Country analysis: Resilience to climate change at a glance

SAINT VINCENT AND THE GRENADINES

KEY MESSAGES

Climate change risks

Increased hot season	Major hurricanes	Sea level rise	Warmer oceans	Increasing flash floods	Droughts

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 Vincent and The Grenadines

Total Area (square km)	*389*
Population	*101,800*
Percent Urbanization	*52.2*
GDP per capita	*US$ 11,500*
Debt as a percent of GDP	*73.8*
Unemployment Rate	*18.8*
Services as a percentage of GDP	*76*
Services as a percentage of workforce	*57*
Agriculture as a percentage of GDP	*7.1*
Agriculture as percentage of workforce	*26*
Percent Agriculture Land	*25.6*
Percent Forests	*68.7*
Human development Index value	*0,738*

Map of Saint. Vincent and the Grenadines

Figure 1: www.worldatlas.com

AFD Adapt'Action Expertise France

This technical assistance operation is financed by the French Development Agency (AFD) and implemented by Expertise France, within the framework of the Adapt'Action facility. This facility, which began in May 2017, supports African countries, LDCs and SIDs in implementing their commitments under the Paris climate agreement, through financing studies and activities on capacity-building and technical assistance, especially in the adaptation sector.

OVERVIEW

Saint Vincent and the Grenadines consists of 32 islands, islets and cays, with a total land area of 345 Km². These islands are part of the **Windward Island chain of the Lesser Antilles**. Saint Vincent, occupying the majority of the total land area, is located at latitude 13°15′ N, longitude 61°12′ W. The other islands extend south for 75 km and form two thirds of the Grenadines archipelago.

The population of Saint Vincent and the Grenadines was estimated at around 109,400 in 2014. About 91 percent of the country's population lives on the main island, Saint Vincent, and sizeable communities live on Bequia, Union Island, Canouan and Mustique. The island of Saint Vincent has a rugged terrain rising to an elevation of 1,234 m at the cone of the Soufriere volcano, with very few flat areas. Rich, volcanic soils and the elevated rainfall allow for dense rainforest in Saint Vincent, with a drought-tolerant natural vegetation type in the Grenadines.

Saint Vincent and the Grenadines is exposed to trade winds, which keep temperatures moderate at around 27°C along the coastline, but with higher humidity and rainfall, as well as lower temperatures with increasing elevation. The hot season (May to October) is characterized on average by 42 hot days (when day-time high temperatures are close to or exceed 32°C) and 33 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 over 2000 mm at low elevations on Saint Vincent and up to over 4000 mm at the highest elevations. By contrast, rainfall is about 50% lower in the Grenadines – which are semi-humid to semi-arid – than in coastal areas of Saint Vincent. The wet season spans June to November, coinciding with the Atlantic hurricane season. Each of the wet season months totals over 200 mm on Saint Vincent.

Extreme rainfall has the potential to trigger a flash flood nearly every other year between June and August, and once to twice per year between September and December. By contrast, a number of spells of seven consecutive dry days occur from February to April, potentially limiting growth of sensitive crops. Finally, impactful drought occurs on average once per 4-5 years during the dry season, and once every 15 years in the wet season, potentially impacting freshwater availability. This year, a major eruption of the volcano in April severely impacted the entire country (above 16 000 people were evacuated off the country while the Covid pandemic was taking place).

Eruption of the Soufriere volcano in April 2021 (left) and Kingstown (Saint Vincent and the Grenadines) covered with ash (right).

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.

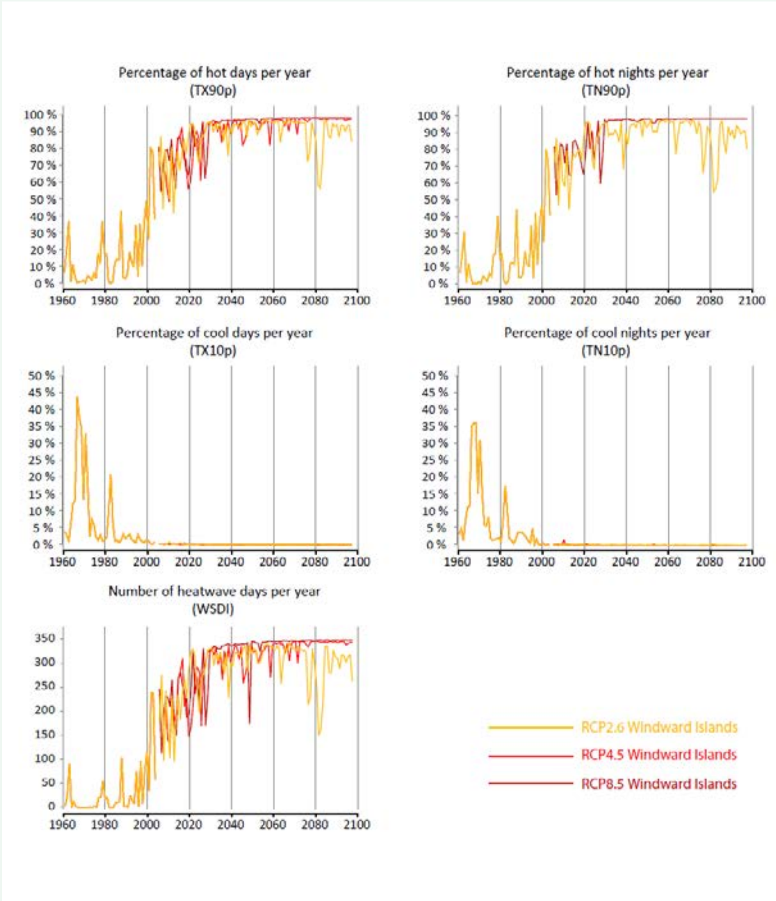


Figure 2

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 the 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 barely 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.

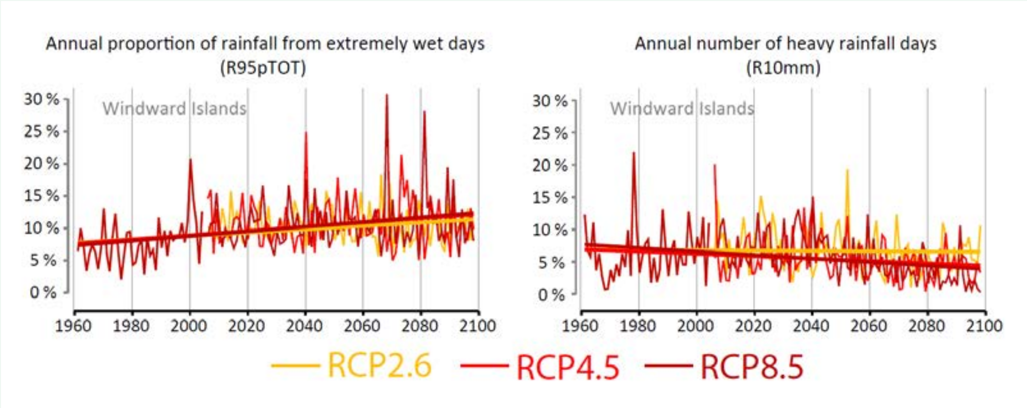


Figure 3

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 the 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 the 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 take anywhere between a few weeks and about 6 months of rainfall deficit – 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 become affected. Finally, after about 9 to 12 months of rainfall deficit – i.e. **long-term drought** –, water levels in the largest surface reservoirs and in aquifers tend to fall 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 Vincent and The Grenadines. 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 do not change 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 SPI6 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. These significant trends stand out even with the large interannual variability in both the SPI-6 and SPI-12.

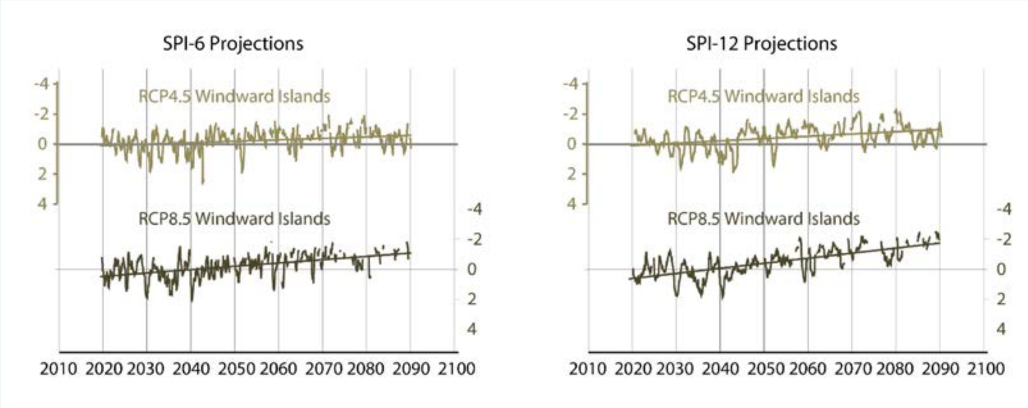


Figure 4

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 copious rainfall of St Vincent and the Grenadines 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.

Saint Vincent and the Grenadines (BY-SA 3.0)

SOCIOECONOMIC CHARACTERISTICS

Population

According to the 2012 Census Preliminary Report, the population in that year stood at 109,188. Of that recorded population, 98,954 (90.6%) lived in Saint Vincent, while 10,234 (9.4%) were in the Grenadines (Government of Saint Vincent and The Grenadines, 2015). However, the World Bank (2018) estimates that by 2018 the population had increased to 110,210 with a male to female ratio of 50.79% to 49.21%, respectively. In 2015, life expectancy at birth was 77.1 for females and 73.1 years for males (PAHO, 2017).

Main economic drivers

The GDP of Saint Vincent and the Grenadines was estimated at XCD 1,731.59M in 2008 (Government of Saint Vincent and The Grenadines, 2015). The most important sector of the island's economy is agriculture, mainly from the production of bananas. The services sector, based mostly on a growing tourism industry, is also important. Recent growth is thought to have been stimulated by activity in the construction sector and an improvement in tourism (See Table 1, Government of Saint Vincent and the Grenadines, 2019). There is also a small manufacturing and offshore financial sector.

Tourism

Tourism is a significant economic driver, foreign exchange earner and employment creator. Currently, Saint Vincent and the Grenadines is changing its tourism model to include eco- and sports tourism, as well as to improve the accommodation sector. In 2018, the ECCB estimated that a total of 356,069 visitors entered SVG, the majority being cruise ship (217,876) and yacht passengers (56,826). The main country of origin for the visitors that stayed over was the USA (26,351), closely followed by other Caribbean islands (23,807), then the UK (12,959), Canada (9,822) and other countries (7,141).

Table 1

Sector contribution to GDP (in millions) for the years 2008 and 2013, in constant 2006 prices.

Sector	2008	2013
Agriculture, Hunting and Forestry	87.74	88.25
Fishing	5.31	5.58
Mining & Quarrying	5.00	2.03
Manufacturing	69.60	58.91
Electricity & Water	58.10	58.46
Construction	139.89	123.48
Wholesale & Retail Trade	243.94	224.16
Hotels & Restaurants	46.62	34.18
Transport, Storage and Communications	217.04	208.57
Financial Intermediation	104.36	101.84
Real Estate, Renting and Business Services	233.98	235.27
Public Administration, Defence & Compulsory Social Security	121.48	168.25
Education	60.58	67.94
Health and Social Work	40.58	44.20
Other Community, Social & Personal Services	29.42	30.09
Private Households with employed persons	3.06	3.50
GDP at market prices	**1731.59**	**1693.28**

Energy

Approximately 80% of the electrical energy generated in Saint Vincent and the Grenadines comes from fossil fuel. The remaining 20% comes from hydro-electricity which is generated from three of the large rivers (Cumberland, South Rivers and Richmond) by the island's lone electricity provider, St Vincent Electricity Services Limited (VINLEC). Research has also shown that La Soufriere has potential for geo-thermal energy. The main consumers of electricity are the domestic sector (48.9%), commercial sector (43.2%), industry (5.5%) and street lighting (2.4%) (Government of Saint Vincent and The Grenadines, 2015).

Transport

There are several small airports (Aryle International Airport, airstrips on Bequia, Union Island, Canouan and Mustique islands) between all the islands that make up Saint Vincent and the Grenadines; however, they still face the challenge of quantity of flights and airlines (Government of Saint Vincent and The Grenadines, 2015). There are five marine terminals in the country including the main deep-water port at Kingstown, which accommodates the cruise ships and ferries servicing the Grenadines. There are also several smaller ports and jetties scattered around the island.

Land use

Of the 96,000 acres of land in Saint Vincent and the Grenadines, approximately 32% is available for agriculture. Forestry accounts for 47% of the land space; approximately 11% is designated for built-up areas and 10% for miscellaneous land uses. Tropical rain forest still exists on the island, but on the central mountains which are difficult to penetrate. The decline of agriculture over the last thirty years has resulted in rural-urban migration to the Grenadines and the Greater Urban area of Kingstown as people move in search of jobs in the tourism and urban sectors. This has placed great pressure on land resources, leading to high population and development densities and uncontrolled expansion of informal settlements into the fragile and ecologically sensitive hillsides surrounding Kingstown (Isaacs, 2013).

Agriculture

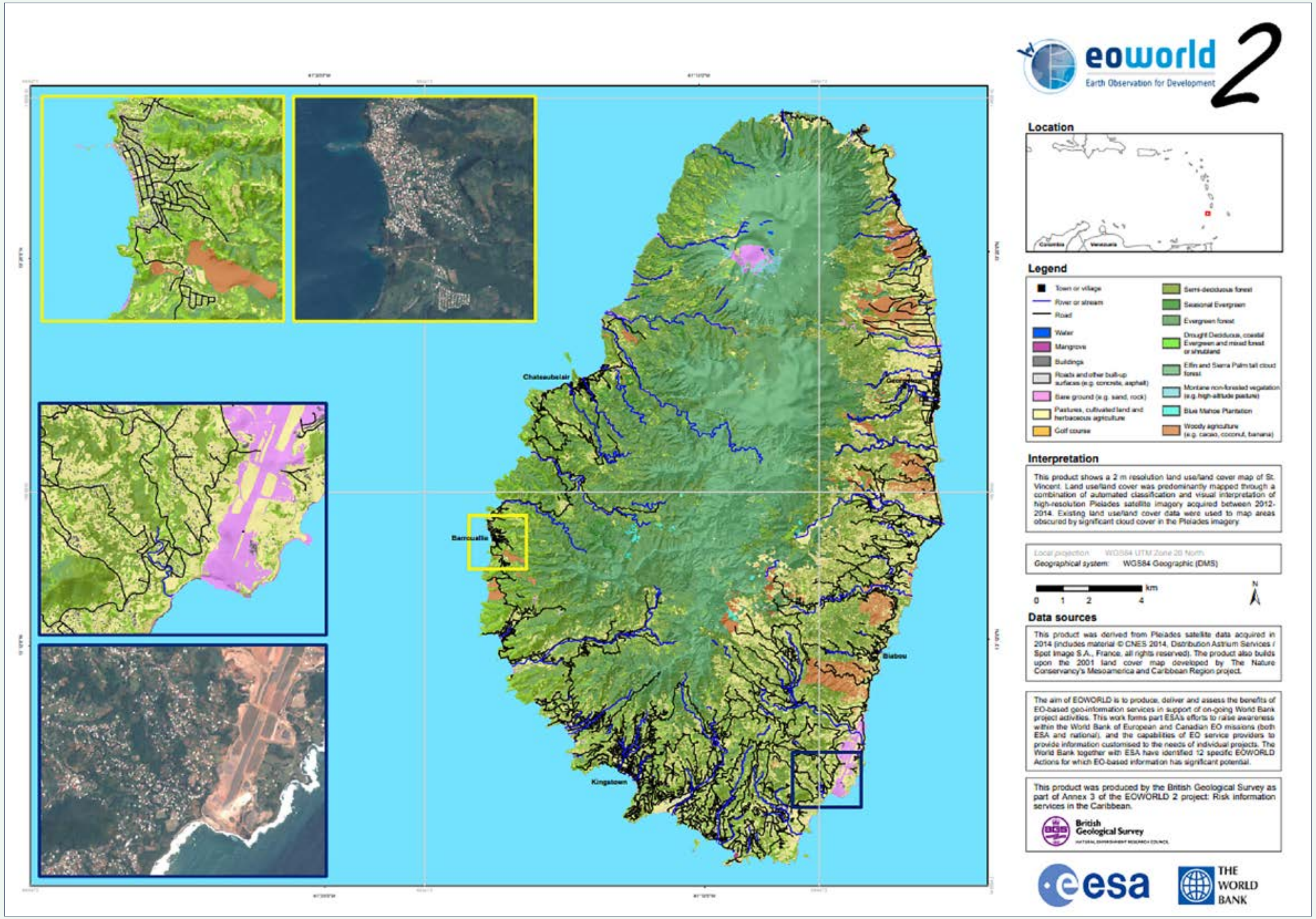
The majority of farming in Saint Vincent and the Grenadines is done on the mainland with some subsistence farming on the larger islands of the Grenadines. Family farms, usually small (less than 4000 m2) and very labour intensive, make up over 90% of the approximately 7000 holdings across the country (IICA, Nd). Bananas 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 Vincent and the Grenadines from a net exporter of food crops to a net importer.

Health

There are around 40 health centres, and seven hospitals, such as Milton Cato Memorial Hospital in Kingstown (PAHO, 2017). A new wing at Milton Cato was recently built that act as a centre for paediatric surgery, not only for St Vincent and the Grenadines but also other nearby Caribbean nations (Commonwealth Health, 2019). All other serious medical problems often require air evacuation to another country with the necessary medical facilities. Between 2012 and 2014, the technical workforce comprised 793 people, including 87 physicians, 341 registered nurses, 46 community health aides, 7 dentists, and 23 pharmacists (PAHO, 2017).

Figure 5

LAND USE IN SAINT VINCENT



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 Saint Kitts and Nevis with a water stress index of 51%, followed by Saint 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. Specialty 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 14 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 food security section on fisheries). The major future impacts of sea level rise (SLR) 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 1m 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.

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 show the number of people affected by key natural hazards between 1985 and 2018 and the frequency of distribution of natural hazards (Source: World Bank Climate Change Portal).

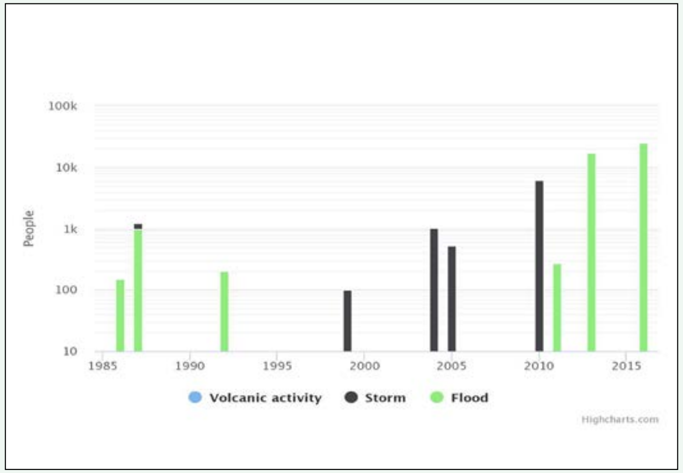


Figure 6

Number of people affected by key natural hazards in Saint Vincent and the Grenadines (1985-2018).

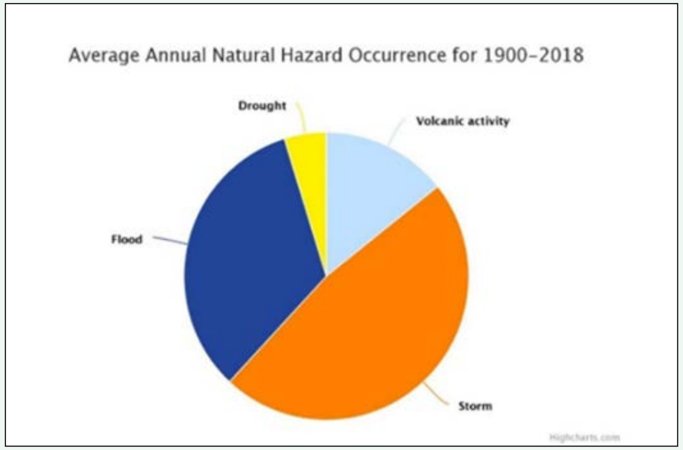


Figure 7

Frequency distribution in Saint Vincent and the Grenadines.

Gaps in research and information

Although significant progress has been made to collate the available historical records of climate and hazards, 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, to a large extent, the case for the E.T. Joshua Airport station on Saint Vincent's south coast However, no sufficiently long daily data records are available for any other location on Saint Vincent or anywhere in the Grenadines. Therefore, comprehensively assessing the nature of climate hazards for the windward side of Saint Vincent, where a sizeable proportion of the population resides, or the Grenadines 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 national level in Saint Vincent and the Grenadines.
- 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 Vincent and the Grenadines. However, not much is known or measured with respect to heat impacts on the country's society and environment.

Data and information gaps

- The E.T. Joshua Airport records of daily weather observations exceeds 30 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 and drier portions of the country, including the mountainous inland areas and the Grenadines, 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 Vincent and the Grenadines. 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 Vincent and the Grenadines is a parliamentary democracy and constitutional monarchy; it is a Member of the Organisation of Eastern Caribbean States. It is fully committed to low-carbon and resilient development. The country ratified the UNFCCC on 2 December 1996.

- Saint Vincent and The Grenadines has submitted two **National Communications**, the latest in 2015 and will be preparing its first Biennial Updated Report (BUR) in conjunction with its Third National Communication.

Saint Vincent's Nationally Determined Contribution (NDC) was submitted in November 2015 and the country signed the Paris Agreement on 29 June 2016.

- The NDC states that Saint Vincent and the Grenadines intends to achieve an unconditional, economy-wide reduction in greenhouse gas (GHG) emissions of 22% compared to its business as usual (BAU) scenario by 202.
- It includes the commitments for adaptation planning in several sectors: agriculture, coastal zone, water resources, health, disaster risk reduction and climate change adaptation.
- The NDC concludes: "Despite the injection of funds to the country through the PPCR, the need for financing climate change adaptation and mitigation in Saint Vincent and the Grenadines remains significant."

Selected adaptation interventions

SELECTED PROGRAMME / PROJECT	*VALUE (USD)*	*DONOR*	*YEAR*	*IMPLEMENTING AGENCY*
Disaster Vulnerability and Climate Risk Reduction / Additional Financing to the Regional Disaster Vulnerability Reduction Project (RDVRP) in St Vincent and the Grenadines & Climate. Information Systems and Disaster Risk Management	US$ 7 million	World Bank	2014-2017	Ministry of Finance and Economic Planning (MoFEP) – Central Planning Division (CPD)
At the Water's Edge (AWE), Demonstrating that governments and communities of small island states can enhance their resilience to climate change by protecting, restoring and effectively managing their marine and coastal ecosystems and strengthening local capacity for adaptation.	N.A.	N.A.	On -going	The Nature Conservancy and the Red Cross International several partners
"Pass it on" home gardens in the community; Boosting Food security in the Home Garden Movement in a climate change/disaster management context.	N.A.	N.A.	On -going	The Nature Conservancy and the Red Cross International several partners

KEY RESOURCES

BRGM and World Bank (2016) ThinkHazard!

Commonwealth Health. (2019). Saint Vincent and the Grenadines: Health Systems. from the Commonwealth Health Online.

CSGM and CIMH (2020) State of the Caribbean Climate 2017: Information for Resilience Building. Produced for the Caribbean Development Bank. In press.

ECCB. (2018). Statistics. Retrieved 15th December, 2019, from Eastern Caribbean Central Bank.

Government of Saint Vincent and The Grenadines. (2015). Second National Communication Report to the United Nations Framework Convention on Climate Change.

Government of Saint Vincent and The Grenadines. (2019). Citizens: Economy. Retrieved 15th December, 2019 official website of the Government.

IICA. (n.d). IICD Country Strategy 2014 – 2018: St Vincent and the Grenadines. Inter-American Institute for Cooperation on Agriculture.

IPCC (2012) Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA.

PCC (2019), IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)].

Isaacs, Philmore, 2013. Draft Issue Paper, Sustainable Land Management. Saint Vincent and the Grenadines.

National Adaptation Plan for Saint Vincent and the Grenadines (2019).

OECS (2019) Caribbean Regional Oceanscape Project - Developing Ocean Policy Baseline Analysis Report.

OECS (2020) Climate Change and Projections for the OECS Region.

PAHO. (2017). Health in the Americas: Saint Vincent and The Grenadines. Retrieved 15th December, 2019 from Pan American Health Organization.

Saint Vincent and the Grenadines Intended Nationally Determined Contribution (2015).

World Bank. (2018). Saint Vincent and The Grenadines: Population. Retrieved 15th December, 2019 from The World Bank.

ACKNOWLEDGEMENTS AND DISCLAIMER

Date of publication : **2021**
Climate Risk Profile prepared by: **Artelia and the Caribbean Institute for Meteorology and Hydrology (CIMH)**

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