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

CARIBSAVE Climate Change Risk Profile for St. Vincent and the Grenadines

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 ST. VINCENT AND THE GRENADINES

St. Vincent & the Grenadines (SVG) 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 St. Vincent & the Grenadines 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 **Georgetown** area to climate change; and
2. project sea level rise and storm surge impacts on **Belmont Walkway, Bequia and Canash Beach, Indian Bay, Johnson Point and Villa Beach**.

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

- Household incomes, financial support and security and insurance coverage rates are low.
- One-third of the households surveyed have food shortages, with a high dependence on an external food supply.
- Many precursor conditions exist undermine the community's ability to respond to impacts of climate-related hazards.
- The 2009 drought resulted in significant losses to farmers; food prices rose and produce had to be imported from other islands to supplement the limited supply in St. Vincent.

Vulnerable coastlines

- 1 m SLR places 10% of the major tourism properties at risk, along with 1% of road networks, 50% and 67% of airport and sea port lands respectively.
- With 2 m SLR, 24% of major tourism resorts will be impacted and 75% of airport lands.
- With 100 m of erosion (resulting from approx. 1 m SLR), 76% of the major tourism resorts will be impacted.
- Annual losses in tourism resulting from the reduced amenity value from beach loss is estimated to be between US $46 million by 2050 to US $174 million by 2080 for 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 ST. VINCENT AND THE GRENADINES

Four primary variables were considered in determining the vulnerability of SVG to climate change. The projections of *temperature, precipitation, sea surface temperatures* and *tropical storms and hurricanes* 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.

Box 1: Climate Modelling Projections for St. Vincent and the Grenadines

Temperature: Regional Climate Model (RCM) projections indicate an increase spanning 2.4-3.1˚C in mean annual temperatures by the 2080s in the higher emissions scenario.

Precipitation: General Circulation Model (GCM) projections of rainfall span both overall increases and decreases, ranging from -34 to +6 mm per month by the 2080s across 3 scenarios. Most projections tend toward decreases. Both RCM projections indicate large decreases in total annual rainfall (-30% when driven by HadCM3 boundary conditions and -22% based on ECHAM4).

Sea Surface Temperatures (SST): GCM projections indicate increases in SST throughout the year. Projected increases range from +0.9˚C and +3.0˚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

Figure 1: Beach erosion at Indian Bay Beach, St. Vincent

The majority of infrastructure and settlements in SVG, like most SIDS, are located on, or near the coast, including government, health, commercial and transportation facilities. High-density tourism development on the coast is particularly vulnerable to climate change and SLR and tends to increase the degradation of coastal and marine biodiversity, thereby reducing 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 staff from the National Parks, Rivers and Beach Authority to complete detailed coastal profile surveying at five study sites: Belmont Walkway, Bequia; and Canash Beach, Indian Bay, Johnson Point and Villa Beach in St. Vincent. One metre and two metre 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 indicate that 1 m SLR places 10% of the major tourism properties at risk, along with 1% of road networks, 50% of airports and 67% of sea ports. With 2 m SLR, 24% of major tourism resorts will

be impacted and 75% 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.

With 100 m of erosion (resulting from approx. 1 m SLR), 76% of the major tourism resorts will be impacted and 47% of sea turtle nesting sites will be impacted (see **Error! Reference source not found.**, Figure 2 and Figure 3). 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 SVG

		Tourism Attractions		Transportation Infrastructure		
		Major Tourism Resorts	Sea Turtle Nesting Sites	Airport Lands	Major Road Networks	Port Lands
SLR	1.0m	10%	11%	50%	1%	67%
	2.0m	24%	16%	75%	1%	67%
Erosion	50m	38%	34%	-	-	-
	100m	76%	47%	-	-	-

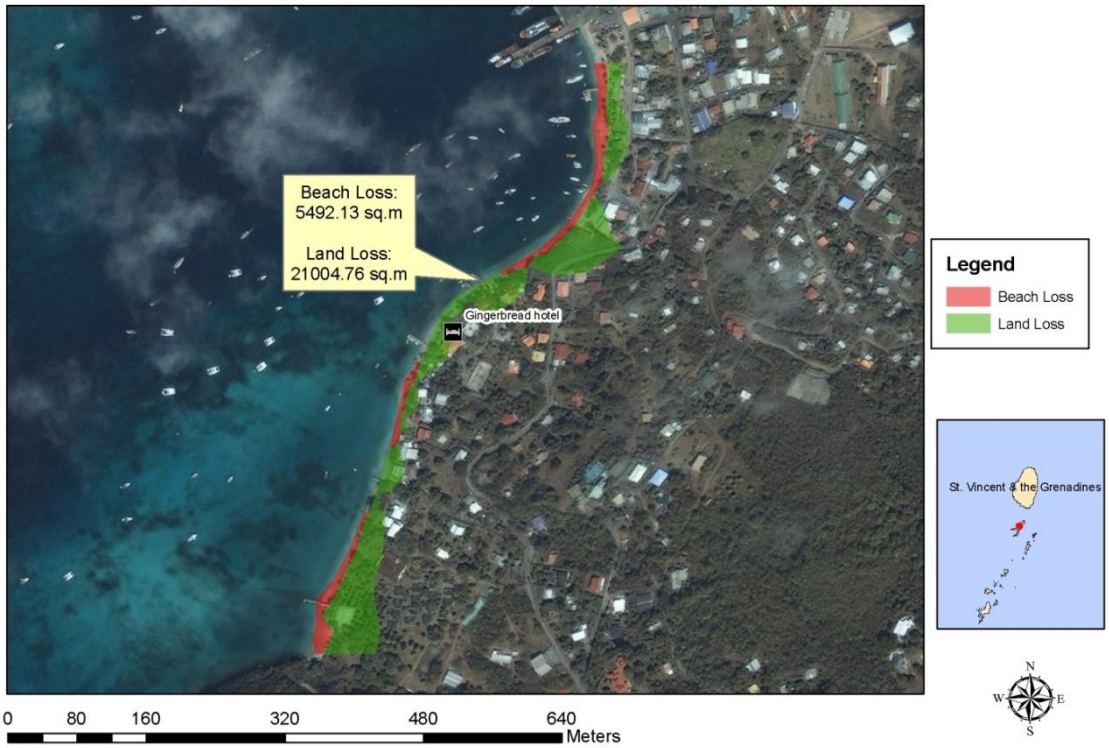

Figure 2: Land and beach loss at Belmont Walkway, Bequia

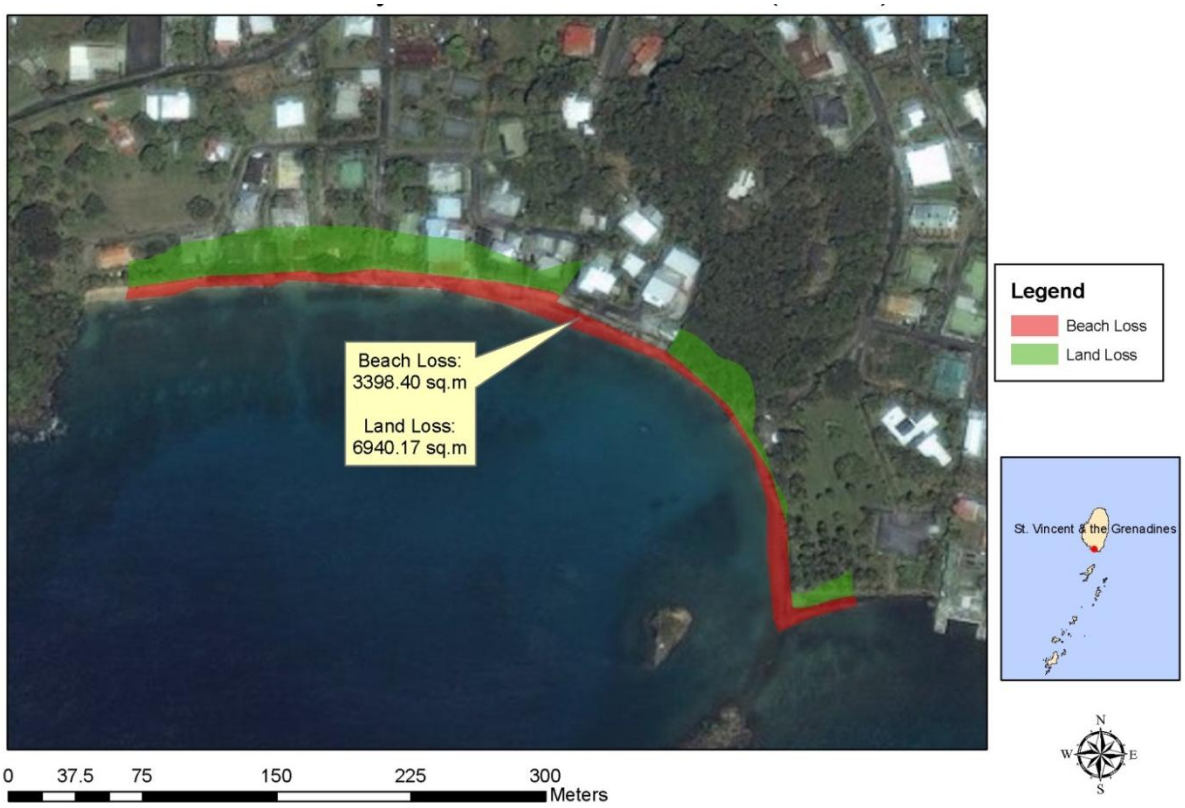

Figure 3: Land and beach loss at Indian Bay Beach, St. Vincent

This study therefore reinforces that serious, comprehensive and urgent action that addresses the challenges of adapting to SLR is needed in SVG. 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.

This study revealed the geographic areas that will be impacted by SLR, 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. Annual reductions in the contribution of tourism to SVG's GDP as a result of the reduced amenity value from beach loss is estimated to be between US $46 million by 2050 to US $174 million by 2080 for a mid-range SLR scenario. The cost of rebuilding the infrastructure in 2050 is estimated to be over US $134 million to rebuild major tourism resorts and an additional US $81 million to rebuild airports and US $54 million to rebuild ports[i]. As the CCCRA reveals, projected impacts from climate change involve much more than SLR impacts and therefore losses to national economies will also be greater than the figures mentioned.

This SLR work provides SVG with new, high resolution geospatial data of coastal areas and a quantification of the extent of SLR impacts projected for the islands. The involvement of staff from the National Parks, Rivers and Beach Authority in the coastal profile surveying has also contributed to capacity building in SVG with regard to coastal survey methodology and survey equipment.

COMMUNITY LIVELIHOODS, GENDER, POVERTY AND DEVELOPMENT

Figure 4: Residents create a vulnerability map of their community, Georgetown

More than 50 residents and workers in Georgetown (the capital city) participated in CARIBSAVE's research which included vulnerability mapping, focus-groups and household surveys which were developed according to a sustainable livelihoods framework. The activities aimed to provide understanding of: how the community livelihoods are dependent on the natural resources and how they have been affected by climate-related events; the community's adaptive capacity; the complex factors that influence their livelihood choices; and the differences in the vulnerability of men and women.

Community Characteristics and Experiences

Rivers and the land support a number of livelihoods in the community outside of public or private sector employment, mainly in agriculture and fisheries. Although tourism is relatively small-scale in the community, some residents work as craft-makers and vendors and are patronised by tourists.

Within the community, households are relatively small to moderate in size, although a few households are large. Access to most types of physical assets and social capital are moderate as well. However, there are gaps in other important areas. Household incomes, financial support and security and insurance coverage rates are fairly low. One-third of the households have food shortages, with a high dependence on an external food supply. These gaps limit a household's ability to sustain themselves under normal circumstances and will ultimately undermine its ability to respond to impacts of climate-related hazards.

Georgetown residents are generally aware of climate change and have already observed some changes in climate patterns, such as:

- An increase in atmospheric temperature, which has been one of the most distinct changes
- Hurricanes appear to be more intense
- Wet and dry seasons are no longer clearly defined
- More frequent sea swells and increased coastal erosion
- Pest and diseases are also more common, which have several implications for human health and agricultural production, respectively.

Given the coastal location of the community, residents are concerned that SLR and storm surge impacts pose a significant threat to livelihoods and property.

Three major events over a span of three years highlighted the vulnerability of the community to climate impacts and in 2009, there was a water shortage resulting from drought conditions. Many residents in Georgetown practice agriculture and farmers suffered losses from reduced crop production that year. Food prices rose and produce had to be imported from other islands to supplement the limited supply in St. Vincent.

Hurricane Tomas then affected the island at the beginning of November 2010, bringing heavy rains and high winds which caused flooding, loss and destruction to several buildings, agricultural plots, livestock and the natural landscape. Persons were displaced from their homes. The impact of the hurricane on the community was exacerbated because most residents did not initially expect the system to affect the country and failed to prepare adequately. Before most residents recovered fully from the impact of Hurricane Tomas, a severe flash flood occurred in April 2011. The flood damaged homes and water pipes. Georgetown was without a piped water supply for about one month. Consequently rainwater harvesting is now commonplace is some households, but needs to be further promoted and integrated in the community, perhaps with appropriate financial assistance mechanisms.

Figure 5: Debris from flood washed onto a beach in Georgetown as a result of torrential rains, April 2011

Based on previous experiences, the impact of extreme events is greater on women in some ways, especially in relation to public shelter situations and household responsibilities. The absence of a piped water supply following Hurricane Tomas and the April, 2011 flood also affected women significantly, as they are the primary care givers of households and are responsible for domestic duties which require water (washing, food preparation). Female headed households in the community are generally more disadvantaged than male headed households. They are more likely to be earning lower incomes, have lower financial security, insurance coverage (no female headed household surveyed had home insurance) and ownership/access to assets. Consequently, there are also greater implications for female headed households in terms of adaptive capacity.

In Georgetown, the psychological impacts of disasters are very evident, especially in men. Some men are unable to manage the burden of recovering and providing for their family or families. Men who have responsibility for their families felt a greater strain than those who did not and suffered a weakened sense of pride when they were unable to fulfil their duties. It has been reported that as a result they resort to heavy drinking and becoming intoxicated. The flash flood also affected older persons more seriously than younger ones, as they also found it harder to recover.

In the face of climate change and the threat that it poses to Caribbean societies and economies, the comprehensive integration of poverty, gender and livelihood issues into climate change impact and vulnerability assessment and planning processes is essential to developing community-specific adaptation strategies. Achieving this, in part requires attention to the underlying power relations and gender equalities and the evaluation of the differing and potentially inequitable access which men and women have to economic, ecological, social and human resources, institutions, governance and infrastructure.

Notwithstanding the threat of climate change, careless human activities (dumping, deforestation) also increase the community's vulnerability to climate impacts. Illegal dumping, burning of waste, deforestation have contributed to erosion and pollution in the community. When drains are clogged with excessive solid waste, flooding is significantly exacerbated and this was blamed in part for contributing to the severity of the April 2011 flood event. More prudence in solid waste disposal is needed to reduce the impact of flooding. Drains and water courses also need to be cleared regularly (moreso during the wet season) to

ensure that drainage is most effective during severe weather. Community residents should consider organising a group and designating time at regular intervals to clear drainage channels.

Complacency is also considered major issue. Some residents do not take enough precautions or prepare adequately when a storm approaches, mainly because up until recently, severe weather impacts have been infrequent. Disaster education and response training activities are needed in the area to engender more proactive attitudes towards storm preparation and hazard mitigation; more important within the younger generations of the community who have little experience with severe weather impacts.

AGRICULTURE AND FOOD SECURITY

Agriculture is one of the major economic activities on St. Vincent and is based largely on banana production, with additional output of arrowroot, sweet potatoes, eddoes, tannias, yams and coconuts. In recent years the erosion of preferential trade agreements and increased competition in the EU banana market have led to declining exports and income. The reliance on just one crop and the small-scale of the farms leaves the sector economically vulnerable.

Figure 6: Banana farming in St. Vincent

Uncontrolled agricultural intensification, poor agricultural practices and inappropriate land use contribute to the vulnerability of the sector through soil erosion and land degradation. When combined with the current trend of converting prime agricultural lands to other uses, agricultural capacity and national food security is threatened. The gap between agricultural exports and imports has been widening making SVG vulnerable as a net food importing country. In 2007, the value of agricultural exports was EC $46.9 million compared to an estimated import bill of EC $157.5 million. In 2008, exports declined to EC $35.8 million while the food import bill increased to EC $198.5 million.

In the Grenadines, geological and environmental conditions prevent much involvement in agriculture. However, small ruminants and marine fisheries make additional, significant contributions to the economy, food security and employment. Although the contribution of agriculture to the GDP has declined from 21.2% in 1990 to 9.6% in 2006, the industry employs more than 40% of the workforce. This decline in agricultural production is a contributing factor in the increasing unemployment situation in the country and as young people migrate to urban areas the available labour for farming in rural areas is depleted. A community-based "*Youth in Agriculture*" project involving young people between the ages of 15 to 25 to help them learn about agriculture through practical work cultivating and harvesting crops using basic low cost technologies would help to promote agriculture as a viable livelihood.

St. Vincent's agricultural sector is high vulnerability to the existing climate, especially extended periods of drought, unevenly distributed rainfall and natural disasters. During the second week of April 2011 heavy rainfall caused rivers to overflow and landslides in the north-eastern section of Saint Vincent in a major agricultural area. This occurred while the sector was still recovering from damages totalling EC $35 million in 2010 caused by hurricane Tomas (primarily in banana and plantain production). Small farmers typically have little or no insurance and are ill-equipped to deal with the impacts of climate change. A programme to build Vincentian farmers' capacity to grow produce using good agricultural practices and to introduce

them to new technologies that will improve the quality and yield of their crops under existing pedoclimatic conditions and future climate would be of great benefit.

ENERGY AND TOURISM

Current tourism related energy use and associated emissions in SVG are estimated to be the equivalent of 81% of estimated national emissions of CO_2, though there are uncertainties regarding current national emissions. SVG is emitting considerably less CO_2 than the global annual average of 4.3 t CO_2 per capita (1.7 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 (34%), cruise ships (28%) and accommodation (22%) were identified as the major direct consumers of energy and emissions in the tourism sector.

Figure 7: St. Vincent Electricity Services Limited – Hydrometric Network

Source: www.stewartengineeringsvg.com

St. Vincent and the Grenadines is largely dependent on imported fossil fuels for power, with just 5% of consumption provided by hydropower (5.7 MW) which is located entirely on St. Vincent at 3 separate locations and consumption has increased by 40% in just 6 years. Most of the capacity is located on St. Vincent with additional diesel-powered units on Bequia, Union Island, Canouan and Mayreau. The other Grenadines islands are supplied by privately owned electricity systems on the basis of diesel plants. Most of the generators are old and inefficient.

A National Energy Policy and Plan that cover planning and management, the power sector, renewable energy, the petroleum sector, the transport sector and energy efficiency have been developed. Even tough very little direct action is proposed for the tourism sector other than highlighting the benefit of investing in renewable energy in smaller, remote islands with high dependency on tourism, the majority of actions put forward are equally applicable to tourism facilities or will impact tourism facilities. Implementing the Energy Policy and Action Plan should be a high priority.

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 Tomas resulted in an island-wide power outage in SVG due to broken lines, fallen trees and damaged poles. 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. For example hydro-power facilities can be impacted by reduced flows in periods of drought.

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 SVG highly vulnerable. A one year period of government price regulation in SVG cost EC $6 million and in 2008 almost 17% of GDP was spent on imported fossil fuels. 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 SVG. In SVG, a fuel surcharge is already applied to electricity consumption per kWh, which varies monthly depending on fuel costs and a number of incentives and tax schemes have been identified for further consideration to encourage energy efficiency and use of renewable energy. 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 and 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. St. Vincent and the Grenadines has recently witnessed a massive decline in arrivals, so considerable effort should be focussed on marketing for longer stays in order to increase spending. Evidence from a case study in Barbados suggests that this is indeed feasible.

WATER QUALITY AND AVAILABILITY

The island of St. Vincent is generally not considered to be water-stressed, with average annual rainfall ranging from 1,500 mm on the coast to 3,800 mm in the central mountains[ii]; in the Grenadines, by contrast, average annual rainfall is lower at around 1000 mm and severe water shortages are experienced[iii]. The 13 watersheds on the island of St. Vincent, many of which are within forest reserves, generate most of the country's supply of fresh water (approximately 120 million m^3/yr of surface water), meeting the demands of the island's population and various sectors, including the generation of hydroelectricity[iv]. In the Grenadines, due to the small size of the islands, the drier climate and the absence of perennial steams, there is limited surface water and an adequate supply of water is highly dependent on the timely arrival of the rainy season[v]. A Sea Water Reverse Osmosis Desalination Plant with a Production Capacity of at least 5 Cubic Meter per Hour was recently installed in Paget Farms, Bequia. This has been operational since September 2011 and is one of the outputs of the Special Programme for Adaptation to Climate Change (SPACC) executed by the Caribbean Community Climate Change Centre. Previously, most residents collected water transported by barge from mainland St. Vincent.

During the period 2009-2010, the Caribbean experienced one of the most severe droughts in recent years. In St. Vincent and the Grenadines, the rains ceased in October 2009 and did not return until July 2010. Considered the worst drought to affect the country since 1987, the Central Water and Sewage Authority (CWSA) was required to shut off the water supply in some parts of the country at various times of the day

and activate emergency response teams. St. Vincent and the Grenadines has not devised a National Water Policy or Water Management Plan[vi] but there is a Draft Road Map toward Integrated Water Resources Management (IWRM) Planning for Union Island, St. Vincent and the Grenadines. The CWSA is the statutory body that oversees all aspects related to production of water and the provision of sewage services. The CWSA, St. Vincent Electricity Company (VINLEC) and the Ministry of Agriculture are the main water resource institutions. Co-ordination between these three entities had been found to be lacking[vii]. Furthermore, the CWSA faces financial and human resource constraints, as well as deficiencies in technical staff particularly water engineers[viii].

As part of the IWRM implementation, improved coordination will be a necessary starting point, along with the strengthening of institutional and legislative frameworks and development of a platform for collaboration across all stakeholder groups, especially government agencies. A working IWRM framework should enable SVG to better respond and adapt to changing rainfall patterns and make individuals more resilient to decreases in precipitation.

Although St. Vincent and the Grenadines lie to the south of the main hurricane storm track, the islands are occasionally impacted by tropical storms, hurricanes and heavy rainfall events. Most recently, heavy rainfall during April 11-12, 2011 caused rivers to overflow and landslides in the north-eastern section of St. Vincent. An assessment by the National Emergency Management Office (NEMO) revealed that the sectors which were most affected were water and agriculture. The potable water infrastructure in Georgetown was severely damaged, including the main catchments and pipes which deliver water to households, as well as the treatment and filtration plants. It is estimated that 20,000 persons depend on these catchments and pipes for their primary source of water[ix].

Accelerated sea level rise is expected to increase the likelihood of the inundation of low-lying coastal areas, increase the salinity of surface and ground water and result in higher water tables[iii].

The Country Poverty Assessment 2007/2008 noted that the cost of water parallels the cost in production however, other operational costs are met through subsidies. Although the water resources on St. Vincent adequately meet domestic consumption, competing uses have substantially reduced streamflow and aged or insufficient water infrastructure also contributes to the vulnerability of the water supply in SVG. Therefore, water infrastructure should be expanded to reduce vulnerability, particularly during drought events and after major storms and hurricanes. There is specific need for additional storage and treatment facilities, so viable options for SVG must be examined to allow for adequate access to water supply in all communities during all seasons. Additional public water supply networks are needed to reach areas, such as Bequia, where they do not currently exist. Maintenance of this infrastructure must be planned and budgeted for so that climate change impacts do not further hinder water supply in SVG.

SVG is highly dependent on surface water to meet its demand but this need not necessarily be the case, particularly on the island of St. Vincent where groundwater sources are not utilised. While the surface systems are reasonably well known, the groundwater resources have not been adequately studied and, while their true potential is not known, resources are expected to be adequate[x]. Aquifers act as large reservoirs of fresh water which reduce vulnerability during periods of drought. The status of aquifers should be assessed in St. Vincent and, if possible, developed to supplement the existing surface water resources.

COMPREHENSIVE NATURAL DISASTER MANAGEMENT

The natural hazards facing SVG are numerous and unpredictable, therefore investments in preparedness and capacity building have and will continue to improve the country's overall resistance and resilience to impacts when they do occur. 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. Historic development trends in SVG, given the limited availability of flat land, have resulted in the construction of homes, roads and public spaces in areas that are at risk to natural hazards. Development planning must also consider construction techniques and although National Building Code legislation has been passed the guiding regulations have yet to be fully adopted by practitioners. This must be remedied by integrating resilient practices into building designs and hiring building inspectors, in permanent positions, with the responsibility of reviewing all construction on the island.

During storms, the mountainous topography combined with construction on steep slopes creates a context where high winds and heavy rains have the potential to generate serious damages from flash flooding and slope destabilisation (e.g. landslides or mudslides). Hurricane Tomas in 2010 resulted in losses to the banana and plantain crops, damages to roofs and severe flooding that prompted 1,200 Vincentians to relocate to public shelters. Transportation routes, electricity and communication were impacted for extended periods and following the storm, emergency assistance funds were received from various governments, development banks and the Caribbean Catastrophe Risk Insurance Facility (CCRIF).

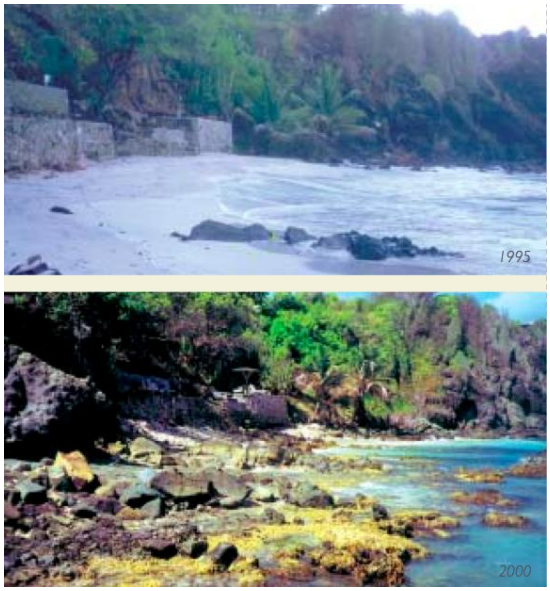

Figure 8: Beach profile of Honor Bay, Mustique before and after Hurricane Lenny

Source: http://www.unesco.org/csi/act/cosalc/vinb.pdf

The Meteorological Service issues warnings with information from the National Hurricane Center (NHC) in the United States of America and the Ministry of Agriculture maintains a system of stream gauges and meteorological stations on the island, but the system is not automated. This is a good start on an EWS, but it demands good cooperation and strong information sharing systems. The system for monitoring hydro-meteorological stations should be automated so that data can quickly be updated and the early warning system becomes more effective. In contrast, the seasonal nature of rainfall creates drought conditions, particularly in the Grenadines where rainwater harvesting is the primary source of water.

The most recent eruption of La Soufrière volcano was from April – June 1979. There was no permanent monitoring, but reports seem to indicate that there was a continuous strong steam emission from the crater and powerful vertical explosions that produced ash clouds reaching 8 km high[xi]. The largest pyroclastic flow that was observed descended the Larikai valley to the west of the crater and out to sea, while other pyroclastic flows followed the Wallibou and Rabacca river valleys. The populated areas of northern St Vincent were evacuated to the south as the eruption started and although impacts were generally limited to the island of St. Vincent, Barbados, which is 180 km east of St. Vincent, reported ash plumes on April 13 and 14[xii]. While there were no deaths reported as a direct result of the eruption, some traffic accidents occurred during evacuation and there were multiple reports of respiratory problems as a result of the ash. Major eruptions can impact global climate, however, there is no evidence that a changing

climate will cause volcanic eruptions. Seismic monitoring is done by the regional University of the West Indies Seismic Research Centre through the Soufrière Monitoring Unit located in the SVG Ministry of Agriculture. The monitoring unit should be automated so that data can be updated faster and therefore improve the efficiency of the early warning system. Hazard mapping has been done in SVG for volcanic risk and basic geographic information is available in a geographic information system (GIS) format. The next step is to improve the mapping coverage for other hazards so that environmental and land use planning can better identify and enforce areas of high risk.

National Emergency Management Office (NEMO) has responsibility for emergency management and preparedness in SVG and the system includes district disaster committees and 40 local community disaster committees that have received training in damage assessment, shelter management, relief supplies management, first aid and related activities. This provides a strong basis for disaster management, especially when coupled with the regular public awareness campaigns issued by NEMO and the Prime Minister. Many technologies have been employed in education and awareness building in schools and for the general public.

However, the current national curriculum is deficient on climate change and disaster risk reduction and teachers require better training and text books with Caribbean specific information[xiii]. An interactive and innovative community education and capacity building initiative designed to reach all levels of Vincentian society would enable individuals to manage their own risk levels and also build resilience to natural hazard events. Also, capacity building and technical training programmes for NEMO employees are still required so that the current technical deficiencies can be remedied and skills gained. Also,

The recent Strategic Programme for Climate Resilience (SPCR) proposed work in many areas where climate change adaptation and disaster risk management overlap. Of particular importance to management activities is the issue of technical training and information management. Civil Servants in various government ministries participated in a training workshop with NEMO in 2011 in order to promote collaboration of the comprehensive disaster management (CDM) strategies within the country. The SPCR also led to a project that will create information packages for families and communities in the "Red Zone" and will take an "all hazards" approach to community-based disaster risk reduction, delivering talks, leader training and advocacy training, for those living in high risk areas[xiii].

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, sea-level rise and natural disasters; indirect effects are associated with changes in ecosystems 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.

The health sector was not specifically mentioned in the Initial National Communication to the UNFCCC, but one recommended adaptation measure recognises the need for “An expansion of the country’s environmental education programme that speaks to climate change, vulnerability, sustainability, human health and safety” and “The strengthening and equipping of the local vector-control unit to respond to expanding insect populations and the emergence or re-emergence of vector-borne diseases”[iii].

Vector borne diseases that threaten the health sector include dengue, leptospirosis and infrequent cases of malaria. It has been shown that dengue fever transmission is altered by increases in temperature and rainfall. In SVG, there were 37 cases per year for the last decade with 58% of cases occurring in 2010. This may be due to either drought conditions between October 2009 and January 2010 or episodes of high precipitation such as severe floods in April 2010 or Hurricane Tomas in October 2010. Definitive statements can only be made with monthly data.

Leptospirosis is endemic with poor disposal habits and improper disposal infrastructure contributing to conditions that encourage the proliferation of rats in the country. It is recommended that the Wolrd Health Organisation (WHO) Integrated Vector Management Programme be adopted and further research undertaken that links the epidemiology of diseases with climate data in SVG. This research must be based on improved, peer reviewed data potentially collected and disseminated through a Caribbean data information centre or Clearing House that includes temporal, environmental and climatological 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.

A lack of potable water supply and adequate sanitation facilities can result in the spread of a number of diseases and in SVG these include dengue, malaria, cholera and leptospirosis. Diarrheal diseases (e.g. salmonellosis, shigellosis and campylobacterosis) and gastroenteritis are also diseases of importance due to the high number of cases and the economic and social burden to the country. Over one third of the population in the Grenadines do not have access to continuously supplied public water and almost 30% of the population of SVG are using either pit-latrines, ventilated pit latrines or have no sanitation facilities. Improved water storage and sanitation infrastructure must therefore be prioritised. An early disease warning system could also be established so that people can take the necessary precautions in their day-to-day activities.

Dry spells can affect air quality and increase diseases like acute respiratory infections, influenza-like illnesses and asthma which are quite common among residents of SVG, but there has been a decline in reported cases of acute respiratory infections in the last decade. The climate related impacts on the agricultural sector as well as invasive pests have affected productivity which in turn could affect the availability and cost of food. In SVG the prevalence of babies being born underweight and under-nutrition in children less than five years of age is 5.7%[viii]. This situation combined with the lower percentage expenditure on the health sector contributes to the vulnerability of the population. Emergency services only exist in St. Vincent; patients from the Grenadines Islands must be flown or shipped to St. Vincent for emergency treatment and some services are not even offered in St. Vincent and must therefore be sought abroad. It has been suggested that a more business-like approach be taken which includes considerations for health insurance[viii]. The main challenges to addressing climate change impacts on the health sector of SVG are the lack of financial and technical resources with staff shortages in the sector partially filled by Cuban medical practitioners.

MARINE AND TERRESTRIAL BIODIVERSITY AND FISHERIES

The islands of St Vincent and the Grenadines are home to globally important biodiversity and ecosystems including the Central Mountain Range, which represents one of the largest remaining tracts of wet forest in the Lesser Antilles and one of the few forests that maintains a full altitudinal corridor from sea level to 1,200 meters. The islands of the Grenadines encompass a large area of biologically diverse marine and terrestrial habitats, with extensive coral formations and important fisheries.

The impacts of climate change are likely to exacerbate the damage caused by existing anthropogenic impacts, such as deforestation, poor land-use practices, sedimentation, coastal pollution and over-fishing. Improving the management of biodiversity and fisheries will become increasingly important to the welfare of Vincentians and to the sustainability of the country's main economic activities – fishing, tourism and agriculture.

Figure 9: Pristine white sand on the west coast of Union Island

Source: O. Day, 2007

Beaches and mangroves are particularly vulnerable to SLR and more intense storms and coral reefs are at risk from more frequent bleaching events, increasing coastal siltation and sedimentation. In the small islands of the Grenadines, protecting fisheries will be important for maintaining healthy populations of herbivores and hence the resilience of coral reefs, as well as for safeguarding the sustainability of artisanal fisheries.

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 ecosystems 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). They should also explain the importance of preserving and managing ecosystem services in order to protect the livelihoods of communities.

In keeping with SVG's commitment to expand protected areas and its participation in The OECS Sustainable Financing and Management of Eastern Caribbean Marine Ecosystems Project, 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.

Reforestation of the mangrove stands will improve the size and health of fish nurseries thus benefitting both the resilience of coastal ecosystems and the livelihoods of those engaged in marine-based activities. Proposed MPAs will benefit from the presence of mangrove trees, which filter pollutants, stabilise sediments and provide important habitat to juvenile fish and crustaceans. However, reforestation projects

will not be effective if development projects are allowed to continue removing and damaging mangrove stands. Restoration efforts would be particularly relevant to the mangrove stands in Union Island where recent developments have caused extensive damage to existing mangroves.

The projected increase in temperature and decrease in precipitation could have dramatic consequences for the forests and overall biodiversity of SVG. Reduced moisture will result in forests becoming much drier, potentially causing the wilting and death of epiphytes, which provide important habitat for birds, insects and reptiles. The Central Mountain Range includes large areas above 1,000 m and grows a type of vegetation classified as cloud montane forest that requires almost continual cloud coverage and is therefore most vulnerable to climate change. The projected warming could result in a displacement of cloud forests into progressively smaller regions at the tops of mountains ultimately resulting in complete loss if vertical migration is not possible. The increasing intensity of hurricanes is causing more severe damage and potentially longer-term consequences for the integrity of the forest structure and canopy.

Although SVG is a signatory to several Multilateral Environmental Agreements and has developed national legislation for the management of natural resources, the laws need updating and harmonising. Component 3 of the newly developed Pilot Project for Climate Resilience (PPCR) addresses strengthening the policy, legal and institutional framework of SVG for climate change and includes a range of proposed activities. Of particular relevance is the "revamping of the land use or spatial planning legislation in the Caribbean to incorporate climate change resilience and the development of new land codes/practices and guidelines"[xiv].

Various departments and divisions share responsibility for coastal zone management, natural resource management, biodiversity and physical infrastructure, often leading to a lack of coordination and integration and therefore inefficient management. A lack of human, technical and financial resources also limits effectiveness in the public sector of SVG. Strengthening the capacity to manage the network of protected areas must be seen as a priority for the long-term protection of the nation's biodiversity, especially the important mountain forest reserves on St Vincent and marine protected areas in the Grenadines.

The education sector was identified as one of four specific areas that are high priorities for intervention under Component 2 of the Strategic Programme for Climate Resilience (SPCR). 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.

The government recognises the deficiencies and has recommended that a Geographical Information System (GIS) database for biodiversity information be created to improve the effectiveness of biodiversity management, however, progress has been limited. The Grenadines Marine Resource Space-use Information System (MarSIS) project has compiled information on marine space-use on the Grenada Bank that can be used to identify areas for special management attention, and other more localised inventories and assessments have been undertaken either as a single event or on a more regular basis, such as inventories in the Tobago Cays Marine Park and bi-annual Parrot Census by the Forestry Division.

CONCLUSION

Recent and future changes in climate in St. Vincent and the Grenadines 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.

SVG 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 increase in intensity preparedness for disasters (e.g. flooding or drought) and climate change adaptation become common goals.

It is clear that the Government and people of SVG are aware of climate change, as evidenced by some policy responses and planned actions, particularly the SPCR. However, resource users with little or no awareness of alternative courses of action, continue to degrade or over-extract from marine and terrestrial ecosystems including groundwater aquifers, in an effort to sustain themselves or even for recreation. Poorly planned land development and population expansion degrades habitats and introduces pollutants into the environment, thereby decreasing the resilience of plant and animal species and increasing the risk of damages from flooding. Climate change driven impacts will pose even greater threats to ecosystems and populations in SVG as SLR, increased intensity of extreme weather events, oceanic and atmospheric temperature increases and altered patterns of precipitation interfere with their functions and livelihoods.

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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 St. Vincent and the Grenadines 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 St. Vincent and the Grenadines.

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