website and Facebook page where they have relevant information available and warning messages are transmitted to the public. A system of protocols and procedures for communication of warnings to the most vulnerable exists between NODS and the Meteorological Office. The latter has several weather stations and rainfall gauges and they provide data, system tracking and advisories to Antigua and Barbuda, as well as the Leeward Islands and Virgin Islands.

Antigua and Barbuda has also started efforts to incorporate disaster education into school curriculums monitoring efforts at the TN Kirnon Primary and the School for the Deaf which have a disaster plan in place, an evacuation process defined and a disaster Preparedness Committee. This is a positive effort that should be expanded as it shows that the broader society in Antigua and Barbuda is aware of the importance of DRR and preparedness.

Antigua and Barbuda also has a National Building Code and NODS identified that their current mandate calls for greater attention to safety in public spaces and mass gathering locations (e.g. schools or churches); therefore action must be taken to address these matters under the disaster management framework and within the building codes. Following the many hurricane impacts between 1989 and 1999, NODS has developed a low-cost design for reconstruction of buildings and housing that has proven to be resistant to impacts[vii].

Additionally adaptive capacity should be had through the Physical Planning Act which requires an environmental assessment and the designation of areas at risk to flooding, slope instability or similar hazards. However, a 2001 capacity assessment reported that the lack of land use and zoning regulations were a challenge to hazard mitigation[vi]. Areas of high vulnerability were identified in various hazard maps created as part of the USAID/OAS Post-Georges Disaster Mitigation Project. While the Physical Planning and Land Development and Control Act have since been updated, the dynamic nature of development, demands monitoring and enforcement of high risk zones, as well as enforcing the requirement for EIAs. Technical persons in the Development Control Authority must be capable of reviewing an EIA and hazard assessments for such monitoring and enforcement to be effective and this is currently an area of weakness. Building regulations should be updated and building inspectors appointed in permanent positions, with the responsibility of reviewing all construction on the islands.



Dark blue- very high hazard > 600 mm; yellow- high hazard 300 - 600 mm; magenta- moderate hazard, 150 - 300 mm; green- low hazard 75 - 150 mm and very low hazard < 75 mm

Figure 9: Flood hazard maps of Antigua and Barbuda

(Source: USACE, 2004)

The tourism industry in Antigua and Barbuda is particularly vulnerable to impacts from extreme events and tourists are also vulnerable to heat related conditions. The closure of the airport during and following a hurricane disrupts the movement of tourists and since much of the tourism in Antigua and Barbuda is based on the coast, the infrastructure is at great risk from flooding, storm surge, coastal erosion and strong winds. To address the issue of disaster management, the Ministry of Tourism has committed to leading a partnership between public and private sector stakeholders to ensure information on hygiene, safety and disaster risks are managed and guests and staff are prepared for any emergency situation[viii]. Work should be done with the relevant tourism stakeholders to develop and implement the existing sustainable tourism plans with a focus on diversification of the tourism product toward the interior to reduce vulnerability.

HUMAN HEALTH

Health is an important issue in the tourism industry because tourists are susceptible to acquiring diseases whilst travelling, but they are just as likely to act as carriers of diseases. The potential effects of climate change on public health can be direct or indirect: direct effects include those associated with extreme weather events such as heat stress, changes in precipitation, SLR and natural disasters; indirect effects are associated with changes in eco-systems and various sectors such as water, agriculture and the wider economy.

The acquisition of an infection can have consequences for persons visiting a destination which can significantly affect the economies of Small Island Developing States (SIDS) because of a loss of reputation and avoidance of these destinations by tourists. In the Antigua and Barbuda Initial National Communication under the United Nations Framework Convention on Climate Change (UNFCCC) vector-borne diseases (malaria and dengue) and the increased risk of cardiovascular diseases are the main areas expected to be impacted in the country's Health Sector. The government conducts a malaria surveillance programme aimed to prevent the re-introduction of the disease through travel and immigration. It is recommended that the WHO Integrated Vector Management Programme be adopted. Increasing temperatures may exacerbate the onset of cardiovascular diseases, an important consideration for elderly travel enthusiasts. There have also been links drawn between warmer sea temperatures and outbreaks of Ciguatera fish poisoning (CFP), which is a major health risk in the Caribbean Region with one of the highest incidence recorded in Antigua and Barbuda[ix]. Further research is needed that links the epidemiology of diseases with climate data in Antigua and Barbuda and this must be pinned on improved, peer reviewed data.

In addition to the direct threat of injury or death from a particular natural disaster such as floods, physical and capital damage to health facilities may also arise. Displacement of persons and loss of shelter are important because of the associated mental and physical impacts and increasing temperatures can result in heat stress; heat wave events have been found to be associated with short-term increases in mortality globally as well as morbidity related to heat exhaustion and dehydration. Both locals and visitors should be provided with continued health education and promotion campaigns which will be crucial in sustainable disease prevention and may save lives during and after natural disasters.

The frequent drought conditions in Antigua and Barbuda, leave the population vulnerable to diseases linked to inadequate water supply and sanitation, such as cholera, typhoid and bacterial dysentery. The use of underground cisterns for water storage is quite common, but there have been concerns regarding water contamination from sewage systems by salmonella, gastroenteritis, shigellosis and campylobacter. The high percentage of the population using pit latrines and ventilated pit latrines (21.3% of the population), combined with the low water table increases the chance of contamination of potable water sources. The Government has recognised the need to develop and implement sewage treatment systems at the

municipal and regional level and the provision of communal sanitation facilities in communities most in need has helped to address this problem. There are also proposals to design a sewage system in St. John's. Improper filtration and treatment of rainwater is also a concern. Improved water storage and sanitation infrastructure must therefore be prioritised. Drought conditions also reduce crop production and affect livestock resulting in undernourishment of the population. This has been identified as a challenge in addressing poverty with a total of 28.3% of the population considered to be indigent or 'at risk'[x]. A recently approved Vagrancy Control programme aims to provide "food, health care, and shelter to the homeless"[xi]. Dry spells can also affect air quality and increase diseases like acute respiratory infections and influenza like illnesses which are quite common among residents of Antigua and Barbuda.

Conversely, increased precipitation that causes flooding, often results in increased pest populations and contamination of surface and groundwater, especially from pit latrines. Important diseases associated with excess water and sanitation in Antigua and Barbuda include: dengue, gastroenteritis and schistosomiasis. Their prevalence could have increased during the rainy and hurricane seasons. Pest control operators and farmers took part in a training workshop in 2009.

In the 2011 Budget speech, the Government of Antigua and Barbuda stated its intention to develop a comprehensive Healthcare Policy which aims to further develop health services in the country, including disease prevention, control of communicable and non-communicable diseases and improving provisions for the elderly and other vulnerable groups. There are also plans to develop the medical tourism industry with the revenue generated channelled into the national health care sector. Since the sector is currently challenged by limited human resources, Cuban health professionals supplement the staff at the Mount St. John Medical Centre and the clinics.

Food Safety Training Workshops are one way to protect against food-borne diseases and Antigua and Barbuda has taken part in the WHO Prevention of Food Borne Disease training programme for food service providers and food handlers. An early disease warning system could also be established so that people can take the necessary precautions in their day-to-day activities.

MARINE AND TERRESTRIAL BIODIVERSITY AND FISHERIES

Figure 10: Cades Bay, south coast of Antigua

Source: http://scitec.uwichill.edu.bb/bcs/
(Photo credit: Sean Carrington)

Antigua and Barbuda enjoys relatively high levels of biodiversity, particularly in the coastal and marine environment. Mangroves, coral reefs, and seagrass beds are among the principal eco-systems in coastal and marine areas and provide habitat for a range of threatened and endangered species of flora and fauna. The country's natural resources form the basis for the country's tourism and fisheries sectors as well as serving as protective barriers against tropical storm and hurricane activity. One of the rarest snakes in the world, the Racer Snake (*Alsophis antiguae*),

exists only on Great Bird Island off the northeast coast of Antigua and is the focus of international conservation efforts.

Rapid and ad hoc development of tourism, residential and industrial infrastructure over the last 30 years has led to loss of habitat and habitat fragmentation on Antigua, and to a much lesser extent on Barbuda. Over-grazing of livestock and the spread of the alien invasive lemon grass has also increased the vulnerability of terrestrial biodiversity to external stressors. Sedimentation, nutrient enrichment and poor boating practices are degrading the quality of coastal waters and damaging marine habitats; over-extraction and harmful fishing practices are also increasing threats to seagrass beds and coral reefs. There is no municipal wastewater treatment plant in Antigua and Barbuda and septic tanks and soak-aways are usually poorly built resulting in groundwater contamination and impacts on downstream coastal waters. A GEF project attempted to address the lack of adequate sewage treatment at Siboney Beach, but has yet to develop a working solution.

Education and awareness projects for residents and in-bound tourists could be developed. Short videos that encourage residents and visitors to be more conscious of their impacts on eco-systems can be shown on national TV networks and during in-bound international flights. The films should focus on positive actions that individuals can take to minimise their impact on the environment by decreasing energy and water consumption, wastage and precautions to be taken during marine based recreation (diving, snorkelling, boating). The films should also explain the importance of preserving and managing eco-system services in order to protect the livelihoods of communities.

Very small islands, like Antigua and Barbuda, are at greater risk of losing their remaining natural resources and are particularly vulnerable to SLR (SLR), elevated sea surface temperatures (SST), changes in rainfall patterns and the increasing intensity of storms and hurricanes. The projected higher temperatures and lower rainfall are likely to exacerbate the current threats to the country's biodiversity; in particular those that affect the limited forested areas.

The outlook for Antigua's forests is not good, and this is particularly worrisome as these forests control the local micro-climate and capture much needed moisture in the soils and vegetation. On-going efforts to restore and protect forests in watershed areas (e.g. Wallings Forest and Watershed Area) should be scaled up to ensure that rainfall is maintained and captured in aquifers and reservoirs. This will require effective forest management, including reforestation as well as controlling over-grazing, lemon grass, bush fires and illegal deforestation.

The islands' marine eco-systems are particularly important to tourism and fisheries. Coral cover has declined dramatically in the last 30 years, due to a combination of sedimentation, pollution, over-fishing and climate change (coral bleaching). This trend is likely to continue unless effective management interventions are developed that increase the resilience of coral reefs and coastal eco-systems. The enforcement and communication of fisheries laws would benefit from new ICTs that engage fishermen in the management of their sector. A strategy should be created for:

- establishing a more effective fish sanctuary management and enforcement system for coastal communities;
- enhancing the capacity of resource managers and users to be more resilient to climate change; and
- establishing a sustainable finance mechanism for supporting fish sanctuary management.

The strategy should increase the involvement of the tourism sector in supporting community-based MPAs, as well as provide opportunities for alternative livelihoods and technologies for public education.

The Government of Antigua and Barbuda has established a legislative and institutional framework that contributes to biodiversity conservation. Lack of political will has been cited as a significant reason for the delayed implementation of these strategies, but increased awareness of the threats and issues has led to improvements and a declining rate of environmental degradation[xii]. Tools such as Environmental Impact Assessments (EIAs) and protected areas have been employed to minimise the impacts of economic development on the natural environment and the biodiversity budget has been increased over ten fold[xii].

Habitat mapping is underway at several locations, including the mountains and the South-West coast. But a chronic shortage of trained personnel in biodiversity management limits the ability of the various stakeholder agencies to address the issues facing eco-systems in Antigua and Barbuda. Incorporation of climate change and biodiversity issues into school curricula starting at the primary level will help to improve public awareness, while building adaptive capacity through knowledge and training. Doing so at the primary, secondary and tertiary levels will encourage students to view environmental management as a viable career choice and address the lack of trained personnel in this field.

CONCLUSION

Recent and future changes in climate in Antigua and Barbuda have been explored using a combination of observations and climate model projections. Despite the limitations that exist with regards to climate modelling and the attribution of present conditions to climate change, this information can provide very useful indications of the changes in the characteristics of regional climate that one might expect under a warmer global climate. Consequently, decision makers should adopt a precautionary approach and ensure that measures are taken to increase the resilience of economies, businesses and communities to climate related hazards.

Antigua and Barbuda has a history of damages and losses from natural disasters. Disasters not only interrupt development progress at the national level, but they also cause individuals to invest time and resources into rebuilding their homes and livelihoods after an impact. Since it is predicted that under climate change hurricanes may increase in intensity and extreme rainfall events may also increase in intensity, preparedness for disasters (e.g. flooding or drought) and climate change adaptation become common goals. The Government of Antigua and Barbuda has initiated work in the development of a national climate change adaptation policy and since then various ministries have started to incorporate climate change considerations into their own policies and plans.

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This document provides a synopsis of critical *sectoral* vulnerabilities and capacities and highlights challenges, opportunities and strategies for action. The complete, 250+ page, Climate Change Risk Profile for Antigua and Barbuda is also available from www.caribsave.org and provides detailed climate modelling for various climate parameters, sectoral assessments, and analyses using proven, scientific methodologies to inform pragmatic strategies specific to key sectors in Antigua and Barbuda.

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