Country analysis: Resilience to climate change at a glance

COMMONWEALTH OF DOMINICA

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 Dominica

Total Area (square km)	*751*
Population	*74,000*
Percent Urbanization	*70.5*
GDP per capita	*US$ 11,000*
Debt as a percent of GDP	*82.7*
Unemployment Rate	*23*
Services as a percentage of GDP	*65*
Services as a percentage of workforce	*28*
Agriculture as a percentage of GDP	*22.3*
Agriculture as percentage of workforce	*40*
Percent Agriculture Land	*34.7*
Percent Forests	*59.2*
Human Development Index	*0.742*

Map of Dominica

Figure 1: www.lonelyplanet.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

The Commonwealth of Dominica is a Small Island Developing State located within the Lesser Antilles, among the **Windward Islands** in the Eastern Caribbean. It is located between 15°12'N and 15°39'N Latitude and 61°14'N and 61°29'W Longitude and is 48 km long and 25 km wide at its widest point, and has an area of 751 km^2. The population of Dominica was estimated at 72,340 in 2014.

Dominica has a rugged coastline and lush mountainous interior, is renowned for its pristine natural environment and is proud to call itself the "Nature Island" of the Caribbean. Flat land is limited to coastal areas in the northeast, river valleys and certain areas in the centre of the island. The highest peak at 1447 m is the Morne Diablotins volcano located in the north of the island, while many summits across the island are close to or in excess of 1000 m.

Relatively high rainfall levels as compared to evapotranspiration rates, combined with mostly fertile soils, mean up to 69% of the island is forested with forest types ranging from dry scrub woodland on the coast to lush, tropical forest in the interior (UNFCCC 2012).

Dominica is 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 mountains produce a strong windward-leeward effect, with over 1°C higher temperatures, lower humidity and significantly lower rainfall on the leeward shores. The hot season (May to October) is characterized on average by 45 hot days (when day-time high temperatures are close to or exceed 32°C) and 33 hot nights (with night-time lows close to or 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 21.3°C) occur on average.

The wet season spans from May (Windward side) or June (Leeward side) to November, coinciding with the Atlantic hurricane season. The mean annual rainfall total varies from 1700 to 2000 mm on the leeward coast, to around 3000 mm on the windward coast and up to 7620 mm in the highest locations (UNFCCC, 2012; Dominica Meteorological Service). Extreme rainfall has the potential to trigger a flash flood nearly every other year between April and May, and nearly twice per year during the period from July to December. By contrast, a number of spells of seven consecutive dry days occur from February to May, potentially limiting growth of sensitive crops. Finally, though Dominica is the wettest island in the OECS, drought occurs on average once per 4 years during the dry season, and once every 8-10 years in the wet season, potentially impacting fresh water availability.

According to the Post Disaster Needs Assessment (PDNA) undertaken by the Government in collaboration with international development agencies, Maria, a Category 5 hurricane that hit the state on 18 September 2017, caused damage and loss of 226% of GDP and impacted 100% of the population and every sector of the economy. As a result, the Climate Resilience Execution Agency for Dominica (CREAD) was created to lead and coordinate strategic initiatives across all sectors with the goal of leading the climate resiliency mission in Dominica.

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 o served 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.

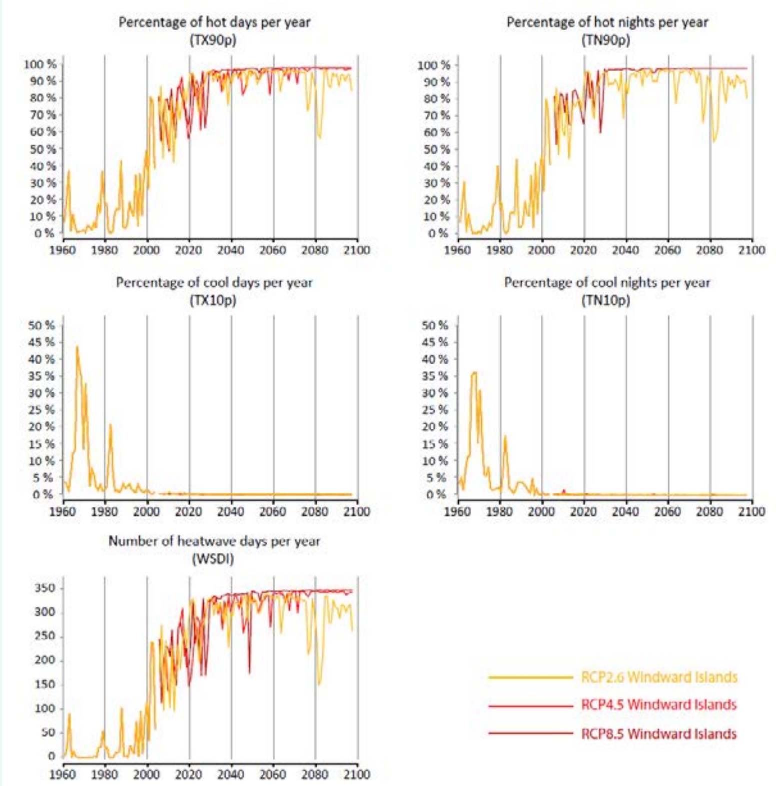


Figure 2

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.

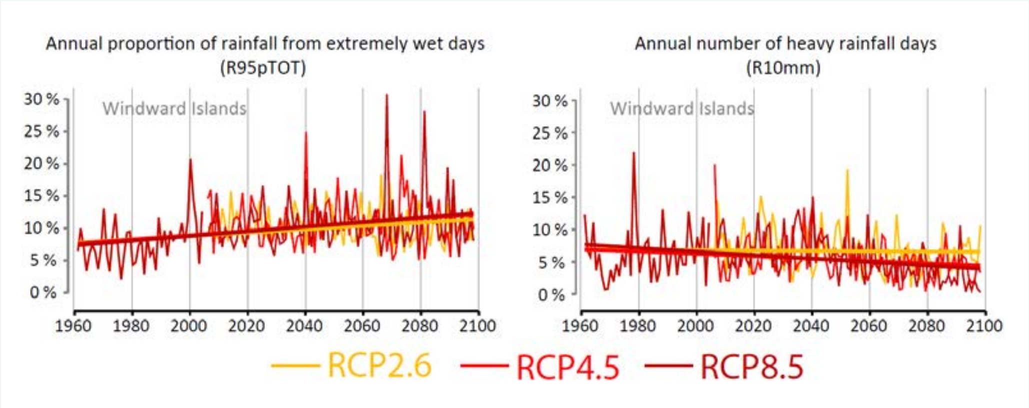


Figure 3

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 Dominica The heat – being moderated by a prevalent easterly breeze – has **historically** not been regarded as a major hazard but 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.

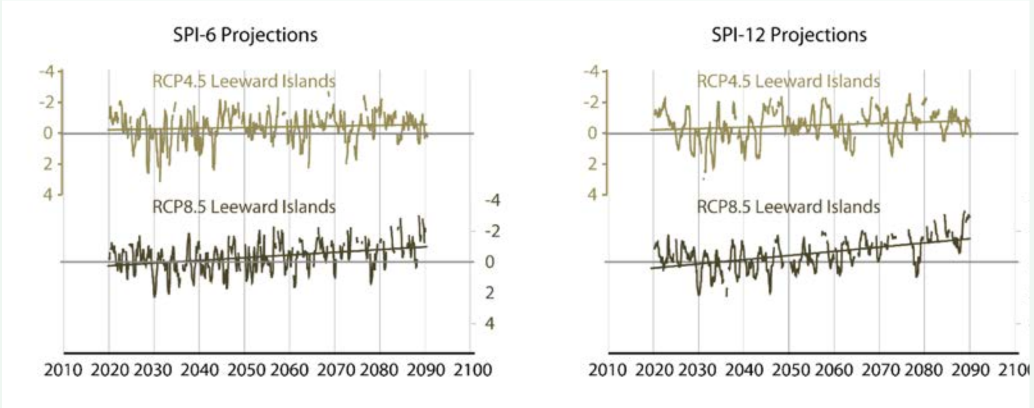


Figure 4

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 copious rainfall of Dominica 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 99^{th} 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.

DOMINICA – *source: EbA-GESI Egis*

SOCIOECONOMIC CHARACTERISTICS

Population

According to the 2010 population census, Dominica's population was estimated at 71,293, with a male to female ratio of 103/100 (PAHO, 2017). This number indicated an overall population decrease of 0.6% from the last census. The census results also revealed that total births continued to decrease, recording a significant 31.5% decline over the past two decades. Life expectancy at birth is currently 72.8 years for males and 78.9 for females. Decreasing fertility rates and increasing life expectancies will continue to sustain the "greying" of Dominica's population.

Main Economic Drivers

In 2017 Dominica was hit by Category 5 Hurricane Maria, while it was still recovering from Tropical Storm Erika which caused severe damage in 2015. The International Monetary Fund (2018) has projected its output to decline by 14% and that it would take approximately 5 years to recover from the hurricanes. Like most Caribbean islands, Dominica's economy has traditionally been dominated by agricultural production and exports, especially bananas. A sector contribution breakdown or sector employment breakdown with gender could not be identified.

Tourism

Dominica has a relatively small, but developing, tourism sector based on the country's extensive natural resources, in particular its forests and its marine resources such as coral reefs. One of the main challenges to the growth of Dominica's tourism industry has been the lack of adequate facilities for direct international air travel from major tourism markets such as Europe and North America (Government of Dominica, 2012). Tourist numbers have been in decline since 2014, when they peaked at a total 378,812. This is due to the major storm and hurricane in 2015 and 2017 respectively. In 2018, there were 206,374 recorded visitors to the island, of which 62,985 were defined as stay-over visitors. The main countries of origin of tourists are other Caribbean islands (36,883), the USA (10, 449), the UK (3,709), Canada (1,810) and others (10,134) (ECCB, 2018).

Energy

Dominica has no known petroleum resources but does produce some hydro-electric power (25.34%). The Government of Dominica is also considered a leader in the development of geothermal energy. Many Eastern Caribbean countries are only now beginning their exploration phase of geothermal development, whereas Dominica is on the verge of its construction phase.

The main users of electricity are domestic, commercial and institutional customers and road transport, as is the case in most other developing countries where road transport is consuming an increasing quantity of petroleum.

Transport

There are two main ports, one at the deep-water harbour in Woodbridge Bay, and the other in Prince Rupert's Bay, Portsmouth. There are also two airports, Douglas Charles at Melville Hall (64 km north-east of Roseau), and Canefield (5 km north of Roseau), which can only accommodate turbo-prop passenger aircraft. Tourists flying into Dominica must therefore generally come via the nearby island of Antigua. There are approximately 1,510 km of road networks of which 50% are paved (Commonwealth, 2019), with public transport and private taxis available throughout the island.

Land use

There has not been a recent study on changes in land use within Dominica. However, Table 1 shows the data collected during 2000.

Table 1

Population and Gender by Parish *(Government of Dominica, 2011)*

Parish	Male	Female	Total
Total	36411	34882	71293
St. George	10504	10737	21241
St. Paul	4916	4870	9786
St. Andrew	5003	4468	9471
St. Patrick	3907	3715	7622
St. John	3375	3084	6206
St. David	3248	2795	6043
St. Joseph	2970	2667	5637
St. Mark	913	921	1834
St. Luke	835	833	1668
St. Peter	740	690	1430

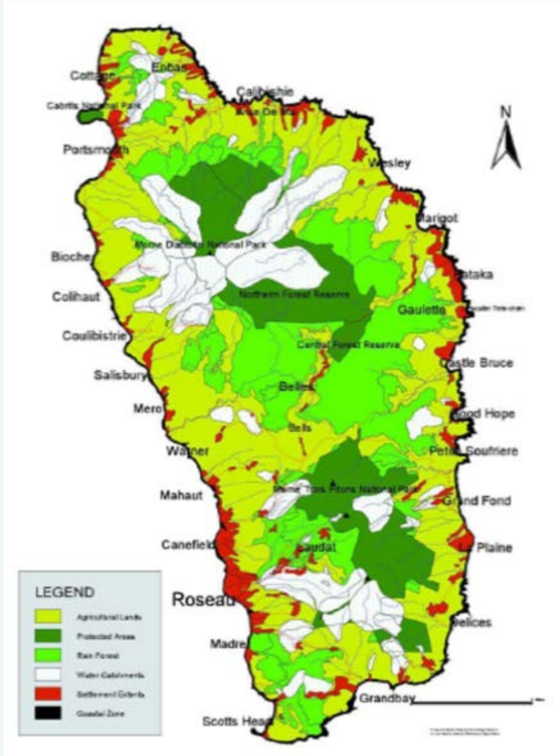
Table 2

Land use in Dominica *(FAO, 2015; Government of Dominica, 2012; Wood, 2000)*

National Classes 2000	2000 (1000 ha)
Submontane Rainforest	23.63
Lowland/ Submontane Seasonal Evergreen Forest	5.68
Lowland Drought Deciduous Shrub/Semi Deciduous	5.55
Montane Cloud Forest	0.25
Seasonally Flooded R.F/W.L/G.L	0.25
Disturbed Submontane Rainforest	8.4
Evergreen Montane Shrubland	1.07
Montane Rainforest	3.04
Total Forest	**47.88**
Fallow/Cleared Land	2.69
Short/Medium/ Tall Grassland	1.68
Active Agriculture	21.9
Urban/Residential/Bare Soil/Rock	1.3
Fumarole	0.02
Fumarole Sulphurous	0.0
Total other Land	**27.59**
Total Land Area	**75.47**

Figure 2

Land use in Dominica



Agriculture

It is estimated that 20% of the population is employed within the agricultural sector (Government of Dominica, 2012). However, a decline in the number of farmers has been observed. Farm sizes usually range from 0.5 to 10 ha; small, subsistence farms are mainly involved in food crops and complex multiple cropping systems whilst the larger commercial farms practise monoculture of banana and plantain, coconut, citrus, mango, avocado or root crops. Approximately 30% of the total land area is under farms of which 54% is cultivated (FAO, 2008). The main crops that are grown are banana, plantain, coconut, tree crops and root crop plantations (Table 3). A wide range of short-term vegetables are also grown. These locally-grown crops provide the basis for an advantageous food security, rural employment, and the export of products to the Caribbean, North America and Europe.

Health

Dominica has primary and secondary health services; but, for the most part, tertiary care has to be provided outside the country. Dominica has seven health districts, each of which has its own budget that is managed at the central level due to lack of human resources. There are approximately 52 health clinics distributed throughout the towns and villages across the island (PAHO, 2017). The main hospital is the Princess Margaret Hospital. Private services are also available on the island; however, they are limited to mainly outpatient care provided by private practitioners.

Table 3

Crops Cultivated for Export
(Government of Dominica, 2019)

Crops	Acreages 2018/2019	Acreages 2017/2018	Percentage Change (%)
Vegetables	123.42	230.07	-46.4
Passion Fruit	103.31	56.76	+82
Bananas Plantain	463.69 1233.00	289.45 751.03	+60.2 +64.2
Yam	522.18	346.8	+50.6
Pineapple	38.42	28.10	+36.7
Tania	273.24	210.33	+29.9
Dasheen	694.5	591.2	+17.5
Ginger	135.6	118.33	+14.6
Sweet Potato	278.05	251.24	+10.7
Total	**3865.41**	**2873.31**	**+34.53**

VULNERABILITY OF SECTORS AND TERRITORIES 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. 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. The Figure below shows the number of people affected by key natural hazards between 1985 and 2018 (Source: World Bank Climate Change Portal).

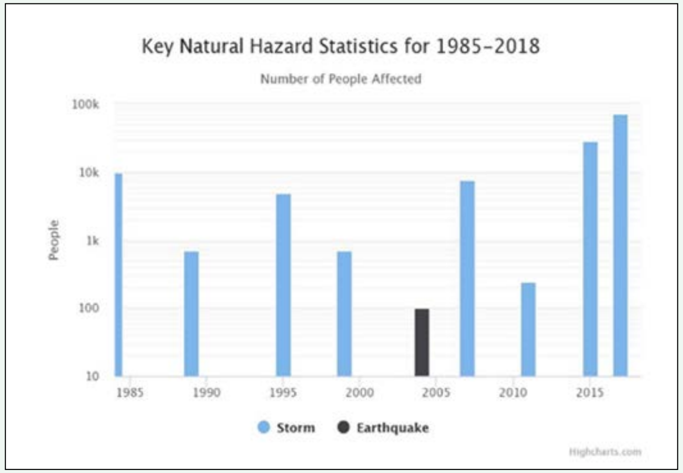


Figure 6

Number of People Affected in Dominica

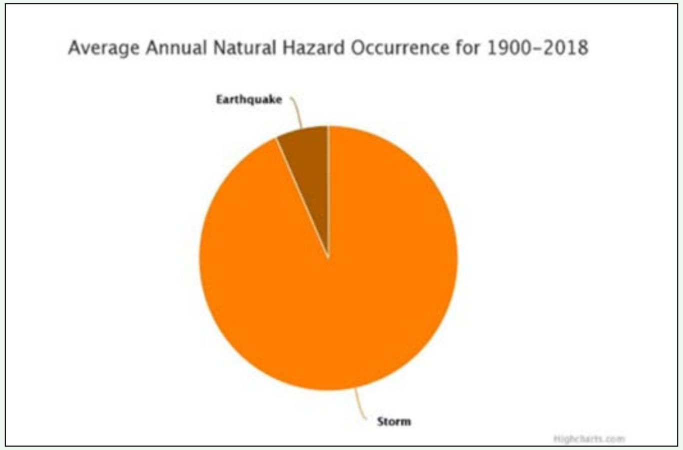


Figure 7

Frequency distribution in Dominica

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 is possible if long, good quality data records of (sub-)daily weather observations are available. This was the case for the Canefield Airport station on the leeward side and the Douglas Charles Airport station on the windward side. However, a significant portion of the population lives higher up inland, where no data was available for analysis. Hence, comprehensively assessing the nature of climate hazards and risk inland is an outstanding 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, sea level rise at the OECS regional level, let alone the Dominica 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, Dominica. However, not much is known or measured with respect to heat impacts on Dominica's society and environment.

Data and information gaps

- The Canefield and Douglas Charles airport records of daily weather observations exceed 30 years in length. This makes the climatological analysis robust for the low-lying 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 mountainous inland areas 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 Dominica. 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 of which we are most confident it will continue to intensify. Therefore, in future, heat impacts on public health, agriculture, water, education, energy and labour need to be observed, 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

The Commonwealth of Dominica submitted its Intended Nationally Determined Contribution (INDC) on 30 September 2015. It includes a mitigation target "to progressively reduce total gross greenhouse gas (GHG) emissions below 2014 levels" and a contribution reflecting its Climate Resilient National Plan (CRNP) which includes adaptation.

- The Climate Resilient National Plan (CRNP) is based on three main pillars: Climate-Resilient Systems, Prudent Disaster Risk Management, and Effective Disaster Response and Recovery. The costs for the abovementioned priority adaptation measures that are to be implemented over the next 5 years amount to US$25 million.

- The legal establishment of the Climate Change Trust Fund - in addition to US$5 million seed funding - provides support to priority communities with climate change risk management measures identified through community vulnerability mapping and adaptation planning, and the establishment of micro-finance and micro-insurance for the private sector and vulnerable segments of society.

- The 'National Climate Change Trust Fund' has been established (under the Climate Change, Environment and Development Bill 2015), which will serve as the **National Implementing Entity** (NIE) for climate change programs in Dominica.

- Following the devastation wrought by Hurricane Maria, the Government established an executive agency, the "Climate Resilience Execution Agency of Dominica" (CREAD), which is facilitating the implementation of projects as part of rebuilding the country as "the world's first climate resilient nation". This was endorsed with the adoption of the Climate and Resilience Act 16 in 2018.

Relevant Programmes / Projects

SELECTED PROGRAMME / PROJECT	*VALUE (USD)*	*DONOR*	*YEAR*	*IMPLEMENTING AGENCY*
Developing Climate Resilient Integrated Coastal Management in Dominica	US$24,000,000 additional US$14M co-finance identified from a range of sources	GCF (grant requested)	5-year	Ministry of Planning, Economic Development and Investment as the National Designated Authority (NDA)
Enabling the Commonwealth of Dominica to Prepare its First National Communication in Response to its Commitments to UNFCCC	US$ 168,700	GEF	1998-2016	UNDP
Implementation of Pilot Adaptation Measures in coastal areas of Dominica, St. Lucia and St. Vincent & the Grenadines	US$ 5,770,000.00	GEF Trust Fund	2004-2012	World bank-CARICOM
Strengthening Resilience of Agricultural Lands and Forests in Dominica in the Aftermath of Hurricane Maria	US$ 3,641,484.00	GEF Trust Fund	2018-2019	UNEP

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