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Grenada climate change and health vulnerability and adaptation assessment

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Acknowledgments

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Executive Summary

Prior to the activities outlined in the present report, no projects had been undertaken that focus specifically on climate change adaptation in the Grenadian health sector. The present health and climate change vulnerability and adaptation assessment (V&A) serves as a first step towards guiding the Ministry of Health and Social Security (MoHSS) in its future climate-sensitive health programming.

Small Island Developing States such as Grenada are disproportionately affected by the negative consequences of climate change. Rising temperatures and sea levels are predicted along with a growing tendency of extreme weather events such as tropical storms, hurricanes, and floods. These changes in climate and weather patterns can have direct and indirect impacts on human health. The climate change related health risks identified by the V&A include direct impacts from extreme weather events and natural disasters such as: Physical injury, death, heat stress and heat-related illness, psychological trauma, loss of livelihoods, water, sanitation and hygiene related issues, food insecurity, displacement; as well as indirect impacts brought about by rising temperatures and changing rainfall patterns such as an increase in vector-borne (dengue, chikungunya, Zika), waterborne (diarrheal diseases) and rodent-borne infectious diseases (Leptospirosis). Furthermore, increasing amounts of airborne particulates from Saharan dust during the rainy season may increase cases of chronic respiratory disease and acute respiratory infections.

The V&A revealed several key constraints to effective climate and health management in Grenada: Inadequate human and financial capital; limited collaboration and cooperation at both inter- and intra-sectoral levels; and a lack of a functioning surveillance and monitoring mechanism. Nonetheless, several adaptive measures were outlined based on the outcomes of workshops and key stakeholder interviews. Specific adaptive measures for direct health impacts include improved disaster preparedness and mitigation, disaster protection measures, and health infrastructure resilience. Specific adaptive measures for indirect health impacts include the development of disease early warning systems, improved surveillance of disease and vector populations, as well as integrated vector management.

Grenada needs to take several other steps to be able to protect health from climate change. These include: conducting more research on the complex inter-relationship between climate, vector ecology, and human health; linking data on epidemiology of diseases with climate data (including historical climate data); evaluating the effectiveness of vector control; implementing an electronic health information system for improved disease surveillance, monitoring and control; implementing a national information center containing detailed information on temporal, environmental and climatological data; solidifying the institutionalized collaboration and cooperation at both inter- and intra-sectoral levels; and strengthening the capacity of MoHSS for evidence-based planning and budgeting.

The present vulnerability assessment provides the basis for future strategic planning and forms an important first step in creating a climate resilient health system. A key recommendation is for MoHSS to develop a Health and Climate Change Action Plan (HCCAP), as well as a National Climate Change and Health Strategy. A draft HCCAP outline has been proposed in Appendix II of this study and should be extended with concrete adaptation actions. These should be integrated into the health sector Corporate Plan and Health Sector Strategic Plan to allocate adequate financial and human resources.

As an immediate outcome of this assessment, it was agreed with the MoHSS that GIZ ICCAS and the GIZ Global Program 'Adaptation to Climate Change in the Health Sector' support the development of a funding proposal for climate-resilient clinical waste management. A further outcome was an explorative workshop with regional and national stakeholders in the field of health and climate change, to discuss the possibilities for linking health and climate information and improving data management (see Appendix III). In consequence, GIZ will support the integration of climatic and environmental data into the disease surveillance system of Grenada, a process which will start with an upgrade and streamlining of the national health information system.

1. Introduction

Climate change has been referred to as 'the defining health issue for this century' by dr. Margaret Chan, Director General of the World Health Organization (WHO), and tackling it could be 'the greatest global health opportunity of the 21st century' (The Lancet Commission on Health and Climate Change 2015). Depending on the geographical area, rising mean temperatures, droughts, increasing frequency and intensity of precipitation and extreme weather events can already be observed and are likely to increase (IPCC 2013). Climate variability and change pose a threat to the health and well-being of populations, can endanger livelihoods, and thereby impact a country's economic development (see Figure 1).

The impacts of climate variability and change on hydro-ecological systems may give rise to droughts, floods, or extreme weather events, which in turn impact food security, distribution patterns and incidences of zoonotic, food-, water- and vector-borne diseases, as well as the prevalence of diseases associated with air pollution and aeroallergens. For example, respiratory and cardiovascular diseases may become more common in areas with low air quality, and the geographic ranges of diseases such as malaria, dengue, and Zika are set to change (Luber, et al. 2014, WHO 2013). Extreme weather events further lead to premature deaths, injuries, as well as physical and mental trauma (IPCC 2014).

The impacts of climate variability and change will not be felt equally across the globe. The most vulnerable populations currently live in developing countries and include people living in resource-poor settings, who have limited capacity to adapt to the negative consequences of a changing climate (IPCC 2014). This is especially true for Small Island Developing States (SIDS) in the Caribbean, such as Grenada (Ebi, Lewis and Corvalan 2006).

Grenada is the southernmost island of the Lesser Antilles and will be facing the challenges arising from climate variability and change characteristic of the Caribbean region. In the Caribbean, rising sea levels are predicted along with a growing tendency of extreme weather events such as tropical storms, hurricanes, and floods (Monnereau, et al. 2015). These events can significantly impact SIDS societies and economies, since main settlement areas and economic infrastructures are concentrated in the coastal zones (OECS 2004, OECS 2013). Grenada's adaptive capacity and vulnerability is further challenged by limited financial and technical resources available in the country (GoG 2000) and its significant distance from large market economies (Ebi, Lewis and Corvalan 2006, Voccia 2012).

The extent of destruction caused by extreme weather events was experienced in Grenada through tropical storms Ivan and Emily, which made landfall on the island in 2004 and 2005, respectively (see Box 1). The close succession of the storms caused severe damage to the health care infrastructure, triggered a heavy drop in industrial and agricultural production, and further affected the local economy due to the slump in tourism. In consequence, Grenada's post-storm reconstruction became highly dependent on international aid (World Bank 2009).

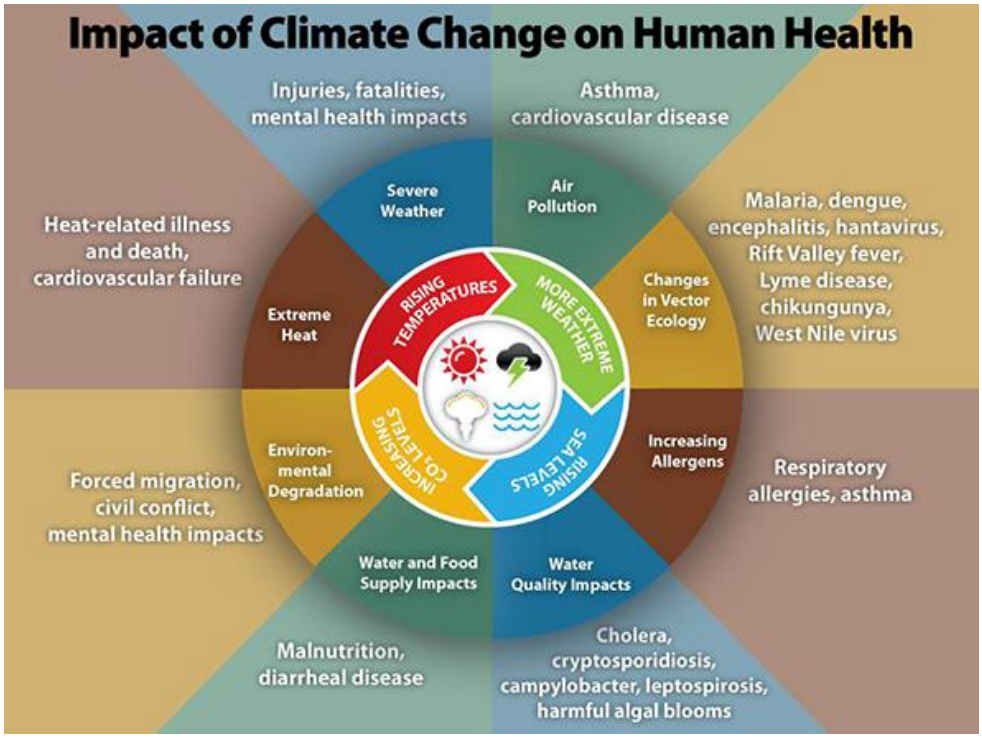


Figure 1: The Impact of Climate Change on Human Health
(Source: National Centre for Environmental Health)

Box 1: Tropical Storms Ivan and Emily – 2004 and 2005

Climate-related disasters can have catastrophic impacts on countries in the Caribbean region. Before 2004, Grenada was considered relatively safe from hurricanes, as only 3 hurricanes had been recorded since the beginning of the 20th century. However, in 2004 and 2005, Grenada was hit by tropical storms Ivan and Emily, hurricanes of the categories 3 and 4, which had devastating consequences for the population and infrastructure of the island (GFDRR 2010).

Hurricane Ivan caused extensive flooding and landslides, which strongly impacted the health care system and resulted in around 37 deaths. The storm damaged or destroyed as much as 80 percent of all buildings, with damages totaling more than 900 million USD (World Bank 2009, WMO 2004). In comparison, the yearly GDP of Grenada amounted to 591 million USD prior to the environmental disaster in 2003 (World Bank 2003).

In the health care sector, 69 per cent of infrastructure and 11 health facilities, including the second largest hospital, were seriously damaged. As a result, health services were available in the immediate aftermath of the disaster only on a very limited scale (World Bank 2009).

Grenada's First National Communication (FNC) to the United Nations Framework Convention on Climate Change (UNFCCC), submitted in October 2000, identified the following sectors as being particularly vulnerable to the impacts of climate change: water resource management, coastal infrastructure, agriculture and fisheries, tourism and human health. The FNC established these sectors as priority areas for future programs and development activities (GoG 2000). While human health had been identified as a priority sector, apart from some awareness raising sessions no projects specifically on climate change adaptation in the health sector were launched prior to the activities outlined in the present report.

For the health sector to successfully respond to the future health hazards caused by climate variability and change, efforts are needed to understand and adequately address the adverse health outcomes of climate change. A first step in assessing the impacts of climate change on a country's health sector and population is to conduct a vulnerability assessment, on the basis of which adequate adaptation measures can be defined (WHO 2013). In June 2015, the Grenadian Ministry of Health and Social Services (MoHSS), together with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) conducted a qualitative health and climate change vulnerability and adaptation assessment (V&A), which was combined with an adaptation action planning workshop. At a later stage, disease-specific data was gathered and analyzed to complete the V&A report, which can guide the MoHSS in its future climate-sensitive health programming.

2. Methodology

This vulnerability and adaptation assessment was guided by WHO guidelines "Protecting Health from Climate Change – Vulnerability and Adaptation Assessment", GIZ's "Vulnerability Sourcebook" and CARE's "Climate Vulnerability and Capacity Analysis Handbook" (WHO 2013, GIZ 2014, CARE 2009). The V&A is comprised of two parts, which were conducted at different times, but are here presented in a coherent report (see Figure 2). First, a country-driven adaptation analysis was conducted by international consultants (contracted by the GIZ Global Program 'Adaptation to Climate Change in the Health Sector') in cooperation with the bilateral program 'Integrated Climate Change Adaptation Strategies' (ICCAS) in June 2015, implemented by GIZ and the Environment Division of the Ministry of Agriculture, Lands, Forestry, Fisheries and the Environment (MoALFFE). This preliminary analysis identified climate change related adaptation needs and Grenada's current adaptive capacity. A preliminary report was published in November 2015. As a follow-up, a more detailed risk analysis of climate-sensitive diseases, identified during stakeholder interviews, was carried out from June to July 2016.

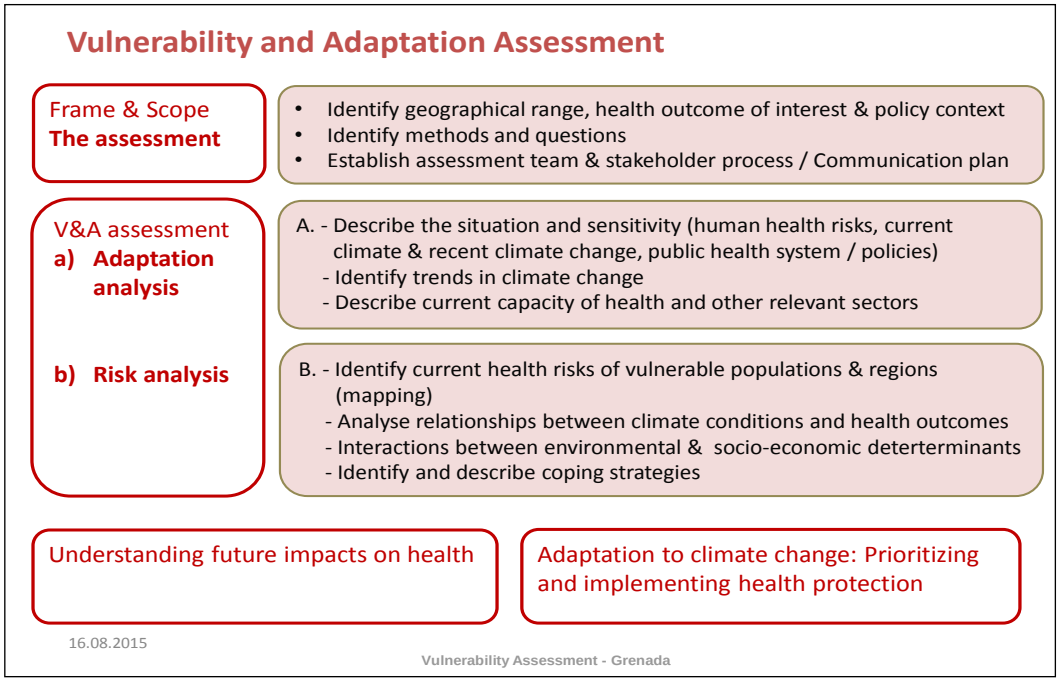


Figure 2: Overview of the V&A approach in Grenada, based on the PAHO/WHO guidelines (WHO 2008)

2.1. Literature review

A literature review was performed to identify historical data and current data on climate variability and change in Grenada, as well as key health information relevant to the assessment. In addition, historical and current data, as well as information on ongoing projects and programs, regional partnerships, and policies relevant to climate and health at the country level were collected.

Based on the findings in the literature, a vulnerability and risk analysis was performed for the main climate sensitive health outcomes identified during the stakeholder workshops (see section 3.2). Diseases of importance included: vector-borne diseases (dengue, chikungunya, Zika), food and water-related diseases (diarrheal illness, gastroenteritis, leptospirosis), respiratory diseases. Disease case information was collected from the Health Information Department of the MoHSS, and the literature was reviewed to describe the possible risk of these diseases to Grenada under climate variability and change. In addition, the vulnerability of health infrastructure to flashfloods and landslides was presented visually using recently developed hazard maps (Van Westen 2016).

2.2. Expert interviews

Expert interviews were conducted to collect policy data and information at the country level. Interviewees were either from one of the key departments or units of the Ministry of Health and Social Services (MoHSS), from other relevant Ministries, medical personnel, regional stakeholders, local civil society organizations, or from the local science community. A total of ten theme-guided individual or group interviews were carried out between 15 to 23 June 2015 (see Appendix I). The outcomes of these interviews were included in the vulnerability analysis of this study.

2.3. Stakeholder workshops

Four stakeholder workshops were organized in collaboration with MoHSS to inform and engage national stakeholders:

- One awareness raising workshop was organized on the island of Grenada on 16 June 2015 and one on the island of Carriacou on 22 June 2015. Both workshops were attended by healthcare staff on the respective islands, as well as by the general public. The objective of both sessions was to create awareness of the impact of climate change on health in Grenada and have a discussion amongst participants about their felt impact and the related difficulties they predict and already face. These workshops enabled the inclusion of new input into the vulnerability assessment in addition to that from national stakeholders.
- The development of first ideas for a Health and Climate Change Action Plan (HCCAP) 2016-2020 for the health sector was the objective of a workshop on 18 June 2015. Key persons within the MoHSS attended the workshop, as well as the Chief Medical Officer and the Chief Community Health Nurse. This session's output constitutes the basis of the adaptation analysis of this V&A (see Section 3.4).
- Based on the outcomes of the workshop held on 18 June 2015, in which adaptation actions were identified, a follow-up workshop was held in November 2015 on 'linking epidemiological and meteorological data'. The objective was to bring together all relevant stakeholders of climate-sensitive health surveillance in Grenada and the relevant regional organizations to jointly identify the next steps for strengthening national capacity for conducting climate sensitive disease surveillance and analysis of health and climate data (see Appendix III).

2.4. Identifying adaptation options

To identify and plan adaptation actions for the next five years, a workshop was organized with the key departments and units of the MoHSS (see Section 3.2.3), including the Chief Medical Officer and the Chief Community Health Nurse. Based on the health impacts identified during the assessment (see Table 2, page 22), possible adaptation actions were compiled accordingly by going through the draft Health Sector Corporate Plan 2015-17 and the National Disaster Plan (MoHSS 2014, NaDMA/NaDMAC 2005). This exercise ensured that adaptation actions are no 'stand-alone' measures that would need additional resources. Rather, by climate-proofing relevant activities of both plans, the adaptation actions proposed here can easily be mainstreamed into the sectoral planning and budgeting processes and cycles, as they are already part of existing health plans.

After identifying and compiling possible adaptive measures, the authors of this V&A clustered the activities according to the six building blocks of a health system (WHO 2015). Workshop participants then rated all activities according to priority and affordability. Every participant received five points for tagging specific activities as priority and five points for tagging activities considered affordable. Those activities that received high priority (i.e. more points than others), but were considered as not affordable (i.e. receiving no points for affordability) by available domestic funding, were designated as activities for which additional funding needs to be sought. It was proposed that for at least one activity a funding proposal would be developed for one of the high-investment actions.

On the basis of the vulnerability assessment, the workshop identified potential adaptation options rankings, and the authors of this V&A developed a draft HCCAP for the MoHSS (see Appendix II). The draft document will be integrated in the National Adaptation Plan (NAP) for Grenada by the October 2016, which is facilitated by the GIZ ICCAS project.

3. Country profile and current adaptive capacity

3.1. Geography and climate

Grenada is the tri-island State of Grenada, Carriacou and Petite Martinique located north of Trinidad and Tobago and south of St. Vincent and the Grenadines in the Eastern Caribbean. Most of the 110,000 residents live on the main island of Grenada, which is also the largest, with a total area of 344 km² (Sander 2015). The main island is divided into six parishes: Saint Patrick, Saint Mark, Saint John, Saint Andrew, Saint George and Saint David. The capital St. George's is located at the southern end of the island.

Grenada experiences a humid tropical marine climate with little seasonal or diurnal variation, and fairly constant, strong easterly trade winds (GoG 2010). The tri-island State is affected by the subtropical cyclone belt and the inter-tropical convergence zone, which influence the climate of the region (GoG 2010). The location of these two meteorological systems varies in a cyclical pattern. Moderate temperatures prevail in Grenada year round with annual average temperature ranges from a low of 24°C (75°F) to 33°C (91,4°F). Although annual and seasonal variations of temperature are small, the temperature at sea level is generally rather high with little seasonal, diurnal and location variation due to the dampening or stabilizing effect of the ocean mass (GoG 2010). There are some risks of hurricanes from June to December, however, Grenada lies south of the path of most tropical storms and – in comparison to other Caribbean islands – is only rarely affected by hurricanes. During the last 100 years, three major hurricanes have struck Grenada, in addition to several tropical storms and northerly hurricanes causing peripheral damages (GoG 2010).

Annual rainfall in Grenada varies from approximately 1.270 mm (50 in) in dry coastal locations to 4.060 mm (160 in) in wet central mountains. Grenada experiences wet and dry seasons, the durations of which vary greatly depending on location. However, there tends to be a dry season from about January to May and a wet season from about June to December. About 75% of annual rainfall occurs during the wet season. The north-eastern and southern parts of the mainland island receive the lowest rainfall, and have the longest dry periods. Also Carriacou and Petite Martinique receive lower levels of rainfall and can experience severe drought conditions during the dry season (GoG 2010).

Due to its volcanic origin Grenada is characterized by a mountainous inland, which is crowned by Mt. St. Catherine with a height of 833m above sea level. On the islands of Grenada and Carriacou, approximately 77% and over 54% of the land area has slopes exceeding 20-degree inclines, respectively (UNDP 2015). These slopes, especially the roads that crisscross the island, are made increasingly vulnerable to landslides due to heavy rainfalls (Van Westen 2016). According to the Food and Agriculture Organization of the United Nations (FAO), 50% of the Grenadian land is forested, mostly at higher altitude. Trends of deforestation are currently not visible as farmers prefer flat or gently sloping lands, which are usually found at the middle or lower altitudes (Mongabay 2010).

Only 3% of Grenada's land area lies at sea level. Nonetheless, the major towns and (fishing) villages of Grenada, home to most of the population and socio-economic activity, as well as key infrastructure such as main roads, tourist accommodations, ports and agricultural lands, are located in these coastal zones. Grenada's coastal zones also include beaches, coral reefs, sea grass beds and mangrove swamps, which are important ecosystems to support resilience to the adverse impacts of climate change (GFDRR 2010, Sander 2015, GIZ/ICCAS Project (b) 2015).

3.2. Vulnerability to climate change

Grenada is already experiencing the impacts of climate variability and change. Situated in the southern end of the hurricane belt, the country is annually subjected to natural hazards and extreme weather events, such as tropical storms, coastal storm surges, flooding, and occasional hurricanes (GoG 2000). These weather phenomena are highly nurtured and intensified through increased sea surface temperatures, brought about by climate change (IPCC 2013).

Further challenges are posed by the ongoing rise in sea levels, which leads to coastal erosion, flooding and salt water intrusion – Grand Anse, Carenage, Marquis and Soubise are especially vulnerable to sea level rise due to their coastal locations (CARIBSAVE 2012, GRDS/TNC 2013). Rising air temperatures, shorter rainy seasons and less annual rainfall, contrasted with heavy rainfall events, are affecting water resources and security. During the 2009/2010 drought, water production was reduced by up to 65% which had significant impacts on the agricultural sector (GIZ/ICCAS Project (a) 2015).

In 2012, the United Nations Development Program (UNDP) published a climate change country profile for Grenada, which summarizes climate modelling projections for temperature, precipitation, sea surface temperatures, tropical storms and hurricanes (McSweeney, New and Lizcano 2012). A summary of the results is provided in Box 2. These projections have already been used in making expert judgments on the impacts of climate change on various socio-economic sectors (CARIBSAVE 2012, NaDMA 2014). It is widely recognized that in Grenada, climate change will severely affect the economy, land and property, human health and welfare, and the country's natural resources. In a report from 2011, the Caribbean Community Climate Change Centre (CCCCC) estimated that Grenada will face costs of 21.3% of its GDP by 2025 due to the changing climate, 'taking into account hurricane damage, loss of tourism revenue, and infrastructure damages' (CCCCC 2011).

Box 2: Climate Modelling Projections for Grenada
(McSweeney, New and Lizcano 2012, CARIBSAVE 2012)

Temperature: Observations show that mean annual temperature has increased by about 0.6°C since 1960, at an average rate of 0.14°C per decade. Regional Climate Model (RCM) projections indicate an increase ranging from 2.4°C to 3.2°C in mean annual temperatures by the 2080s in the higher emissions scenario. The range of projections by the 2090s under any one emissions scenario is around 1-2°C, with rates of warming similar throughout the year. Furthermore, all projections indicate substantial increases in the frequency of 'hot' days and nights, and decreases in the frequency of days and nights that are considered 'cold' in the current climate.

Precipitation: Projections of mean annual rainfall from different models generally indicate a decrease in rainfall for Grenada. General Circulation Model (GCM) projections of rainfall span both overall increases and decreases, ranging from -40 to +7 mm per month by 2080 across three scenarios. Most projections tend toward decreases from -22% to -29%, with decreases occurring largely during wet season rainfall (June – November).

Sea Surface Temperatures (SST): GCM projections indicate increases in SST throughout the year. Projected increases range from +0.9°C and +3.1°C by the 2080s across all three emissions scenarios.

Tropical Storms and Hurricanes: North Atlantic hurricanes and tropical storms appear to have increased in intensity over the past 30 years. Observed and projected increases in SSTs indicate potential for continuing increases in hurricane activity and model projections indicate that this may occur through increases in intensity of events but not necessarily through increases in frequency of storms.

Before 2004, the island was considered relatively safe from hurricanes, as only 3 hurricanes had been recorded since the beginning of the 20th century. However, in 2004 and 2005, Grenada was hit by Ivan and Emily, hurricanes of the categories 3 and 1, with devastating consequences for the population and infrastructure of the island (GFDRR 2010, Sander 2015). For more information on the impacts of the two hurricanes Ivan and Emily, which followed a prolonged dry period, see Box 3 below. In 1999, Grenada suffered damages from storm surges caused by Hurricane Lenny (World Bank 2005).

Box 3: Information on the impacts of the hurricanes (World Bank 2005)

Hurricane Ivan struck Grenada in September 2004 causing an unprecedented 200% of GDP damage, and Hurricane Emily in July 2005, causing additional 12% of GDP damage.

Classified as a Category 3 hurricane with sustained winds of 120 mph and gusts of up to 135 mph, Ivan left tremendous devastation in its wake. Ivan was considered a 'dry' hurricane, with most damage being caused by its strong winds. A damage assessment jointly conducted by the Organization of Eastern Caribbean States (OECS) and the United Nations Economic Commission of Latin America and the Caribbean (ECLAC) estimated damage over US$800 million or twice Grenada's Gross Domestic Product (GDP) at the time (OECS 2004). Specific losses can be distilled as follows:

Housing: 89 percent of the country's housing stock was damaged, almost 30 percent of which required complete replacement. With only 15 percent of private homes insured at the time, a significant problem of underinsurance was brought to light;
Public Buildings: in excess of 80 percent of building structures on the island sustained some form of damage;
Education: all but two of the primary and secondary schools were affected;
Health: 69 percent of infrastructure in the health sector was damaged. 11 health facilities, including the second largest hospital, were seriously damaged. As a result, health services continued to be available in the immediate aftermath of the disaster only on limited scale.
Environment: 91 percent of the forest lands and watersheds were stripped of vegetation;
Tourism: close to 70 percent of hotel infrastructure was rendered inoperable.
Power Sector: nearly the entire electricity distribution system was destroyed
Agricultural Sector: suffered a near complete loss of the year's crop. Nearly 85 percent of the nutmeg crop (Grenada was the second biggest nutmeg producer in the world) was affected and 60 percent was completely destroyed. The hurricane also destroyed virtually the entire banana crop and roughly 60 percent of the cocoa trees.

Damages were compounded with the passage of Hurricane Emily in July 2005, which passed over Grenada as a Category 1 hurricane. Losses related to Emily, while not nearly as severe, had a serious impact on the agriculture sector in particular, as the hurricane brought torrential rains, triggering runoff.

3.3. Demographic and socio-economic factors

Grenada's estimated population was 110,694 in 2015, with a growth rate of 0.48% per annum (CIA 2016). The majority of the population lives in settlements within the vulnerable coastal zones, due to the island's mountainous topography (CIA 2016). The main settlements are St. George's (St. George parish) and Grenville (St. Andrew parish). The populations of these parishes account for almost 60% of the total population (MoALFFE 2010).

In 2008, the Grenada Country Poverty Assessment concluded that 52.3% of the total population were at risk of becoming vulnerable, poor or indigent (critically poor) (Kairi 2007). Furthermore, 37.7% were classified as being below the poverty line[1], and therefore vulnerable to food insecurity and at increased risk of weather or climate related impacts. One contributing factor is Grenada's high rate of unemployment measured at 33.5% in 2013 (an increase compared to 25% unemployment in 2008) (CIA 2016). The distribution of poverty in Grenada varies widely by parish. Three of six parishes (St. Andrew, St. George and St. Patrick) account for approximately 75% of persons vulnerable to food insecurity, with the highest concentration of vulnerable persons living in the most populous parishes of St. George and St. Andrew.
The present economic situation in Grenada is extremely challenging and must be viewed within the context of external development pressures of changing global trade arrangements and also the reconstruction efforts following two major hurricanes in 2004 and 2005. The hurricanes severely affected every sector of society (see Box 3 for more information).

The economic activity in the country is very small and vulnerable as it is dominated primarily by services (tourism and education) and agricultural production (nutmeg and cocoa), which depend heavily on a healthy ecosystem. Currently agriculture contributes 5.6% to the GDP, the industrial sector 15.6% and related services (mainly tourism) contribute 69% to the GDP (CIA 2016). The tourism and agricultural sectors are particularly vulnerable to climate change related impacts such as extreme weather events or droughts. Prior to Hurricane Ivan, Grenada contributed a quarter of the world output of nutmeg (MoALFFE 2010). Today, Grenada accounts for approximately 13% of the world output of nutmeg, a drop of more than 10% (MoALFFE 2010). The tourism sector has been the main driver of the economy since the 1980s, and although Hurricane Ivan caused massive damage to the sector, there has been a relatively rapid recovery (MoALFFE 2010).

3.4. Health status and health system

3.4.1. Health Status

The health indicators for Grenada are comparable to those of the rest of the Eastern Caribbean. Mean life expectancy was 74.05 years (males 71.47 years and females 76.88 years) in 2015 (CIA 2016). Children in Grenada are generally well nourished and 95 - 100% are vaccinated against the common communicable diseases (Diphtheria, Hepatitis B, Haemophilus influenza Type b, Polio and Measles, Mumps, Rubella).

[1] Below the poverty line refers to persons who could not simultaneously meet their food and non-food needs.

There were no reported cases of vaccine-preventable diseases during 2005-2010 (PAHO 2012). Antenatal care is available to all pregnant women, and all births are attended by a trained professional (PAHO 2012).

Non-communicable diseases are the main cause of morbidity and mortality in Grenada, accounting for approximately 65% of total deaths each year in the 2006-2010 period (PAHO 2012). Cancers, cardiovascular disease, hypertension, diabetes, chronic pulmonary diseases (CPDs), and mental health are priority areas of concern. In particular, respiratory diseases such as asthma or acute respiratory infections (ARI), are one of the main causes of morbidity in Grenada, with ARIs the leading cause of morbidity in children under 5 (PAHO 2012). According to the Epidemiology Unit of the MoHSS, there has been an increase of approximately 8 - 11% of cases reporting respiratory diseases in all age groups for the year 2012. A recent study found that Saharan dust, transported across the Atlantic, interacts with the Caribbean seasonal climatic conditions (Akpinar-Elci, et al. 2015). High humidity, especially during the rainy season (June-December) results in the dust becoming respirable, potentially contributing to increased numbers of respiratory illness. This study also reported an increase in asthma cases presenting at the emergency department in conjunction with seasonal humidity.

Communicable diseases, particularly new and emerging diseases, pose a particular challenge for Grenada within the context of climate change (see Figure 3). Vector-borne diseases transmitted by the *Aedes aegypti* mosquito, such as Dengue fever, chikungunya virus, and Zika virus are of specific concern to health authorities, with outbreaks of the former two having occurred in recent years, and an outbreak of Zika occurring at time of writing. In 2014, Grenada experienced an outbreak of chikungunya virus for the first time, with a total of 3070 cases (26 laboratory confirmed) (PAHO/WHO 2015). At time of writing, a Zika virus outbreak is being observed on the island, with 9 confirmed cases, over 30 suspected cases, and two Guillain-Barré Syndrome cases being reported in July 2016. Other climate sensitive diseases such as rodent-borne leptospirosis, are present with low prevalence rates. Water-borne diseases (gastroenteritis) are reported to be more common during the dry season, especially on the islands of Carriacou and Petit Martinique, which experience harsher dry seasons (Glasgow, Forde, et al. 2013).

3.4.1. Health System

Grenada's total health expenditure as a percentage of GDP was estimated at around 6.3% in 2013, similar to other countries in the region (WHO 2015). However, public sector budget shortfalls pose an ongoing threat to the health sector. This accounts for an increasing use of private health care providers and a growing reliance on out-of-pocket payments to finance health care (an estimated 48% of total health spending in 2009) (USAID 2011)

Grenada's health service delivery system includes four public hospitals and the community health service facilities (6 district health centers and 30 medical stations that are all within 5 km of their catchment population's home). Figure 4 provides a map showing the locations of medical stations. Furthermore, civil society

organizations are highly engaged in Grenada's health sector. According to a USAID report from 2011, the Grenadian health system provides a good coverage of, and access to, primary and basic secondary health care services. However, secondary health care facilities are often overcrowded with primary care-seekers due to lack of quality in public primary health care facilities (long waiting times and lack of confidentiality were mentioned by clients). Approximately 46% of Grenadians have access to private facilities as their first source of medical care (USAID 2011). There are 30 – 40 doctors actively serving private clients, in addition to several small private health facilities offering their services.

Although a sufficient number of general medical practitioners and nurses support the current health service system in Grenada, the country's disease burden requires an increased number and range of human resources for health, such as medical and nursing personnel. Furthermore, the MoHSS's capacity for evidence-based planning and budgeting could be strengthened. For instance, the management of pharmaceuticals and medical supplies benefits from cost-saving due to Grenada's participation in the OECS Pharmaceutical Procurement Service. Public sector stock-outs and wastage are nonetheless common due to the lack of public sector funds, the use of manual forecasting, and weaknesses in inventory management (USAID 2011). Some of these issues could be solved by improving the national health information system.

In Grenada, health data collection and reporting is paper-based, with health centers sending weekly disease tally sheets to the health surveillance officers at the MoHSS, who input this information into EpiInfo software (communicable diseases) and into Excel (non-communicable diseases). This poses challenges in compiling all the data from the different parts of the tri-island state and prevents timely data analysis for evidence-based response and action. A robust health information system is especially important for the control of epidemic-prone diseases, as these require constant surveillance and reporting, early action, and quick response. Certain epidemic-prone diseases are more climate sensitive than others, such as vector-borne diseases, which present existing and emerging threats to Grenada. The active surveillance of these diseases, including the vector biology and disease transmission patterns is essential to informing vector control strategies and treatment regimens (see Box 4).

3.4.1. Health Infrastructure

In recent years, vulnerability assessments and studies of the health sector infrastructure have been conducted (PAHO/WHO 2014, PAHO/WHO 2010, PAHO 2008). In 2008, the main healthcare facility of the country, Grenada General Hospital located in St. George´s, was assessed using PAHO's Hospital Safety Index (HSI) (for further information on the HIS please see chapter 3.6). The HSI assessment 'noted vulnerabilities to earthquakes, volcanic eruptions and landslides to which the entire island is susceptible' (PAHO/WHO 2014). Due to the buildings' location on the shoreline, it is particularly vulnerable to tsunamis and storm surges. The second largest healthcare facility, the Princess Alice Hospital, located in the north of the island, was assessed using HSI in 2009. Its vulnerability to natural hazards like earthquakes, hurricanes and volcanic eruptions is equal to all facilities of Grenada.

However, as a result of its inland location and flat environment, it is not vulnerable to tsunamis, storm surges and landslides. Furthermore, non-structural and functional vulnerabilities have been identified such as insufficient potable water storage, insecure air conditioning units, outdated disaster plans, and inadequate Emergency Operations Centers. The HSI index was also used to assess other hospitals, health centers and medical stations (PAHO/WHO 2014).

In addition to being vulnerable to the impacts of climate change, the health care sector is also a significant source of carbon emissions, and generator of waste (WHO/HCWH 2009). Inadequate hospital and biomedical waste management, as found in Grenada, can lead to environmental contamination with biological material, disease agents and other toxic substances, giving rise to biohazards. In Grenada, chemical waste that should be treated as hazardous waste, is disposed of in the drain, contaminating nearby streams, rivers, and the sea. Solid waste is usually burned on site at health centers, leading to the emission of black carbon or smoke, which in turn impact human health. Burning practices also pose a threat to the surrounding environment because they do not allow for sufficient disinfection, pose as a fire hazard (especially during the dry season), and contribute to local air pollution and greenhouse gas emissions. Contributing to this mismanagement of biomedical waste is a lack of policies, procedures and trainings (NRMU/OECS 2002).

Box 4: Integrated Vector Management: An approach for effective vector control

Effective vector control programs should be informed by robust scientific information on: 1) Mosquito genetics, ecology, behavior and vulnerable life stages; 2) Anthropogenic factors affecting human population size, housing patterns, behavior, culture and socio-economic conditions and 3) Knowledge of various aspects of the environment (biotic and abiotic factors) which foster the development of the vector and enhance disease transmission. Programs should be well designed with sound management processes, and avoid irrational use of insecticides, but rather use a combined – or integrated – approach of vector control.

The most important disease transmitting vector in Grenada is the *Aedes aegypti* mosquito, which is responsible for the transmission of dengue, chikungunya and Zika virus, amongst others. The WHO promotes a strategic vector control approach called Integrated Vector Management (IVM), which is defined as "a rational decision-making process for the optimal use of resources for vector control" (WHO 2012). IVM is a way of managing a vector control program, and includes five key elements:

- *advocacy, social mobilization and legislation* – the promotion of IVM principles in all policies, across relevant ministries, national agencies, organizations and civil society; strengthening of regulatory and legislative controls for public health; and the empowerment of communities;
- *collaboration within the health sector and with other sectors* – the collaboration within and between public and private sectors; planning and decision-making delegated to the lowest possible administrative level; and strengthening communication among key partners;
- *integrated approach to disease control* – utilization of a range of interventions (non-chemical and chemical), in combination and synergistically; ensuring the rational use of available resources through the application of a multi-disease control approach; integration of vector control methods; and integration with other disease control measures;
- *evidence-based decision-making* – adaptation of strategies and interventions to local vector ecology, epidemiology and resources, guided by operational research and subject to routine monitoring and evaluation;
- *capacity-building* – the development of essential infrastructure, financial resources and adequate human resources at national and local levels to manage IVM programs, based on a situation analysis.

Source: (WHO 2009)

COMMUNICABLE DISEASE 2006 - 2014. GRENADA.

No.	COMMUNICABLE DISEASE	2006	2007	2008	2009	2010	2011	2012	2013	2014		
		Total	Total	Total	Total	Total	Total	Total	Total	Male	Female	Total
1	Acute Respiratory Infection <5	3990	4079	2839	3497	5038	4196	4559	3956	1850	2107	3957
2	Acute Respiratory Infection ≥5	3618	3456	3443	4795	5989	5868	6570	6086	3530	2579	6110
3	Gastroenteritis <5	1094	661	666	1111	857	604	1563	640	595	658	1253
4	Gastroenteritis ≥5	958	494	843	1708	1559	1109	2181	1155	1137	917	2054
5	Undifferentiated Fever <5	246	118	108	99	144	160	242	335	190	240	430
6	Undifferentiated Fever ≥5			84	108	149	100	180	356	346	333	679
7	Acute Haemorrhagic Conjunctivitis	67	58	78	52	30	43	59	37	57	32	89
	Chicken Pox	52	33	61	98	46	197	116	21	26	35	61
9	Neonatal Conjunctivitis			26	17	16	24	41	27	12	13	25
10	Foodborne Illness	39	67	57	108	94	128	109	119	47	49	96
11	Genital Discharge	151	148	143	89	173	170	173	149	103	38	141
12	Chlamydial Infection	9	12	9	8	23	18	13	20	5	3	8
13	Gonoccocal Infection	67	74	45	83	99	121	153	189	44	97	141
14	Genital Ulcer – Syphilis	37	7	6	28	23	49	38	34	13	7	20
15	Genital Ulcer – Herpes	7	6	12	18	14	12	10	8	8	4	12
16	Hepatitis B Confirmed	31	57	98	84	50	52	32	24	11	13	24+(2 unknown)
17	Leptospirosis confirmed	3	4	4	7	2	11	23	5	6	0	6
18	TB Confirmed	1	3	6	5	4	2	1	1 *	0	0	0
19	Malaria	0	0	0	0	1	0	1	0	0	0	0
20	Dengue Confirmed	14	7	7	28	134	92	85	155	18	21	39
21	Scabies	197	N/A	215	260	200	244	230	177	99	80	179
22	Pelvic Inflammatory Disease	N/A	N/A	192	188	191	248	186	129	130	0	130

* Imported.

Figure 3: Accumulated communicable disease cases in Grenada, 2006 – 2014 (Source: MoHSS, Grenada)

Figure 4: Hospitals and community health services facilities in Grenada
(Source: http://healthmap.opixels.net/)

3.5. Climate Change and Health Governance

3.5.1. Climate Change Governance

Grenada signed the United Nations Framework Convention on Climate Change (UNFCCC) in December 1992 and ratified the convention in August 1994. However, first climate change related activities began with the implementation of the regional project "Caribbean Planning for Adaptation to Climate Change" from 1997-2001. This and other similar projects were coordinated by the National Climate Change Committee. The committee was established under the auspices of the Ministry of Finance until it was transferred to the Ministry of the Environment in 2009. The Committee became dormant after climate change related project activities phased out in 2011 due to lack of financial and human resources (GoG/GIZ ICCAS Project 2014). In 2014 the Committee was reinstated under new terms to steer new climate change and adaptation projects. Currently it functions as a coordinating and oversight body for climate change activities of the Government, the private sector, NGOs, and international agencies.

Since its First National Communication (FNC) to the UNFCCC in 1998, Grenada has taken many important steps towards climate resilience (see section 3). However, an overarching strategic framework is needed to ensure efficient and effective use of existing resources and of current and future projects according to nationally determined priorities.

As a result of hurricane Ivan in 2004, the government strengthened its efforts in preparing for natural disasters. The National Disaster Management Agency (NaDMA) previously Emergency Recovery Organization (NERO) was established in 2004. NaDMA, a department of the Office of the Prime Minister, is the body charged with the responsibility of coordinating all disaster-related activities on Grenada, Carriacou and Petite Martinique as outlined in the National Disaster Plan from 2005 (NaDMA/NaDMAC 2005). NaDMA cooperates with the sub-working group of climate change adaptation under the National Climate Change Committee, as well private companies, civil society organizations, and governmental departments involved in climate change related activities, to ensure adequate disaster and emergency preparedness processes.

In 2015, Grenada kick-started its National Adaptation Plan (NAP) process which will result in a document by October 2016. The NAP will be able to fill current gaps in adaptation planning, prioritise adaptation actions across sectors and hence will provide guidance for potential future donors. In addition, the NAP will constitute a sound basis for accessing and using international climate finance such as the Green Climate Fund (GCF).

3.5.2. Health and Climate Governance

Grenada´s FNC identified health as one of the most vulnerable sectors in the country. It states that 'the main effect is likely to be caused by the increased incidence of vector-borne communicable diseases, for which the vectors are currently resident or are likely to be imported. Respiratory diseases associated with regional dust storms

during the hurricane seasons are also likely.' It also stresses that the link between health and climate change in Grenada requires further research (GoG 2000).

Presently, Grenada is working on its Second National Communication (SNC) to the UNFCCC. The SNC will include a quantitative analysis of the impacts of climatic variables on climate sensitive disease outcomes, expanding on the results of the present study, and building on the outputs of regional projects. In addition to providing an analysis of historical climate and disease trends, the SNC aims to provide an insight into Grenada's changing disease burden under different climate change scenarios.

The MoHSS developed a sector specific 'National Health Sector Disaster Management Plan' in 2006, which aims 'to provide guidance to the Health Sector in the management of an event whether natural or human made, ensuring that the health sector is able to respond, with the goal to save as many lives as possible' (MoHSS 2006). Several elements are highlighted as key to the success of this plan: input by all sectors; preparation and preparedness; ongoing training and re-training; continuous monitoring, evaluation and commitment. Although the plan does not address all phases in the disaster cycle, it is a start for integrating risk reduction into the recovery phases of an emergency situation.
A new 'Corporate Plan' for 2015-2017 was drafted in 2014, providing a road-map for MoHSS programs and activities, and outlining priority areas for health spending in that period (MoHSS 2014). While the Corporate Plan does not explicitly mention specific climate change activities, the SWOT analysis undertaken to develop the plan does identify climate change as a threat to national health. Furthermore, several activities that can be linked to climate change were identified, most of which correspond to the WHO health systems building blocks, and the ten components for building climate resilient health systems (see Figure 5). The activities identified in Grenada include: improvement of health infrastructure (repair and maintenance, preventative maintenance plans); health systems development and strengthening (management information system, health disaster risk management including safe hospitals); health services development and delivery (implementation of international environmental health regulations, improved vector control); and implementation of a functional communications strategy (MoHSS 2014).

Key stakeholder interviews conducted during the assessment revealed several key constraints to effective climate and health management in Grenada:

- Inadequate human and financial capital,
- Limited collaboration and cooperation at both inter- and intra-sectoral levels,
- Lack of a functioning surveillance and monitoring mechanism.

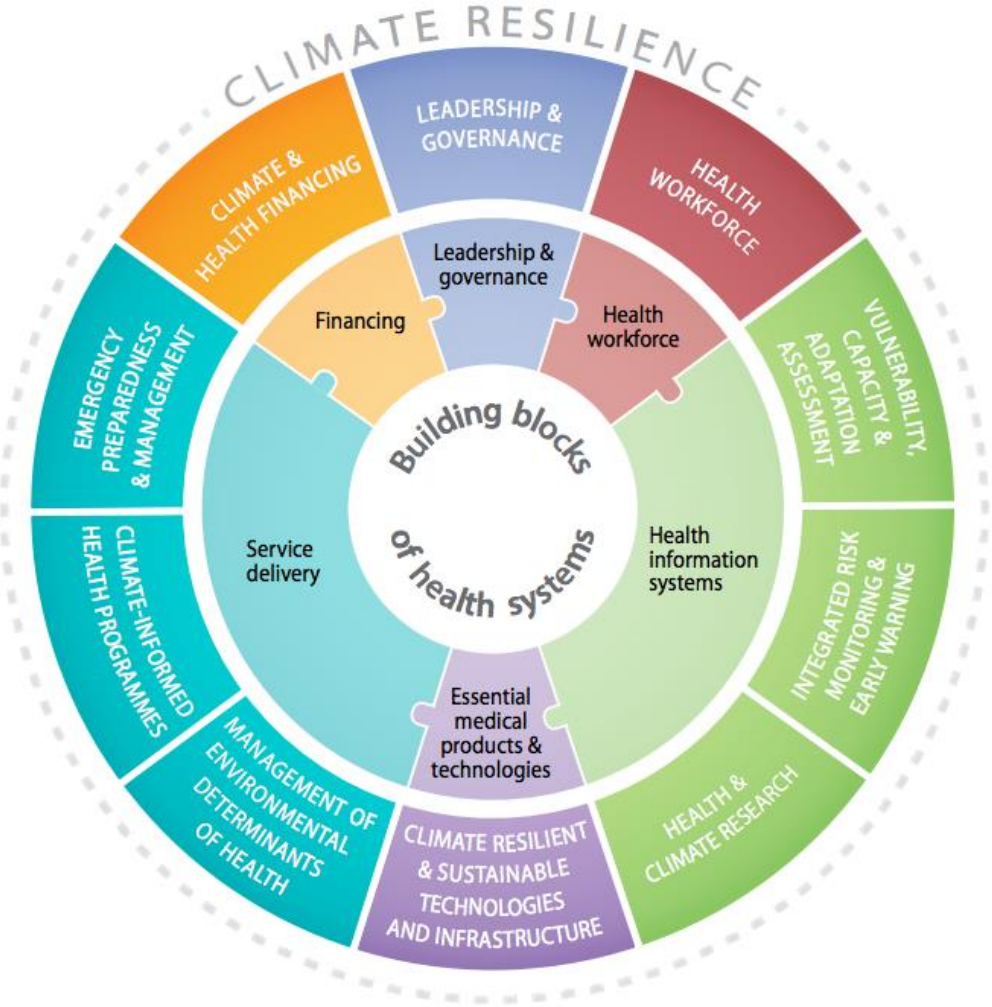


Figure 5: WHO Building blocks of health systems and their respective components for creating climate resilient health system *(WHO 2015)*.

3.5.3. Regional cooperation

CARICOM (Caribbean Community)

As a member of CARICOM, Grenada benefits from economic integration, coordinated foreign policy, security, as well as human and social development efforts in the Caribbean region. With regard to climate change, CARICOM governments delivered a 'Regional Framework for Achieving Development Resilient to Climate Change (2009-2015)' in 2009, followed by an implementation plan 'Delivering Transformational Change 2011-2021', which was approved by CARICOM Heads of Government in 2012 (CCCCC 2009, CCCCC 2011). The Regional Framework identified health as once sector in which actions need to be delivered. In 2015, Grenada submitted a monitoring and evaluation framework to CCCCC as a requirement of the implementation plan.

OECS (Organization of East Caribbean States)

The OECS is a sub-regional organization of nine countries functioning primarily as an economic union with a single financial and economic space, and harmonized development policies. The OECS has an Environment and Sustainable Development Unit (ESDU), which is responsible for the provision of natural resource and

environmental management services to OECS member states. In 2011, OECS member states launched a USAID funded project 'Reduce Risks to Human & Natural Assets Resulting from Climate Change (RRACC)', which benefited Grenada in the form of investments for financial and technical support for activities in vulnerable communities and areas. Health was not a specific focus area of the RRACC project in Grenada (OECS 2016).

CDEMA (Caribbean Disaster Emergency Management Agency)
CDEMA is the disaster management organization serving CARICOM. Apart from supporting member states with preparedness and response activities, CDEMA is also involved in disaster risk reduction activities, including support for vulnerability assessments, hazard mitigation, and safer building, amongst others. In 2014, CDEMA published a comprehensive 'Regional Comprehensive Disaster Management Strategy and Programming Framework', which aims to be linked with global agendas such as the Hyogo Framework on Disaster Risk Reduction, as well as CARICOM's Regional Framework (CDEMA 2014). Grenada's National Disaster Management Agency (NaDMA) benefits directly from the guidance, expertise, and network provided by CDEMA.

CARPHA (Caribbean Public Health Agency)
CARPHA is the single regional public health agency for the Caribbean Community. Launched in 2013, it combines five regional health institutes into a single agency, providing expertise in environmental health, epidemiology, food and nutrition, health research, and laboratory services. CARPHA responds to issues of regional importance, including emergency responses to disasters, non-communicable and communicable disease management and surveillance, and contributes to the fulfilment of global health agreements and member state compliance with international health regulations. CARPHA collaborate closely with the Pan American Health Organization (PAHO) on emerging issues related to climate change and health. While no specific climate and health program has yet been launched, a three-day meeting in November 2015 brought together stakeholders to address the health impacts of climate change in the Caribbean region (CARPHA 2015).

PAHO (Pan American Health Organization)
Grenada is a member country of PAHO, the specialized health agency of the Americas. PAHO provides technical cooperation to member countries and promotes inter-country coordination to advance national health goals. In 2011, PAHO launched its regional 'Strategy and Plan of Action on Climate Change' with four overall objectives: evidence; awareness raising and education; partnerships; and adaptation (PAHO/WHO 2014). In Grenada, this has led to the Smart / Safe Hospitals project, in which two major hospitals on the island were retrofitted and made resilient to climate hazards (PAHO/WHO 2014). PAHO has further provided technical assistance to other Caribbean islands, such as Dominica, in conducting their vulnerability assessments, and drafting national (health) adaptation plans.

CIMH (Caribbean Institute for Meteorology and Hydrology)
The CIMH is the training and research organization on hydrology and meteorology for the Commonwealth Governments of the Caribbean Region. It provides and

promotes hydrometeorological services (such as drought monitoring and real time flood forecasting) and offers specialized trainings and advice to member states. CIMH co-organizes a biannual Caribbean Climate Outlook Forum (CariCOF) that seeks to develop regionally appropriate climate services to support the goals of climate change adaptation and disaster risk reduction. The last CariCOF (May 2016) focused specifically on the health sector, bringing together regional climate and health stakeholders to sensitize participants on the health risks of climate change, and share climate and health work being done in the region (CIMH 2016). The next CariCOF (October 2016) will be held in Grenada.

3.6. Current Activities and Projects to Strengthen the Adaptive Capacity of the Health System

At time of writing, there are no programs and projects in Grenada that are specifically designed for climate and health or health system adaptation to climate change. Nonetheless, there are several projects that contribute to a strengthened health system, or increased climate resilience in different ways:

3.6.1. ICCAS (Integrated Climate Change Adaptation Strategies)

The ICCAS Program in Grenada aims to make Grenada's population and ecosystems more resilient to climate related risks. It is funded by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), and jointly implemented by the Ministry of Agriculture, Lands, Forestry, Fisheries and the Environment (MoALFFE), the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and UNDP. Under ICCAS, the Environment Division and GIZ are supporting the National Adaptation Plan (NAP) process in Grenada (GoG/GIZ ICCAS Project 2014).

Health is no explicit focus area of the ICCAS project. However, health has been identified as a priority for action in the FNC and it will be included as a priority area for action in the SNC. Due to this increased national interest in linking climate and health, GIZ-ICCAS has reached out to the GIZ Global Program 'Adaptation to Climate Change in the Health Sector' for technical support. This program was established by the German Federal Ministry for Economic Cooperation and Development (BMZ) and has been implemented by GIZ since late 2013. The program aims to position health issues more strongly in the international climate debate and to put them higher on national agendas. The program particularly supports governments and civil society institutions. Since climate change-related health risks are often linked to other sectors, such as agriculture or water, the program follows a cross-sector approach.

3.6.2. Strengthening Communities through Safer Health Care Facilities

The Safer Health Care Facilities project is funded by the European Commission and implemented by PAHO/WHO. The project was launched with a workshop based on PAHO's *Hospital Safety Index* in 2008. PAHO trained MoHSS officials and hospital staff to apply the index in eight hospitals in Grenada, St. Kitts and Nevis, St. Vincent

and the Grenadines, Dominica, Montserrat, Anguilla, and Barbados. The HSI allows each facility to evaluate its location, construction, condition, support system, and disaster preparedness and response plans (PAHO/WHO 2014). Grenada's General Hospital in St. George's participated in this project and the results of the first evaluation highlighted the need to take action in nearly all areas. It remains unclear if any of those recommended actions were carried out sufficiently.

3.6.3. SMART Health Care Facilities in the Eastern Caribbean Project

The SMART health care facilities project was launched in early 2015 (PAHO 2016). It is financed by the United Kingdom's Department for International Development (DFID) and is being supported by PAHO/WHO. The aim of this project is to support vulnerable Caribbean countries, including Grenada, to assess and prioritize vulnerability reduction investments for their health facilities. Several tools, including the HSI, are being used to run the evaluations. The health facilities are being assessed in their infrastructure, services, disaster safety, as well as water and energy efficiency. The results feed into a road-map for investment and will be incorporated within national risk exposure databases. In Grenada, three health facilities will be retrofitted to help reduce downtime and potential damage to the facility in the event of a disaster, as well as reduce operational expenditures by improving water and energy management. Ensuring energy auto-sufficiency is another goal, which will allow for continued healthcare delivery in the event of a major disaster.

3.6.4. Climate Resilient Water Sector in Grenada (CREWS)

The CREWS project proposal is due to be submitted to the Green Climate Fund (GCF) in 2016. It will be supporting new or improved drinking water storage, and improved plumbing and/or rainwater harvesting infrastructure at 16 community health facilities and related services in four parishes of Grenada and in Carriacou (MoF/DETC 2015). This project will especially impact the Carriacou health sector, as it is highly dependent on rainwater harvesting.

4. Vulnerability analysis of climate change impacts on health

Climate change can affect human health by giving rise to conditions that can directly kill or injure human beings, such as extreme weather events, or by creating conditions that alter disease and vector distributions (WHO/WMO 2012). Grenada is likely to experience climate change health impacts that are typical for Caribbean SIDS (Clarke, et al. 2013). These include direct risks to health brought about by hurricanes, tropical storms, flooding and heavy rainfalls, but also by extreme heat. Slow-onset climate related changes such as increasing temperatures, sea-level rise, reduced annual rainfall and drought, combined with more intense rains, give rise to indirect health impacts such as shifting patterns of vector borne diseases. The table below provides an overview of the direct and indirect impacts of climate variability and change on human health in Grenada.

Grenada's FNC identified several diseases of which incidence is likely to increase under climate change (GoG 2000). Vector-borne diseases (particularly dengue, chikungunya and Zika virus) are a primary concern of Grenadian public health officials, due to the difficulty of vector management and the outbreak prone nature of these diseases. An increase in intense rainfalls and temperatures is likely to create favorable mosquito breeding conditions, making the control of these diseases a priority in the health sector (Patz, et al. 2003). Rodent-borne diseases such as leptospirosis are prone to outbreaks during floods, when sewage can mix with drinking water supplies, increasing the risk of human infection. Moreover, heavy rainfall and hurricanes are often accompanied by an increase in water-borne diseases, when communities using pit latrines are flooded and their water supplies contaminated. Grenada's Second National Communication (SNC) is currently being prepared and will include a quantitative analysis of the diseases highlighted in the present study and their potential climate linkages.

Furthermore, Grenada's water supply is strongly affected by the dry season, during which available surface water can decrease as much as 30 to 40% (CARIBSAVE 2012). This contributes to the decline in water quality during dry seasons and an increase of water-borne diseases (diarrheal diseases in particular). Carriacou and Petite Martinique are particularly affected due to their reliance on rainwater harvesting (CARIBSAVE 2012). Dry spells, drought conditions and prevailing winds during the dry season can also increase particulate matter in the air. This in turn can aggravate persons with respiratory illnesses, such as asthma, and result in an increase of acute respiratory infections. Air-borne respiratory infections may therefore become more common among those who suffer from chronic respiratory diseases, and have already seen an increase in recent years (Akpinar-Elci, et al. 2015, CARIBSAVE 2012).

Another indirect impact of climate change on health is through potentially affecting food security. Grenada's agricultural sector is already highly vulnerable to current climate variability and is especially sensitive to extended periods of drought, increasing temperatures, hurricanes and heavy rainfalls (CARIBSAVE 2012, GoG 2010). The northeast region of Grenada and the island of Carriacou in particular, experience

prolonged dry spells that adversely affect the yields of crops that are not grown using irrigation. This might lead to disruptions in food supply, changing patterns of crop, pest and weed species, lower food production, lower access to food due to reduced supply, and higher prices (UNECLAC 2011). This in turn may result in malnutrition and vitamin deficiencies in poor communities that are unable to afford increasing prices of local or imported foods.

The direct and indirect impacts of climate variability and change on human health in Grenada listed above are important considerations to take into account when assessing Grenada's vulnerability and discussing adaptation needs. The table below outlines activities that were identified as climate change related adaptation needs to reduce direct and indirect health impacts in Grenada:

Table 2: Climate change related adaptation needs in the health sector

Health impacts	Specific adaptive measures	General adaptive measures
Extreme weather events (direct effects on health)	• Disaster preparedness and mitigation • Disaster protection measures • Health infrastructure resilience	• Conduct more research on the complex inter-relationship between climate, vector ecology, and human health • Link data on epidemiology of diseases with climate data (including historical climate data) • Evaluate effectiveness of vector control • Implement an electronic health information system for improved disease surveillance, monitoring and control • Implement a national information center – linked to relevant regional centers – containing detailed information on temporal, environmental and climatological data • Solidify the institutionalized collaboration and cooperation at both inter- and intra-sectoral levels • Strengthen the capacity of MoHSS for evidence-based planning and budgeting
Infectious diseases (indirect effects on health)	• Early warning systems • Improved surveillance of diseases and vector populations • Integrated vector management, following the recommendations provided in Box 5	

4.1. Vector-borne diseases

Grenada's population is primarily exposed to diseases transmitted by the *Aedes aegypti* mosquito. This mosquito is responsible for the transmission of dengue, chikungunya and Zika viruses, and has been identified as a climate sensitive vector (IPCC 2014). All three diseases are arboviruses and pose an on-going threat to the island's population under a changing climate. While dengue has been recorded in the Caribbean region since the 17th century, chikungunya and Zika are emerging threats, with outbreaks in Grenada first occurring in 2014 and 2016, respectively. A study by Clarke et al. provides an empirical analysis identifying variations in disease-specific impacts of climate change under different emissions scenarios (A2 and B2) in the Caribbean. The results indicate that cases of vector-borne diseases including malaria and dengue are likely to exceed the number of cases under the baseline scenario in the forecast period 2011-2050.

The rates of many tropical diseases such as malaria, dengue, chikungunya, Zika, filariasis and schistosomiasis are increasing in small island states (Ebi, Lewis and Corvalan 2006). Reasons for this include poor public health practices, inadequate epidemiological surveillance, poor infrastructure, increasing global travel, poor waste management, and changing climatic conditions – all of which are true for Grenada. The abundance of vectors present in Grenada, such the *Aedes aegypti* or *Anopheles* spp. (malaria transmitting) mosquitoes, can be affected by small changes in ambient temperature and rainfall. In Grenada, a vector surveillance system is in place, but at the time of the assessment vector populations were not being monitored against changing climatic variables. Also, discussions with community health nurses and vector control officers indicate that the present system is not effectively controlling *Aedes aegypti* populations. It was assumed that not all households are following adequate vector control measures. A lack of coordination between community health nurses and vector control officers was also suggested. A study into the effectiveness of the Grenadian vector control system would provide more insight. .

4.1.1. Dengue

Although dengue is endemic to Grenada and other Caribbean island states, large outbreaks do not occur every year (Ebi, Lewis and Corvalan 2006). From January 2001 – June 2002 an outbreak with 546 cases was reported in Grenada, with further notable outbreaks occurring in 2010 and 2013. The figure below shows the numbers of reported dengue cases from 1969 – 2013. Dengue cases have been increasing over the last 25 years, and most significantly since 2000. Due to its epidemic potential, the MoHSS has made dengue a reportable disease and a major health priority. While dengue seasonality has been observed in other Caribbean islands (Verret, et al. 2016, Taylor, Chen and Bailey 2009), no studies have so far been done to correlate climate data to dengue cases in Grenada. However, while most Caribbean countries report dengue outbreaks during the rainy season in the second half of the year, Grenada's dengue outbreak in 2002 peaked during the dry season, with most cases reported in March of that year. This may be due to water storage practices creating suitable breeding grounds for vector populations during the dry season.

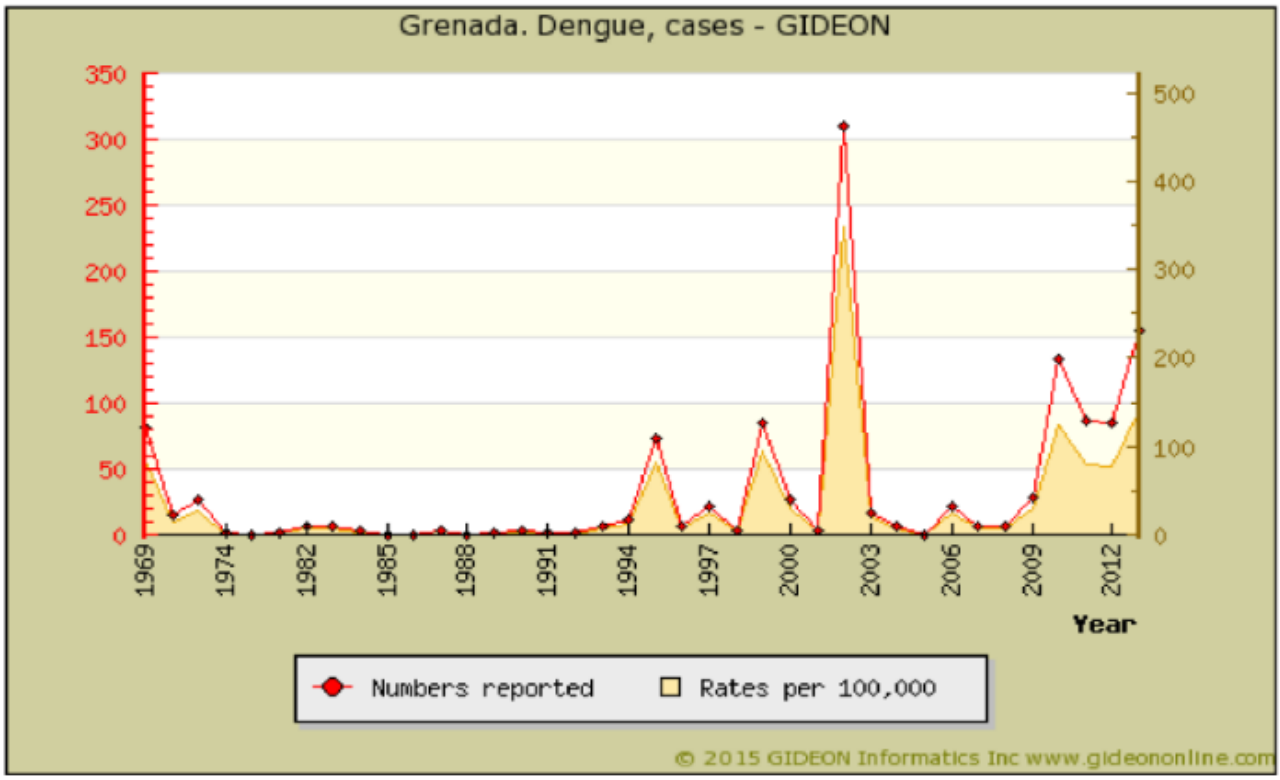


Figure 6. Dengue trends by year in Grenada (Berger 2015)

4.1.2. Chikungunya

While dengue can be considered endemic to the Caribbean region, chikungunya is classified as an emerging threat, which caused a region-wide epidemic in 2014 (Cauchemez, et al. 2014). Due to the extensive movement of people around the Caribbean islands, and the presence of the mosquito vector *Aedes aegypti*, chikungunya has the potential to emerge and re-emerge throughout and beyond the region. The first regional outbreak started with an imported case on the island of Saint Maarten in 2013, and quickly spread along the entire island chain. CARPHA has suggested that the virus may become endemic in the region. In Grenada, it is estimated that 60% of the population have been infected with the virus since its emergence in 2014 (Clegg 2015). The outbreak saw a total number of 3116 cases in Grenada, with 26 laboratory confirmed. The outbreak peaked in September, or the middle of the rainy season (see Figure 7). The outbreak coincided with a period of heavy rainfall and thunderstorms, as well as carnival season, during which many people visit the island. Additional analysis using historical climate data should be performed to describe the linkages between chikungunya disease patterns and climate variability.

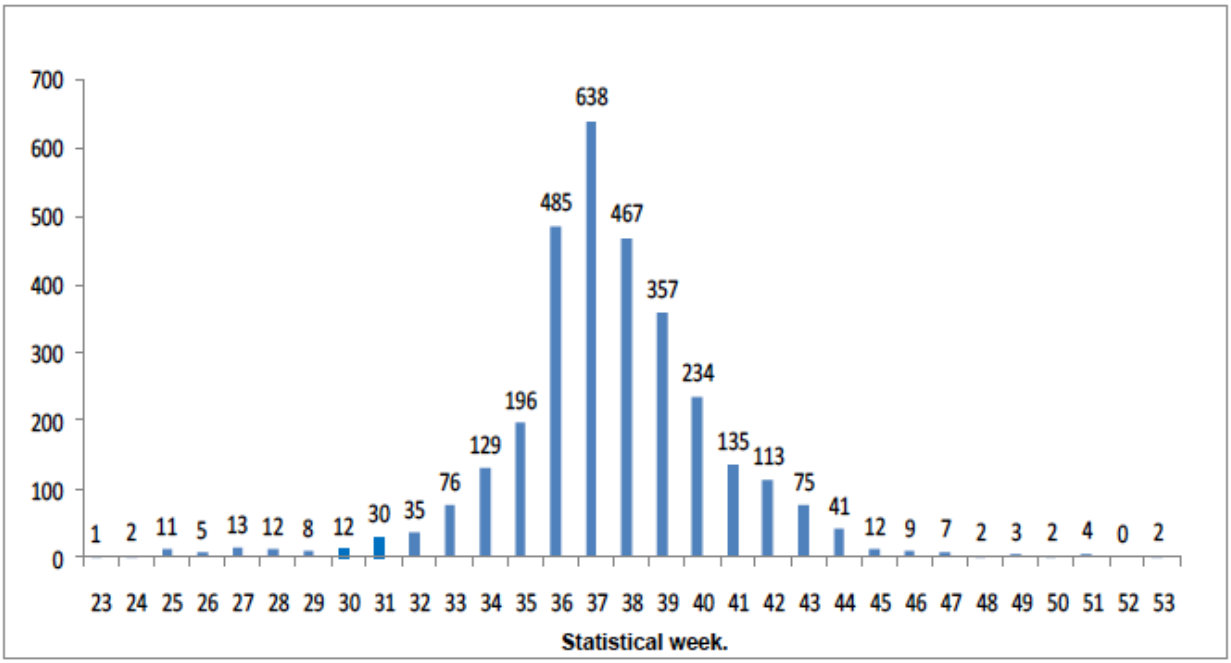


Figure 7. Chikungunya trends by epidemiological week in Grenada, 2014 (Source: MoHSS, 2015).

4.1.3. Zika

Zika virus is the newest arbovirus transmitted by the *Aedes aegypti* mosquito to cause an epidemic in Grenada. Since 2015, 40 countries and territories in the Americas have confirmed autochthonous transmission of Zika virus, with five countries having reported sexually transmitted cases (PAHO 2016). On February 1st 2016, the WHO declared the cluster of microcephaly cases and other neurological disorders in Brazil a public health emergency of international concern (WHO 2016). Grenada reported its first case of Zika virus in April 2016 and has since seen 56 suspected cases, of which 9 were confirmed. However, it is likely that the number of cases is much higher, as patients do not seek out medical support due to the mild symptoms. Moreover, Grenada's surveillance system is not very robust, with many private clinicians not reporting to the MoHSS. At time of writing, Grenada has reported two cases of Guillain Barré Syndrome, which have been linked to Zika infection. One of these cases resulted in death, despite the administration of treatment.

Similar to dengue and chikungunya, Zika can be described as a climate sensitive disease due to its dependence on the *Aedes aegypti* mosquito as a vector. Furthermore, Zika is a type of flavivirus, which mutates frequently (more so than dengue and yellow fever viruses) and is therefore able to adapt quickly to a changing environment (Faye, et al. 2014). This in combination with the geographic range of the mosquito vector can create transmission cycles favorable to the virus. While the behavior of Zika virus

at different temperatures and climatic conditions is not well understood, the fact that it shares a common vector with dengue and chikungunya, diseases known to be linked to climatic variables, make it a virus that must be monitored under changing climatic conditions.

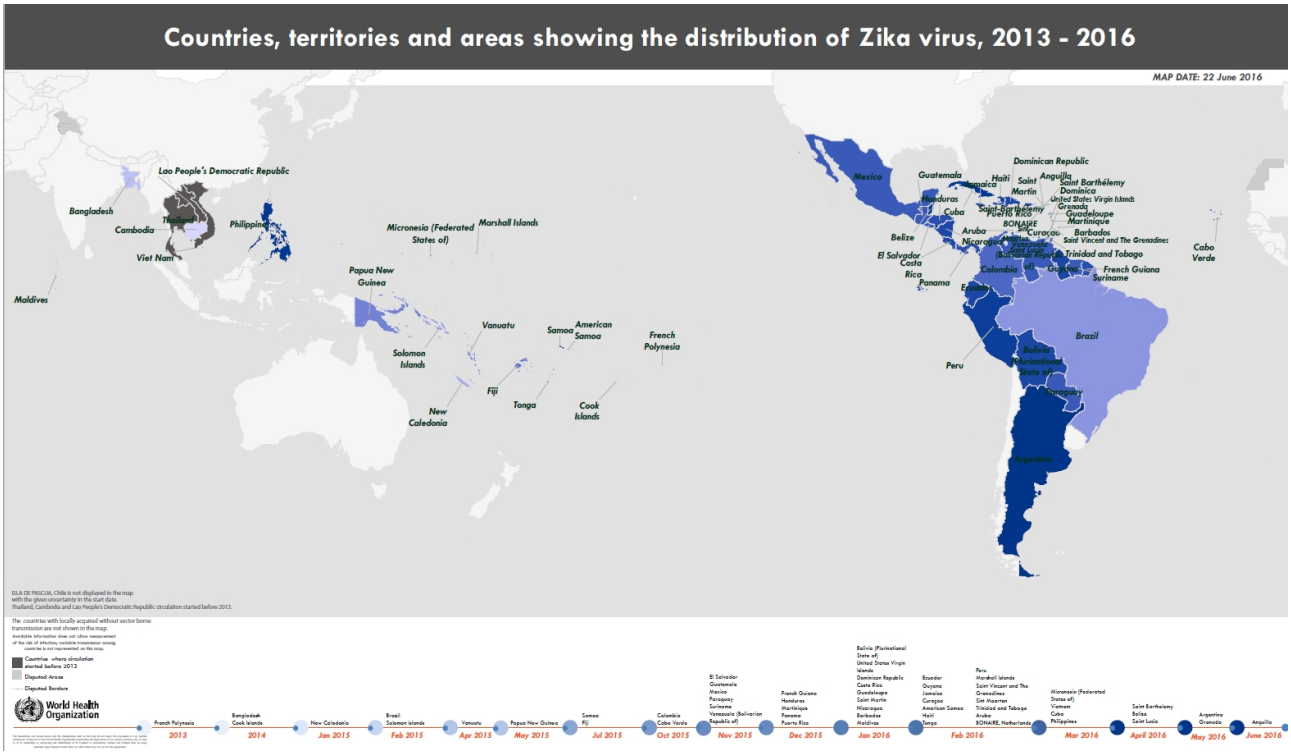


Figure 8. Geographical distribution of Zika virus. (WHO, 2016)

4.2. Food and water-related diseases

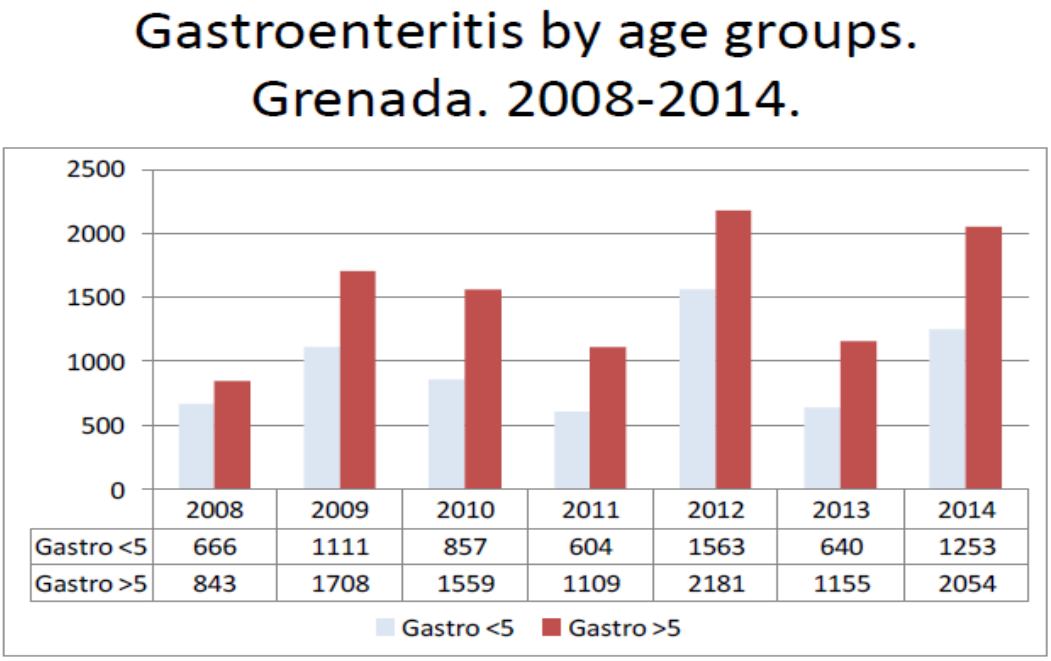
4.2.1. Diarrheal illness and gastroenteritis

The most common clinical outcomes of foodborne illness in Grenada are diarrheal illnesses such as gastroenteritis, which affect the entire population and can be caused by an array of viral, bacterial or parasitic organisms (Glasgow, Forde, et al. 2013). The MoHSS has identified diarrheal illness as a major cause of morbidity, with most cases occurring in children under the age of five (MoHSS 2014). Figure 9 below clearly shows an increase in the number of gastroenteritis cases reported in Grenada between 2008-2014. Furthermore, a burden of disease study on acute gastrointestinal illness conducted between 2008 and 2009 found that the percentage of underreporting of gastroenteritis to the MoHSS was 69%, suggesting that for every reported case, there are 316 additional cases occurring in the population (Glasgow, Forde, et al. 2013). The study found that *Salmonella enteritidis* was the most common foodborne pathogen associated with gastroenteritis.

While there have been no empirical studies showing the relationship between gastroenteritis and climatic variables in Grenada, research done elsewhere has suggested a link between El Nino, increasing temperatures, and dry conditions on infectious gastroenteritis transmission (Onozuka 2014, Hall, et al. 2010, Verret, et al. 2016, Clarke, et al. 2013). For instance, Clarke et al. described that impacts of

gastroenteritis in children may increase under different emissions scenarios and to varying degrees in different demographic groups and projection decades. In Grenada, gastroenteritis cases showed an increase after Hurricanes Ivan and Emily (Glasgow, Forde, et al. 2013).

Risks of contracting food or water borne illnesses tend to rise during dry spells, when there is insufficient clean water for proper sanitation practices, as well as inadequate water storage habits, and marginally after heavy rainfall, when clean water sources can become contaminated (Verret, et al. 2016). These patterns point towards the seasonality of these diseases, yet further studies need to be done locally to determine a clearer link.



	2008	2009	2010	2011	2012	2013	2014
Gastro <5	666	1111	857	604	1563	640	1253
Gastro >5	843	1708	1559	1109	2181	1155	2054

Figure 9: Gastroenteritis trends by year (MoHSS, 2015)

4.2.2. Leptospirosis

Leptospirosis is a rodent borne bacterial disease caused by *Leptospira* pathogens, and is endemic to the Caribbean region. Humans can become infected by direct or indirect exposure to urine of infected rodents (WHO 2012). Indirect transmission can occur through contact of contaminated water with cuts or abrasions of the skin, or through mucous membranes of the eyes, nose and mouth (WHO 2012). Risk of leptospirosis infection is especially high when flooding occurs, such as after a hurricane or heavy seasonal rainfall, which can cause conditions that increase human exposure to contaminated waters (WHO 2012).

While the number of annual leptospirosis cases in Grenada is not high, a total of 57 cases were reported over 2008-2014, with an average of 10 cases per year, the endemicity of disease, presence of the zoonotic host (rats), and changing climatic conditions, such as heavy rainfall and periodic flooding, are all factors that may increase the risk of disease transmission. As the rainfall and hurricane intensity

increase with climate change, so may the instances of flooding, leading to favorable conditions for leptospirosis transmission. Clarke et al. indicated that in the Caribbean region, leptospirosis cases are likely to exceed the number of cases under the baseline climate scenario.

4.3. Respiratory diseases

Acute respiratory infections (ARI) are the most common reported communicable disease in Grenada (see Figure 3). Reported cases of ARIs have almost doubled since 2006, and significantly affect the under-five age group (ca. 1/3 of cases occur in <5 patients). With over 6000 cases being reported annually, ARIs pose a significant threat to the wellbeing of the Grenadian population. Climate variability and change, in particular the presence of Saharan dust have been linked to the increasing number of infections (Akpinar-Elci, et al. 2015). The changing climate in western Africa, in conjunction with intensified land-use, has contributed to increased arid conditions in the region, facilitating the displacement of Saharan dust to the Caribbean since the 1970s (Akpinar-Elci, et al. 2015). The study conducted by Akpinar-Elci et al. between 2001-2005 found that there is a positive correlation between rainfall, humidity, Saharan dust and asthma incidence in Grenada. This study clearly shows a link between climate variables and respiratory diseases.

4.4. Health infrastructure vulnerability

Grenada's health infrastructure has been studied in the past as part of disaster risk reduction and emergency preparedness programs (PAHO/WHO 2010, PAHO/WHO 2014, PAHO 2016, PAHO 2008). In addition to the vulnerabilities of the main hospitals mentioned in section 3.4.1, health facilities in Grenada may be susceptible to landslides and flooding as a result of heavy rainfall. The following maps provide a visual representation of landslide susceptibility and flashflood hazard for Grenada's main island. Health center locations have been inserted as overlays for this study and the maps have been adapted from a recent study by van Westen et al., 2016. These maps provide a visual representation of the proximity of Grenada's health centers to hazardous areas. While most centers are well located, flashfloods or landslides occurring in their proximity may damage nearby infrastructure such as roads, water and electricity supply, impairing access to the centers and potentially damaging service delivery.

A thorough analysis of health center disaster preparedness, as has been done for the St. Georges and Princess Alice Hospitals using the HIS is recommended for the district health centers to improve future planning and response in the case of disasters. During further discussions with nurses at the awareness raising workshop on Carriacou, the vulnerability of the health centers to prolonged periods of drought was repeatedly stressed. Reports of a lack of fresh water at the health facilities during the drought in 2014 were shared. With predictions of a decrease in rainfall (McSweeney, New and Lizcano 2012), this is an indication towards the need for improved rainwater harvesting and plumbing.

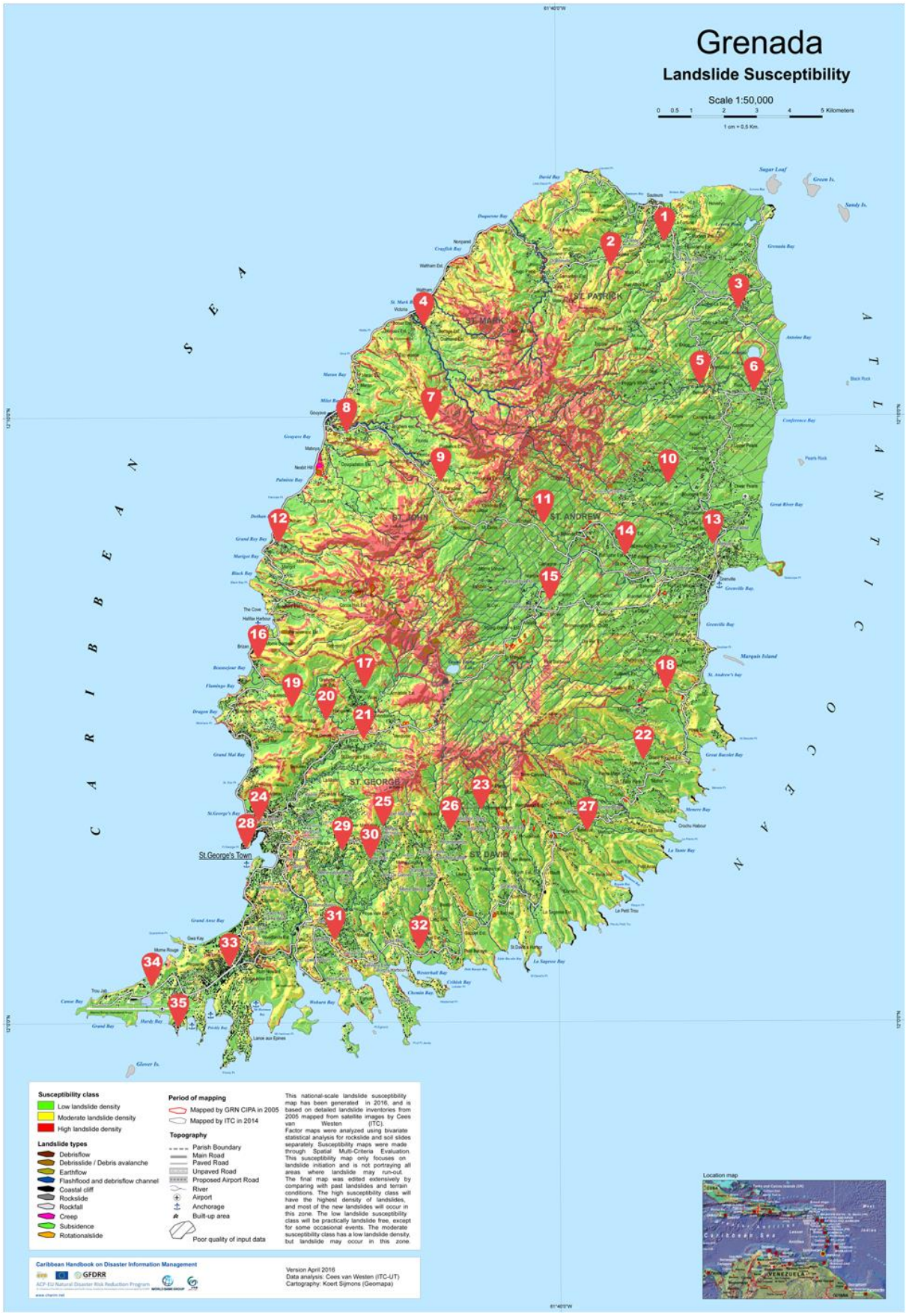


Figure 10. Landslide susceptibility map for Grenada with locations of health centers. (Adapted from: van Westen et al., 2016)

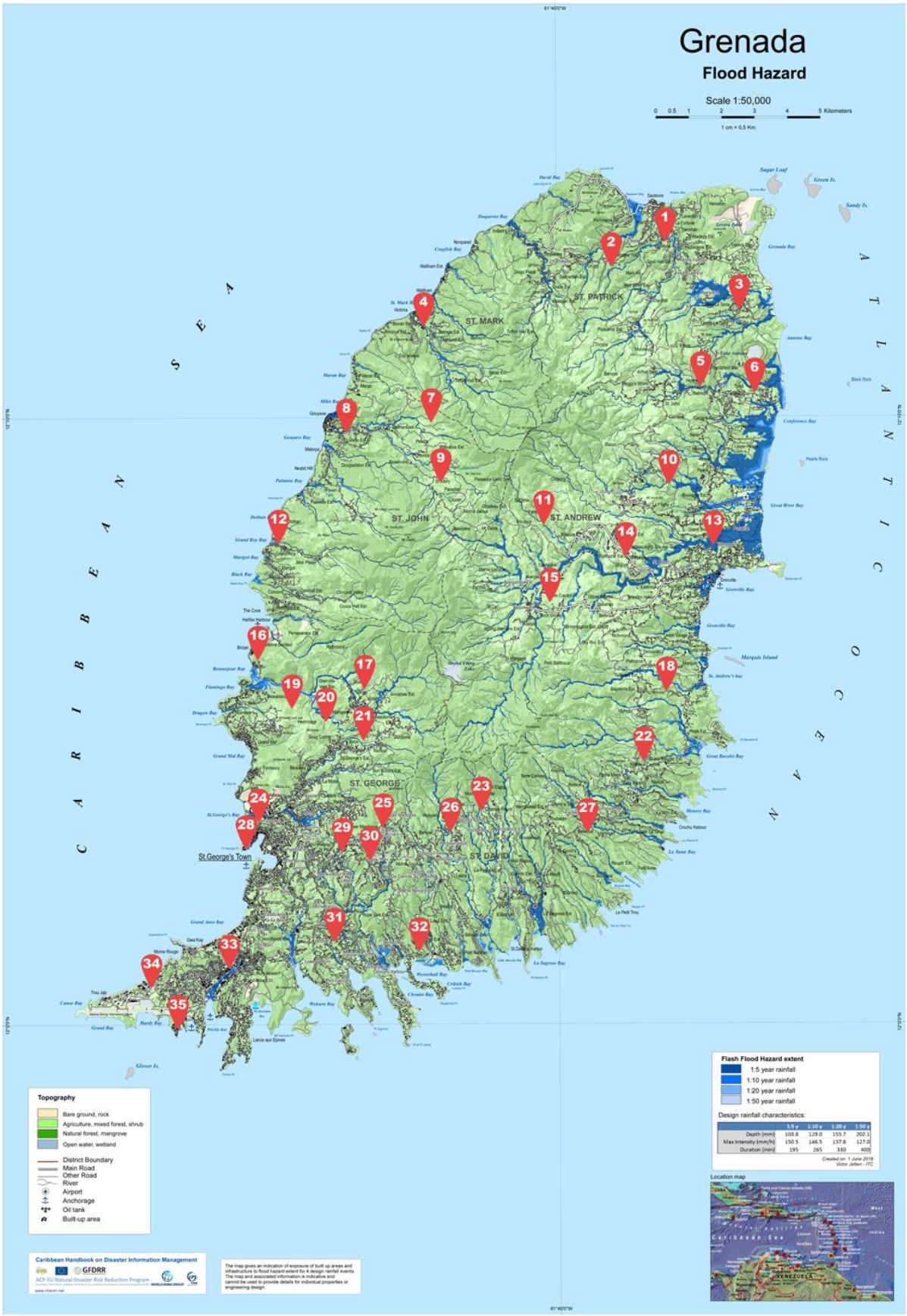


Figure 11. Flashflood hazard map for Grenada with locations of health centers. (Adapted from: van Westen et al., 2016)

5. Public health adaptation to climate change

The impact of climate change on the health outcomes of the population in Grenada is complex and manifold. Direct impacts are due to extreme weather events, which are predicted to become more frequent. Indirect impacts on human health result from changes in the hydro-ecological environment, altering infectious disease patterns, and impacting on food and water security.

Despite the inherent degree of uncertainty of climate predictions and the complexity of the impact on health in Grenada, priority adaptation actions can be identified. These actions should strengthen already existing health programs: such as those aiming to reduce morbidity and mortality from extreme weather events, to secure access to safe water, food and improved sanitation, and to enhance vector-borne diseases surveillance and control. Therefore, successful and cost-effective adaption in the health sector is based on including climate change considerations into all main budgeting and strategic health planning processes. Simultaneously these have to be aligned with the overall National Adaptation Plan (NAP) (WHO 2012).

WHO's 'operational framework for building climate resilient health systems' promotes ten essential components, which together form a comprehensive approach to health adaptation planning (see section 4.5.2) (WHO 2015). Relating to the six health sector building blocks, these interrelated components can provide a structure for identifying adaptation actions which would mainstream climate change into sector-wide or vertical programs. This present assessment used this structure to identify adaptation actions and develop a preliminary climate change adaptation plan for 2016-2021, which will be introduced on the following pages. As a next step, it will be crucial to include the identified adaptation actions into the national budget planning process, and to mobilize additional funding for those activities that cannot be covered by available financial resources. The V&A, however, already triggered the inclusion of climate considerations into the development of the National Health Strategic Plan 2016-2025, which was finalized at the end of 2015.

5.1. Adaptation action considerations to address climate change related health outcomes

Members of key departments and units of the MoHSS, including the Chief Medical Officer and the Chief Community Health Nurse identified possible adaptation actions according to the health impacts determined during the assessment (see Table 2, page 22). A brainstorming session based on the draft Health Sector Corporate Plan 2015-17 and the National Disaster Plan are the basis of the adaptive measures introduced in the following pages.

During the brainstorming session, all the participants stressed that certain activities and frameworks need to be strengthened for any successful climate adaptation action plan. These activities are not specific to climate and health, but serve as a requirement for strengthening the health system:

- Provision of adequate human and financial capital to ensure the successful implementation of the adaptation measures;

- Institutionalize cooperation between relevant departments, institutions and Ministries to ensure a needed cross-sectoral approach to protect human health from the adverse effects of climate change;
- Implementation of international health regulations, protocols and guidelines;
- Design and implement a functioning monitoring system to ensure the effective implementation of a climate change action plan;
- Implementation of the reviewed primary health care policy, as this was identified as the basis for any effective response of the healthcare system to climate change.

For the direct impacts on health through extreme weather events such as hurricanes, tropical storms, heavy rainfalls and floods, the following adaptation measures were identified:

- Revision of the National Health Sector Disaster Management Plan (MoHSS 2006) to include aspects of climate change adaptation; subsequent alignment of the strategy with a future climate change adaptation strategy for health;
- Integration of "Safe Hospitals" / "Smart Hospitals" activities in the health sector strategic plan of the MoHSS; including the provision of hurricane proofed maintenance;
- Conduct research on and evaluate the actual disaster preparedness of the health system;
- Improve management of emergency supplies, such as Emergency Kits;
- Review the "Disaster Risk Reduction" (DRR) training curriculum and include climate sensitivity, climate sensitive diseases and emergency mechanisms;
- Conduct adequate training of health care personnel and volunteers in communities (once per year);
- Establish a communication system (early warning) via SMS.

Indirect climate change related health outcomes are due to changes in hydro-ecological conditions. Especially vector- (dengue, chikungunya and Zika) and water-borne diseases (diarrheal diseases) were identified as important climate-sensitive diseases in Grenada. It was also decided that despite the low case numbers, leptospirosis should be included in adaptation efforts due to its proven climate sensitivity and rodent-borne nature. Acute respiratory infections (ARI), notwithstanding a relatively broad case definition, were acknowledged as a climate-sensitive as well. To address these indirect adverse health outcomes, the following actions were proposed:

- Conduct research on vector management and vector control (analysis of effectiveness);
- Conduct climate sensitive analysis of historical data of priority diseases (climatic and land use data should be considered);
- Strengthen case detection, registration and confirmation through improved diagnostic tests and adequate mechanisms for public health surveillance;
- Comprehensive and climate-inclusive data analysis and usage (link health data with climate data);
- Design and implement adequate climate change related disease preparedness strategy (standards and guidelines);
- Strengthen disease outbreak response and disease control by improving data-analysis and usage in all relevant departments and institutions;

- Strengthen disease surveillance and outbreak response through regular training of relevant health personnel (nursing and medical assistants at national and community level);
- Improve public awareness to vector control in cooperation with NaDMA and other relevant actors;
- Improve collaboration and cooperation between environmental health officers and primary health care activities at community level.

5.2. Prioritizing adaptive actions for the development of a Health & Climate Change Action Plan (HCCAP)

To stress the health system strengthening character of all adaptation actions in the health sector, adaptive actions identified during the brainstorming session were grouped according to the building blocks of a health system, as promoted by the WHO (2015). This organization of actions revealed that most actions are related to leadership and governance, as well as service provision. The two-way ranking according to priority and affordability sketched the direction a climate change action plan for health in Grenada should take. On the basis of this exercise, a draft Health and Climate Change Action Plan (HCCAP) has been proposed (see Appendix II).

In the field of leadership and governance, it was considered most important to adopt and implement the existing Primary Health Care Policy and synchronize human resources and activities related to disaster management and healthcare provision at community level. In the health service delivery category, ensuring that hospitals are "safe" and "smart" according to existing criteria, and improving community awareness of their duties related to vector control, ranked highest. For the health workforce, the most relevant issues are climate change and health related trainings of all health personnel and disaster risk management training of health care personnel working at the community level. For essential medical products and technologies, an improved management of emergency supplies was highlighted to ensure the availability of emergency kits in all relevant facilities. Finally, stakeholders stressed the importance of a robust health information system (HIS). In order to improve the national HIS and therefore also the national surveillance and monitoring and evaluation system, the need to link health data with climate data (including research on historical data) was highlighted (see Appendix III). It was agreed that a project proposal covering one of the priority actions which cannot be financed using domestic resources, should be developed for accessing external climate financing. The ranking of the adaptation actions per health system building block according to priority and affordability can be found in Appendix IV.

5.3. Including climate change considerations into the National Health Strategic Plan, 2016-2025

Grenada has embarked on improving its health strategic planning, for which it has received support from PAHO/WHO in 2015. The process of conducting the present vulnerability assessment in June 2015 triggered the inclusion of climate change considerations into the National Health Strategic Plan for 2016 to 2025. Specifically, climate change considerations were included into the chapter on environmental health (Chapter 1.2.12) and Emergency Preparedness and Disaster Management (Chapter

2.1.8). The following climate change related performance indicators and activities were proposed:

Building Block: Governance and Policy

Objective 1.6:	Updated / new policies include climate change considerations, where applicable, and prioritized climate change actions implemented by 2020.
Activity 1.6.1:	Based on a vulnerability assessment, develop a health sector plan on climate change (merged with the Health Disaster Plan)
Activity 1.6.2:	Identify policies in the health sector where climate change adaptation measures should be included.

Building Block: Health Financing

Objective 2: Develop a proposal for climate change adaptation in the health sector by 2020.

6. Recommendations and next steps

As Grenada is in the middle of the NAP process, this is a good opportunity for the MoHSS to get involved in the national adaptation processes and to develop a Health and Climate Change Action Plan (HCCAP), as well as a National Climate Change and Health Strategy. The present vulnerability assessment provides the basis for future strategic planning and forms an important first step in creating a climate resilient health system. As a next step, the MoHSS should work on refining the draft HCCAP as proposed in Appendix II, and extend the plan with concrete adaptation actions. These should be integrated into the health sector Corporate Plan and Health Sector Strategic Plan to allocate adequate financial and human resources.

As an immediate outcome of this assessment, it was agreed with MoHSS that GIZ ICCAS and the GIZ Global Program 'Adaptation to Climate Change in the Health Sector' support the development of a funding proposal for climate proofing of medical waste management. A further outcome was an explorative workshop with regional and national stakeholders in the field of health and climate change, to discuss the possibilities for linking health and climate information and improving data management (see Appendix III). In consequence, GIZ will support the integration of climatic and environmental data into the disease surveillance system of Grenada, a process which will start with an upgrade and streamlining of the national health information system.

Based on ongoing collaboration between GIZ ICCAS, the GIZ Global Program and Government of Grenada stakeholders involved in climate and health (including experts from MoHSS and MoALFFE), the following next steps are recommended to strengthen the health system against the impacts of climate change:

- Drafting of Terms of Reference for an inter-sectoral and inter-ministerial climate and health working group (CHWG) who will lead all future climate and health related efforts
- Elaborate and finalize the Health and Climate Change Action Plan (HCCAP) with concrete adaptation actions
- Develop a National Climate Change and Health Strategy based on the outcomes of the present study, as well as the HCCAP
- Strengthen disease surveillance and health information system (by piloting the district health information system - DHIS2 - with international partners)
- Organize DHIS2 introduction workshop to discuss the potential roll-out process, including establishment of costs, stakeholder involvement, responsibilities
- Collect, prepare, and digitalize available health datasets, including case data on climate-sensitive diseases and vector populations (Bretteau index, household index etc.) to be able to migrate the data into digital databases (such as the National Water Information System or DHIS2)
- Provide support on the health chapters of Grenada's Second National Communication to the UNFCCC (SNC), and National Adaptation Plan (NAP), based on the outcomes of this study
- Explore the opportunities for external funding for climate and health related activities in Grenada

7. Bibliography

Akpinar-Elci, M, F Martin, J Behr, and R Diaz. "Saharan dust, climate variability, and asthma in Grenada, the Caribbean." *International Journal of Biometeorology* 59, no. 11 (2015): 1667-71.

Berger, S. *Infectious Diseases of Grenada.* Los Angeles, CA: Gideon Informatics, Inc, 2015.

CARE. *Climate Vulnerability and Capacity Analysis Handbook.* CARE International, 2009.

CARIBSAVE. *The CARIBSAVE Climate Change Risk Atlas - Climate Change Risk Profile for Grenada.* Barbados: CARIBSAVE, 2012.

CARPHA. "Caribbean Environmental Experts Seek Solutions for Climate Change and Public Health Challenges." Saint Lucia: Caribbean Public Health Agency, November 17, 2015.

Cauchemez, S, et al. "Local and regional spread of chikungunya fever in the Americas." *Euro surveillance: European communicable disease bulletin* 19, no. 28 (2014): 20854.

CCCCC. *Delivering transformational change 2011-21: Implementing the CARICOM 'Regional Framework for Achieving Development Resilient to Climate Change'.* Caribbean Community Climate Change Centre, 2011.

CCCCC. *Regional Framework for Achieving Development Resilient to Climate Change (2009-2015).* Caribbean Community Climate Change Centre / CARICOM, 2009.

CDEMA. *Regional Comprehensive Disaster Management Strategy and Programming Framework 2014-2024.* Barbados: Caribbean Disaster Emergency Management Agency, 2014.

CIA. *The World Factbook - Grenada.* June 30, 2016. https://www.cia.gov/library/publications/the-world-factbook/geos/gj.html (accessed July 12, 2016).

CIMH. "The Caribbean Regional Climate Outlook Forum (CariCOF)." *Concept Note.* Dominica: Caribbean Institute for Meteorology and Hydrology, May 25-31, 2016.

Clarke, C, C Gomes, D Alleyne, and W Phillips. *An assessment of the economic and social impacts of climate change on the health sector in the Caribbean.* Santiago: United Nations/Economic Commission for Latin America and the Caribbean (ECLAC), 2013.

Clegg, P. "Ebola, Chikungunya, and the Caribbean: Struggling to PRepare and Respond." *The Round Table* 104, no. 1 (2015): 65-67.

Ebi, K, N Lewis, and C Corvalan. "Climate variability and change and their potential health effects in small island states: information for adaptation planning in the health sector." *Environmental Health Perspectives* 114, no. 12 (2006): 1957-1963.

Faye, O, et al. "Molecular evolution of Zika Virus during its emergence in the 20th century." *PLoS Neglected Tropical Diseases* 8, no. 1 (2014): e2636.

GFDRR. *Disaster Risk Management in Latin America and the Caribbean Region: GFDRR Country Notes Grenada.* Washington D.C.: Global Facility for Disaster Reduction and Recovery, 2010.

GIZ. *The Vulnerability Sourcebook. Concepts and guidelines for standardized vulnerability assessments* . Bonn: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, 2014.

GIZ/ICCAS Project (a). "How to protect our water resources from climate change. A brief from the Integrated Climate Change Adaption Strategies (ICCAS) Programme." Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, 2015.

GIZ/ICCAS Project (b). "Protecting Our Coastline: Coastal Zone Management in Grenada Community consultation at Happy Hill Secondary School. A brief from the Integrated Climate Change Adaptation Strategies (ICCAS) Programme." Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, 2015.

Glasgow, L, M Forde, S Antoine, E Perez, and L Indar. "Estimating the burden of acute gastrointestinal illness in Grenada." *Journal of Health Population and Nutrition* 31, no. 4 (2013): S17-S19.

Glasgow, L, M Forde, S Antoine, E Perez, and L Indar. "Estimating the Burden of Acute Gastrointestinal Illness in Grenada." *Journal of Health, Population and Nutrition* 31, no. 4 (2013): S17-29.

GoG. *Grenada Disaster Vulnerability Reduction Project - Environmental Impacts Assessment.* Assessment, Ministry of Finance, Planning, Energy and Corporative, St. George's: Government of Grenada, 2010.

GoG. *Grenada's Initial Communication to the United Nations Framework Convention on Climate Change.* Government of Grenada, UNFCCC, 2000.

GoG/GIZ ICCAS Project. "Integrated Climate Change Adaptation Strategies (ICCAS) Grenada." *Grenadian - German Pilot Programme.* Government of Grenada / Deutsche Gesellschaft fuer Internationale Zusammenarbeit GmbH, 2014.

GRDS/TNC. *Vulnerability Capacity Assessment of Grenville Area (Marquis, Soubise, Grenville, Telescope).* St. George's: Grenada Red Cross Society / The Nature Conservancy, 2013.

Hall, G, I Hanigan, K Dear, and H Vally. "The influence of weather on community gastroenteritis in Australia." *Epidemiology and Infection* 139, no. 6 (2010): 927-936.

IPCC. "Ch. 11. Human health: impacts, adaptation, and co-benefits." In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, 709-754. Cambridge: Cambridge University Press, 2014.

IPCC. "Summary for Policymakers." In *n: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, 1-32. Cambridge: Cambridge University Press, 2013.

Kairi. *Country Poverty Assessment: Grenada, Carriacou and Petit Martinique. Vol. 1. Main Report.* Caribbean Development Bank, 2007.

Luber, G, et al. *Ch. 9: Human Health. Climate Change Impacts in the United States: Third National Climate Assessment.* Washington D.C.: U.S. Global Change Research Program, 2014.

McSweeney, C, M New, and G Lizcano. *UNDP Climate Change Country Profiles - Grenada.* UNDP, 2012.

MoALFFE. *Grenada: Country report on the state of plant genetic resources for food and agriculture.* Food and Agriculture Organization (FAO), 2010.

MoF/DETC. *Climate Resilient Water Sector in Grenada (CREWS).* Funding Proposal, St. Georges: Ministry of Finance / Department for Economic and Technical Cooperation, 2015.

MoHSS. *Corporate Plan 2015-2017.* St. George's: Ministry of Health & Social Security, 2014.

MoHSS. *National Health Sector Disaster Management Plan for Grenada, Carriacou and Petit Martinique.* St. George's: Ministry of Health, Social Security and the Environment, 2006.

Mongabay. *Grenada Forest Information and Data.* 2010. http://rainforests.mongabay.com/deforestation/2000/Grenada.htm#03-deforestation (accessed July 12, 2016).

Monnereau, I, R Mahon, R McConney, L Nurse, R Turner, and H Valles. *Vulnerability of the fisheries sector to climate change impacts in Small Island Developing States and the Wider Caribbean.* Faculty of Science and Technology, University of the West Indies, Barbados: CERMES, 2015.

NaDMA. *Country Document on Disaster Risk Reduction for Grenada.* St. George's: National Disaster Risk Management Agency, 2014.

NaDMA/NaDMAC. *National Disaster Plan.* St. George's: National Disaster Management Agency of Grenada / National Disaster Management Advisory Council, 2005.

NRMU/OECS. *Audit of Biomedical Waste Management Practices Grenada.* Natural Resource Management Unit - Organization of Eastern Caribbean States, 2002.

OECS. *Climate Change Knowledge, Attitudes and Behavioural Practices in the OECS. Report on the KAP Survey of six participating Member States.* Survey Report, Organization of Eastern Caribbean States, Castries: OECS, 2013.

OECS. *Grenada: Macro-Socio-Economic Assessment of the damages caused by hurricane Ivan.* Assessment, Organization of Eastern Caribbean States, St. George's: Government of Grenada, 2004.

—. *Rallying the Region to Action on Climate Change (RRACC) Project.* 2016. (accessed July 12, 2016).

Onozuka, D. "Effect of non-stationary climate on infectious gastroenteritis transmission in Japan." *Scientific Reports* 4 (2014).

PAHO. *Annual Report - Emergency Preparedness and Disaster Relief.* Washington D.C.: Pan American Health Organization, 2008.

PAHO. "Grenada." In *Health in the Americas, 2012 Edition: Country Volume*, 342-357. Pan American Health Organization, 2012.

—. *PAHO announces start of Phase II of SMART health care facilities project.* March 16, 2016. http://www.paho.org/ecc/index.php?option=com_content&view=article&id=426:paho-announces-start-of-phase-ii-of-smart-health-care-facilities-project&Itemid=332 (accessed 12 2016, July).

—. *Regional Zika Epidemiological Update (Americas) - 14 July 2016.* July 14, 2016. http://www.paho.org/hq/index.php?option=com_content&view=article&id=11599:regional-zika-epidemiological-update-americas&Itemid=41691&lang=en (accessed July 21, 2016).

PAHO/WHO. *Case Studies in Grenada and St. Lucia as part of the Project Caribbean Health Services Resilient to Impact of Emergencies and Disasters.* Project Report, Pan American Health Organization, 2014.

—. *Hospital Safety Index.* May 3, 2010. (accessed July 12, 2016).

—. "Number of Reported Cases of Chikungunya Fever in the Americas, by Country or Territory 2013-2014." October 23, 2015.

—. "Strategy and Plan of Action on Climate Change." *53d Directing Council of PAHO, 66th Session of the WHO Regional Committee for the Americas.* Washington D.C.: Pan American Health Organization, 2014.

Patz, J, A Githeko, J McCarty, S Hussein, and U Confalonieri. "Chapter 6: Infectious Diseases." In *Climate Change and Human Health*, by WHO. Geneva: World Health Organization, 2003.

Sander, K. *Assessment of the Adaptive Capacity to Climate Change of the Tourism Sector in Small Island Developing States – A Case Study of Grenada.* Master's Thesis, Carl von Ossietzky University Oldenburg, University of Oldenburg, 2015.

Taylor, M, A Chen, and W Bailey. "Review of Health Effects of Climate Variability and Climate Change in the Caribbean." CCCCC, 2009.

The Lancet Commission on Health and Climate Change. "Health and climate change: policy responses to protect public health ." *The Lancet* 386, no. 10006 (2015).

UNDP. *Grenada.* 2015. http://www.adaptation-undp.org/explore/caribbean/grenada (accessed July 12, 2016).

UNECLAC. *The Economics of Climate Change in the Caribbean.* Trinidad: United Nations Economic Commission for Latin America and the Caribbean, 2011.

USAID. *Grenada Health Systems and Private Sector Assessment.* Bethesda, MD: United States Agency for International Development: Health Systems 20/20 project and SHOPS project, 2011.

Van Westen, C. *National scale landslide susceptibility assessment for Grenada.* ACP-EU Natural Disaster Risk Reduction Program / GFDRR, 2016.

Verret, M, P Berry, T Tiam-Fook, and A Lal. "Assessment of Climate Change and Health Vulnerability and Adaptation in Dominica." (Ministry of Health and Environment, Dominica) May 2016.

Voccia, A. "Climate change: what future for small, vulnerable states?" *International Journal of Sustainable Development & World Ecology* 12, no. 2 (2012).

WHO. *Dengue: Guidelines for diagnosis, treatment, prevention and control.* Guidelines, Geneva: World Health Organization, 2009.

—. *Grenada: WHO statistical profile.* January 2015. http://www.who.int/gho/countries/grd.pdf?ua=1 (accessed July 12, 2016).

WHO. *Handbook for Integrated Vector Management.* Guidelines, Geneva: World Health Organization, 2012.

—. *Leptospirosis.* August 12, 2012. http://www.wpro.who.int/mediacentre/factsheets/fs_13082012_leptospirosis/en/ (accessed July 26, 2016).

WHO. *Operational framework for building climate resilient health systems.* Geneva: World Health Organization, 2015.

WHO. *Protecting health from climate change: vulnerability and adaptation assessment.* Geneva: World Health Organization, 2013.

WHO. *WHO guidance to protect health from climate change through health adaptation planning.* Geneva: World Health Organization, 2012.

—. *Zika virus and complications.* July 21, 2016. http://www.who.int/emergencies/zika-virus/en/ (accessed July 21, 2016).

WHO/HCWH. *Healthy Hospitals, Healthy Planet, Healthy People - Addressing climate change in health care settings.* World Health Organization & Health Care Without Harm, 2009.

WHO/WMO. *Atlas of Health and Climate.* Geneva: World Health Organization/World Meteorological Organization, 2012.

WMO. *WMO Centres on full alert to mitigate the impact of hurricanes/typhoons.* September 17, 2004. http://reliefweb.int/report/world/wmo-centres-full-alert-mitigate-impact-hurricanestyphoons (accessed July 12, 2016).

World Bank. *Grenada Trade Summary 2003.* 2003. http://wits.worldbank.org/CountryProfile/en/Country/GRD/Year/2003/Summarytext (accessed July 12, 2016).

World Bank. *Grenada: A Nation Rebuilding - An assessment of reconstruction and economic recovery one year after Hurricane Ivan.* Washington, D.C.: World Bank, 2005.

—. *Grenada: Dealing with the Aftermath of Hurricane Ivan.* September 23, 2009. http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:22324886~pagePK:34370~piPK:34424~theSitePK:4607,00.html (accessed July 12, 2016).

8. Appendix

8.1. Appendix I

Mission Plan - Health and Climate Change – 15-19th June 2015

Date	Time	Activity	Where?	Who?	Status
13th June (Saturday)	20:27	Arrival from Germany	Airport	Pick-up by GIZ	confirmed
	18:30	Attendance of Medical Association meeting	SGU/ Caribbean House	Dr. Martin, GIZ	confirmed
14th June (Sunday)	11:00	Planning of week/ briefing/ PPT for Tuesday	TBD	GIZ	confirmed
15th June (Monday)	8:30-10:00	Meeting with MoH staff (plan for the week and interview confirmations, overview awareness session)	Minister's office (Agriculture)/ Ministerial Complex	Chief Medical Officer, Mr. Worme, Dr. Martin, Mr. Gabriel and Mr. Antoine, GIZ	confirmed
	10:30-10:45	Courtesy meeting with PS Health	PS Office/ Ministerial Complex	PS/MoH officers/GIZ	confirmed
	11:30-12:30	Interview with Red Cross	Red Cross Building	GIZ/Terry Charles	confirmed
	14:00-15:00	Interview with Benedict Peters	Ministerial Complex	GIZ	confirmed
	15:00-16:00	Interview IV (NaDMA and NaDMA focal point in MoH)	NaDMA	Terrance Walter/GIZ/ Mr. Osbert Charles	confirmed
16th June (Tuesday)	8:00-9:00	Interview SGU (Public Health)	SGU	GIZ	TBC
	9:00-9:15	Courtesy meeting with PS w.r.f Agriculture, Lands & the Environment	PS office	GIZ/PS	confirmed
	10:00-12:00	Discussion on PPT and finalization	Ministerial Complex	GIZ (with input from MoH)	
	14:00-15:30	Information session on CC and Health	PWU	MoH, GIZ, opening by whom?	Follow-up on Friday
	15:30-16:00	Debriefing	PWU	MoH, GIZ	

17th June (Wednesday)	9:00-10:00	Interview with Mr. Gabriel and staff	Labour room/ Ministerial Complex	Planning department MoH, GIZ	confirmed
	10:00-12:00	Interview with the Epi Unit		Epi Unit, GIZ	confirmed
	Afternoon	Preparation of Thursday workshop		GIZ	
18h June (Thursday)	8:00-12:00	Workshop / Strategic Health Plan	PWU	Planning department MoH and other technical officers (Mr. Charles, Dr. Martin, Mr. Worme, Chief Nursing Officer, Chief Community health Nurse) GIZ	confirmed Memo went out
	Afternoon (max. 1 hour)	Debriefing and next steps	TBD	Chief Medical Officer, Mr. Worme and Dr. Martin, GIZ	
19th June (Friday)	8:45	Airport drop-off		GIZ	
	9:00-10:00	Interview with Dr. Malachy Dottin (Zero Hunger Project)	His office/ Ministerial Complex	GIZ	confirmed
	Afternoon	Internal De-briefing Other meetings if required		GIZ	
22nd June (Monday)	Afternoon	Information session on CC and health	Carriacou	GIZ, MoH	
23rd June (Tuesday)	10:00	Skype Interview with PAHO		GIZ, PAHO	
	11:00	Skype Interview with Dominica		GIZ, CC and health officer of MoH Dominica	
	17:50	Airport drop-off		GIZ	

8.2. Appendix II

Draft Health & Climate Change Action Plan (HCCAP) 2016-2020

The impact of climate change on the health outcomes of the population in Grenada is complex and manifold. Direct impacts are due to extreme weather events, which are predicted to become more frequent, and indirect impacts result from changes in the hydro-ecological environment, altering infectious disease patterns, and impacting on food and water security.

The Health Climate Change Action Plan (HCCAP) provides a set of specific actions and measures to respond to the growing risks and impacts of climate change on the public health of the Grenadian population, and is a part of the national effort to adapt to the challenges brought about by climate change. The HCCAP is based on the outcomes of a vulnerability and adaptation assessment (V&A) conducted in 2015/16 and the results of the Second National Communication (SNC) to the UNFCCC.

Table 1: Climate change related health risks identified in Grenada

Direct	**Indirect**
Extreme weather events and natural disasters: - Physical injury - Death - Heat stress and heat-related illness - Psychological trauma - Loss of livelihoods - Water, sanitation and hygiene related issues - Food insecurity - Displacement	**Rising temperatures and changing rainfall patterns:** **Infectious Diseases** - Vector-borne: Dengue, chikungunya and Zika Virus - Water-borne: Diarrheal diseases - Rodent-borne: Leptospirosis **Airborne particulates from Saharan dust:** - Chronic respiratory diseases e.g. Asthma - Acute respiratory infections

The following risks were identified as priority health concerns that will be exacerbated by climate change:

In response to these priority health issues, three strategic areas and related actions were identified. These focus on enhancing existing national efforts and mechanisms, increasing the resilience of the health system, as well as improving the adaptive capacity of medical personnel and vulnerable populations to be able to cope with the health impacts of climate change.

CORE STRATEGIES:

Strategy 1: Reduce the impact of extreme weather events and disasters through improved emergency preparedness and response

- Implement International health regulations, protocols and guidelines
- Update National Health Sector Disaster Management Plan; include evacuation sites and procedures into plan

- Improve management of emergency supplies & ensure availability of "Emergency Kit"
- Set up a "Safe & SMART Hospitals/Facilities" Program; including hurricane-proof retrofitting
-

Strategy 2: Improve surveillance and control of climate sensitive diseases (vector- and water-borne diseases)

- Perform study on prevalence/incidence of priority diseases collated with climatic data for the last 10 years
- Improve and fully digitalize health surveillance system
- Link health data analysis with climatic and environmental data
- Improve vector surveillance; esp. digitalization of data, analysis & usage

Strategy 3: Improve resilience of health care personnel and population to respond to the health impacts of climate change

- Implementation of Primary Health Care Policy; including improving community health care provision by strengthening collaboration and cooperation between actors at the community level
- Training of health personnel in communities on climate sensitive diseases and disaster risk management
- Strengthen public awareness to strengthen vector control

The HCCAP will become part of the routine health planning, budgeting and M&E procedures of the MoHSS. Additional funding for climate-proofing healthcare facilities will be mobilized through (pooled) climate financing and donors.

KEY ACTIVITIES:

In detail, each action's objective, rationale, activities and expected result, estimated costs and timeframe are as follows:

Action 1: **Implement international health regulations, protocols and guidelines**
Objective
Rationale in relation to strategy 1
Short description of the activities and expected results
Implementation arrangements
Indicator(s)
Estimated costs
Timeframe

Action 2: **Update National Health Sector Disaster Management Plan; include evacuation sites and procedures in plan**
Objective
Rationale in relation to strategy 1
Short description of the activities and expected results
Implementation arrangements
Indicator(s)
Estimated costs
Timeframe

Action 3: **Improve management of emergency supplies & ensure availability of "Emergency Kit"**
Objective
Rationale in relation to strategy 1
Short description of the activities and expected results

Implementation arrangements
Indicator(s)
Estimated costs
Timeframe

Action 4: Set up a "Safe & SMART Hospitals/Facilities" Program; including hurricane-proof retrofitting
Objective
Rationale in relation to strategy 1
Short description of the activities and expected results
Implementation arrangements
Indicator(s)
Estimated costs
Timeframe

Action 5: Perform study on prevalence/incidence of priority diseases collated with climatic data for the last 10 years
Objective
Rationale in relation to strategy 2
Short description of the activities and expected results
Implementation arrangements
Indicator(s)
Estimated costs
Timeframe

Action 6: Improve and fully digitalize health surveillance system to be able to link health data analysis with climatic and environmental data
Objective
Rationale in relation to strategy 2
Short description of the activities and expected results
Implementation arrangements
Indicator(s)
Estimated costs
Timeframe

Action 7: Improving vector surveillance; esp. digitalization of data, analysis & usage
Objective
Rationale in relation to strategy 2
Short description of the activities and expected results
Implementation arrangements
Indicator(s)
Estimated costs
Timeframe

Action 8: Implementation of Primary Health Care Policy; including improving Community Health Care provision by strengthening collaboration and cooperation between actors at the community level
Objective
Rationale in relation to strategy 3
Short description of the activities and expected results
Implementation arrangements
Indicator(s)
Estimated costs
Timeframe

Action 9: **Training of health personnel in communities on climate sensitive diseases and disaster risk management**

Objective
Rationale in relation to strategy 3
Short description of the activities and expected results
Implementation arrangements
Estimated costs
Timeframe

Action 10: **Strengthen public awareness to strengthen vector control**

Objective
Rationale in relation to strategy 3
Short description of the activities and expected results
Implementation arrangements
Indicator(s)
Estimated costs
Timeframe

8.3. Appendix III

SUMMARY REPORT

Workshop 'Linking epidemiological and meteorological data in Grenada'
St. George's, 4 November 2015

1. Background

In June 2015, the Grenada Ministry of Health and Social Security (MoH) developed first ideas for a climate change adaptation plan with the support of the 'Integrated Climate Change Adaptation Strategies in Grenada' (ICCAS) programme – jointly implemented by the Ministry of Agriculture, Lands, Forestry, Fisheries and the Environment (MoALFFE), the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and UNDP – and the GIZ Global Program 'Adaptation to Climate Change in the Health Sector'. One of the adaptation measures for the health sector identified was the establishment of mechanisms for joining epidemiological and meteorological data for climate-sensitive surveillance and reporting.

In October 2015, the MoH conducted a series of sessions on climate change and health with the support of Pan-American Health Organization (PAHO). Participants discussed among other topics potential indicators for measuring and documenting the impact of climate change on health, which are also to guide appropriate actions of the health sector. It was acknowledged that a necessary precondition for climate-sensitive surveillance is the accessibility and the availability of epidemiological, environmental and meteorological data.

As a first step towards climate-sensitive surveillance in the health sector, the MoH, the ICCAS programme and the GIZ Global Programme organized the workshop 'Linking epidemiological and meteorological data in Grenada' on 4 November 2015 in St. George's. Participants were the Environmental Health Department, the Epidemiology Unit and the Chief Medical Officer of the MoH, the Department of Land Use of the MoALFFE, PAHO Grenada, the Caribbean Institute for Meteorology and Hydrology (CIMH), the Caribbean Public Health Agency (CARPHA), the National Water and Sewerage Authority (NAWASA), the National Disaster Management Authority (NaDMA), and the St. George's University (SGU).The Grenada Meteorological Service and the representative of Dominica were not able to attend the meeting.

2. Workshop objective and outline

The workshop had the objective to bring together all relevant stakeholders of climate-sensitive health surveillance in Grenada and the relevant regional organizations to jointly identify the next steps for strengthening the national capacity in Grenada to conduct climate sensitive analyses of health data. The specific outcomes of the workshop were defined as:

1. Understanding the needs and challenges regarding data collection and exchange for epidemiological and meteorological data
2. Considering the data currently available and understanding of the possibilities for climate-sensitive collaborative monitoring and surveillance projects
3. Agreement on content for a Memorandum of Understanding between MoHand MoALFFE on a common platform for data exchange

The workshop was organized around three thematic clusters. First, an overview of the relevant activities in the Caribbean and potential synergies that might support climate-sensitive surveillance in Grenada presented by CIMH and CARPHA; second, presentation and assessment of epidemiological, environmental and meteorological data availability within MoH and MoALFFE; and third, a joint discussion on next steps and timeline, taking into

account the following: 1) what kind of data exists and how could this data be brought together; 2) the potential contributions and support by regional institutions; and 3) the resources and gaps that currently exist within the Environmental Health Division, the Epidemiology Unit and the Department of Land Use.

3. Summary of important outcomes of the workshop

Relevant regional activities

CARPHA 's activities in regard to health and climate change have only just started. One of the activities is to jointly work with CIMH on improving the evidence-base of the impacts of climate change on health in the Caribbean and to develop early warning mechanisms and meteorological products for the health sector to improve appropriate planning and action.

Currently, there are three CIMH products available online that might be of interest for the health sector. These are: regional heat forecasts, regional precipitation forecasts, and a 7-day dust forecast[2] .CIMH also supported Dominica's healthvulnerability and adaptation assessment (V&A) in 2014/5 that will feed into the National Adaptation Plan (NAP). In early 2015, CIMH launched the project Regional Sectoral Early Warning Information Systems Across Climate Timescales (EWISACs). CIMH has also embarked on a collaboration with CARPHA to develop health sector specific climate products. There is a baseline survey on health sector product needs to be filled by countries. The survey is online and still open, and it is suggested that Grenada should participate in[3].

Data availability within MoH and MoALFFE

MoH has three types of relevant health data available. Health facilities mandatorily report the number of cases of a defined set of reportable communicable diseases and syndromes for which case definitions exist. Reporting is done weekly (Sunday-Saturday), paper-based, and aggregated by parish. In addition, cases of specific diseases or 'unexpected or unusual events' have to be reported to the Ministry on the day of diagnosis. MoH sends weekly summary reports to CARPHA. Vector monitoring is under the Department of Environmental health. Data on *aedis aegypti* (house, container, Breteau indices) are collected by parish; there is no fixed monitoring scheme but all parishes are at least sampled once or twice per year. The reports are paper-based and available since 2005. Finally, the Environmental Health Department receives weekly water quality reports from NAWASA for each water treatment plant.

The Department of Land Use runs the Grenada Water Information System (WIS)[4] with GIS tagged monthly data on rainfall (approx. 30 stations, mostly Grenada), and temperature and humidity from 4 automatic stations. The WIS is a database designed to store data and link them with GIS in order to allow presentation in different ways of geographical and environmental layers, like by parish, by watershed, by water consumption area, Climatic zones, Land use, etc. The Grenada Meteorological Service has daily temperature, humidity and rainfall data from one station at the Maurice Bishop Airport. According to CIMH, the Grenada Meteorological Service considers its services as basic.

Discussions and conclusions

First all stakeholders agreed that the planned collaboration was necessary, important and potentially fruitful, and committed themselves to pursue it.

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[2] Accessible at: http://rcc.cimh.edu.bb/long-range-forecasts/caricof-climate-outlooks/ (heat and precipitation) and http://dafc.beta.cimh.edu.bb/7-day-dust-predictions/ (dust)

[3] Accessible at: http://bit.ly/1RKwXJD_HealthSectorBaselineSurvey

[4] Accessible at: http://www.cariwin.gd/webmap/app/db/index.php (use Internet Explore to access!)

Since the WIS platform is readily available and can potentially be extended to host additional datasets, it was decided to use it as a common joint database where surveillance data, vector data and environmental data should be integrated.

Since only diseases for which climate change is relevant should be investigated, the diseases under surveillance were reviewed and prioritized. The participants agreed that vector-borne diseases (Dengue, Chikungunya which is not yet but about to be included in the mandatory reporting) and gastroenteritis have highest priority and should be integrated in the database in the first place. Even though Leptospirosis is regularly reported, due to the very low number of cases it does not play a major role but shall still be included nevertheless to be able to analyze data if floods or other natural hazards occur that might influence its spread. The inclusion of acute respiratory infections (ARI) was discussed, but was rejected for the time being due to the relatively unspecific case definition, maybe to be included at a later stage of the project. The question of cases of asthma and its relation to Sahara dust was discussed. At the moment Grenada does not have surveillance for non-communicable or chronic disease, therefore asthma is not regularly monitored.

For analysis the different datasets need to be harmonized regarding geographical aggregation (parish as the most likely common denominator), and reporting period (week/month). The WIS will have to be adapted to host the new datasets, but the database manager sees this task as feasible. An update of the software is available through the software company. It will be explored if it suits the needs of the joint database. Data which are currently only available on paper need to be digitalized. Vector control data are completely paper-based. Data entry could be covered by staff hired through next round of recruitment of the IMANI program (a program for unemployed youth to bring them into the workforce). Health surveillance data arrive on paper but are entered into an excel file in the Epidemiology Unit and can potentially be uploaded to the WIS database.

Data available

	Health	Meteorological data	Vector monitoring	Water quality
Time	epidemiological week (Sun-Sat)	daily (on paper), recorded monthly to the database	paper based, annually (monthly but not for all parishes at the same time)	Daily collection, weekly reporting
Place	Parish, health facility	Manual rainfall stations (ca 30), automatic stations (4)	Parish (down to district/locality)	Water treatment plants
What is recorded?	Cases of reportable diseases, unusual and unexpected events	Rainfall Autom. Stations: temperature, humidity	Aedesaegypti House, container, Breteau indices	Bacteriological assessment (daily), chemical assessment (monthly)
Available since?	2005	1961	2005	1990

The participants discussed different levels of confidentiality of the datasets vs open access. WIS data are publicly available only through the provision of a user name and password from the system administrator. The current practice is for any potential user to ask for access to the database by giving the reasons for use, and to be granted rights to access, download and use the data. Problems were seen with this practice for health data since they might contain confidential information (like location of diseases outbreak), and data on water quality. For health data the aggregation done at the Epidemiology Department was felt to be sufficient to anonymize the data. However, water quality data remain critical, Options

regarding restricted access for MoH and MoALFFE only, differentiated access, or exclusion of the water quality data from the data sharing agreement were discussed and remain to be explored with support of legal advice. However, even if water quality data are not included into the common database, gastroenteritis outbreaks can still be analyzed jointly with MoH and NAWASA using the respective datasets, and gastroenteritis cases within the common database can be mapped and correlated with data on precipitation and the water distribution system (piping). It is important to note that the information provided through the collating and analyzing of the datasets along geographic and climate parameters can be a great asset to assist planners, policy makers and technical staff address climate related health outbreaks.

Before starting concrete activities, the first step will be to draft a Memorandum of Understanding (MoU) between MoH and MoALFFE to agree and lay out which data are shared, where the data are stored, who has access to it, who will manage the database, which resources are allocated to the project, how they will be analyzed, etc., and have it signed by both ministries. The Statistical Office shall be informed about the availability of health data on the WIS platform, once it is available.

Once the common database is established, MoH and MoALFFE will discuss and decide in what way the data will be used, e.g. in an annual report, for studies, jointly with SGU, etc. Sophisticated statistical analyses will not be possible with the actual data available due to low number of cases, e.g. for Leptospirosis, and missing capacities for laboratory confirmation e.g. for Dengue and Chikungunya, but mapping and simpler correlations and outbreak investigations can be performed. On the longer term it seems necessary to also strengthen the surveillance system to be able to improve on early detection of and response to trends and outbreaks of infectious diseases.

Propositions for joint projects already on the table include analysis of gastroenteritis data in relation to precipitation and water quality, and mapping of Dengue and Chikungunya cases together with vector indices and precipitation to be further developed into risk maps.

CARPHA’s suggestions for possible support to the project include exploration of availability of historical data at CARPHA HQ, and filling in of missing data, training in collection of epidemiological data, and support with human resources, and exploring if fellows of the Caribbean Field Epidemiology Training Programmes (FELTP) could place some of their assignment in the projection Grenada.

CIMH has already supported Grenada to procure four additional automatic meteorological measurement stations, which will be installed in 2016. This will improve the Climatic data collection in Grenada and in turn also the climate-sensitive surveillance of the MoH. CIMH will also share research results on the relationship between climate and health outcomes, and of the report exploring data sharing and integration

4. Agreed next steps and timeline

WHAT?	WHO?	WHEN?
Drafting of MoU	Mr. Worme	By end of January 2016
Digitalization of data from vector monitoring (*aedesaegypti*)	Environmental health department	With next round of IMANI recruitment
Exploring the extension of the WIS database including information about the upgrade of the software and conditions for purchase	Land use	As soon as possible
Establishing of potential costs for extending the WIS system	Land Use/ GIZ ICCAS/ GIZ global programme	By end of 2015
Technical discussion about data format of epidemiological, meteorological and vector data; and technical requirements for WIS platform	Land Use/ Epi Unit/ Environmental Health/ GIZ ICCAS	After signing of MoU/ early 2016
Start of updating WIS platform and to add data	Land Use/ Epi Unit/ Environmental Health/ GIZ ICCAS (GIZ global programme)	Early/Mid 2016

5. Additional recommendations to be considered

- To ensure that data can be used for a consorted analysis, timeframe for collection of epidemiological data, vector monitoring data and meteorological data should be compatible. As currently epidemiological data are collected on a weekly basis, rainfall data are collected daily, but reported monthly, and vector monitoring is done on an irregular basis by parish, solutions have to be discussed to harmonize the data collection scheme to allow for the most reliable and valid data analysis possible given the options.
- GIS tagging of epidemiological data could be done by reporting health facility, thus allowing for more detailed geographical allocation.
- The use of ARI data should be thoroughly discussed since the numbers are steadily rising, and if necessary the case definition might have to be sharpened to allow for better distinction. Whether data on asthma can be included at a later stage needs to be decided in the context of introducing surveillance for non-communicable diseases.
- Overall the quality of data is of concern, and needs to be assessed and monitored closely in order to allow for valid analyses. This should be targeted in collaboration with the regional organizations who might be able to support the national authorities strengthening their capacities. The work done under this project will however, result in improved data quality and increased data quantity.
- Lack of human resources poses a problem in all departments and units concerned, and needs to be addressed at another level. However, with the capacities currently available the project needs to remain realistic and look for external support, and feasible projects within the limits of the system.
- Once the additional 4 meteorological measurement stations procured by CIMH are in use, it should be made sure that this data is made available in WIS as well.

8.4. Appendix IV

In detail, the results of the adaptation actions ranking per health system building block according to priority and affordability are as follows (the more points an activity received, the more it was considered a priority or affordable, respectively):

Leadership & governance:

Action	Priority	Affordability
Implement International Health Regulations, Protocols and Guidelines	2 points	0 points
Development and adoption of the National Health Promotion Strategy	1 points	0 points
Implementation of Primary Health Care Policy	1 point	3 points
Design and implement adequate climate change related disease preparedness strategy (standards and guidelines)	1 point	0 points
Align National Health Sector Disaster Management Plan with climate change action plan for health	0 points	0 points
Update disaster National Health Sector Disaster Management Plan	1 point	0 points
Include evacuation sites into disaster plan of MoHSS	3 points	0 points
Improve Community Health Care provision by strengthening collaboration and cooperation between actors at the community level	0 points	7 points

Health workforce:

Action	Prioritiy	Affordability
Inclusion of climate sensitive diseases in Disaster Risk Management training	2 point	0 points
Training of health care personnel on Disaster Risk Management	3 points	1 points
Establishment of training curriculum on climate sensitive diseases & emergency mechanisms	0 points	2 points
Training of health personnel in communities	2 points	5 points

Health information systems:

Action	Priority	Affordability
Establish a communication system via SMS	0 points	0 points
Research: Prevalence/incidence of priority diseases collated with climatic data for the last 10 years	2 points	2 points
Link health data with climate data	3 points	1 points
Improving vector surveillance; esp. data analysis & usage	2 points	5 points
Research: Evaluation of vector control effectiveness	0 points	0 points

Essential medical products & technologies:

Action	Priority	Affordability
Improve management of emergency supplies & ensure availability of "Emergency Kit"	2 points	3 points

Service Delivery:

Action	Priority	Affordability
Health Infrastructure: Set up a "Safe & SMART Hospitals/ Facilities" Program	5 points	0 points
Health Infrastructure: Hurricane proofed maintenance	1 point	0 points
Strengthen public awareness to strengthen vector control	1 points	3 points
Conduct Disaster Risk Management training of communities	1 point	1 points
Improve the response of the surveillance system	1 point	2 points
Improve vector control based on an adequate response to data	1 point	0 points

Financing:

Action
Development of one proposal for accessing climate & health financing