ECS

Country analysis: resilience to climate change at a glance

SAINT KITTS AND NEVIS

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 Kitts and Nevis

Total Area (square km)	*269*
Population	*53,100*
Percent Urbanization	*30.8*
GDP per capita	*$28,200*
Debt as a percent of GDP	*62.9*
Unemployment Rate	*4.5*
Services as a percent of GDP	*69,9*
Services as a percent of workforce	*N/A*
Agriculture as a percent of GDP	*1.1*
Agriculture as percent of workforce	*N/A*
Percent Agriculture Land	*23.1*
Percent Forests	*42,3*
Human Development Index	***0.777***

Map of Saint Kitts and Nevis

Figure 1 - www.lonelyplanet.com

AFD | AdaptAction | 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 Kitts and Nevis is a twin island Federation located in the **Leeward Islands of the Lesser Antilles**. St. Kitts is located at 17°15′ N Latitude and 62°45′ W Longitude, while Nevis is located 3 km to the southeast at 17°10'N and 62°35′ W. St. Kitts and Nevis has a total land area of 269 sq. km with St. Kitts, the larger of the two islands accounting for 176 sq. km (65% of the land area). In 2014 the population of St. Kitts and Nevis was estimated around 54,940. The islands are volcanic and are characterized by three volcanic centres (Central Northwest, Middle range, and Southern Range). The highest point Mont Liamuiga is located in the central northwest ranges and rises with a pronounced crater to 1,156 m. Volcanic soils, combined with ample rainfall, support rainforest at higher elevations. However, due to lower rainfall and higher evapotranspiration rates, scrub vegetation is more common near sea level. St. Kitts and Nevis, the twin islands are well exposed to trade winds, which keeps temperatures moderate at around 27°C near sea level, with a relative humidity of 76% (St. Christopher Air & Sea Ports Authority (SCASPA) – Meteorological Dept.). The heat season (May to October) is characterized by 54 hot days (when day-time high temperatures are above 32°C) and 35 hot nights (with night-time lows above 26°C) on average, as well as, by several heat waves. During the cool season (December to March), heat levels are comfortable and 33 cool nights (with lows below 22°C) occur on average.

The wet season spans May to November, largely coinciding with the Atlantic Hurricane Season. The mean annual rainfall total varies from around 1200 mm in low-lying areas, and exceeds 3000 mm at the highest elevations. (St. Christopher Air & Sea Ports Authority, SCASPA – Met. Dept., rcc.cimh.edu.bb). Extreme rainfall has the potential to trigger flash floods once every 4-5 years in the period April to May and roughly once every two years between September and November. By contrast, spells of seven consecutive dry days occur throughout the year, peaking in frequency during January to May, potentially limiting rainfed crop growth. Finally, impactful drought occurs roughly every 4-5 years during the dry season, potentially impacting on fresh water availability, but rarely during the wet season.

ST KITT AND NEVIS - *Source Elite Traveler*

ST KITT AND NEVIS - *Source: J. P. Ross*

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 Leeward 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.

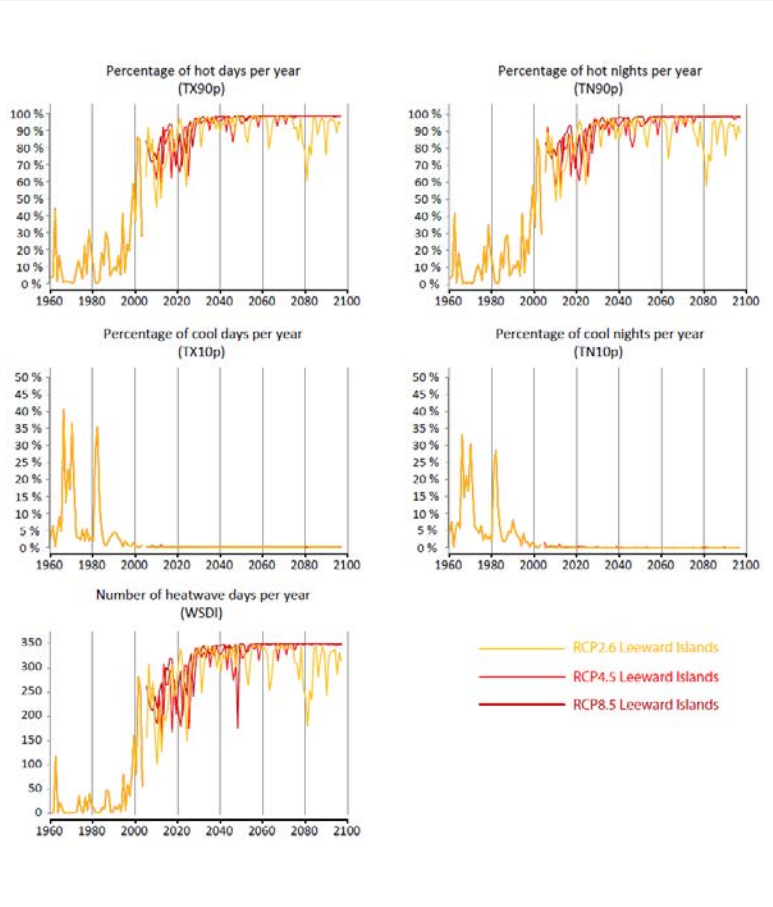

Figure 2

In the Leeward 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 heat-wave 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. But 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

There are **no clear signals in projected trends of extreme rainfall** in Figure 3. 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.

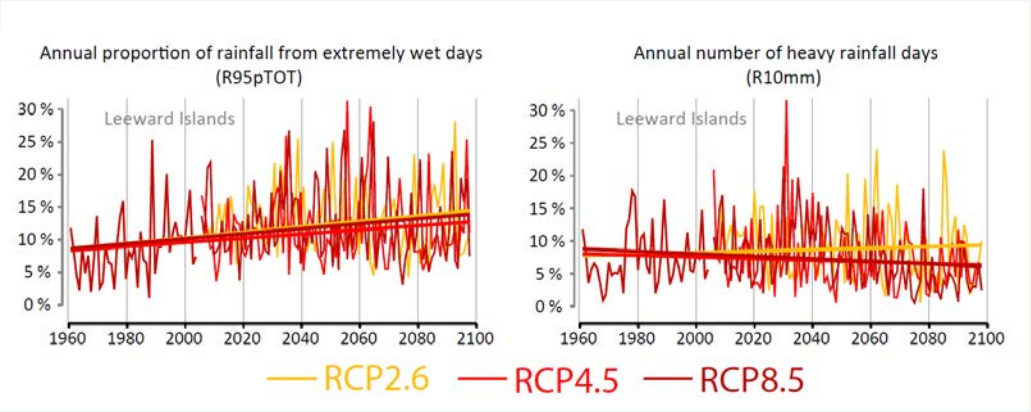

Figure 3

For the Leeward 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. s will robustly reflect the level of heat exposure and associated heat stress.

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.

HEAT - AN UNDERESTIMATED HAZARD

Air temperature does not vary much between seasons and years in St. Kitts and Nevis. The heat – being moderated by a prevalent easterly breeze – **has historically** not been regarded as a major hazard but, at best, 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 hazard, in particular for 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 thousands 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);

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.

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.

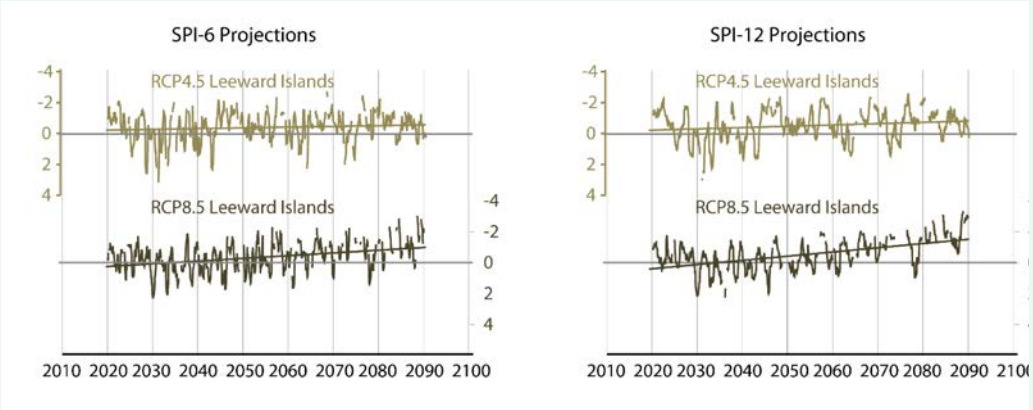

Figure 4

For the Leeward Islands: Simulated trends in the standardized precipitation index over six months (SPI-6, left) and twelve months (SPI-12, right) per year 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. Kitts and Nevis 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).

For St. Kitts and Nevis, seven out of a total of seven reported floods between 1988 and 2011 as recorded in the Caribbean Climate Impacts Database (cid.cimh.edu.bb) occurred during (or within 2 days) of an extreme wet spell.

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

Close up of worker picking bell peppers in hydroponic farm in Nevis, West Indies

SOCIOECONOMIC CHARACTERISTICS

Population

The last census was in 2011 where the population was estimated at 46,398, with 34,983 in Saint Kitts and 11,415 in Nevis, with the gender ratio being 49.23% males and 50.77% females (Government of Saint Kitts and Nevis, 2015). However, the World Bank estimates the current total population to be around 552,441 (World Bank, 2018). The urban parishes of St. Kitts (Saint George and Saint Peter) and Nevis (Saint Paul) account for 37% and 15% of the population, respectively.

Main Economic Drivers

As is the case for most islands in the Caribbean region, the economy for many years was based mainly on the sugar industry, this has since shifted to a more service-based economy, due to the travel and tourism. Table 1 shows the changes in sectoral contribution to the GDP for 2012 and 2013.

Tourism

The tourism industry directly generated around 1,500 jobs in 2013; which is 6.1% of total employment. This includes employment by hotels, travel agents, airlines, restaurant and leisure activities, and other passenger transportation services (excluding commuter services) (World Travel & Tourism Council, 2014). The estimated total amount of tourists for 2018 was 1,297,385, however only 9.5% (122,946) actually stayed over, tourism industry relying heavily on cruise ships. The main origin country for stay over visitors is the USA (74,439), followed by other Caribbean islands (26,512), UK (8,616), Canada (7,185) and other countries (6,194) (ECCB, 2018).

Table 1

GDP by Sector based on Current Prices (in millions) for the years 2012 and 2013 (adapted from Government of Saint Kitts and Nevis, 2015).

SECTOR	2012	2013
Agriculture, Livestock and Forestry	*18.04*	*20.61*
Fishing	*9.12*	*8.93*
Mining and Quarrying	*1.44*	*2.37*
Manufacturing	*213.46*	*193.42*
Electricity and Water	*30.09*	*29.92*
Construction	*195.81*	*222.91*
Wholesale and Retail Trade	*142.89*	*152.33*
Hotels and Restaurants	*105.72*	*111.20*
Transport, Storage and Communications	*224.09*	*236.22*
Financial Intermediate	*113.82*	*118.00*
Real Estate, Renting and Business Activities	*283.80*	*297.19*
Public Administration, Defense and Compulsory Social Security	*166.25*	*193.35*
Education	*91.19*	*98.64*
Health and Social Work	*45.72*	*49.74*
Other Community, Social and Personal Services	*46.28*	*50.28*
Activities of Private Households as Employers	*5.29*	*5.76*
GDP in Market Prices	***1 976.18***	***2 090.34***
Growth Rate	***0.53***	***5.78***

Energy

Like most other island nations, St. Kitts and Nevis is heavily reliant on imported fossil fuels for electricity, therefore leaving it vulnerable to global oil price fluctuations. The residential sector consumes the largest percentage of energy (43%) closely followed by the transportation sector (40%) (Government of Saint Kitts and Nevis, 2018). With a large geothermal resource and moderate-to-high wind and solar resources, St. Kitts and Nevis has sufficient renewable energy resource potential in order to meet some, if not all of its current and future electricity needs (NREL, 2015; IDB,2015).

Transportation

There is a regular passenger ferry service connecting the two islands, from Basseterre and Charlestown. Basseterre, in Saint Kitts has a deep-sea port, where cruise ships and cargo vessels can dock, whereas Charlestown in Nevis has a 126 m pier. There are also smaller ports, such as Sandy Point Saint Kitts and Newcastle Nevis. The Robert Llewellyn international airport is located in Golden Rock Saint Kitts and has direct flights from USA and Canada, flights to other continents go via Antigua. There is only an airstrip in Nevis, near to Newcastle.

Land use

Saint Kitts and Nevis has one of the highest percentages of forest cover in the Caribbean. However, as in most countries of the Caribbean, there is a large amount of evidence of human disturbance of the forest ecosystem Table 2.

Table 2

Land Cover in Saint Kitts and Nevis in 2000 (FAO b, 2015).

LAND COVER CLASS	AREA (HA)
Pasture, Hay or other Grassy Areas	5 358
Sugar cane (and minor crops)	4 572
Evergreen Forest (including Sierra Palm Forest)	3 481
Semi-Deciduous Forest (includes Semi-Evergreen Forest)	3 090
Seasonal Evergreen Forest	2 484
Drought Deciduous Open Woodland	1 625
Low Density Built-up Land (Rural or Residential)	972
Deciduous, Evergreen Coastal and Mixed Forest or Shrubland	963
High-Medium Density Urban or Built-up Land	869
Sierra Palm, Transitional and Tall Cloud Forest	685
Drought Deciduous Forest/Shrub	397
Water - Permanent	267
Elfin and Sierra Palm Cloud Forest	239
Bare Soil (including bulldozed land)	238
Coastal Sand, Rock, Cliffs or Bare Ground	211
Evergreen Forest with Coconut Palm	182
Montane Non-Forest Vegetation	115
Golf Course	105
Steep Non-Forest Vegetation	80
Quarries	28
Coconut Palm-Pasture	23
Mangrove	14
Seasonally Flooded Savannahs and Woodland	5
Emergent Wetland	2
TOTAL	**26,005**

Health

Health leadership and governance are guided by health policies and legislation. Financing of the health sector is challenging and the new financing mechanism being considered is a national health insurance scheme. The Ministry of Health is organized into three programs: The Office of Policy Development and Information Management, Community-based Health Services, and Institution-based Health Services. There are two public hospitals, seventeen public health centres and private facilities that provide health care to the population in both islands. The government is currently working on a Registry for persons with disability and also development of a policy and plan. The country has a National Social Protection Strategy, 2012-2017, which include addressing the social determinants of health. This system of social protection which includes social security and safety net programmes are complementary to universal access to health care services and should ensure equity and support sustainable development.

Agriculture

Most of the crop farming in St. Kitts and Nevis is dominated by small farmers with the average farms size being less than 1.0 ha, with larger farmers about 5 hectares. The sugar industry was officially closed by the Government in 2005 and embarked on a programme to diversify the agricultural sector and stimulate the development of other sectors of the economy. The agricultural diversification programme is continuing with emphasis on crops and livestock such hot pepper, white and sweet potato, vegetables, dairy, beef, mutton, pork and poultry. As a result of this policy, the ability of farmers to meet a significant portion of the demand for local produce has been strengthened. The provision of vegetables such as tomatoes, green peppers and pumpkin in 2009 was enough to meet 37.20% of the total national demand (Government of Saint Kitts and Nevis, 2015). In 2008 the production of Sea Island cotton was re-introduction in Nevis which further boosted productivity in the agricultural sector.

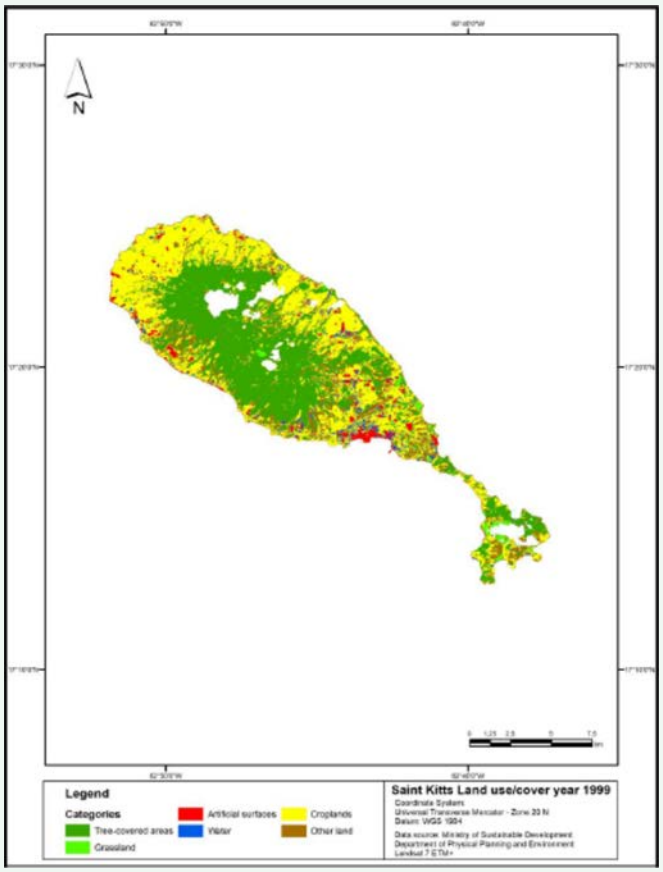

Figure 5
Land use in Saint Kitts and Nevis

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 with the impacts of climate change mainly affecting 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 desalinization 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 infrastructure 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 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 within them. 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 other effects on crop production, water quality and water-borne illnesses. Additionally, the increased morbidity and mortality of water borne illnesses, as well as mental health effects of extreme events, along with

impacts on cardiovascular and respiratory conditions are all subject to climate stress. Moreover, the region's aging population is vulnerable to increased heat stress. Disease outbreaks closely associated with the climatic conditions of the Eastern Caribbean include those transmitted by certain mosquito species. Temperature is an important determinant of biting rate and mosquito development. 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. Other climate-related public health issues include harmful sargassum algal blooms and Sahara dust which could have serious implications for human health.

IMPACTS OF RAPID ONSET EXTREME EVENTS

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 (Source: World Bank Climate Change Portal) and the Frequency distribution of natural hazards.

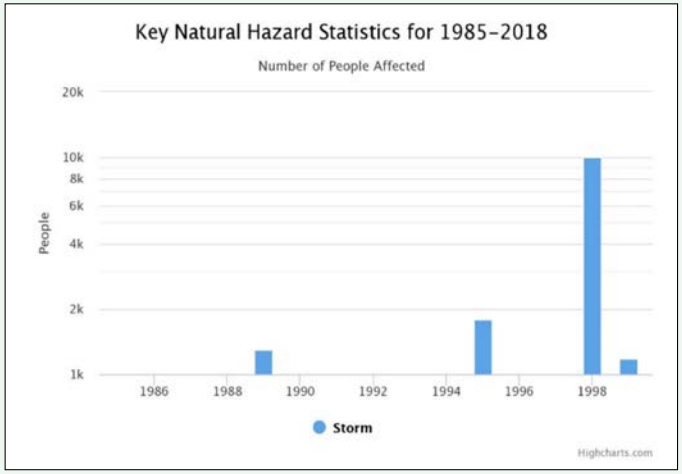

Figure 6
Number of People Affected by Key Natural Hazards in Saint Kitt and Nevis

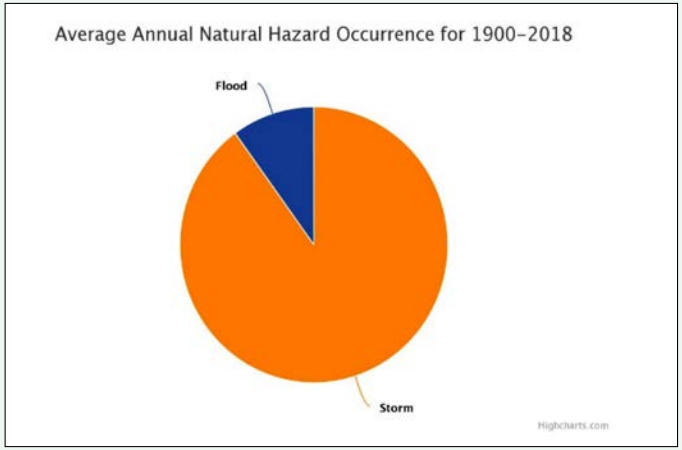

Figure 7
Frequency distribution of natural hazards in Saint Kitts and Nevis

Gaps in research and information

Although significant progress has been made to capture 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 is possible if long, good quality data records of (sub-)daily weather observations are available. This was the case for St. Kitts to the extent that only around 25 years of record were available for a station near sea level, but not for Nevis, hence limiting the majority of the analysis to low-lying areas in St. Kitts.
- 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, sea level rise at the OECS regional level, let alone the St. Kitts and Nevis national 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, St. Kitts and Nevis. However, not much is known or measured with respect to heat impacts on Kittitian and Nevisian society and environment.

Data and information gaps

- A thorough knowledge of the climatology and trends, as well as, the drivers of hazard-triggering extremes within a country depends first and foremost on the availability of long, good quality data records of (sub-)daily weather observations. With only one record with sufficient data to some extent available for St. Kitts, namely from the weather station at National Agricultural Station in the far northwest of St. Kitts – an area protected from direct exposure of trade winds by tall volcanoes during the heat season, exacerbating heat locally, research into sub-national differences in climate-related hazard impact potential is challenging at this time and will remain so until the R.L. Bradshaw Airport station record of daily observations becomes extended to over 25 years at least.
- The National Agricultural station record of daily weather observations spanning 25 years in length 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 because extreme rainfall occurrence is typically enhanced by pronounced topography, data records of daily rainfall for the wetter portions of the island, and for Nevis would be beneficial to assess flash flood across the island.
- Much more so than weather observations, 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 St. Kitts and Nevis. This is particularly the case for heat impacts.

CLIMATE CHANGE POLICY PRIORITIES IN TERMS OF ADAPTATION

The Federation of Saint Kitts and Nevis is a democratic and sovereign country, signatory to the UNFCCC and Paris Agreement. St Kitt and Nevis is a full Member to the OECS.

A **National Adaptation Strategy (NAS)** was adopted for the period 2006-2013 (in response to the closure of the sugar cane industry in 2005) identified environmental management as an integral component of overall national development (focus areas included, among others, agriculture, coastal zone and water).

The **National Communication (NC2)** submitted in 2016 to the UNFCCC listed its technology needs In the context of adaptation across all relevant sectors: Domestic water conservation technologies; Irrigation technologies including sprinkler systems and drip irrigation; Rainwater harvesting; Technologies for soil and water conservation (also applicable to the agricultural sector) such as storage ponds; Desalination (potentially costly option); Early warning systems for forecasting of wet and dry periods; Adoption of drought-resistant cultivars; Geographical Information Systems (GIS); Change of sowing and harvesting periods. Pesticide application technologies and practices; Integrated Pest Management (IPM) systems and practices; Soil management technologies and practices; Aquaculture and mariculture technologies; Deployment of fogging machines for vector spraying; Use of insecticide-treated nets; Integrated vector management systems (IVM) (process for managing vector populations in such a way as to reduce or interrupt transmission of disease). The study also identified the nexuses and synergy across sectors for technology applications.

Its **First Intended Nationally Determined Contribution (iNDC)**, submitted in April 2016, proposes a reduction target of 22% (for 2025) and 35% (for 2030) for GHG emissions projected in the business as usual (BAU) scenario. Its iNDC states that the country will develop comprehensive resilience plans for the water, agriculture and coastal infrastructure sectors as part of its overall adaptation plan. The NDC highlights water, coastal infrastructure and agriculture as the most important sectors for immediate action.

Selected adaptation interventions

SELECTED PROGRAMME / PROJECT	*VALUE (USD)*	*DONOR*	*YEAR*	*IMPLEMENTING AGENCY*
Developing a "Climate change Adaptation Strategy" (2018-2030);it aims to operationalize the policy directives and objectives outlined in the National Climate Change Policy of 2017	N.A.	EU GCCA (Regional)	2018-2019	OECS
Climate Change Adaptation Program (CCAP) Regional initiative to establish data nodes in ten countries including St Kitt and Nevis, Grenada, St Lucia and Antigua.	N.A.	United States Agency for International Development (USAID).	2016 - 2020	Caribbean Community Climate Change Centre (CCCCC)

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