



ECS

Country analysis: Resilience to climate change at a glance SAINT LUCIA

KEY MESSAGES

Climate change risks



Temperatures will continue to rise. Further intensification of the hot season, high to extremely high heat impact potential by 2030, along with more frequent and more intense heat waves. The number of extreme heat events will increase roughly 15-fold by the 2020's and become a nearly year-long occurrence by the 2040s.

Major hurricanes: The frequency of category 4 and 5 hurricanes is expected to increase by 25%–30%. Storms are likely to become 2% to 11% stronger in terms of maximum wind speeds and possibly more frequent.

Continued sea level rise of 11 to 25cm. Rising sea levels combined with stronger winds during the strongest storms substantially increase the potential impact of storm surge and coastal inundation.

Warmer oceans along with steadily rising sea levels, even if global warming is halted in the foreseeable future. Trends in sea surface conditions include a projected rise of 0.77°C to 2.5°C by the end of the 21st century.

Rainfall: Changes in precipitation are more difficult to project; a slight decrease in total rainfall is anticipated, while single rain events will become more intense. Rainfall rates inside hurricanes could increase by up to 30%, increasing flash flood potential.

Droughts will become more prevalent. However, the trend may only become a major issue from the 2050s onwards.

Summary of key socio-economic indicators for Saint Lucia

Total Area (square km)	616
Population.....	165,000
Percent Urbanization.....	18.7
GDP per capita	US\$14,400
Debt as a percent of GDP	70.7
Unemployment Rate.....	20
Services as a percentage of GDP	83
Services as a percentage of workforce	54
Agriculture as a percentage of GDP	2.9
Agriculture as percentage of workforce	22
Percent Agriculture Land	17.4
Percent Forests	77
Human development Index value.....	0,759

Map of Saint Lucia



Figure 1: www.lonelyplanet.com

OVERVIEW

Saint Lucia is located at 13° 59' N Latitude and 61° W within the Lesser Antilles in the Eastern Caribbean, and is one of the **Windward Islands**. Its land area is 616 km² (42 km long and 22 km at its widest point) and it is situated on a volcanic ridge that connects it with the north. In 2014, St. Lucia's population was estimated at around 183,600.

St. Lucia has very steep, rugged landscape, characterized by a centrally located north-south oriented mountain range, deep valleys and fast-flowing rivers. The highest point on the island is Mount Gimie, which stands 950 m above sea level, while the most spectacular landmarks are the Pitons. These two volcanic spires rise side-by-side from the sea to heights of 770 m and 743 m respectively, and are the focal points of the Pitons Management Area, a World Heritage Site (UNFCCC 2012).

Rich, volcanic soils and the elevated rainfall allow for dense rainforest over much of the inland regions, especially in the centre and south, with a more drought-tolerant natural vegetation type in the extreme south and north.

Saint Lucia is well exposed to trade winds, which keep temperatures moderate at around 27°C along the windward coastline, but with higher humidity and rainfall, as well as lower temperatures with increasing elevation. The tropical marine climate ranges from humid in the inland and west coast areas to semi-humid in the extreme north, extreme south and portions of the east coast.

The hot season (May to October) is characterized on average by 26 to 37 hot days (when day-time high temperatures are close to or exceed 32°C) and 33-36 hot nights (with night-time lows above 26°C), as well as by several heat waves. During the cool season (December to March), heat levels are comfortable and 30 cool nights (with lows below 22.5°C) occur on average.

The annual rainfall totals around 1500 mm in the extreme south to 2000 mm on the west coast and over

3000 mm at high elevations. The wet season spans June to November, coinciding with the Atlantic hurricane season. Each of the wet season months totals over 150 mm, except in the driest locations in June.

Extreme rainfall has the potential to trigger a flash flood nearly every other year between April and December, and once to twice per year between August and November. By contrast, spells of seven consecutive dry days peak in frequency from December to May, potentially limiting crop growth. Finally, impactful drought occurs on average once per 4-5 years during the dry season, and once every 8-12 years in the wet season, potentially impacting fresh water availability.



CASTRIE WATER FRONT, SAINT LUCIA

Picture: CCASAP project

MARIGO BAY, SAINT LUCIA

CLIMATE TRENDS AND PROJECTIONS

OECS, with CIMH, undertook an extensive analysis of the current trends and future projections of climate for the region was based on data from various meteorological services across the region, as well as future projections from regional circulation models (RCMs) developed by the Climate Studies Group of the University of the West Indies. In terms of priorities of relevance for the Windward Islands, these climate trends and projections (across a range of emissions scenarios: a low (Representative Concentration Pathway 2.6 – RCP2.6), mid-range (RCP4.5) and high (RCP8.5)), (see details page 8) point to the following risks.

PROJECTED HEAT TRENDS

Figure 2 shows that the increase in frequency of hot days and nights in the Leeward Islands is further accelerated into the 2020s, when frequency is eight-fold, to end up close to a 100% of all days in the year in most years during the 2040s. However, given the recent observed increase rate appears to be somewhat slower for hot days and hot nights, one might expect a delay in reaching a near 100% frequency.

For **cool days and nights**, one can see that, from a 1961-1990 model baseline of 10% frequency, a decrease of over 75% was already noted by 1981-2010. This compares to observed decrease rate of over 60% for cool days and over 40% for cool nights.

Cool days and nights become virtually absent from the projected future as early as the 2020s.

Finally, looking at the number of days spent in **heat waves** of at least six consecutive days (the so-called warm spell duration index or WSDI), a remarkable increase is noted across all three scenarios, as well as, in the observations.

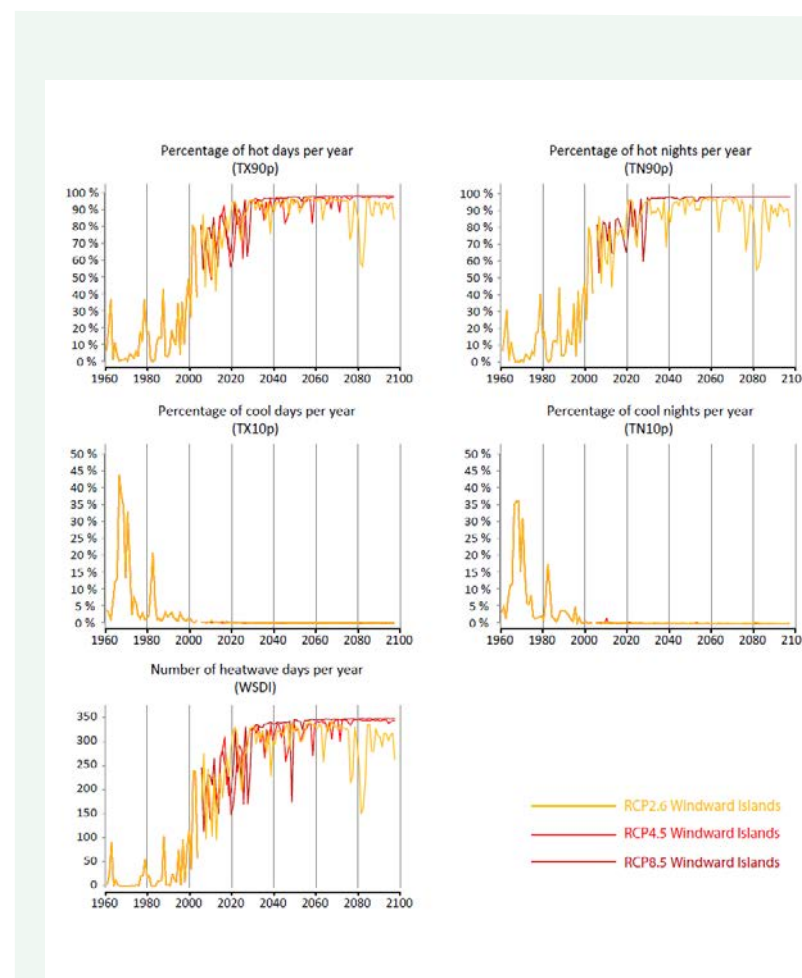


Figure 2

For the Windward Islands: simulated annual trends in the percentage of hot days (TX90p, top left), hot nights (TN90p, top right), cool days (TX10p, middle left) and cool nights (TN10p, middle right) per year, as well as, trends in the annual number of heatwave days during long heat waves of at least six consecutive days (WSDI, bottom) from three downscaled projections.

Whereas the simulated baseline period only recorded 18 such heatwave days per year on average, the numbers had already increased fivefold by 1981-2010 to further increase roughly 15-fold by the 2020s and becoming a nearly yearlong occurrence by the 2040s.

It should be stressed that the strong simulated trends in the heat-related indices after around 1980 only corresponds well qualitatively with the strong observed trend. However, even with the downscaled projections overestimating the actual trends, hot days and hot nights will likely occur during most days of each year by mid-century, while cool days will likely disappear much sooner. Unfortunately, this committed future change seems to be mostly unavoidable, because the conclusion is valid no matter what RCP scenario is considered.

EXTREME RAINFALL

Projected Changes in Extreme rainfall

As can be seen from Figure 3, there are **no clear signals in projected trends of extreme rainfall**. Clearly, the year-to-year variability exceeds by far the long-term trend in both the proportion of annual rainfall totals from extremely wet days (R95pTOT) and the number of days with heavy rainfall (R10mm). While the former appears to increase over time in all three scenarios, the R10mm decreases in both RCP4.5 and RCP8.5. However, if both trends do manifest, this means extreme rainfall will become less frequent, but even more intense. This means that the **potential for flash flooding** and related hazards may increase throughout the 21st Century, though changes may be hardly detectable by the 2020s and 2040s. An indication of such increasing flash flood potential towards 2100 comes from the fact that the RCP8.5 systematically

projects fewer years with at least 5 days with heavy rainfall than RCP4.5 during the second half of the Century. The same is apparent when comparing RCP4.5 to RCP2.6. Indeed, the period 2050 to 2089 contains 19 years with at least 5 days with heavy rainfall in RCP2.6, versus 16 in RCP4.5 and only 10 in RCP8.5.

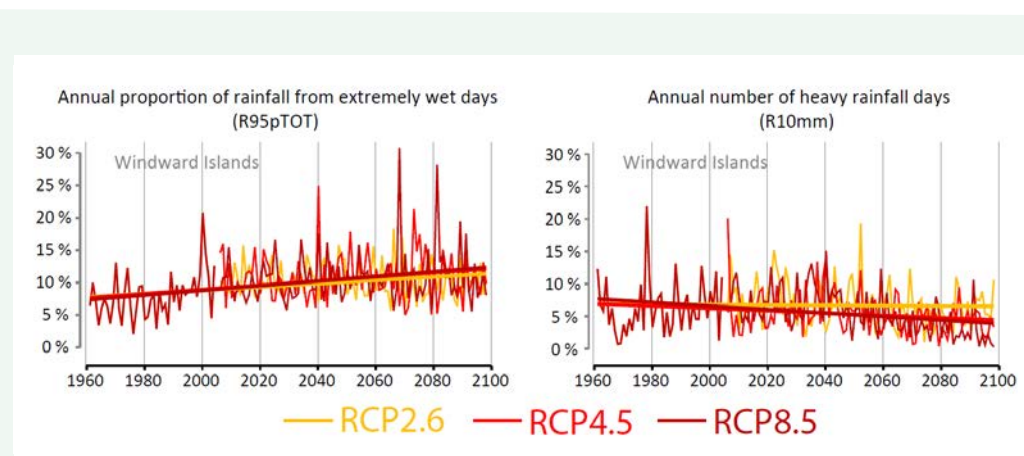


Figure 3

For the Windward Islands: Simulated annual trends in the percentage of the rainfall total from extremely wet days (i.e., days with rainfall above the 95th percentile only (Rp95TOT, left), the number of days with heavy rainfall (i.e. with at least 10 mm of rainfall – R10mm, right). Also plotted are the simulated trends in the duration (in days) of the longest dry spell (CDD, bottom). The results are shown for the RCP2.6, RCP4.5 and RCP8.5 downscaled projections.

Notes: The absence of significant simulated trends in Rp95TOT and R10mm indicates that flash flood potential may not significantly change in future. Also plotted are the simulated trends in the duration (in days) of the longest dry spell (CDD, bottom). The results are shown for the RCP2.6, RCP4.5 and RCP8.5 downscaled projections. Data source: projections provided by the Climate Studies Group, Mona of the University of the West Indies – Mona Campus, Jamaica

DROUGHT

Drought has been and will remain an integral part of climate in the OECS region. This hazard, while physically dependent on both rainfall and evapotranspiration rates, is of lesser concern in the wetter islands with complex topography than in drier, low topography areas of the OECS region. However, where water consumption is intense due to high population density or high consumption by the islands' industries, the sensitivity of the environment and society to drought is significant.

Rainfall-Based Drought Indices

Meteorological drought can be defined as a deficit of rainfall over a period of several weeks to years.

When drier than normal conditions are significant and extend long enough to reduce the amount of available soil moisture, this can lead to crop wilting. Such droughts are called agricultural drought. If drought extends long enough to affect streams, rivers and water reservoirs above and below ground, one can refer to such droughts as hydrological drought. With reduced freshwater availability during prolonged hydrological drought, other socio-economic sectors start being affected, e.g. firefighting, household water provision, construction, tourism, etc. Such drought may be referred to as socio-economic drought.

Typically, reduced soil moisture and reduced flow in streams and small rivers takes anywhere between a number of weeks and about 6 months of rainfall deficits – i.e. **short-term drought** – to manifest. After 6 months of significant meteorological drought, stream flow in larger rivers and water levels in large reservoirs becomes affected. Finally, after about 9 to 12 months of rainfall deficits – i.e. **long-term drought** –, water levels in the largest surface reservoirs and in aquifers tend to lower and stream flow in the largest rivers tends to decrease.

Hence, a proxy for the different types of droughts should account for the different timescales involved. Furthermore, it should be scalable to the national context of water management. Its calculation should be possible given the climate record available within the territory. One such proxy, recommended by the WMO is the Standardized Precipitation Index (SPI, McKee et al., 1993). The SPI is calculated as a normalized precipitation anomaly over 1 month to 48 months. Given that most droughts in the OECS are seasonal in nature, the most relevant indices are SPIs calculated over three-month (SPI-3), six-month (SPI-6) and twelve-month (SPI-12) periods. However, it is possible for rainfall deficits to exceed 12 months as was the case during the 2014 to 2016 Caribbean drought.

HEAT - AN UNDERESTIMATED HAZARD

Air temperature does not vary much between seasons and years in Saint Lucia. The heat – being moderated by a prevalent easterly breeze – has **historically** not been regarded as a major hazard but, at worst, a discomfort at times. However, with rising temperatures year-round, a more pronounced heat season with more frequent and intense heatwaves are becoming a **new norm**. Heat discomfort and heat stress has started affecting society and the environment. Important impacts (supported by research findings from around the world, including tropical regions and, where references are given, Caribbean countries):

Human health: increased heat-related **mortality and morbidity** (suspected, but not measured in the territory – note that heatwaves are the deadliest weather-related

hazard), in particular in persons with lower fitness; increased apathy and aggression; accelerated proliferation of vector borne diseases such as Dengue, etc. (e.g. Lowe et al., 2018).

Education: children's **learning ability** significantly decreases with increased heat exposure.

Energy: increased cooling demand and reduced efficiency in energy production.

National productivity: loss of hundreds of **man hours**.

Environment: exacerbation of **drought**; facilitation of **wildfires**; stress on **animal populations**.

Food security: **crop failure** due to wilting; severe heat stress related mortality and **morbidity in livestock** (e.g. Lallo et al., 2018).

Finally, because freshwater availability from soils and surface reservoirs can be reduced due to enhanced evapotranspiration rates relative to rainfall, a similar index called the Standardized Precipitation Evapotranspiration Index (SPEI, Vicente-Serrano et al., 2010) can be very useful in monitoring drought. The index is constructed in the same way as the SPI and can therefore be calculated over any relevant time period (e.g. SPEI-3, SPEI-6 and SPEI-12). However, it offers the advantage of calculating a balance between rainfall (i.e. local water input onto the surface) and evapotranspiration (i.e. local water output from the surface).

Projected Changes in Drought

Projected trends in drought are shown in Figure 4 for RCP4.5 and RCP8.5) from 2020 to 2090. Aside from a marked increase in heat exposure, the future projections also indicate that **drought will become more prevalent**. However, the trend may only clearly manifest from the 2050s onwards. An SPI value of around 0 is expected on average if rainfall totals are not changing from the 1961-1990 model climatology. However, in the RCP4.5 projection the SPI-6 shifts from close to 0 in the 2020s and 2030s to -0.6 and the SPI-12 from 0 to -1.4 – the latter value falling in the very dry category – in the 2070s and 2080s. Over the same periods in RCP8.5, the SPI-6 shifts from near 0 to -0.8 – moderately dry – and the SPI-12 from near 0 to -1.8, or **extremely dry on average** in the 2070s and 2080s. Those significant trends stand out even with the large interannual variability in both the SPI-6 and SPI-12.

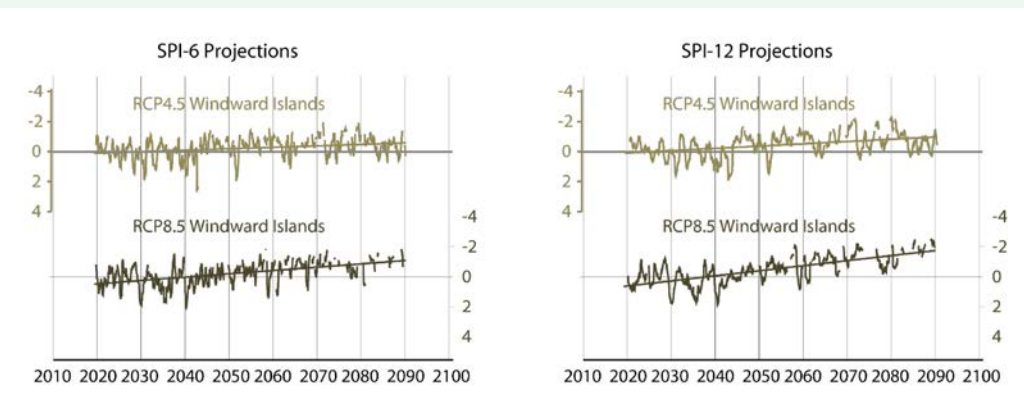


Figure 4

For the Windward Islands: Simulated trends in the standardized precipitation index over six months (SPI-6, left) and twelve months (SPI-12, right) per year on Windward Islands from the RCP4.5 and RCP8.5 downscaled projections.

Data source: projections provided by the Climate Studies Group Mona of the University of the West Indies – Mona Campus, Jamaica

EXTREME WET SPELLS - A PROXY FOR FLASH FLOOD POTENTIAL

The rainfall of Saint Lucia occurs when spells of intense showers occur in a rapid succession over a small number of days and associated with weather disturbances. The recurring heavy rains during such **wet spells** can be beneficial for replenishing major water reservoirs. However, extremely intense showers often lead to flash flooding.

Flash floods occur when the rainfall accumulation rate exceeds the rate of soil infiltration and surface drainage. There are rainfall thresholds beyond which the occurrence of wet spells correlates well with the occurrence of flash flood across much of the Caribbean. Caribbean-wide, such **extreme wet spells** are defined as a three-day period during which the rainfall totals are among the top 1% (i.e. exceed the 99th percentile) of all three-day rainfall totals in the historical record at a weather station (CSGM and CIMH, 2020).

While the flood record is incomplete and the number of recorded floods too low for robust statistical analysis, the use of extreme wet spell occurrence as a proxy for flash flood potential is validated regionally by similar findings in countries with a much larger sample of floods.



FUTURE CLIMATE PROJECTIONS - THE USE OF SCENARIOS AND CLIMATE MODELS

The most widely used tools to assess and simulate future or projected climates are **Global Climate Models** (GCMs, in academic circles referred to as General Circulation Models or Earth System Models). Such models can simulate to a great level of detail and reasonable accuracy how climate would behave around the world provided a scenario of socio-economic evolution or external physical factors would affect the energy balance of the earth's climate system. Three commonly used scenarios are the **RCP2.6** (a scenario based on a low carbon emissions future), **RCP4.5** (medium level of emissions) and **RCP8.5** (high emissions), elaborated by the Intergovernmental Panel on Climate Change (IPCC).

The major advantage of GCMs for the purpose of assessing how climate may change through time in future, is that they provide a **full spatio-temporal coverage** of earth's atmosphere. However, for the purposes of small island states in the OECS region, the spatial resolution is **far too coarse** to allow rigorous sub-regional analysis of future heat, drought and climate extremes. Island sub-regions such as the OECS are better served by **Regional Climate Models** (RCMs), which offer finer spatial resolutions. Among the CMIP-5 generation of projections run by a multitude of different GCMs and used in the IPCC's Fifth Assessment Report and many studies thereafter is the HadGEM2 GCM. To enable sub-regional analysis of trends in extremes, downscaled simulations can be performed using the **PRECIS regional climate** model.

Climate change may put pressures on our societies and environments by shifting them closer to or beyond the thresholds of their coping ranges. Therefore, climate projections are conceived to help provide the **scientific evidence base** for societies to adapt to climate change in future and hence build climate resilience for future generations. Such projections provide necessary insight to support **long term planning** for infrastructure, societal activities and the protection of environmental resources. In this climate profile, a special emphasis will be placed on two-time horizons: a **short-term horizon**, namely the 2020s (relevant within the current political context), and a **mid-term horizon**, namely the 2040s, relevant for infrastructure planning and many other societal and environmental systems.



SOCIOECONOMIC CHARACTERISTICS

Population

St Lucia's total population was estimated at 181,889 in 2018 (World Bank, 2018) with the majority (46.9%) below 30 years old (Government of Saint Lucia, 2017). Within the total population the gender ratio has a slightly higher female component, with 50.75% women compared to 49.25% men (World Bank, 2018). Life expectancy has increased to about 74 years for males and 79 years for females (2010). The population is concentrated along the coastal regions, where lowland agriculture, coastal resources and tourism are the main sources of livelihood. Approximately 60% of the population resides along the north-west corridor, where the capital is located (FAO, 2015).

Main economic drivers

Since 1990 the economy has seen the service sector, in particular tourism, leading economic growth. Between 1990 and 2015, the contribution of agriculture declined from 13.85% to 3.00% of GDP while the tourism sector's contribution rose from 9.18% to 10.9%. Table 1 shows the changes in sectoral contribution to GDP from 2012 to 2015.

Tourism

St Lucia depends mainly on tourism for its overall economic growth. After the terror attacks in 2001 its economy shrank by 4%, due to the fall in tourism, and was seen to have recovered strongly by 2003; this can be linked to increased air services to the island and the construction of a new resort (Commonwealth, 2019).

In 2018, there were a total of 1,228,718 visitors to St Lucia of whom 394,780 were defined as stay-over visitors. The main countries of origin for stay-over visitors are the USA (175,073), other Caribbean countries (77,548), the UK (76,142), Canada (40,213) and others (25,804) (ECCB, 2018). Therefore, the vast majority of the island's tourism is based on cruise ship passengers with over 400 cruise calls recorded in 2017. However, cruise visitors have been found to generate far less tourist expenditure than stay-over visitors (XCD\$56.5 million and XCD\$1914.5 million, respectively) (Central Statistical Office, 2018).

Table 1

Contribution to GDP by industry (%) in 2012, 2014 and 2015 (adapted from Government of Saint Lucia, 2017)

SECTORS	2012	2014	2015
Agriculture, Livestock, Forestry, Fishing	2.95	2.8	3.0
Mining and Quarrying	0.51	0.1	0.1
Manufacturing	4.81	4.7	4.8
Construction	9.54	7.3	7.8
Electricity and water	4.31	4.4	4.4
Distributive Trade Services	8.44	7.6	7.5
Hotels and Restaurants	9.84	11.0	10.9
Transport	11.77	13.1	13.4
Communication	7.16	6.0	5.7
Financial Intermediation	7.81	8.0	8.9
Real Estate, Renting and Business Activities	17.5	18.9	18.4
Public Administration & Compulsory Social Services	6.46	6.8	6.7
Education	4.3	4.5	4.4
Health	2.05	2.1	2.1
Other Community, Social and Personal Services	5.08	4.5	4.5

Energy

Saint Lucia has no known petroleum reserves and, apart from limited usage of combustible renewables, all energy is imported, mainly from Trinidad and Tobago. Demand for imported fuels has continued to increase over the last few years. Saint Lucia possesses significant renewable energy potential; its geothermal prospects are excellent, and it has wind and solar resources that are available year-round (Government of Saint Lucia, 2017). The transportation sector consumes the largest proportion of energy (41% of total energy), followed by the commercial sector with 26%, the residential sector with 17%, the industrial sector 4%, and others 8% (IDB, 2015).

Transport

Saint Lucia has two airports: George F.L. Charles Airport, and Hewanorra International Airport. George F. L. Charles Airport is situated in the north of the island, and caters to general aviation and regional airlines, whereas Hewanorra International Airport is situated in the south of the island, and serves more than 90% of the tourists. Saint Lucia also has five sea ports, two of which are major harbours: Port Castries and Port Vieux Fort. Most cargo is imported through Port Castries and then transported by road to the rest of the island (UNCTAD, 2017). The public transportation system consists of privately-owned 12- to 15-seat minibuses and a smaller number of larger buses licensed by the Ministry of Infrastructure, Transport and Port Services, which are assigned to specific routes (Government of Saint Lucia, 2017).

Land use

As seen in Table 2, there was a huge increase in settlements, scrub land and densely vegetated farming between 2000 and 2009. However, there were major decreases in other types of farming such as intensive and mixed farming.

Table 2

Changes in land use in Saint Lucia (Government of Saint Lucia, 2017).

Land-use Categories	Land-use Classifications	2000	2009	Change in Area (000 hectares) 1990 - 2010
Forest Land	Forest Reserve	7972	9415	+1444
	Natural Tropical Forest	6159	4786	-1373
	Scrub Forest	6756	6303	-453
	Other Forest Vegetation	-	8691	+8691
	Mangrove	229	184	-45
Croplands	Densely Vegetated Farming	3586	13652	+10066
	Intensive Farming	12203	2953	-9250
	Mixed Farming	11479	1556	-9923
Grasslands	Grasslands	2694	188	-2507
Wetlands	Ponds	43	43	0
Settlements	Built-up Areas	9049	10131	+1082
Other Land	Bare Ground/Scrub	472	2740	+2268
Total area for Country		60641	60641	

Health

Saint Lucia has two public hospitals, St Jude’s Hospital and Victoria Hospital, with the latter being the largest. There are also district hospitals at Vieux Fort, Dennerly and Soufriere that offer primary health care services and limited secondary care and emergency services. There are also more than 30 health centres island-wide (Commonwealth Health, 2019). Saint Lucia has one privately-run hospital and a number of other private facilities that provide specialised medical and dental services. In the most recent survey, conducted between 1997 and 2010, there were 47 doctors, and 216 nurses and midwives per 100,000 people.

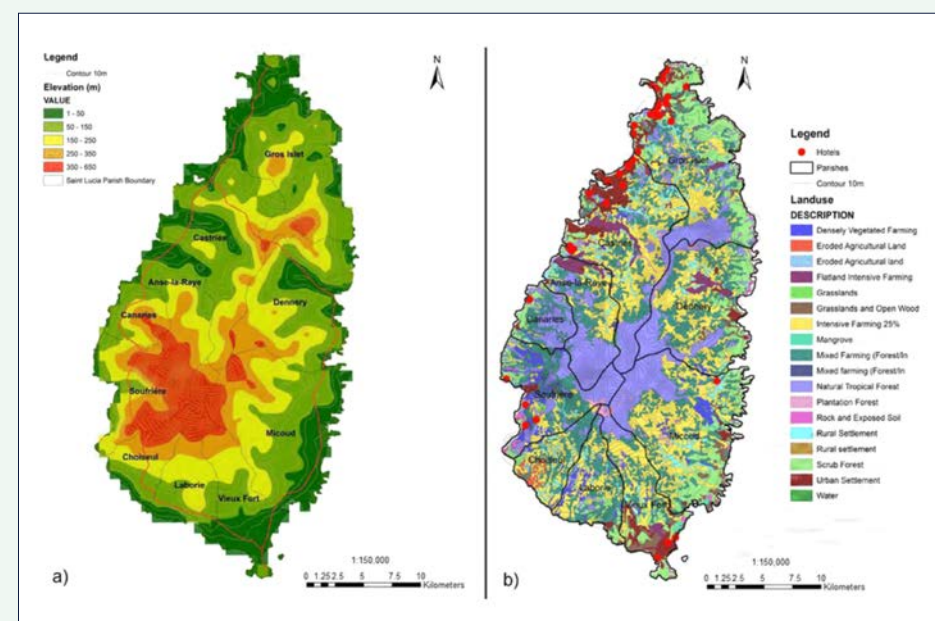
Agriculture

Agriculture continues to be an important sector for St Lucia as it provides approximately 21% of the island’s total employment (2012). However, its contribution to GDP has steadily decreased in the past few decades, from 13.85% 1990 to 3% in 2015; this was due to damage caused by natural disasters, pests and diseases. St Lucia’s production of bananas for exportation continues to dominate the sector. It occupies 48% of the cultivated land, accounts for 41.4% of gross agricultural output and, in 2015, total banana exports reached 14,787 tonnes. Bananas however were the main crop grown throughout the second half of the twentieth century until the loss of trade agreements with Europe, and due to competition from the megaproducers in Central and South America. This decline turned Saint Lucia from a net exporter of food crops to a net importer.

Agriculture in Saint Lucia is mainly small-scale, with the average farm size estimated at 3 acres. They are dominated by traditional rain-fed production systems, with limited use of modern technologies (Government of Saint Lucia, 2016).

Figure 5

Elevation (left) and Land use (right) in Saint Lucia



VULNERABILITY OF SECTORS TO CLIMATE RISKS

WATER RESOURCES

The trend indicating a decrease in the extents of water-related ecosystems is observable in all OECS Member States (except Grenada) that report information on SDG 6 achievements. In terms of water stress, the most critical situation is currently observed in St. Kitts and Nevis with a water stress index of 51%, followed by St. Lucia with an index of 14%. The rest of the islands are not under critical water stress, although the current situation can change drastically as the impacts of climate change mainly affect water resources. There is still a lack of information concerning the impacts of climate change on water resources in OECS Member States, as well as on the identification of possible conflicts of use that may occur in the future if climate change further affects water resource systems resulting in increased scarcity. Nevertheless, some of the Eastern Caribbean islands are already water-stressed for at least part of the year. Some of them currently rely heavily on desalination or unsustainable abstraction of groundwater resources, especially to serve the tourism industry. Changes in temperature, rainfall and extreme events will inevitably lead to reductions in water availability and quality, as a result both of damage to service infrastructure and reduced water quality through siltation of streams and rivers via landslides and destructive floods.

AGRICULTURE AND FOOD SECURITY

Agriculture is a critical sector in the economies and livelihoods of many of the countries in the Eastern Caribbean, although the region still relies heavily on food imports to meet local needs, at a significant cost. The sector comprises primarily rain-fed, small-scale subsistence farms growing multiple crops such as yams, sweet potatoes, and various vegetables such as peppers. There are also some large commercial farms focused on export

crops such as banana and plantain, coconut, citrus, mango, and avocado. Speciality crops such as nutmeg, cinnamon, ginger and cloves are also important export earners for some islands such as Grenada. Other important grown crops are tropical fruit, coconut, cocoa, vegetables, herbs, tree crops and cut flowers.

Livestock production, likewise, is a basic source of food security for local populations in the Caribbean. Cattle, pigs, chickens, and goats are widely produced across the region, as are dairy foods. The sector is integral to rural livelihoods, providing food, materials, income and mechanical power for pulling carts and ploughing fields. Most of the livestock production follows a similar dynamic to that of agriculture, with small-scale subsistence and commercial producers catering primarily to a domestic market. However, recent efforts to diversify the agricultural industry in response to climate change and global markets have supported livestock exports. Fisheries will be severely impacted by climate variability and change, as the associated impacts of rising seas and extreme weather events alter the productivity of aquatic habitats and the distribution and productivity of marine fish species. These changes are threat multipliers to existing stressors on the sector, including overfishing, loss of habitat, pollution, coral bleaching, and the proliferation of invasive species.

TOURISM

Tourism is essential to the economy of the Eastern Caribbean, contributing substantially to territorial GDP and serving as a source of employment across the region. Tourism relies on critical, government-owned infrastructure such as airports and seaports serving travel between islands, as well as on coastal communication systems, utilities and roads. Tourism also

depends on a range of privately-owned infrastructure, including hotels and other beach facilities as well as boats for ocean activities and vehicles for land transportation. All this infrastructure is vulnerable both to rising sea levels and damage from floods and storm surge, and more directly to the impacts of hurricanes and other extreme events.

COASTAL RESOURCES

Coastal zones in the Eastern Caribbean are all highly vulnerable to changes brought about by climate-change forces such as rising sea levels, warming ocean temperatures, increasing ocean acidity, and the impact of storms. Rapid coastal erosion and increased salinization of coastal areas, as well as impacts on coral bleaching, have immediate impacts. Vulnerability is also increased through inappropriate land use planning and badly designed coastal works such as structures built right on the coast, too close to the beach, hard longitudinal coastal defences on upper beaches (seawalls, revetments), hard cross-shore coastal structures (jetties, groynes), and reclamation of wetlands and mangroves. Built infrastructure, including roads, settlements, hotels and coastal defences, as well as sand mining and other resource extraction and coastal activities have jeopardized the coast and contributed to the destruction of important living resource systems, such as coral reefs, mangroves and seagrass beds (see also the section on food security). The major future impacts of sea level rise facing the OECS region include coastal erosion, reduction of land space - including urban space - near coastlines, and saline intrusion into soils and aquifers. Forecasts of coastal erosion impacts on tourism activity within CARICOM member countries point to 30% of coastal tourism infrastructure being affected by a 1 m shoreline retreat (SLR) and 60% by a 100 m shoreline retreat.

TRANSPORT SECTOR AND BUILT ENVIRONMENT

Sea level rise, shifting temperatures and precipitation patterns are climatic changes to baseline conditions that affect transport and housing — and especially the people living there. These changes can lead to more frequent or more severe droughts, floods, tropical storms and storm surge, and should be considered in road and housing design, siting, materials selection, construction, use, and maintenance. Roads and housing, especially permanent structures, need to be designed to reduce exposure and sensitivity to climate variability and change. Improperly or poorly constructed housing presents one of the greatest risks associated with climate hazards, leaving inhabitants highly vulnerable. Relocation of settlements may become necessary due to gradual impacts such as sea level rise; however, many questions remain on the relocation issue. In many cases managing for greater uncertainty and risk associated with potential extreme conditions rather than past historical trends should be applied. This type of focus on risk analysis and management is commonly applied by the financial and insurance industries and can also be used in assessing proposed development activities.

HEALTH

Extreme weather, coupled with higher temperatures and changes in rainfall, will impact the region's population both directly and indirectly. Heat stress, for example, induces dehydration and has been linked to chronic kidney disease in agricultural and construction workers, and has the potential to increase respiratory and cardiovascular disease risks. Storms and hurricanes can cause death and lead to flooding with significant effects on crop production, water quality and water-borne illnesses.

Additionally, the increased morbidity and mortality of water borne illnesses such as gastroenteritis and Leptospirosis, mental health effects of extreme events, and impacts of cardiovascular and respiratory conditions are all subject to climate stress. The region’s aging population is also vulnerable to increased heat stress. Disease outbreaks closely associated with the climatic conditions of the Eastern Caribbean include those transmitted by mosquito species of the genus *Aedes* (*a. aegypti* and *a. albopictus*). Temperature is an important determinant of biting rate and mosquito development (such as virus development time and survival at all stages of the mosquito life cycle). Precipitation provides habitats for the aquatic stages of the mosquito life cycle and strongly influences vector distribution. Changes in climate are already altering the spatial and temporal dynamics of dengue ecology, potentially increasing vector ranges, lengthening the duration of vector activity, and increasing the mosquito’s infectious period. Dengue is endemic in Saint Lucia, and is likely to continue increasing as dengue vectors reproduce more quickly and bite more frequently at higher temperatures. Other climate-related public health issues in the region include harmful sargassum algal blooms and Saharan dust; the latter travels across the northern tropical Atlantic to the Caribbean every year from the Sahara region. The majority of territories in the Caribbean do not have routine air quality monitoring programmes, and several do not have or enforce air quality regulations.

IMPACTS OF RAPID-ONSET EXTREME EVENTS

Most of the Eastern Caribbean is made up of small island developing states. When an extreme event happens, it is therefore likely to overwhelm an entire country or territory because of its small size and have an outsize impact on national GDP. Emergency services are likely to be overwhelmed, while critical infrastructure serving the entire country may be significantly damaged or destroyed. The devastation is likely to be debilitating without outside support to address the immediate needs of the

population. Figures 6 and 7 shows the number of people affected by key natural hazards 1985-2018 in Saint Lucia (Source: World Bank Climate Change Portal).

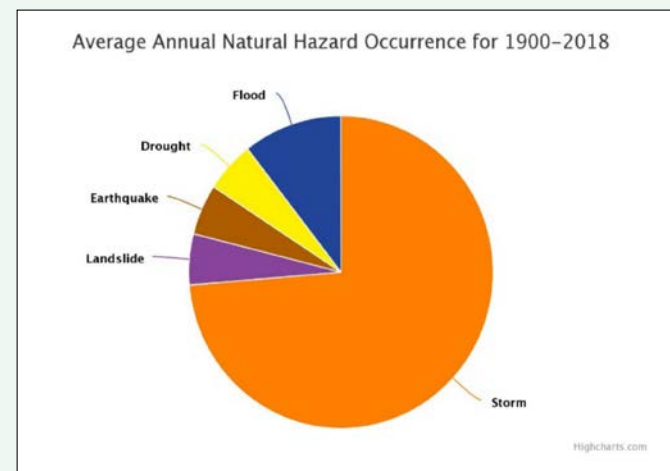


Figure 6
Saint Lucia

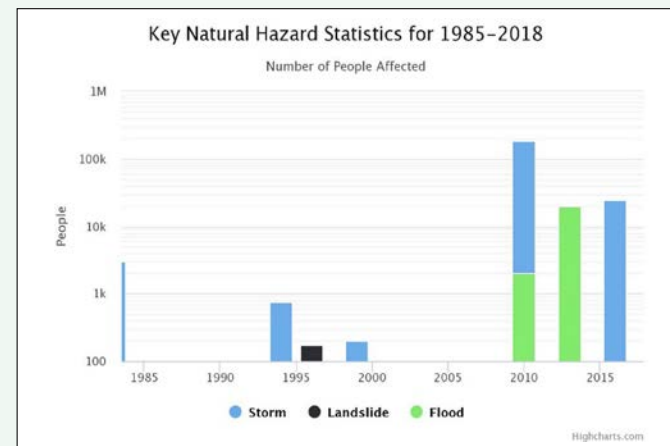


Figure 7
Saint Lucia

Gaps in research and information

Although significant progress has been made to collate the available historical records of climate and hazards in St Lucia, there are still large variations in the needs and quality of research, information, and data.

Research gaps

- Analyses allowing a robust description of the climatology, variability, extremes and trends at any location are possible if long, good quality data records of (sub-)daily weather observations are available. This was the case for the Hewanorra Airport station in the extreme south, representing the drier parts of Saint Lucia. To a lesser extent, due to the limited amount of data prior to 1995, this was also the case for the George F.L. Charles Airport station near the capital (Castries) in the north-west. However, a significant portion of the population lives in other areas, where limited data were available for analysis. Therefore, comprehensively assessing the nature of climate hazards for the central and southern portions (except the extreme south) is an immense challenge.
- Some knowledge has been gathered since the 1990s on drivers of drought, excessive rainfall and tropical cyclones in the Caribbean as a whole. However, little information is available on the drivers of heat, extreme rainfall or sea level rise at the OECS regional level, let alone the Saint Lucia Island level.
- Knowledge on the impacts of and risk associated with hurricanes, sea level rise and rising ocean temperatures engendering coral reef bleaching in the Caribbean is relatively well established. In addition, recent efforts have led to some advancement in mapping flash flood/flooding and drought as hazards and risk factors to socio-economic sectors in the Caribbean and, by extension, Saint Lucia. However, not much is known or measured with respect to heat impacts on Saint Lucia's society and environment.

Data and information gaps

- The Hewanorra airport record of daily weather observations exceed 45 years in length. This makes the climatological analysis robust for the low-lying, drier areas with respect to heat and drought/dryness related hazards. However, since extreme rainfall occurrence is a smaller-scale, highly variable physical process and extreme rainfall occurrence is typically enhanced by pronounced topography, data records of daily rainfall for the wetter portions of the country, including the mountainous inland areas, would be beneficial to assess flash flooding across the island.
- Much more so than weather observation data, socio-economic and environmental impact data with respect to climate-related hazards beyond tropical cyclones and sea level rise are scant in the Caribbean, let alone Saint Lucia. While in-depth data mining has not been done, regional experience teaches that this is particularly the case for heat impacts. Apart from sea level rise, heat is the one hazard that has already intensified and that we are most confident will continue to intensify. Therefore, in future, heat impacts on public health, agriculture, water, education, energy and labour need to be observed and archived and data sets made available for research, so as to determine the different dimensions of risk from excessive heat exposure.

CLIMATE CHANGE POLICY PRIORITIES IN TERMS OF ADAPTATION

Saint Lucia is a democratic and sovereign country, a full Member of the OECS (OECS country host), a signatory to the UNFCCC and the Paris Agreement.

- The Government of Saint Lucia has submitted three **National Communications to the UNFCCC (NC)**: NC1 in 2001, NC2 in 2012 and NC3 with National GHG Inventory Report in 2017. These documents were produced according to the UNFCCC reporting guidelines, and provided very detailed information on climate-related issues.
- The Saint Lucia Government has approved the **Climate Change Adaptation Policy (CCAP 2015)**. The CCAP seeks *“to ensure that Saint Lucia and its people, their livelihoods, social systems and environment are resilient to the risks and impacts of climate change. It also provides a framework for addressing the impacts of climate change in an integrated manner across all key sectors, based on three interconnected processes: adaptation facilitation which entails creating the appropriate policy, legislative and institutional environment; adaptation Financing which involves putting in place measures to ensure adequate and predictable financial flows; and adaptation implementation which entails taking concrete actions to prepare for, or respond to, the impacts of climate change”*.
- The Saint Lucia **first Nationally Determined Contribution (NDC)** was submitted in September 2016 and updated in January 2021: Saint Lucia’s updated NDC will reduce greenhouse gases by 7% compared to 2010 emissions, a deeper reduction than the first NDC which effectively resulted in an emissions reduction of 2%. The key adaptation actions in water, fisheries, agriculture and resilient ecosystems sectors expected to have mitigation co-benefits are listed below.

Selected adaptation interventions

SELECTED PROGRAMME / PROJECT	VALUE (USD)	DONOR	YEAR	IMPLEMENTING AGENCY
Point Sable Environmental Protection Area (PSEPA): Integrated Ecosystem Management, Restoration of Forests on the South East Coast of Saint Lucia Increasing resilience to Climate Change and Natural Hazards.	Total budget of US\$7.57m (Saint Lucia components: US\$241,544.00)	GEF, St Lucia National Trust KFW GEF Regional project GEF	2018 - 2022 2016 2011	UNEP
Soufriere Marine Management Area (SMMA)	n/a	CARICOM - GIZ		UNDP
Bellevue Farmer’s Coop (gender balance component). Carib Aqua-Terrestrial Solutions initiative.	n/a			CAFRA - Ridge-to-reef
Catalysing Implementation of the Strategic Action Programme for the Sustainable Management of Shared Living Marine Resources in the Caribbean and North Brazil Shelf Large Marine Ecosystems Project.	n/a		2018-2030	CANARI
Rainwater Harvesting Project	n/a	Saint Lucia Development Bank		National Emergency Management Organization (NEMO)
Resilient Environmental & Agricultural Caribbean Habitats (innovation in weather data for private sector).	n/a	CDEMA		Ministry of Agriculture (MOA)
Rainwater harvesting; water tanks; and retaining walls (small loans designed for Small & Medium Enterprise quasi-adaptation projects).	n/a	Climate Adaptation Financing Facility (CAFF) of the SLDB,		
Sustainable Cities Project, Maintaining ecosystem integrity and a focus on coastal resilience in Southern Saint Lucia	n/a			OECS

KEY RESOURCES

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ACKNOWLEDGEMENTS AND DISCLAIMER

Date of publication : 2021

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