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 Saint Lucia

Summary Document

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THE CARIBSAVE CLIMATE CHANGE RISK ATLAS (CCCRA) PROJECT

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 SAINT LUCIA

Saint Lucia is already experiencing some of the effects of climate variability and change through damages from severe weather systems and other extreme events, as well as more subtle changes in temperatures and rainfall patterns.

Detailed climate modelling projections for Saint Lucia 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 extensively assessed. Primary data were collected and analysed to:

1. assess the vulnerability of the livelihoods of community residents in the Soufriere area to climate change; and
2. project sea level rise and storm surge impacts on Pigeon Island, Pigeon Causeway, Rodney Bay and Soufrière.

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

- With its many unique attractions, Soufrière is the "tourism capital" of Saint Lucia. However, it has one of the highest poverty rates in the country.
- After Hurricane Tomas, the cost of ground provisions, plantains and green bananas became very high, resulting in a shift in diets as people began to rely on rice and flour as staples.
- The cycle of poverty and vulnerability to climate change is very apparent in Soufrière.
- Adaptation interventions must also address poverty.

Vulnerable coastlines

- The areas of Pigeon Island, Pigeon Causeway, Rodney Bay and Soufrière have been identified as some of the most vulnerable to SLR and include notable resorts, ports and an airport that all lie within less than 6 m above sea level.
- 1 m SLR places 7% of the major tourism properties at risk, along with 50% of airports and 100% of the ports.
- 2 m SLR places 10% of major tourism resorts at risk.

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 SAINT LUCIA

The projections of *temperature, precipitation, sea surface temperatures;* and *tropical storms and hurricanes* for Saint Lucia 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 Saint Lucia

Temperature: Regional Climate Models (RCMs) indicate increases ranging from 2.4˚C and 3.3˚C by the 2080s in higher emissions scenarios.

Precipitation: General Circulation Models (GCMs) indicate overall decreases in annual rainfall of -37 to +7 mm by 2080, with RCMs are indicating decreases between -11% and -32%.

Sea Surface Temperatures (SST): GCM project annual mean SST increases of +0.8 to 3˚C by 2080s.

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

Much of the coastal zone of Saint Lucia is characterised by high-density tourism and these areas already face pressure from natural forces (i.e. wind, waves, tides and currents) and human activities (i.e. beach sand removal and inappropriate construction of shoreline structures). Saint Lucia's beaches have been monitored since 1995 by the Fisheries Department, who measure the beach slope and width at regular intervals at numerous sites around the island. Beaches change from season to season and from year to year, but the underlying trend in many locations has been a loss of beaches due to accelerated erosion. The impacts of climate change, in particular SLR, will magnify these pressures and accelerate coastal erosion.

Figure 1: High Resolution Coastal Profile Surveying with GPS

The CARIBSAVE Partnership coordinated a field research team with members from the University of Waterloo (Canada) and the staff from the Ministry of Physical Development, Environment and Housing to complete detailed coastal profile surveying.

The areas of Pigeon Island, Pigeon Causeway, Rodney Bay and Soufrière have been identified as some of the most vulnerable to SLR and include notable resorts, ports and an airport that all lie within less than 6 m above sea level. Results of the surveys indicate that 1 m SLR places 7% of the major tourism properties at risk, along with 50% of airports and 100% of the ports in Saint Lucia. With a 2 m SLR, 10% of major tourism resorts will be impacted. Critical beach assets would be affected much earlier than the SLR-induced erosion damages to

tourism infrastructure; indeed, once erosion is damaging tourism infrastructure, it means the beach, a vital tourism asset, has essentially disappeared! With 100 m of erosion, 30% of the major tourism resorts would be impacted and 53% of sea turtle nesting sites, a key tourism attraction, would be impacted.

The high resolution imagery provided by the techniques utilised in this project component is essential to assess the vulnerability of infrastructure and settlements to future SLR, but its ability to identify individual properties also makes it a very powerful risk communication tool. Having this information available for community / resort level dialogue on potential adaptation strategies is highly valuable. Results for the popular Sandals Grande resort area found that a 3.5 m flood scenario resulted in a total loss of more than 17,690 m^2 of beach area and an additional loss of 10,650 m^2 of land area (See Figure 2).

Figure 2: Total Land Loss, Sandals Grande, Saint Lucia

Similar results were found for The Landings resort in Rodney Bay and a 3.5 m flood scenario resulted in a total loss of more than 15,020 m^2 of beach area and an additional loss of 29,066 m^2 of land area (See Figure 3).

Figure 3: Sea Level Rise Vulnerability at The Landings in Rodney Bay

Table 1 identifies what tourism infrastructure would be at risk of inundation from a 0.5 and 1 m SLR scenario and to erosion of 50 and 100 m. These results highlight that some tourism infrastructure is more vulnerable than others. A 1 m SLR places 7% of the major tourism properties at risk, with 10% at risk with a 2 m SLR.

Table 1: Impacts Associated with 1 m and 2 m SLR and 50 m and 100 m Beach Erosion in Saint Lucia

		Tourism Attractions		Transportation Infrastructure		
		Major Tourism Resorts	Sea Turtle Nesting Sites	Airport Lands	Road Networks	Seaport Lands
SLR	1.0 m	7%	6%	50%	0%	100%
	2.0 m	10%	10%	50%	0%	100%
Erosion	50 m	2%	30%	-	-	-
	100 m	30%	53%	-	-	-

Even under a 0.5 m SLR, 90% of the highly valued beach at The Landings on Rodney Bay would be inundated, as would 52% of the beach at Sandals Grande in Rodney Bay. The response of tourists to such a diminished beach area remains an important question for future research; however local tourism operators perceive that these beach areas along with the prevailing climate are the island's main tourism attractions.

Based on a mid-range scenario, Saint Lucia will incur annual losses between US $41 million in 2050 to over US $144 million in 2080. Capital costs are also high, with rebuild costs for tourist resorts damaged and inundated by SLR amounting to over US $134 million in 2050 up to US $315 million in 2080. Infrastructure critical to the tourism sector will also be impacted by SLR resulting in capital costs to rebuild an airport estimated to be between US $42 million by 2050 to US $98 million by 2080. Capital costs to rebuild ports are estimated to be between $57 million in 2050, to $132 million by 2080.

Adaptations to minimise vulnerabilities in Saint Lucia will require revisions to development plans and investment decisions especially since there are currently no institutional frameworks that require setbacks, nor that state what types of developments are permissible along particular areas of the coast. These considerations must be based on the best available information regarding the specific coastal infrastructure and eco-system resources along the coast, in addition to the resulting economic and non-market impacts.

Hard engineering structures such as dikes, levees, revetments and sea walls, can be used to protect the land and related infrastructure from the sea. This is done to ensure that existing land uses, such as tourism, continue to operate despite changes in the surface level of the sea. However, it is important to consider that, the capital investment needed for engineered protection is expensive.

When hard engineering is not possible or feasible, soft engineering methods which require naturally formed materials to control and redirect erosion processes should be considered. For example beaches, wetlands and dunes have natural buffering capacity which can help reduce the adverse impacts of SLR and storm surge. Through beach nourishment and wetland renewal programmes, the natural resilience of vulnerable areas against SLR impacts can be enhanced. Moreover, these adaptation approaches can simultaneously allow for natural coastal features to migrate inland, thereby minimising the environmental impacts that can occur with hard engineering protection.

The Government of Saint Lucia, through its continued commitment towards sustainable development and climate change adaptation, is working towards the development and implementation of the necessary mechanisms required for achieving sustainable development and climate resilience on the island. A key policy undertaken is the Saint Lucia National Climate Change Policy and Adaptation Policy and Plan, recognising the island's vulnerability to climate change and global warming, especially with regard to SLR. This policy aims to "foster and guide a national process of addressing the short, medium and long term effects of climate change in a coordinated, holistic and participatory manner"[i]. Consistent with this policy, SLR should be integrated in the design of all new coastal structures and the adaptive capacity of the tourism sector should be assessed so that specific interventions at the facility level can be implemented.

COMMUNITY LIVELIHOODS, GENDER, POVERTY AND DEVELOPMENT

More than 50 residents and workers from the town of Soufrière and surrounding communities [1](in the District of Soufrière) on the west coast of Saint Lucia 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

[1] In this report these areas are collectively referred to as "The community" or "The Soufrière community".

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.

Fishing and agriculture are significant contributors to the local economy and livelihoods of Soufrière residents but tourism is the mainstay of the district, employing the majority of the residents directly and indirectly (See Table 2).

Table 2: Natural Resources and Uses/Livelihoods in Soufrière, Saint Lucia

RESOURCE	USE / LIVELIHOOD
Land	Farming/Agriculture
Waterfalls	Tours, Hikes } (both locals and tourists)
Forests	Trails for hiking, Tours } (both locals and tourists)
Marine Biodiversity	Fisheries

Some of the main attractions include the Sulphur Springs and geothermal system, the Pitons and the Diamond waterfall, therefore branding Soufrière as the "tourism capital" of Saint Lucia. However, despite its prosperity in tourism, a recent report found that, between 2005 and 2006, Soufrière had one of the highest poverty rates in the country (42.5%).

Community Characteristics and Experiences

The community has some degree of awareness of climate change, although knowledge of concepts, details and perceptions of risks and impacts vary widely. Observations from community members include:

- the lack of distinction between the wet and dry seasons;
- fewer numbers in certain species of fauna;
- mangoes coming into season earlier than they did in the past, whereas citrus trees bear fruits later than normal; and
- coral bleaching.

Figure 4: Community residents creating a vulnerability map of Soufriere

The vulnerability of the community and the urgent need to improve adaptive capacity to climate change was no more evident than after Hurricane Tomas. In Saint Lucia, the district of Soufrière suffered the greatest losses and damage to housing stock, forests, agricultural holdings and marine fisheries resources; thereby affecting the livelihoods and well-being of residents who rely heavily on these resources.

The majority of farmers in Soufrière are male, so they were directly impacted by the damages to their farmlands. Women use streams and rivers for washing and obtaining water, but immediately after

the storm, rivers were unsuitable for these uses. Many employed in tourism were also heavily impacted, since most of the tourism facilities were not operational for some time after the event. Community residents are now far more vigilant about extreme climate events compared to the laid-back approach that was taken in the past when warnings were issued. However, despite this, economic force some persons to continue practices that essentially place themselves and the community in danger, such as undermining the natural resource base that provide eco-system services in order to save money (e.g. cutting down trees to make coal as an alternative to gas, sand mining to build less sturdy houses instead of concrete). The viscous cycle of poverty and vulnerability is apparent as is the need for: awareness and education on linkages between eco-system health and disasters; and capacity building for alternative livelihoods.

It is important to note that some pre-existing conditions in the area contributed to the extent of the hurricane damage. Lack of proper drainage, which is a chronic issue, was indicated as an exacerbating factor for flooding and damage to roads – some of which ultimately collapsed. Following Hurricane Tomas, some roads were repaired temporarily to make them usable, however, residents remain concerned that unless the drainage issue is addressed, flooding will continue to affect the area and roads will be repeatedly damaged. Additionally, the cost of food (especially ground provisions, plantains and green bananas) became very high after the hurricane, resulting in a shift in diets as people began to rely on rice and flour as staples.

Given the extent of the damage to crops, the Ministry of Agriculture assisted farmers by providing subsidies and small grants (average EC $1,000) to help them to replant and to cover personal expenses. The international aid community was also strongly acknowledged for their rapid response to assist the country as a whole but for residents of Soufrière, non-governmental organisations, family and friends came to their aid and contributed to community recovery efforts.

Community-specific adaptation responses are important if they are to be successful and understanding the demographics of a community contributes greatly to determining the most suitable interventions. Our research shows that, on average, more men (56%) are the heads of their households when compared to women. However, more females are the heads of single-parent households (poor and non-poor) and poor women in particular have generally been found to bear more children than other more financially stable women. Men in general and male-headed households also have greater reserves and levels of support than women and female-headed households, apparently placing women (and the children they look after) at a clearly higher level of vulnerability. Despite this, women take the lead and are more involved in activities in the interest of community development.

With the regard to the aftermath of hurricane Tomas, women perceived their own experiences to be far more difficult than for the men. Some women and single mothers reportedly lost homes and many or all their possessions and mothers were unable to adequately provide for their children's school and home needs after the hurricane. One resident said: "*the women had to send the children back to school, so it was kind of hard, getting books, getting uniforms*".

Men, on the other hand, believe that they are the more vulnerable gender with regards to climate change impacts since the majority of farmers in Soufrière (and Saint Lucia on a whole) are male, so they were directly and severely impacted by the damages to their farmlands. An entrenched community norm is such that if a man is unable to support his family he is looked down upon. So affected farmers resorted to other means to cope by planting more short term crops while others sought employment elsewhere (e.g. as security guards).

With agriculture as a main activity and the repeated occurrences of flooding, landuse planning and watershed management (in particular the protection of water catchments) should be priorities for Soufrière. It is also important to conduct hazard assessments for the area as this should inform landuse planning to avoid development in vulnerable areas. Assessments should of course be participatory in nature and involve community members who could share invaluable information and garner wider support. An important factor which makes residents in Soufrière so vulnerable is poverty. As such, economic development in this area should be promoted and facilitated. This also addresses the problem of increasing urbanisation. Community members shared their concerns relating to the economic prospects for people living in rural areas and have identified the following as hindrances to their development. As such, interventions should seek to address these areas.

- Lack of access to markets for agricultural products
- Lack of access to technology for improved agricultural practices
- Lack of access to resources for purchasing land and technology

Additionally, the use of fruit trees instead of mahogany trees (which are currently used) for reforestation programmes will have the added benefit of supplying a source of food for subsistence and for sale. This could also support food processing enterprises and provide employment opportunities for community members, in which case, the capability for food processing should be explored. Overall the residents in Soufrière are fully aware of their vulnerabilities and desperately need them to be addressed. However it is unlikely that they can do this on their own at this time.

AGRICULTURE AND FOOD SECURITY

Traditionally, the agricultural sector in Saint Lucia was heavily dependent on banana cultivation, which has been in a state of steady decline due to rising competition. This has serious implications for national food security because historically, the banana trade financed food imports and provided rural households with a steady source of income. Despite its contraction over the years, banana production remains central to the sector, occupying 48% of all cultivated land and accounting for 41.4% of gross agricultural output.

The agricultural sector exhibits high sensitivity to climate and is susceptible to extended periods of drought, unevenly distributed rainfall and natural disasters. The implications of climate change suggest worsening soil conditions, soil erosion and land degradation from flooding; and potentially increased crop loss due to high temperatures and changing rainfall patterns. Uncontrolled agricultural intensification, poor agricultural practices and the current trend of converting prime agricultural lands to other uses, exacerbate the vulnerability of this sector.

The prevalence of small-scale agriculture in Saint Lucia and the large number of ex-banana farmers who have limited experience in viable agricultural diversification hinders national efforts to adapt to

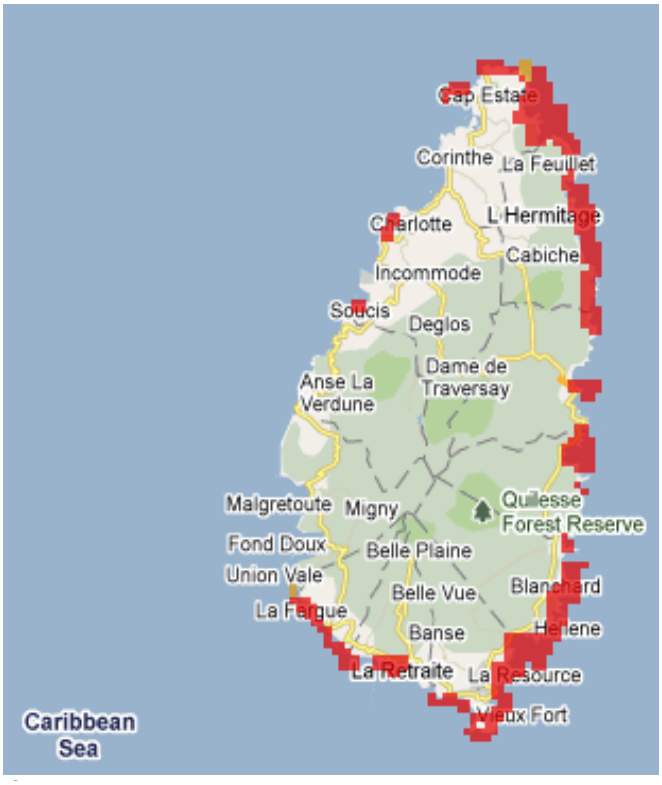

Figure 5: Areas of Over Fishing in Saint Lucia
(Source: IUCN and UNEP. 2009)

environmental and climatic changes. Further, unlike most other Caribbean countries, Saint Lucia is recording a growing interest in very young and female farmers. However, there has been a marked decrease in able-bodied farmers between the ages of 20 to 34 years.

The social vulnerability of agricultural communities in Saint Lucia was dramatically exposed with the passing of Hurricane Tomas in October 2010. The event demonstrated that rural families in Saint Lucia are in fact largely vulnerable to extreme weather events. The United Nations Economic Commission for Latin America and the Caribbean (ECLAC) assessment of the damage and losses caused by Hurricane Tomas also suggests that women who are responsible for their households are at a distinct disadvantage because they are unable to earn an income or meet their family's food needs by subsistence farming after such an episode. Many women lost crops and land through land slippage and others lost their shops and the goods in them with the passage of the hurricane. Male farmers were also unable to farm in the weeks after the hurricane as their land was washed away, or they had no access to their farm lands because of blocked roads and damaged forest trails. These implications for the different genders are consistent with the findings in the CARIBSAVE community vulnerability and adaptive capacity assessment in Soufrière.

A review of the agricultural policies in Saint Lucia shows that the major provisions for the sector focus on agricultural diversification, enhancing food security and promoting competitiveness and do not specifically address climate change. It is also evident that farm level adaptive capacity for addressing climate change impacts is severely limited. A recent study found that farmers are mostly unaware of the type of soil of their farms, with a large share having no access to sustainable crop alternatives or to current agricultural technology. Saint Lucian farmers are therefore in dire need of climate change sensitisation and adaptation training to improve and increase agricultural outputs. Delivery of training courses should be farm-based, practical and should target organised groups such as female farmers, youth and farmers' associations based in agricultural districts. The Caribbean Agricultural Research and Development Institute (CARDI) has endorsed the Sloping Agricultural Land Technology (SALT) to control soil erosion in agricultural areas, help to restore soil structure and fertility and increase efficiency in food crop production. Training in such an area would be of great benefit to farmers in Saint Lucia.

ENERGY AND TOURISM

In the case of Saint Lucia, per capita emissions are currently considerably less than the global average (3.2 t CO_2 compared to 4.3 t CO_2). However, tourism is an increasingly significant sector in energy use and emissions of greenhouse gases in the Caribbean and estimates of current tourism related energy use in Saint Lucia put emissions at almost 70% of national emissions because tourism is a mainstay of the economy. Energy consumption in Saint Lucia has grown alongside economic and tourism growth, with diesel consumption increasing by 68% between 2002 and 2010 and aviation fuel use increasing by over 300% in the same period. Within the tourism sector, estimates show aviation (56%) and accommodation (20%) to be the biggest contributors to CO_2 emissions.

Since Saint Lucia currently depends almost entirely on fossil fuels for energy production, the potential physical climate change impacts on traditional energy systems are of critical concern. Impacts on the proposed renewable energy infrastructure should be also considered. The omission of these considerations in the current system means that the vulnerability of the energy sector remains a worry that is likely to have negative physical and financial impacts for the country.

An increase in the intensity of severe low pressure systems, such as hurricanes, has the potential to affect both traditional and renewable energy production and distribution infrastructure, including generating

plants, transmission lines and pipelines, as experienced during Hurricane Tomas in 2010. Power generating stations and other major infrastructure located on the coastline are also highly vulnerable to damage from flooding and inundation resulting from SLR and storm surges. Temperature increases have been shown to reduce the efficiency of energy generation at thermal power plants and reduced precipitation may affect water availability for non-contact cooling of power generators.

Rising prices for fossil fuels and emerging climate policy will make the tourism sector in Saint Lucia increasingly vulnerable, in addition to climate change impacts that will threaten energy infrastructure. Specific targets have been set in the National Energy Policy for the reduction of demand as well as increasing capacity from renewable energy technologies (30% of capacity by 2030), thereby reducing fossil fuel imports and emissions. Geothermal, wind and solar energy are the main options being investigated.

The National Energy Policy has identified the tourism sector and hotels in particular, as potentially large consumers that will be required to conduct energy audits and based on the results, undertake energy efficiency initiatives to reduce their consumption. New resorts will also be mandated to use solar water heaters and energy product pricing has been identified as a key mechanism to address energy efficiency generally. The Saint Lucia Government has already determined that an energy efficiency building code will be developed that will ensure all new developments and commercial retrofits incorporate the appropriate technologies.

To support the initiatives outlined in this policy mechanisms are needed to engage stakeholders in tourism planning with regard to energy use and emissions. Without clear policy goals regarding energy use and emissions, as well as the communication and monitoring of these goals, it is unlikely that stakeholders will effect major changes in their operations. Consequently, measures ranging from regulation to market based instruments to incentives will have to be implemented.

WATER QUALITY AND AVAILABILITY

Water supplies in Saint Lucia mainly come from surface run-off sources such as rivers, wetlands, streams and springs and these supplies are highly susceptible to climate variability and change. Also, five of the seven main rivers in Saint Lucia are at risk from contamination[ii] because of the unregulated development of riverbanks which has compromised the quality of water, with sediments, sewage (from pit latrines), agro-chemicals and the use of rivers for bathing and washing. Population growth, rapid urbanisation, conversion of forests on steep slopes (for banana plantation and other crops and for grazing) and developments in the tourism sector are further challenging the water resources management system to address supply and demand adequately. Moreover, water production costs are not reflected in the prices charged to consumers, leaving little incentive for water efficiency.

Table 3 shows the water demand in various sectors (2005), but the unaccounted water value is believed to be much higher now. The high water losses are due to a number of problems, among them being the mountainous terrain and long distances water has to be transported via aged infrastructure from water source to treatment plants and then finally to the consumers. The agricultural and industrial (construction and mining) sectors can also abstract water easily, with near limitless access to rivers.

Table 3: Demand Distribution Among Sectors

Description	Percentage	Projected Percentage
	1987	2010
Domestic/minor commercial	48.6	53.0
Hotels	9.6	10.0
Government/Institutional	7.0	6.7
Industrial	2.5	5.3
New commercial	0	2.0
Unaccounted for water	32.3	23.0

(Source: Springer, 2005)

In the tourism sector, the water demand is concentrated in the north of the island. Saint Lucia has approximately 5,000-room capacity, however, the actual visitor arrivals is far higher, with some 982,764 visitors recorded in Saint Lucia in 2009 (mainly due to cruise ship arrivals).

With only one major water storage facility on the island, Saint Lucia is highly vulnerable in situations of lower than normal precipitation. During the wet season, heavy precipitation from storm events leads to flooding, with rivers prone to overflowing their banks. While efforts to address these issues have been employed via a National Water Policy, the policy does not support water conservation technologies, with the need for legislation to regulate and licence the abstraction of surface water to ensure future water supplies are of good quality and widespread availability. Another significant challenge is siltation because sedimentation and the inability of treatment plants to treat water after heavy rains means that some communities do not have access to water for as much as 3 to 4 days while plant operators wait for water turbidity in river courses to clear up.

During the dry season, water levels fall drastically, with aged infrastructure contributing to unequal water distribution problems, including limited or no access to water in some rural areas of the country. The dry season (December to April) coincides with a time when there is a high influx of tourists to the island, which increases demand on already limited water supplies. Saint Lucia most commonly experiences agricultural drought conditions, where the quantity and timing of rains throughout the growing season affects the value of outputs from dry land agricultural producers. However, rural areas are prone to water-stress as distribution to remote communities is unequal. To ameliorate this problem of chronic water shortages, a policy of water rationing has been implemented by WASCO to promote the conservation of water supplies.

Water and drought monitoring takes place across the island. Approximately 90% of the island uses meters, installed in 2006. Several of these meters were faulty and are currently being replaced with the hope of increasing the meter coverage and effectiveness on the island. Saint Lucia has a number of drought monitoring stations which are also rain monitoring stations. One of the ways that the Water and Sewerage Cooperation (WASCO) copes with water shortages is through the use of rationing and by issuing Drought Rationing Schedules stipulating the areas expected to be affected and the date and times when water will not be available.

Water resources in Saint Lucia are considered sufficient for current and projected demands but severe vulnerabilities clearly exist**.** Water infrastructure should be repaired and replaced to reduce vulnerability during drought events and after major storms and hurricanes. In particular, (i) water storage should be encouraged through incentives and every new building should have its own stored water storage infrastructure; (ii) the viability of additional storage facilities to supplement the John Compton Dam should be assessed, allowing improved access to potable water in different communities; and (iii) losses in water

distribution should be reduced through pipe replacement. Robust land management policies should also be developed to reduce the discharge of pollutants including sediments, sewage and agro-chemicals into water systems.

Ground water sources should also be explored further to augment surface sources in times of drought. Public education in water resources should be also undertaken. In particular, communities and the population should be educated in conservation and treatment of water and the proper use of rainwater harvesting systems.

Springer (2005) has made three additional recommendations:

1. Charging the full cost of water, including the cost of building and operating water supply systems.
2. Reduce losses in distribution.
3. Protect forests, watersheds and other eco-systems required to regulate and maintain water quality.

COMPREHENSIVE NATURAL DISASTER MANAGEMENT

The geography and topography of Saint Lucia creates a diversity of natural hazards that have the potential to cause damage and loss, including flooding, landslides, hurricanes, earthquakes and volcanic eruptions. Changes in climate are likely to create more disasters as changes in seasonal precipitation cause more droughts, more heavy rainfall events and stronger storms.

Figure 6: Evidence of Landslides along Steep Slopes

In 2010, the impact of Hurricane Tomas reminded Saint Lucians of their vulnerability to natural hazards as flooding and high winds damaged many homes, roadways, bridges and public utilities. Damages to access roads to the main dam in Saint Lucia caused concerns for water supply and further damages to transportation posed challenges for the repair of damaged utility poles. The hurricane also had economic impacts in several sectors. As a result of interrupted service in the tourism sector, advisories were issued for travellers to the island to confirm electricity and water conditions at their hotels before departure. In addition, banana farmers lost 100% of their crops. Although Saint Lucia received financial assistance from the Caribbean Catastrophe Risk Insurance Facility (CCRIF), it will take time to fully recover from these impacts.

Figure 7: Flooding in Dennery from Hurricane Tomas
Source:http://www.djmrp.com/slu-crisis/slu-crisis-hurricane-tomas.htm

The historic development process of locating settlements near steep slopes and valleys puts many communities at risk to damage and loss. The long history of flooding and landslides in Saint Lucia has motivated the National Emergency Management Organization (NEMO) to produce hazard maps and therefore seek to reduce loss of lives and livelihoods.

NEMO leads the country's emergency management and hazard mitigation efforts with a mixture of policy and technological instruments. NEMO considers three types of hazard scenarios i) rapid onset (natural and manmade); ii) slow onset and iii) sink holes. The primary difference between these hazards is the timing of the impacts, which affects the ability of individuals and NEMO to respond. Hurricanes and tropical storms generate the conditions for both rapid and slow onset debris flows and landslides by bringing periods of sustained and/or intense rainfall. There is a strong understanding of comprehensive disaster management and a willingness to apply regional standards in Saint Lucia. Nevertheless, more effort is needed in the promotion of hazard mitigation plans throughout all of the sectors, especially within tourism and the general public.

Saint Lucia has experienced many debris flows in its history but the 1999 Black Mallet/Maynard Hill Landslide is one notable example where there were significant damages to this community south-east of Castries. As early as 1999 residents reported cracking in masonry walls but it was not until 2008 that 80,000 cubic metres of colluvial material flowed toward the river, destroying several concrete structures and rupturing public utility lines that served the communities. A few weeks later, another slippage 70 m higher on the slope caused debris to slide over Maynard Hill Road. Although many coastal areas of the country are at high risk of landslides, the area with the most extreme risk is in the Parish of Soufrière, an area with a growing population.

Figure 8: A collapsed road from Hurricane Tomas' torrential rains
Source: http://www.djmrp.com/slu-crisis/slu-crisis-hurricane-tomas.htm

NEMO has detailed many good efforts in this regard in their Landslide Response Plan (2008) and their acknowledgement of the need to include the community in planning and preparedness exercises will ensure that deaths from such events are kept to a minimum. In addition to this, the monitoring of deforestation and intensive agricultural practices on slopes is needed to minimise risks of landslide and down-slope impacts from the reduced soil stability. Furthermore, in urban and peri-urban areas, clearance of gutters and drainage canals is important for the control of the flow of rain water. NEMO acknowledges the need to conduct regular cleaning of these waterways. However, by educating the public on the link between the presence of debris and garbage and flooding, the risk can be reduced more effectively.

Major tourism developments in Saint Lucia are primarily located on the western coast near the capital of Castries. Tourism infrastructure is at great risk to increasing coastal erosion and rising sea levels will slowly inundate vital beach areas. In November 1999, surge damage in Saint Lucia associated with Hurricane Lenny was in excess of US $6 million, even though the storm was centred many kilometres offshore. Because much of the tourism infrastructure is near the coast, much of that damage was likely to the tourism and hospitality industry. As a result, extreme events threaten the safety and security of tourists and locals alike. Therefore, a Hospitality Industry Crisis Management Plan for Saint Lucia was developed in 1996 to provide an institutional mechanism for the management of disasters within the tourism and hospitality industry.

To address disaster management in the Caribbean tourism sector, CDEMA, with the support of the Inter-American Development Bank (IDB) and in collaboration with the Caribbean Tourism Organization (CTO), CARICOM Regional Organization for Standards and Quality and the University of the West Indies has implemented a Regional Disaster Risk Management (DRM) Project for Sustainable Tourism (The Regional Public Good) over the period of January 2007 to June 2010. The project aimed to reduce the Caribbean tourism sector's vulnerability to natural hazards through the development of a '*Regional DRM Framework for Tourism'*. Saint Lucia has much to offer in terms of beauty in the interior of the island so the diversification of tourism away from the vulnerable coast should be considered – bearing in mind that the interior has its own risks and vulnerabilities.

In recent years, Saint Lucia has experienced significant damages from climate-related events and disasters. As a result, the Government of Saint Lucia has acknowledged some areas that need improvement in the disaster management system and the importance of public awareness. The Strategic Programme for Climate Resilience (SPCR) released in June 2011 offers a few key initiatives that will build resilience in Saint Lucia to reduce vulnerability to current and future disasters. One of these projects is "Mainstreaming the Lessons of Hurricane Tomas and other Recent Climate Events" which should be as a matter of urgency. It also is a priority to build awareness and capacity in communities, especially those that are more remote, to reduce their vulnerability and enable them to respond in times of disasters. Through the use of Soca and Calypso music which have a tradition of telling stories and are still popular today, key messages can reach a wide range of persons. NEMO is already successfully using mobile phone technology to issue advisories and this should be continued.

HUMAN HEALTH

Health is an important issue in the tourism industry because tourists are susceptible to acquiring diseases as well as potential carriers of vector-borne diseases. Additionally, Saint Lucia's tropical climate makes it suitable for the transmission of a number of vector-borne diseases. The effects of climate-related phenomena on public health can be direct or indirect. The former includes weather related mortality and morbidity arising from natural disasters (e.g. hurricanes) and high temperatures (e.g. 'hot' days/nights). Indirect impacts are more extensive, including vector borne diseases such as dengue fever and malaria.

Saint Lucia's population is concentrated in the capital city of Castries, which is low-lying and consists of reclaimed land prone to flooding during heavy rainfall events. Also, because most of Saint Lucia's water resources come from surface sources such as rivers and streams, these are prone to flooding due to higher than normal volumes of water. During such events, the water intakes, dams and reservoirs may be damaged or more commonly become blocked due to debris. This can impact water distribution and lead to health problems such as dengue fever as mosquitoes breed in standing water. It also compromises water quality and may result in municipal supplies being disconnected for a period of time. Curiously, the potential implications for public health are similar to those experienced in drought conditions. Diarrheal illnesses, cholera, shigellosis, salmonella and gastroenteritis are still a concern in Saint Lucia and have been shown to be significantly associated with temperature and rainfall, as a reduction in domestic water supply can impact quality and the standards of sanitisation. This is so despite the fact that 98% of the population has access to piped-water in their houses. As a result of higher temperatures, it is expected that the population of Saint Lucia will be exposed to a higher incidence of heat and stress-related illnesses.

The adaptive capacity of the health sector is influenced by numerous factors, including institutions, government bodies, legislation and actions at the local, national and regional level. However, one of the most relevant issues that may be impacting health in Saint Lucia is poverty. In the last decade, various

internal and external factors have affected the Saint Lucian economy, including high oil prices, trade liberalisation and high external debt, making the economy highly volatile. Limited financial resources will impair the ability of the Government to effectively address vulnerability and adaptation challenges that are presented in this sector.

The Saint Lucia National Climate Change Policy and Plan (2003) has as one of its broad policy objectives to 'foster the development of processes, plans, strategies and approaches to avoid or minimise the negative impact of climate change on human health'. In terms of managing vector borne diseases, limited financial resources or improper allocation of resources will impair the ability of the government to effectively address the challenges that are presented with dengue and malaria outbreaks. Positive areas to note in the health sector that add to its resilience include emergency services designed to help people cope with mental health and traumatic stress during times of disasters and associated disruptions (MOH, 2007) and provision of information for forecasting extreme heat events.

A greater focus on socio-economic issues is needed to isolate and therefore address underlying factors which exacerbate vulnerability to climate change and more research is required for the development of appropriate environmental, agricultural and trade policies so as to strengthen the resilience of the economy. Although existing national policies in Saint Lucia acknowledge the need to conduct further research on diseases and health, specific studies linking the epidemiology of diseases with climate change are recommended. For some diseases such as malaria and diarrhoea which are entirely preventable, education campaigns would be important providing both locals and tourists with continued information to ensure in sustainable disease prevention.

MARINE AND TERRESTRIAL BIODIVERSITY AND FISHERIES

Saint Lucia possesses a variety of eco-systems and biological species, including 1,436 vascular plants (1,147 of which are native) and 175 species of amphibians, birds, mammals and reptiles (157 of which are native). Saint Lucia's coastal and marine eco-systems also include 333 finfish coral reef and pelagic fish species and 3 species of marine turtles that belong to the global stock. The island's natural resources provide numerous goods and services in terms of food, water and agricultural products, the prevention of soil erosion, removal of environmental pollutants, maintenance of soil fertility and resources for recreation. Saint Lucia's forests, waterfalls and freshwater systems, beaches and coral reefs are also important as they provide the main attractions in the tourism industry. However, climate change and SLR threaten the beachscape and will continue to affect recreation activities as well as the livelihoods of those employed who depend on climate-sensitive natural resources if no or inadequate interventions are made.

Persistent heavy rainfall often results in massive landslides in Saint Lucia, as was recently experienced during Hurricane Tomas in 2010. As a result of Hurricane Tomas, approximately 54 km of forest trails were damaged, some of which were used as eco-tourism attractions and are still inaccessible to date. The repercussions on the livelihoods of those who were employed in forest trail tours have reportedly had weighty effects on their morale.

The cost of maintaining roads and trails across Saint Lucia's steep and rugged terrain will almost certainly increase with the projected acceleration of climate change and intensification of extreme weather events. This projected trend further justifies the strategic and economic importance of protecting and managing the integrity of the island's forests and watersheds.

Scuba diving is a popular activity among tourists, mostly occurring along the west coast of the island. A valuation study on coastal capital in Saint Lucia estimated that about 25% of tourists who visit the island do so at least in part for the coral reefs[iii]. Approximately 45,000 total dives and 95,000 snorkelers engaged in reef based activities during 2006. The combined direct and indirect expenditures, including accommodation, glass bottom boat/snorkelling trips, diving, MPA user fees and miscellaneous expenditures on reef-related tourism and recreation in that year was estimated to be between US $160 and $194 million (Table 4).

Table 4: Coral Reef Associated Tourism Economic Impact* for Saint Lucia

Expenditure Categories	($US million)
Accommodation	64.7
Reef recreation - diving	4.9
Reef Recreation – Snorkelling and glass-bottom boats	$0.8
Marine Park Revenues	$0.05
Miscellaneous Visitor Expenses	$21.2
Total Direct Impact	**$91.6**
Indirect economic impact (from multiplier)	$68 – 102
Total Direct and Indirect Impact	**$160 – 194**
Other Values	
Consumer Surplus	$2.2 – 2.4
Local use	52-109

*Not to be confused with climate change impacts. The evaluation by Burke *et al.* (2008) uses the term "impact" to describe the economic contribution of coastal resources. (Source: Burke *et al.*, 2008)

Coral reefs, especially those along the west coast, have long supported vibrant fisheries for Saint Lucian society and economy. Grunts, snappers, parrotfish and groupers are common species extracted from coral reefs and have been valued to between US $520,000 and US $841,000 annually[iii]. This strongly supports the protection of coastal and marine biodiversity.

Figure 9: health coral reefs in Soufriere
Source: SMMA

The healthiest reefs are found off the coast of Soufrière but the development of tourism in this area, a historically agricultural community, is increasing the pressures on those reefs. Furthermore Soufrière is at high risk to landslides and consequently its reefs are prone to sedimentation. Unfortunately, all 90 km of reefs around the island are at risk to human activities and the general trend shows that coral cover around Saint Lucia is on the decline while growth of macro-algae is increasing.

The fisheries sector is an important livelihood activity for many, employing over 2,300 fishers and some 120 fish processors[iv]. Two weekly community fish festivals - Fish Fridays at Gros Islet and at Anse-La-Raye- are highly popular street parties among tourists and locals alike. These attractions feature a wide range of freshly caught seafood including octopus, conch, lobster, whelks and a variety of fish. The events support livelihood activities for cooks, vendors and entertainers.

Unsustainable levels of harvest, illegal fishing methods, habitat degradation and sedimentation of coastal waters are threatening Saint Lucia's fisheries. Near shore fisheries are considered overfished while the pelagic fisheries are regarded as under-utilised. Degradation of coral reef and mangrove eco-systems, which are vital nursery areas for many commercial species, has also been detrimental to the status of fish stocks.

Climate change impacts on beaches will threaten the survival of species such as marine turtles, iguanas and shore birds. A 1 to 2 m SLR is predicted to damage 6-10% of turtle nesting sites on the island[v]. More dramatic changes can occur to the beach profile during a single extreme weather event and although recovery occurs, it may not be to pre-hurricane conditions. During the 1990s, Saint Lucia's beaches appeared to be experiencing net erosion attributable to a series of tropical cyclones that affected that region. The frequency of events did not allow sufficient time for beaches to recover in between events. The reduced aesthetic appeal of beaches will mean reduced quality of one of the island's primary tourism attractions and visitor experience.

The long term effects of extreme events on mangrove stands are uncertain but will most likely mean a loss of the many essential services provided by this eco-system. Of particularly concern will be the reduced coastal erosion protection from lost and damaged mangroves. To address these issues, the management of the island's eco-systems must become central to government policy, since Saint Lucia's economy well-being depends on biologically diverse eco-systems. Greater biodiversity affords greater resilience to climate change and provides more options and opportunities for adaptation.

Climate change related variations in average daily temperature, seasonal precipitation and extreme weather events will exacerbate the effects of existing human stressors on forest eco-systems. Mount Gimie is the tallest peak in Saint Lucia rising to 959 m and grows a type of vegetation classified as cloud montane forest. These species require almost continual cloud coverage and are most vulnerable to climate change. Assuming a cooling rate of 1^{o}C per 150 m of altitude, a projected increase of 1.7^{o}C would require vegetative zones to migrate vertically by 260 m and up to 530 m in a 3.5^{o}C scenario[vi].

The people of Saint Lucia recognise the importance of biological conservation and there is extensive awareness among the population as evinced by a number of successful community-participation management projects. The Government has also taken steps toward integrating biodiversity issues into the national agenda, with several inter-sectoral communities responsible for the over-sight of national legislation and international multilateral environmental agreements.

Adaptation strategies for biodiversity should take an eco-system based approach. This means that strategies should aim to enhance the quality of terrestrial and marine eco-systems, strengthen the linkages between habitats, resource users and resource managers and increase the size and number of protected areas. The tourism sector should be more engaged in biodiversity conservation and the management of protected areas since these resources are a critical component of the very product they promote.

One means of strengthening the linkages between stakeholders and natural resources is by building capacity through education/awareness and empowering resource users to be environmental stewards. If the tourism sector, a significant consumer of natural resources, is to be sustainable, it must engage more actively in the conservation and management of protected areas. Planning and managing for resilient eco-systems and adapting to a dramatically changing climate must become a key priority for the Government of Saint Lucia. One mechanism which facilitates this is the Caribbean Fish Sanctuaries Partnership Fish Fund which was conceived by The CARIBSAVE Partnership as a sustainable financing mechanism to supplement existing funding particularly of those sanctuaries which demonstrate strong community involvement. Income will be generated from a variety of sources, including:

- Contributions on the sale of locally made crafts, eco-tourism tours and diving/snorkelling trips
- Donations from tourists and residents
- On-line micro donations from international supporters viewing website

- International and national institutional donors
- Donations from High Net Worth Individuals with interests in Saint Lucia

CONCLUSION

Saint Lucia has a strong dependence on the tourism industry and the many natural assets that enable tourism to be successful. The natural resources and biodiversity on the island, particularly terrestrial and marine eco-systems and water resources are already facing serious pressures from increasing development and poor land use practices. It is evident that the Government of Saint Lucia is committed to adapting to climate change. Many policies and plans for action are in place, but serious financial resource shortages along with limited technical capacities hinder the successful adaptation efforts across most government ministries and other stakeholder groups.

The CCCRA explored recent and future changes in climate in Saint Lucia 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 provides very useful indications of the changes in the characteristics of climate and impacts on socio-economic sectors. 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.

Saint Lucia has a history of damages and losses from natural disasters. Given climate change projections, preparedness for disasters and climate change adaption become common goals. There is a large percentage of vulnerable persons in Saint Lucia who are only too aware of the dangers of climate change. However, resource users with little or no awareness of alternative courses of action continue to degrade or over-extract from marine and terrestrial eco-systems and consequently increase their own vulnerability. Poorly planned land development and population expansion degrades habitats and increases the risk of damages from flooding. Climate-change driven impacts will pose even greater threats to eco-systems and populations in Saint Lucia as SLR, increased intensity of extreme weather events, oceanic and atmospheric temperature increases and altered patterns of precipitation interfere with their functions and livelihoods.

Considerations for gender, economic security and livelihood activities must be considered in this education plan as not all persons are affected equally and would consequently need to respond differently. Implementing the specific recommendations proposed for each sector can ensure a balanced approach to Saint Lucia achieving its vision for 2030.

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- Saint Lucia Tourist Board

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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 Saint Lucia 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 Saint Lucia.

NOTES

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