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Climate change realities in Small Island Developing States in the Caribbean

A study commissioned by the Global Programme on Risk Assessment and Management for Adaptation to Climate Change

Acknowledgments

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The study was conducted in close cooperation with the Grenadian-German Pilot Programme *"Integrated Climate Change Adaptation Strategies"* in Grenada (ICCAS) – funded by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) under its International Climate Initiative (IKI) and jointly implemented by the Government of Grenada, the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and the United Nations Development Programme (UNDP) – and the regional programme *"Caribbean Aqua-Terrestrial Solutions"* (CATS), which is commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ). It is jointly implemented by the Caribbean Public Health Agency (CARPHA) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH in eight CARICOM Member States, namely Belize, Dominica, Grenada, Guyana, Jamaica, Saint Kitts and Nevis, Saint Lucia, and Saint Vincent and the Grenadines.

The update incorporated by Acclimatise started in October 2015 and builds upon the findings of three selected case studies at regional, national and community level in Grenada conducted in December 2014.

The authors would like to thank all involved experts and all interview partners and especially the colleagues from GIZ in the Caribbean who shared their insights and expertise.

About the GIZ global programme on Risk Assessment and Management for Adaptation to Climate Change (Loss and Damage)

The most recent projections in climate research anticipate a significant increase in the frequency and/or intensity of **extreme weather events** as well as **slow-onset climate-induced changes**. Despite mitigation and adaptation, the risk of residual loss and damage (L&D) remains. To address residual risks appropriate measures are needed. L&D has been recognized under the **UNFCCC** and the topic especially gained importance with the establishment of the Warsaw International Mechanism for Loss and Damage associated with climate change impacts (**WIM**). Against this background, the German Federal Ministry for Economic Cooperation and Development (BMZ) commissioned the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH with the implementation of the global programme *Risk Assessment and Management for Adaptation to Climate Change (Loss and Damage)*.

The programme aims to generate practical experience and recommendations in the field of comprehensive climate risk management to **support the German development cooperation (BMZ) and its international partners** in regions severely affected by climate change.

To reach its goal the programme focuses on:

- creating tried-and-tested **guidelines on climate risk assessment and comprehensive climate risk management** – *e.g. conduction of climate risk assessments in partner countries*
- **enriching knowledge** on climate risk and loss and damage in **key sectors** and on **key topics** – *e.g. risk transfer including climate risk insurance, migration, non-economic loss and damage, resilient recovery (UNISDR Sendai Framework), private sector (SME), fisheries and coastal management*
- **enhancing capacities** in partner countries as well as **initiating and facilitating dialogue** among stakeholders of different sectors and levels (local, sub-national, national and international) – *e.g. training course on comprehensive climate risk management, events, publications*
- supporting BMZ in the **international climate policy debate under the UNFCCC** – *e.g. strengthening the German contribution to the Warsaw International Mechanism for Loss and Damage (WIM)*

The global programme has a term of six years (Dec. 2013 – Dec. 2019) and operates **pilot activities in different regions**, e.g. The Pacific Island Countries, South Asia (India), Central America and East Africa (Tanzania).

Executive summary

Impacts of climate change can already be felt today and adverse impacts are expected to increase in the future. The causes of such negative effects include both extreme events (such as storms, hurricanes, floods, landslides and heatwaves) and slow onset events (such as sea level rise, increasing temperatures, ocean acidification, melting of glaciers and related impacts, salinisation, land and forest degradation, loss of biodiversity and desertification). There are important interrelationships between extreme and slow onset events, as in the case of drought.

In the Caribbean there has been an increasing trend in the recorded number of weather and climate hazards and their associated impacts. Climate change poses significant risks both to the people and economies of the Caribbean region by exacerbating the islands' existing vulnerabilities. While it is challenging to measure comprehensive and long-term impacts of current weather and climate events, it is even more difficult to quantify residual risks associated with projected climate change.

Common challenges faced by Caribbean nations in responding to disasters include: strong dependence on external humanitarian assistance and grants, which in many cases do not meet all financing requirements; the need to give up planned developmental priorities, by having to defer or abandon existing plans and projects and re-channel funds to disaster response; incurrence of additional debts in an effort to close the financing gap, which worsens an already overly leveraged national fiscal situation and limited capacities in risk management; continuous set-backs in socio-economic and environmental recovery and rehabilitation due to the recurrence and accumulation of adverse impacts. This may mean countries remain in "permanent repair mode", which significantly impacts their ability to plan for and build ex-ante resilience.

The Caribbean experiences point to the need for a comprehensive, structured approach at the local, national, regional and international levels to deal with the adverse impacts of climate change. Such an approach must be based on donor harmonisation, and address all phases of the climate and disaster risk management process: assessing risk, building ex ante risk resilience; ex-post recovery and rehabilitation; and risk financing and sharing. In particular, innovative approaches to address impacts associated with slow onset events should be explored.

A comprehensive climate and disaster risk management strategy, in particular through weather-indexed insurance schemes, may represent the best way to turn the issue into action on the ground. The G7 Climate Risk Insurance Initiative – InsuResilience – launched in 2015 supports this model and aims to increase access to climate risk insurance for up to 400 million people in the most vulnerable developing countries by 2020.

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Abbreviations and acronyms

AIMS	Atlantic, Indian Ocean, Mediterranean and South China Sea
AOSIS	Alliance of Small Island States
ARD	Agency for Reconstruction and Development
BMZ	German Federal Ministry for Economic Cooperation and Development
BMUB	German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
BRCCC	Building Regional Climate Capacity in the Caribbean
CARICOM	Caribbean Community
CARPHA	Caribbean Public Health Agency
CATS	Caribbean Aqua-Terrestrial Solutions
CCCCC	Caribbean Community Climate Change Centre
CCORAL	Caribbean Climate Online Risk and Adaptation Tool
CCRIF	Caribbean Catastrophe Risk Insurance Facility
CDB	Caribbean Development Bank
CIFs	Climate Investment Funds
COP	Conference of the Parties
CREWS	Coral Reef Early Warning System
DFID	Department for International Development
DRR	Disaster Risk Reduction
ECLAC	Economic Commission for Latin America and the Caribbean
EU	European Union
EXCOM	Executive Committee of the Warsaw International Mechanism
G7	Group of Seven
G-77	Group of Seventy-seven
GCCA	Global Climate Change Alliance
GhG	Greenhouse Gas
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
ICCAS	Programme on Integrated Climate Change Adaptation Strategies
ICON	Integrated Coral Observing Network
IKI	International Climate Initiative
IOC	Indian Ocean Commission
MDBs	Multilateral Development Banks
NaDMA	National Disaster Management Agency
NERO	National Emergency Recovery Organization
NOAA	National Oceanic and Atmospheric Administration
OFDA	Office of U.S. Foreign Disaster Assistance
PIF	Pacific Islands Forum
LDCs	Least Developed Countries
SIDS	Small Island Developing States
UNEP	United Nations Environment Programme
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations Office for Disaster Risk Reduction
USAID	United States Agency for International Development
WIM	Warsaw International Mechanism for Loss and Damage associated with climate change impacts
WMO	World Meteorological Organisation

1. Introduction

Challenges of Small Island Developing States facing climate change

The United Nations Department of Economic and Social Affairs (UNDESA) officially recognizes 39 Small Island Developing States (SIDS), of which several qualify as Least Developed Countries (LDCs) *(UNDESA, web reference)*. SIDS are geographically broken down into three regions:

- the Caribbean;
- the Pacific;
- the Atlantic, Indian Ocean, Mediterranean and South China Sea (AIMS).

Each of these regions has intergovernmental bodies promoting regional cooperation, namely: the Caribbean Community (CARICOM), the Pacific Islands Forum (PIF) and the Indian Ocean Commission (IOC). Also, sub-regional organizations exist for similar purposes.

In addition, most SIDS are part of the Alliance of Small Island States (AOSIS), a larger ad hoc coalition of small island and low-lying coastal countries, counting 44 States and observers representing about 20 % of the UN's total membership. AOSIS is the voice of SIDS in the climate negotiations under the United Nations Framework Convention on Climate Change (UNFCCC). SIDS have played a leadership role in advocating for global efforts to address climate change.

SIDS face a unique set of challenges due to their social, economic and environmental circumstances. They are especially characterized by fragile environments and are exceptionally vulnerable to natural disasters due to their small size and populations.

While they contribute comparatively little to global climate change in absolute terms, they are greatly affected by changes in climate patterns and their consequences. Weather and climate-related impacts have increased dramatically over the past few decades and are expected to further increase as the frequency and intensity of extreme weather events and the occurrence of slow onset climate-related changes are projected to grow by the end of the century as a result of climate change *(IPCC, 2014)*. **SIDS' advancements towards achieving sustainable development pathways are at risk of being halted by such changes.**

Against this backdrop, limited capacity to take action to mitigate climate change and adapt to adverse climate change effects, represent a serious weakness within existing national institutions. In fact, although SIDS and LDCs are intended as the main beneficiaries of many international cooperation and climate financing initiatives, in practice these countries often find themselves in a situation of impossibility to access or make use of those opportunities due to the lack of human and technical capacity.

Addressing climate risks

This report aims at making the case for developing and implementing a comprehensive, structured approach at the local, national, regional and international levels to deal with residual risk associated with climate-related events.

The report focuses on the Caribbean region with a special emphasis on Grenada, which illustrates the consequences and the responses to deal with climate risk arising from extreme events and slow onset changes through concrete case studies.

The report is based on previously unpublished work commissioned by GIZ, updated with the most recent data and information, under the **Global programme on risk assessment and management for adaptation to climate change (loss and damage).**

About the GIZ global programme on Risk Assessment and Management for Adaptation to Climate Change (Loss and Damage)

The most recent projections in climate research anticipate a significant increase in the frequency and/or intensity of **extreme weather events** as well as **slow-onset climate-induced changes**. Despite mitigation and adaptation, the risk of residual loss and damage (L&D) remains. To address residual risks appropriate measures are needed. L&D has been recognized under the **UNFCCC** and the topic especially gained importance with the establishment of the Warsaw International Mechanism for Loss and Damage associated with climate change impacts (**WIM**). Against this background, the German Federal Ministry for Economic Cooperation and Development (BMZ) commissioned the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH with the implementation of the global programme R*isk Assessment and Management for Adaptation to Climate Change (Loss and Damage).*

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To reach its goal the programme focuses on:

- creating tried-and-tested **guidelines on climate risk assessment and comprehensive climate risk management** – *e.g. conduction of climate risk assessments in partner countries*
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- supporting BMZ in the **international climate policy debate under the UNFCCC** – *e.g. strengthening the German contribution to the Warsaw International Mechanism for Loss and Damage (WIM)*

The global programme has a term of six years (Dec. 2013 – Dec. 2019) and operates **pilot activities in different regions**, e.g. The Pacific Island Countries, South Asia (India), Central America and East Africa (Tanzania).

2. Climate risks in the Caribbean

Historical trend of weather and climate-related impacts

The Caribbean region is highly prone to hydro-meteorological hazards and has a history of being adversely impacted by weather- and climate-related events. Most of the Caribbean islands lie within the North Atlantic hurricane belt. Consequently, the major climatic events affecting the region are tropical depressions and cyclones, which generate strong winds, and rains that frequently result in flooding, landslides, and storm surges.

There has been an increasing trend in the recorded number of weather and climate hazards and their associated impacts in the Caribbean, as shown by Figure 1.

Number of weather and climate hazards occurring per year (1902 – 2015)

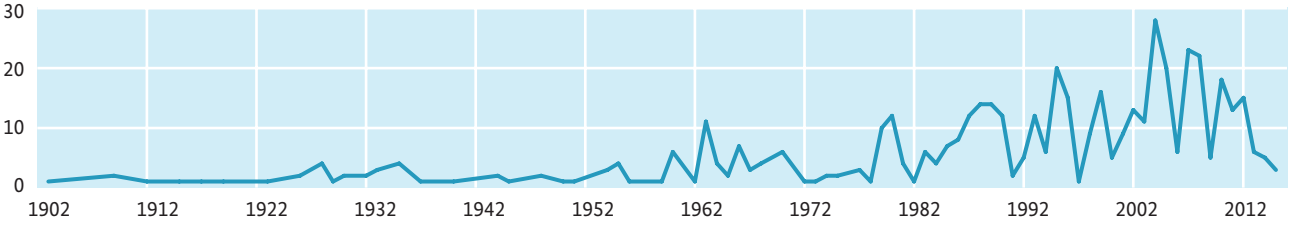

Figure 1: Frequency of storms, floods, droughts, wildfires and landslides which are directly and indirectly linked to global increases in temperature in the Caribbean *(Source: Authors' analysis of data from www.emdat.be/advanced_search/index.html)*

Observed and projected changes in climate

Climate change can already be observed in the Caribbean, notably in temperature, precipitation and sea level rise changes. Over the period 1961 – 2010, temperatures have shown a warming trend, with more warm days, warm nights and extreme high temperatures and fewer cold days, nights and extreme low temperatures. Precipitation trends are less clear, though small increasing trends are apparent, particularly between 1986 – 2010 *(Stephenson et al., 2010)*. Over the last 60 years, sea level in the Caribbean has been rising at a rate similar to the global average of approximately 1.8 mm yr-1 *(Palanisamy et al., 2012)*.

According to the best available science, global climate change projections[1] for the Caribbean region suggest the following projected changes for 2081 – 2100, compared to a 1986 – 2005 baseline *(Nurse et al., 2014)*:

- Surface temperatures increase approximately by 1.2° C to 1.9° C by 2100;[2]
- Precipitation decrease by about 5 %; especially in the southern Caribbean, with a strong tendency to drying in the traditional wet season (June to October), and more rainfall during the latter part of the wet season (November to January) in the northern Caribbean;

1 Using the intermediate low (500 – 700 ppm CO_2e) Representative Concentration Pathway 4.5 (RCP4.5) scenario.

2 The downscaled projections for some islands suggest an increase in temperature across the Caribbean of 1° C to 4° C compared to a 1960 – 1990 baseline, using the Special Report on Emission Scenarios (SRES) A2 and B2.

- Sea level rise projections ranging from 0.5 to 0.6 m by 2100 in the Caribbean Sea.

Climate change poses significant risks both to the people and economies of the Caribbean region by exacerbating the islands' existing vulnerabilities, which are largely associated with their geographical location and the proximity of significant infrastructure and activities, such as human settlements, tourism, agriculture, to the coast.

Among the major threats, the risk of loss of coral reef ecosystems due to ocean acidification will persist. Also, the interaction between rising sea level and high-water-level events, linked to storms, hurricanes and cyclones will endanger low-lying areas. However, it must be noted that the probability of change in frequency and severity of extreme rainfall events and storm surges remains poorly understood for most small islands *(Nurse et al., 2014)*. In general, mathematical models project a slight decrease in the annual number of tropical cyclones, but an increase in the number of the strongest hurricanes (category 4 and 5) by the end of this century *(NOAA, web reference; US NCA, web reference)*.

Climate risk assessment

Quantifying long-term, direct and indirect impacts resulting from weather and climate-related hazards is hampered by methodological and data constraints; damage assessment studies often only capture short-term, immediate economic costs. Furthermore, most studies consider only the impacts of extreme events, whereas slow onset changes and related impacts are neglected due to the lack of input data required to calculate them.

While it is challenging to measure comprehensive and long-term effects of current weather and climate events, it is even more difficult to quantify residual risk associated with projected climate change. In the case of extreme events, such singularities cannot be predicted not even with the best of models currently available because of the complexity of governing parameters and the vagaries of input data. Therefore, little information on potential impacts of climate change in the future exist.

Figure 2: Projected physical impacts of climate change in the Caribbean *(Source: elaborated from Nurse et al. 2014; IPCC, 2014)*

Two studies attempt to quantify future climate-related impacts in the Caribbean:

- The Caribbean Catastrophe Risk Insurance Facility (CCRIF) conducted a study which focussed on quantifying the potential impact of climate change on three hazards – hurricane-induced wind damage, coastal flooding from storm surge and inland flooding due both to hurricanes and non-tropical systems – and indicated that there will be additional significant economic cost to the region as a result of climate change. **Annual expected losses from the effects of disasters triggered by such hazards are expected to be in the range of 1 – 9 % of Gross Domestic Product (GDP) by 2030**, depending on the country and the rate of climate change *(CCRIF, 2010)*.
- Bueno et al. (2008), focussed on three different types of impact – hurricane damage, tourism losses and infrastructure damages due to sea-level rise. For these three categories, **the Caribbean's annual cost of inaction is projected to total USD 22 billion annually by 2050 and USD 46 billion by 2100. These costs represent 10 % and 22 %, respectively, of the current Caribbean economy** *(Bueno et al., 2008)*.

While these studies are useful to illustrate the potentially great impact of future climate change, they are limited in that they cover only consequences in a few key sectors and from specific types of hazards, notably extreme events, whereas slow onset events are not considered. Therefore, they likely significantly underestimate the residual risk caused by future climate change impacts.

Figure 3: Coastal erosion and protection – Grenada

3. Regional responses in the Caribbean

Relevant initiatives on adaptation and risk management

Several international development partners are active in the region with cooperation projects on climate change, including the German Federal Ministry for Economic Cooperation and Development (BMZ), the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), the Department for International Development of the United Kingdom (DFID), the United States Agency for International Development (USAID), the European Union (EU), and the Climate Investment Funds[3] (CIF – Pilot Program for Climate Resilience).

These actors have been extensively supporting initiatives, including programmes, projects, tools and services that help regional and local stakeholders address climate adaptation and deal with climate risk. Some of the initiatives are highlighted below.

Caribbean Community Climate Change Centre (CCCCC)

Since 2005 provides coordination and technical leadership in the region upon mandate by the CARICOM Heads of Government. It is the focal point for many UN specialized agencies and serves as the key hub for information on climate change issues. It has developed a number of tools with which to support climate change programming across the region. These include: a Clearing House providing access to an extensive archive of regional climate change data and documentation; a Caribbean Climate Online Risk and Adaptation Tool (CCORAL) to support climate resilient decision-making. The online-based system helps decision makers to examine investment and development activities through a "climate" or "climate change" lens, and to identify climate risks and adaptation options, thus facilitating early planning to minimize or prevent climate related losses and damages.

Climate Risk Adaptation and Insurance in the Caribbean project (2011 – 2014)

Funded by BMUB and implemented by CCRIF and Munich Re together with MicroEnsure, under the umbrella of the Munich Re Climate Insurance Initiative (MCII). Launched in Jamaica, Saint Lucia and Grenada, the project has developed two parametric weather-index based risk insurance products aimed at low-income individuals and lending institutions exposed to climate stressors.

Caribbean Catastrophe Risk Insurance Facility (CCRIF)

Since 2007, multi-country catastrophe fund to limit the financial impact of devastating hurricanes and events by quickly providing financial liquidity when a policy is triggered. It offers earthquake, tropical cyclone and excess rainfall policies to Caribbean and Central American governments. The insured countries pay an annual premium commensurate with their own specific risk exposure and receive compensation based on the level of coverage agreed upon in the insurance contract in the case of a triggering event. CCRIF is also one of the main sources for data and detailed information on hazards, economic impacts, and risk profiles in the Caribbean.

3 CIFs are financing instruments channeled through the Multilateral Development Banks (MDBs) and 14 donor countries.

Building Regional Climate Capacity in the Caribbean (BRCCC) programme (2014 – 2017)

Funded by USAID and the Office of U.S. Foreign Disaster Assistance (OFDA) and implemented by the Caribbean Institute for Meteorology and Hydrology (CIMH). It has the aim to establish a World Meteorological Organization (WMO) Regional Climate Centre for the Caribbean, capable of developing and distributing sector-driven and user-driven climate and weather products and services to support climate change adaptation and enhanced DRR capabilities across Eastern Caribbean SIDS.

Coral Reef Early Warning System (CREWS) network

Funded by the European Union Global Climate Change Alliance (EU-GCCA) Caribbean Support Project, the system has led to the installation of several measuring stations in Belize, Trinidad and Tobago, Barbados, and the Dominican Republic. CREWS stations have also been installed in Jamaica, Belize and elsewhere in the Caribbean using non-EU funding as part of the wider network. The new CREWS stations became part of the NOAA's Integrated Coral Observing Network (ICON) of climate and biological monitoring stations that collect data on climate, marine and biological parameters for use by scientists to conduct research into the health of coral reefs in a changing and variable climate.

Adaptation of Rural Economies and Natural Resources to Climate Change (Special Energy and Climate Fund) programme (2012 – 2017)

Funded by BMZ and implemented at the regional level by the Caribbean Public Health Agency (CARPHA) on behalf of CARICOM, and GIZ in collaboration with a number of other national and local partners. It implements a ridge-to-reef approach through the umbrella "Caribbean Aqua-Terrestrial Solutions" (CATS) programme funded by BMZ with complementary interventions spanning from terrestrial to coastal and marine ecosystems. It covers eight CARICOM Member States, namely Belize, Dominica, Grenada, Guyana, Jamaica, St. Kitts and Nevis, Saint Lucia, and St. Vincent and the Grenadines, with the goal to improve the practical adaptation of smallholder agriculture as well as forest management including agro-forestry to the adverse impacts of climate change. In addition, it comprises a water component that focusses on water-loss reduction in supply systems and the provision of extra storage capacities to enhance resilience, be it through tanks or continuous sediment management of reservoirs.

Integrated Climate Change Adaptation Strategies (ICCAS) pilot programme in Grenada (2013 – 2018)

Funded by BMUB under its International Climate Initiative (IKI) and jointly implemented by the Government of Grenada, GIZ and the United Nations Development Programme (UNDP). It is aimed to increase resilience of vulnerable communities and ecosystems to climate change risks. The Grenadian-German pilot programme pursues an integrated, multi-sectoral approach, linking community activities to national measures. It is mandated to support the National Adaptation Planning process in Grenada, including the integration of climate screenings by using CCORAL into planning and budgetary processes. An Integrated Coastal Zone Policy for the tri-island state has been developed and a community fund provides direct support to the population in small-scale adaptation measures. The project also promotes measures to enable Grenada to access climate finance – such as from the Green Climate Fund – for adaptation activities over the long term and to share experiences from the comprehensive intervention packages in the region.

4. Experiences in the Caribbean

The 2013 Christmas Eve Trough – St. Vincent and the Grenadines and Saint Lucia

Severe weather, unusual for the time of the year, affected the Eastern Caribbean during the period December 23rd to 25th, 2013, with catastrophic consequences in the islands of St. Vincent and the Grenadines and Saint Lucia, located in the Eastern Caribbean and part of the Windward Islands. The suddenness of the event is captured by this synopsis by the Meteorological services in St. Vincent which stated *"the weather changed so rapidly between 6:00 pm and 8:00 pm on the 24th December that it would have been very difficult to predict and then issue a severe weather bulletin/flood warning with any significant lead time to alert the populace" (Government St. Vincent and the Grenadines, 2014).*

Intense rainfall resulted in major flooding and landslides in all the islands involved. In St. Vincent and the Grenadines, there was flooding in the capital city of Kingston and in the north of the island, where landslips blocked most major roadways. A state of emergency was declared in twelve areas. In Saint Lucia, where approximately 200 to 400 mm of rain fell in less than 24 hours, there were major flash floods and landslides in twelve districts including the capital, Castries, where much of the population resides. The intensity and volume of rainfall within such a short period of time outside of the hurricane season was quite significant and unusual. In both St. Vincent and the Grenadines and Saint Lucia, the rainfall intensity may be in excess of a 1-in-100 year event *(Government St. Vincent and the Grenadines, 2014).*

Disaster related losses and damages were significant in both islands, as shown Table 1 and Figure 4. It should be noted that this is not an exhaustive representation, as impacts on some sectors were not evaluated (e.g. electricity in Saint Lucia, telecommunication in Saint Vincent and the Grenadines).

Country	Damages (USD M)	Losses (USD M)	Total (USD M)	% of GDP
Saint Lucia	80.03	19.95	99.88	8.3 %
St. Vincent & Grenadines	86.4	22.00	108.40	15 %

Table 1: Summary of Losses and Damages (USD million)
Sources: Government of St. Vincent and the Grenadines, 2014; Government of Saint Lucia and the World Bank, 2014

Country	Financing needs (USD million)	Financing available (USD million)	Financing gap (USD million)
Saint Lucia	99.88	17.00	82.88
St. Vincent & Grenadines	108.40	1.90	106.50

Table 2: Financing gap per country (USD million)
Sources: Government of Saint Lucia and the World Bank, 2014; Government of St. Vincent and the Grenadines, 2014

The event created an unanticipated financial burden on the economies of the islands as outlined in Table 2.

The slow-moving, low-level trough was not covered under the CCRIF and therefore did not qualify for payments from the facility. While such an event would be covered under the new excess rainfall facility that was introduced in 2014, payments are likely to only cover a fraction of the financing gap.

Sectoral Losses and Damages from the Christmas Eve Trough (in USD million)

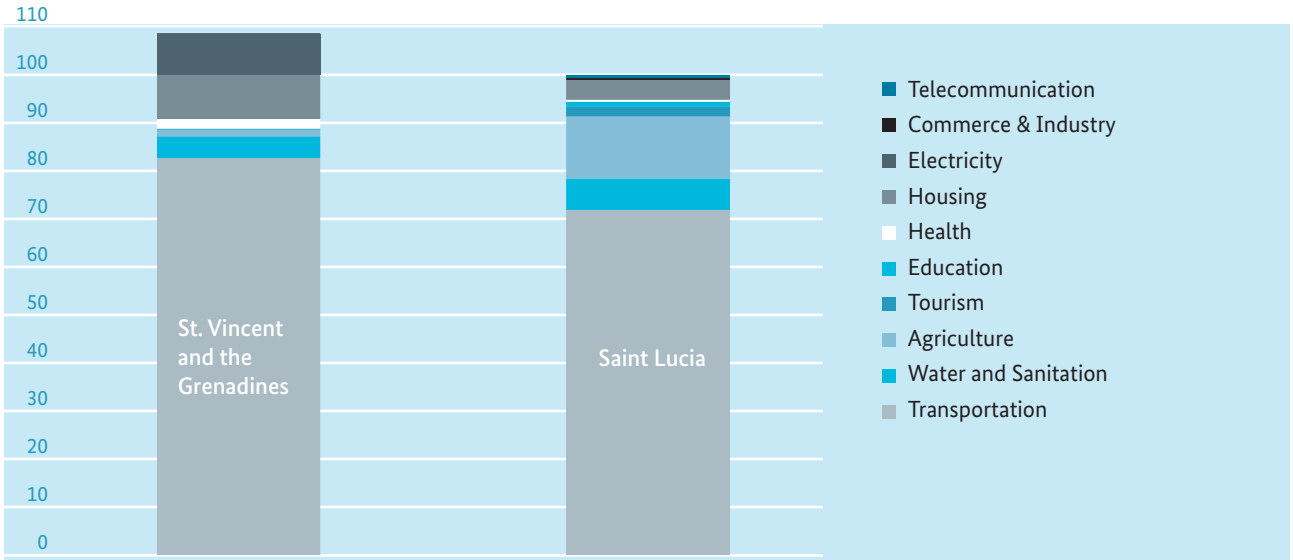

Figure 4: Losses and damages per sector (USD million)
Sources: Government of St. Vincent and the Grenadines, 2014; Government of Saint Lucia and the World Bank, 2014

Figure 5: Banana plantation flattened due to flooding along the Roseau River banks as a result of the 2013 Christmas Eve Trough – Saint Lucia, 2013

Figure 6: Local water utility staff inspecting washed-away road to the John Compton Dam aka Roseau Reservoir following the Christmas Eve Trough – Saint Lucia, 2013

The government of St. Vincent and the Grenadines was forced to pass a supplementary budget in order to close the financing gap, totalling USD 83.98 million, of which USD 41 million was from local revenue, USD 13.5 million from grant funding from Mexico and USD 10 million from Petro Caribe (*Government St. Vincent and Grenadines, press release)*. A recovery and reconstruction framework was also proposed to provide a sequenced, prioritized, programmatic, yet flexible action plan to guide the recovery and reconstruction process that is anchored in disaster risk management – in particular flood risk management *(Government of St. Vincent and the Grenadines, 2014)*.

Saint Lucia, received pledges by various countries and international development partners to assist with the response effort. In the immediate aftermath, a total of USD 1 million from the Caribbean Development Bank (CDB) was mobilized to assist with response and recovery (USD 250,000 for emergency recovery and USD 750,000 for clean-up efforts) *(Government of Saint Lucia and the World Bank, 2014)*.

From an economic and human development perspective, current response strategies are not sustainable and will become even less so with the impacts of climate change. Events like the Christmas Eve 2013 trough, increase recognition of the need for approaches to strengthen disaster risk management and build climate resilience in all Caribbean countries.

The 2004 Hurricane Ivan and its long-lasting impacts – Grenada

The tri-island state of Grenada is the most southerly of the Windward Islands, with an estimated population of 106,300 in 2014 *(World Bank, web reference)*. Due to its location at the southern end of the eastern Caribbean chain of islands, it was believed to be outside of the direct path of Atlantic hurricanes. However, on Monday, September 6th, 2004, Hurricane Ivan hit the island causing unprecedented, catastrophic destruction. Hurricane Ivan struck Grenada directly, and as a category 3 hurricane (later becoming category 5) with severe winds and rains that battered the island for over twelve hours. At their peak, wind speeds measured 193 km/h with gusts of over 233 km/h. Analysis of estimates of wave heights generated under Hurricane Ivan indicates that Ivan may have been a more than 100 year event *(NWS, Cayman Islands Government, 2005)*.

Figure 7: Cleaning up a flooded supermarket after the Christmas Eve Trough – Saint Lucia, 2013

The ferocity of the hurricane resulted in tremendous island-wide damage with the most damages occurring in the parishes of St. Andrew, St. David, St. George and St. John. The coastal areas of Soubise, Marquis and River Antoine in St. Andrew's and Waltham in St. John's were inundated by the storm surge. The hurricane resulted in damage to 91 % of forest areas and watersheds (*Roberts and Shears, 2008)*. A total of 28 persons were killed and many individuals lost property including homes and vehicles and were without shelter, food, belongings or social networks to provide support. Overall, about 90 % of all buildings suffered structural damage *(Carby, 2011; UNEP, 2005)*. It was reported that 18,000 persons were without homes and required relocation to approximately 160 formal and informal shelters *(OECS, 2004)*. In the immediate aftermath only few services were available, as 69 % of health sector infrastructure was affected by the hurricane *(World Bank, 2005)*.

Hurricane Ivan had particularly severe impacts for vulnerable groups in Grenadian society, such as women, children, the poor, and the elderly and physically and mentally challenged. In terms of gender impact, more females than males took refuge in hurricane shelters, often accompanied by their children. These shelters, particularly informal ones, may lack mechanisms for order and protection; reports surfaced of young women seeking transactional sex in order to acquire supplies, and of gender-based violence. There were longer-term impacts as well for women and children, as men were able to find work (e.g. in construction) more easily than women. Mothers were required to care for their children during the day as day care centres and schools were severely damaged, which prevented them from earning an income. Damage to schools also crippled progress toward social and economic transformation and empowerment through education, particularly for the poor *(Caribsave, 2012)*.

Beyond physical damage, the psychological impact was great, as approximately 80 % of Grenadians had never witnessed a hurricane before Ivan *(OECS, 2004)*. Children were especially impacted, prompting UNICEF to set up the "Return to Happiness" programme aimed at providing psychological support to children *(Caribsave, 2005)*.

The total damage resulting from the impact of Hurricane Ivan was estimated to be around USD 900 million, in excess of 200 % of Grenada's 2004 GDP *(OECS, 2004)*.

While the most severe direct damages to assets and stocks at the time of the disaster were felt in the housing sector, indirect damages, such as losses in income and produc-

Figure 8: Nutmeg fruit. Nutmeg crop is made up of two cash components: the nutmeg seed plus the mace (red) – Grenada

tion flows following the disaster, were significant in the tourism, energy-telecommunications and agricultural sectors. Figure 9 shows direct and indirect damage to various sectors of the economy *(OECS, 2004)*.

The economy had been expected to grow by 4.65 % in 2004 but instead it contracted by 3 %. Government revenue declined, unemployment increased from 13 % in 2003 to 20 % in the immediate aftermath, and public sector debt increased from 110 % of GDP in 2002 and 2003 to 130 % in 2004, and continued to rise afterwards *(World Bank, 2005)*.

Crops such as nutmeg, banana and cocoa were heavily affected. The banana crop was devastated to the extent that Grenada, previously an exporter of bananas, became a net importer *(World Bank, 2005)*.

Approximately 85 % of the nutmeg crop, the country's main export crop, was impacted and still faced significant recovery challenges after one year *(World Bank, 2005)*. This is linked to the extended growth cycle of the tree, as it takes about 7 – 9 years for the first harvest and about 20 years to reach full production. During the period 2002 – 2008, the export volume decreased significantly from 2,300 to 1,100 tonnes in 2006, when there were still good nutmeg volumes in stock. By 2009 it was further reduced to about 200 tonnes *(ITC, 2010)*. Recent data show that nutmeg production has been steadily increasing, with good performance in 2011 – 2012 and in 2014 as a result of the maturing of some trees planted in the aftermath of the hurricane, plus the effect of direct incentives provided to local farmers *(Government of Grenada, 2014; 2015)*.

It was estimated that Grenada needed about USD 271 million for recovery in the aftermath of the hurricane in immediate, life-saving aid, including money for food, shelter, water and sanitation, and medicine *(UN, web reference)*. Nearly USD 100 million had been disbursed within one year of Hurricane Ivan by a variety of donors *(World Bank, 2005)*. Data is not available on the government's success in sourcing the financing earmarked for reconstruction, but the Economic Commission for Latin America and the Caribbean (ECLAC) reports a 20 % increase in Grenada's external debt as a percentage of GDP in the year following the hurricane – from 89 % to 109 % *(ECLAC, 2010)*. It is reasonable to assume that at least some of that debt was incurred to assist in the reconstruction process.

Direct and indirect damage from Hurricane Ivan in selected sectors of Grenada's economy (in USD million)

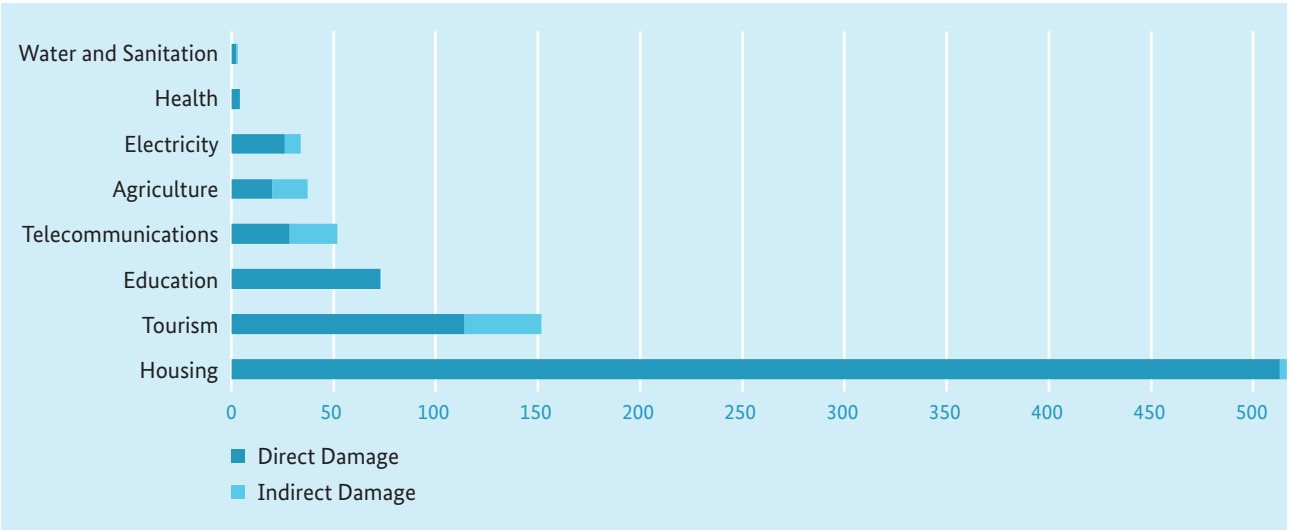

Figure 9: Summary of direct and indirect damage in selected sectors (USD million). Direct damage refers to losses to assets and stocks at the time of the disaster while indirect damage refers to losses in income and production flows following the occurrence of the disaster *(Source: adapted from OECS, 2004)*

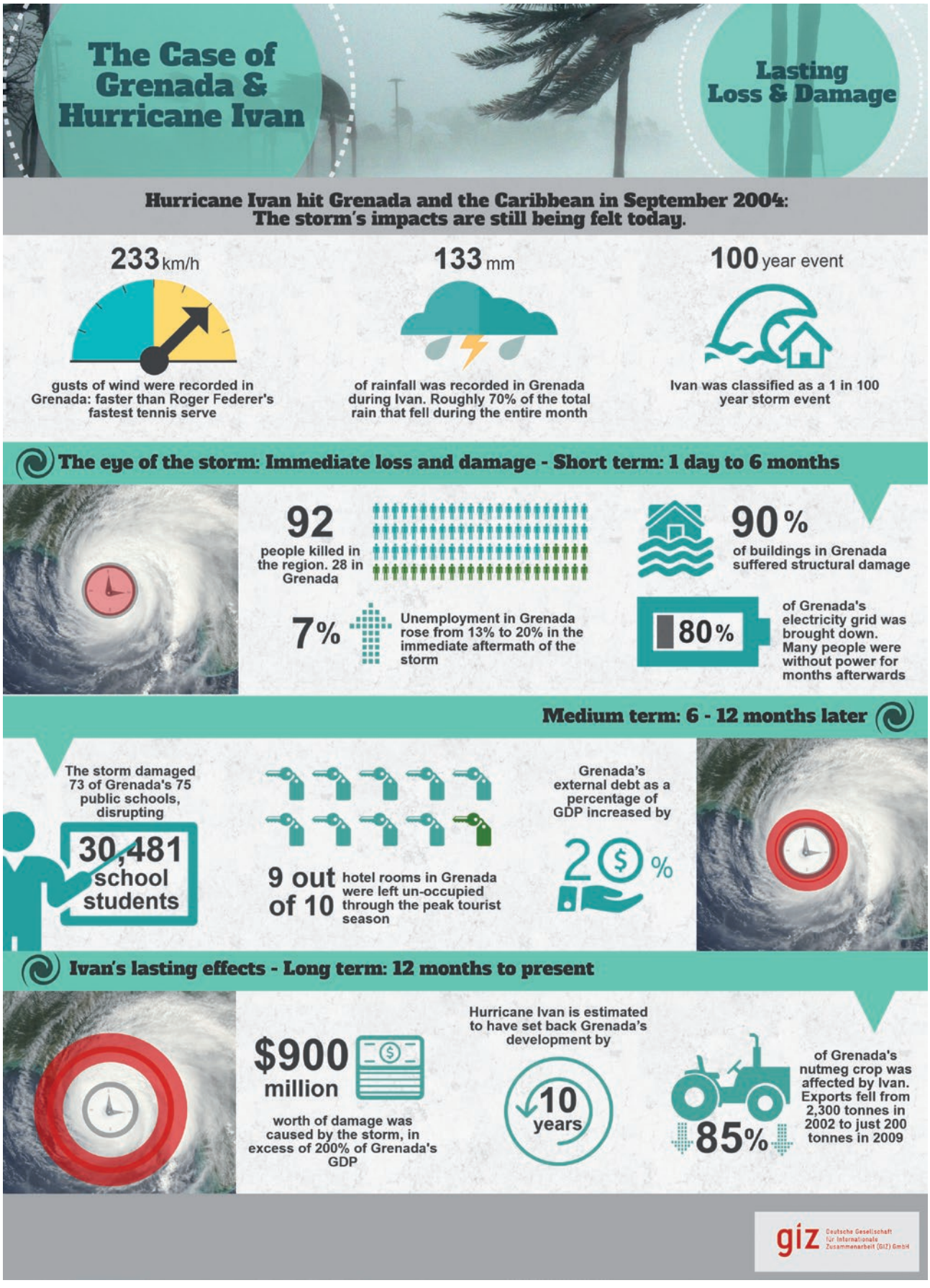

Figure 10: The case of Grenada and Hurricane Ivan

Hurricane Ivan's impact highlights liquidity challenges faced by governments during recovery. The Grenadian Government's limited accrued reserves were quickly overwhelmed and it became difficult to finance the continuation of key public services. At the same time, government revenues drastically declined due to losses in major income generating sectors, resulting in the country's inability to service its debt obligations. The Government thus imposed a set of strict measures to generate income to stimulate economic recovery, such as an increase in the price of fuel, higher taxes on alcohol and tobacco, and a levy on certain incomes. However, the country still faced a fiscal financing gap of 4.5 % of GDP for 2005, with total debt increasing to 150 % of GDP *(CCRIF, 2011)*.

It should be noted that there was no sovereign risk transfer mechanism available in the Caribbean in 2004. The CCRIF was established out of the experience of the region with the absence of risk transfer in the face of the multiple impacts from Hurricane Ivan.

Grenada was not prepared for Hurricane Ivan and some of the damage and losses incurred resulted from a lack of preparation at the individual and national levels. Hurricane Ivan also exposed significant weaknesses in Grenada's social and economic infrastructure and in its disaster risk management capabilities, including slow relay of early warning information by the Meteorological Service; weak emergency response coordination at the national level; weaknesses in disaster relief management including in victim registration, needs identification, lapses in security and breakdown in law and order; ineffective inter-agency coordination; ineffective public information and media response; and poor pre-positioning of resources, personnel and food *(Cletus Springer, 2005)*.

Recognizing these weaknesses, the National Emergency Recovery Organization (NERO) changed its name to the National Disaster Management Agency (NaDMA), for a more comprehensive approach to disaster management. NaDMA has sought to improve public awareness and preparedness at the community level, through a series of initiatives including television presentations, the coordination of disaster awareness in schools, distribution of brochures and public events including Disaster Awareness Week. The government also set up the dedicated Agency for Reconstruction and Development (ARD), to coordinate the recovery effort with a long term strategic view to reduce vulnerability, operating under the tag line "Build Back Better".

The 2011 Flooding from an unusual weather event – Town of Gouyave, Grenada

The town of Gouyave, on the west coast of Grenada, is located at the mouth of the Little River and has a history of flooding during periods of heavy rainfall. Gouyave has an estimated population of 4,378 individuals, many of whom experience high levels of poverty, economic and social vulnerability, with low levels of education, high unemployment, significant levels of female-headed households and poor housing conditions and sanitation. This vulnerability is further exacerbated by the location of many low income houses along the banks of the river *(Caribbean Development Bank, 2011 a)*.

Over the period April 10th to 13th, 2011, Grenada was impacted by torrential rainfall associated with a slow-moving, low-level trough located in the Southern Lesser Antilles. The most adverse effects of this rainfall event occurred in the north-west regions of the island, where flash flooding and landslides caused damage to critical infrastructure and homes. Severe impact from flooding was observed in Gouyave, where approximately 304.8 mm of rainfall was measured in stations closest to the Gouyave watershed within a ten-hour period on April 13th, 2011. This was approximately four times the historic monthly average (estimated at 80.5 mm) for April, which is a traditionally dry month in Grenada. The level and rate of precipitation observed during this rainfall event was indicative of both its unseasonal and intense nature *(Caribbean Development Bank, 2011 a)*.

At a macro level, the flooding and landslides severely damaged roads, bridges and eroded river channels embankments. Road infrastructure suffered damage through undermining of retaining structures, drains and culverts. However, no detailed macro-socio-economic damage and loss assessment was undertaken for the event as it was largely localised in nature *(Caribbean Development Bank, 2011 a)*. At the community level, residential housing located within the flood plain adjacent to the river banks was damaged by the force of the flood waters as well as from the deposition of silt and debris and the residents were forced to evacuate. Additionally, some businesses in Gouyave experienced disruptions, varying between one to five days. At the individual level, residents suffered displacement and damage and loss to homes and personal possessions. 26 households and one-day care facility, comprising 109 individuals (2.5 % of the population of Gouyave in 2008), were affected and many of them relocated to a designated public emergency shelter *(Caribbean Development Bank, 2011 a)*.

The Government agreed a loan with the CDB of around USD 3.2 million to restore and upgrade infrastructure, build a community centre, implement an operational early warning system and identify measures for reduction of flood risk within the Gouyave water shed *(Caribbean Development Bank, 2011 a).*

The scope of the works under the CDB loan addresses the measures which should reduce the flood risk to the area. They also include measures for reducing the potential for loss of life through relocation of the affected residents and the installation of an early warning system. However, the fact that the government needed to borrow funds to institute these measures and to repair the damaged infrastructure is not a sustainable solution, as it worsens the already over-leveraged fiscal position of the country.

Furthermore, the absence of any systems to assist the affected population in the intervening period speaks to the need for mechanisms to provide assistance and support to poor, vulnerable segments of the population that experience such events.

5. Conclusions and outlook

Lessons learnt from the Caribbean

Three experiences on a regional, national and community scale in the Caribbean were presented in this report. These cases highlight several aspects of impacts from weather and climate-induced disasters; the short-term and long-term physical, economic and psychological impacts, as well as the more lasting impacts and challenges posed by such events to Caribbean nations' sustainable development trajectories.

Common challenges faced by Caribbean nations in responding to these events include:

- Strong dependence on external humanitarian assistance and grants, which in many cases do not meet all financing requirements. This may result in damaged areas being left in a state of disrepair for a long period of time.
- The need to give up planned developmental priorities, by having to defer or abandon existing plans and projects and re-channel existing funds to disaster response. This represents an additional indirect cost borne by countries as a result of the impact of the hazard.
- Incurrence of additional debts in an effort to close the financing gap, which worsens an already overly leveraged national fiscal situation and limited capacities in risk management.
- Continuous set-backs in socio-economic and environmental recovery and rehabilitation due to the recurrence and accumulation of adverse impacts. Even moderate weather events can cause damages to already fragile (or ill-prepared) systems. The passage of Hurricane Emily that struck Grenada in 2005, 10 months after Hurricane Ivan, and the 2013 Christmas Eve trough that significantly impacted Saint Lucia following Hurricane Tomas in 2010, simply aggravated and made permanent the damages caused by the previous events. This may mean countries remain in "permanent repair mode", which significantly impacts their ability to plan for and build ex-ante resilience.

While these case studies represent sudden disasters, slow onset changes like sea level rise and ocean acidification, represent creeping environmental changes that cause additional stress to the underlying vulnerability of systems. It is worth noting that adverse impacts from slow onset changes do not match the criteria for traditional risk transfer approaches, such as climate risk insurance, which may be incompatible to insure against longer-term foreseeable climatic stressors.[4] In turn, **resilience building and the consideration of innovative approaches to address slow-onset events should be emphasized** *(Balogun, 2013; Warner et al., 2013)*.

Indeed, these case studies also bring to light several important lessons for regional and local actors to manage future climate risks:

1. the importance of preparedness and building ex-ante resilience through comprehensive climate and disaster risk management;
2. the importance of integrating climate risk reduction considerations into national planning through measures such as appropriate land use and coastal zone policies, building codes and sustainable water supply management;
3. the importance of developing risk financing strategies and transfer mechanisms to avoid reliance on international aid and public debt.

4 These climatic stressors do not meet the insurability criteria – the unpredictability of the event and the ability to spread risk over time and regions, between individuals/entities – as both processes are slow and involve continuous changes that potentially affect the population of one or more countries *(Warner et al., 2013)*.

Strategies, tools and services have already been developed to ensure that longer term resilience requirements are taken into account in development planning; these include the CARICOM regional strategy, the Caribbean Regional Resilience Development and Implementation Plan and the CCORAL tool.

The role of international community to deal with climate risks

The Caribbean experiences, for example by the CATS programme, point to the need for a **comprehensive approach at the local, national, regional and international levels** to deal with climate risks. Such an approach must be based on **donor harmonisation**, which is widely absent, and should **involve a structured response to address all phases of the climate and disaster risk management process** *(see also WMO, web reference)*, namely:

- **Assessing climate and disaster risk** through quantitative assessment, which combines information about the hazards with exposures and vulnerabilities of the population or assets;
- **Minimizing risk by building ex ante resilience** through adaptation and preparedness actions, and undertaking robust mitigation efforts;
- **Assisting in recovery and rehabilitation** from the impacts of weather and climate-related hazards in a manner that integrates resilience into the recovery efforts;
- **Providing risk financing and risk sharing mechanisms**, to transfer the financial impacts of climate-related adverse events. In particular, innovative approaches to address residual risk associated with slow onset events should be explored.

Beneficiaries of initiatives to address climate risk include people but also assets and infrastructure, socio-economic, political and environmental systems. Importantly, assisting governments and other national and regional key institutions characterised by limited human and technical capacity in applying for funding, from the multitude of funds and opportunities available worldwide, should be considered as an integral component of the risk management process.

A comprehensive climate and disaster risk management strategy, and in particular the insurance component, may represent the best way to turn the issue into action on the ground. For instance, weather-indexed insurance is designed to protect against shared risks instead of individual ones, and works on the basis of thresholds rather than the assessment of damages.

The **G7 Climate Risk Insurance Initiative *InsuResilience*** adopted by the G7 partner countries – Germany, France, Italy, Japan, Canada, United Kingdom, and United States – at the G7 Elmau Summit in 2015 promotes this model in the context of ambitious but concrete efforts to tackle climate change *(G7 Germany, 2015; BMZ, web reference)*. InsuResilience seeks to increase insurance coverage for extreme and adverse weather events by facilitating access to direct or indirect insurance for up to 400 million poor and vulnerable people in develeoping countries by 2020. Existing successful regional platforms such as CCRIF in the Caribbean and Central America, have great potential for replication and upscaling to other regions at risk, possibly with additional future oriented innovations *(GIZ, 2015)*.

For slow onset events, consideration of innovative disaster risk financing under the WIM is urgent, to support the countries that are not able to access finance necessary for disaster prevention and response. Also, non-life insurances and parametric insurance policies could be modelled to reflect factors or indicators of changing climate over a longer time frame and inevitable losses *(Balogun, 2013)*.

Sustainable development pathways should ultimately enable vulnerable countries to better manage the adverse effects of climate change.

References

AOSIS, 2008. Proposal to the AWG-LCA Multi-Window Mechanism to Address Loss and Damage from Climate Change Impacts.

Balogun K., 2013. Managing loss and damage from slow onset events: Applicability of risk transfer tools including insurance.

Bueno R. et al., 2008. The Caribbean and Climate Change. The Cost of Inaction. SEI and Tufts University.

Carby B., 2011. Caribbean Implementation of the Hyogo Framework for Action Mid-Term Review.

Caribbean Catastrophe Risk Insurance Facility, 2010. Enhancing the Climate Risk and Adaptation Fact Base for the Caribbean.

Caribbean Development Bank, 2011. Annual Report.

Caribbean Development Bank, 2011 a. Staff Report on Natural Disaster Management Rehabilitation and Reconstruction (Extreme Rainfall Event) – Grenada.

Caribsave, 2012. The Caribsave Climate Change Risk Atlas: Climate Change Risk Profile for Grenada.

Caribsave, 2005. Grenada: A Gender Impact Assessment of Hurricane Ivan – Making the invisible visible.

Cletus Springer, 2005. The 2004 Hurricane Season In the Caribbean. A Review of Disaster Preparedness and Response Arrangements.

CCRIF, 2011. CCRIF: A Natural Catastrophe Risk Insurance Mechanism for the Caribbean – A collection of papers, articles and expert notes, Volume 2.

Denton, F., T. J. Wilbanks, A. C. Abeysinghe, I. Burton, Q. Gao, M. C. Lemos, T. Masui, K. L. O'Brien, and K. Warner, 2014. Climate-resilient pathways: adaptation, mitigation, and sustainable development. 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 [Field, C. B., V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1101 – 1131.

ECLAC, 2010. Analysis Of Extreme Events In The Caribbean 1990 – 2008.

IPCC, 2014. 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 [Field, C. B., V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1132 pp.

INC – Intergovernmental Negotiating Committee for a Framework Convention on Climate Change, 1991. Negotiation of a Framework Convention on Climate Change. Elements relating to mechanisms. Vanuatu: Draft annex relating to article 23 (insurance) for inclusion in the revised single text on elements relating to mechanisms (A/AC.237/WG.II/Misc.13) submitted by the Co-chairmen of Working Group II.

G7 Germany, 2015. Leaders' Declaration G7 Summit, 7 – 8 June 2015.

GIZ, 2015. Climate Risk Insurance For Strengthening Climate Resilience Of Poor People In Vulnerable Countries A Background Paper On Challenges, Ambitions and Perspectives.

Government of Grenada, 2014. 2015 Budget Statement.

Government of Grenada, 2015. 2016 Budget Statement.

Government of St. Vincent and the Grenadines, 2014. Rapid Damage and Loss Assessment, December 24 – 25, 2013 Floods.

Government of Saint Lucia and World Bank, 2014. Flood Event of December 24 – 25, 2013 – Joint Rapid Damage and Needs Assessment.

ITC, 2010. European Union All ACP Commodities Programme Caribbean Region – Grenada Nutmeg Sector Strategy, July 2010.

Klein, R. J. T., G. F. Midgley, B. L. Preston, M. Alam, F. G. H. Berkhout, K. Dow, and M. R. Shaw, 2014. Adaptation opportunities, constraints, and limits. 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 [Field, C. B., V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 899 – 943.

Mace M. J. and Schaeffer M., 2013. Loss and Damage under the UNFCCC: what relationship to the Hyogo Framework? A report prepared by Climate Analytics.

National Weather Service, Cayman Islands Government, 2005. Hurricane Ivan.

Nurse, L. A., R. F. McLean, J. Agard, L. P. Briguglio, V. Duvat-Magnan, N. Pelesikoti, E. Tompkins, and A. Webb, 2014. Small islands. In: Climate Change, 2014. Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V. R., C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1613 – 1654.

OECS – Organisation of Eastern Caribbean States, 2004. Grenada: Macro-socio-economic assessment of the damages caused by Hurricane Ivan, September 7, 2004.

Palanisamy, H., M. Becker, B. Meyssignac, O. Henry, and A. Cazenave, 2012. Regional sea level change and variability in the Caribbean Sea since 1950. Journal of Geodetic Science, 2(2), 125 – 133.

Roberts, D. A., and Shears, R., 2008. Good Agricultural Practices for Climate Risk Management in Grenada.

Seneviratne, S. I., N. Nicholls, D. Easterling, C. M. Goodess, S. Kanae, J. Kossin, Y. Luo, J. Marengo, K. McInnes, M. Rahimi, M. Reichstein, A. Sorteberg, C. Vera, and X. Zhang, 2012. Changes in climate extremes and their impacts on the natural physical environment. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C. B., V. Barros, T. F. Stocker, D. Qin, D. J. Dokken, K. L. Ebi, M. D. Mastrandrea, K. J. Mach, G.-K. Plattner, S. K. Allen, M. Tignor, and P. M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 109 – 230.

Siegele L., 2012. Loss and Damage: The Theme of Slow Onset Impact. Bonn, Germany: Germanwatch.

Simpson MC, Gossling S. and Scott D., 2008. Report on the International Policy and Market Response to Global Warming and the Challenges and Opportunities that Climate Change Issues Present for the Caribbean Tourism Sector. European Commission and Caribbean Tourism Organization, Barbados.

Stabinsky, D. and Hoffmaister, Juan P., 2012. Loss and Damage: Some key issues and considerations.

Stephenson, T. et al., 2010. Changes in extreme temperature and precipitation in the Caribbean region, 1961 – 2010. International Journal of Climatology, 34: 2957 – 2971.

UN, 2015. Sendai Framework for Disaster Risk Reduction 2015 – 2030.

UNEP, 2005. Caribbean Environment Outlook 2004.

UNISDR, 2014. Progress and Challenges in Disaster Risk Reduction. International Strategy for Disaster Risk Reduction.

UNFCCC, 2015. Adoption of the Paris Agreement FCCC/CP/2015/L.9/Rev.1.

UNFCCC, 2014. Decision 2/CP.20: Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts.

UNFCCC, 2014 a. Report of the Executive Committee of the Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts. Subsidiary Body for Scientific and Technological Advice (SBSTA); Subsidiary Body for Implementation (SBI) FCCC/SB/2014/4.

UNFCCC, 2013. Decision 2/CP.19: Warsaw international mechanism for loss and damage associated with climate change impacts.

UNFCCC, 2013 a. Gaps in existing institutional arrangements within and outside of the Convention to address loss and damage, including those related to slow onset events. UNFCCC Technical Paper, FCCC/TP/2013/12.

UNFCCC, 2013 b. Non-economic losses in the context of the work programme on loss and damage. UNFCCC Technical paper, FCCC/TP/2013/2. http://unfccc.int/resource/docs/2013/tp/02.pdf

UNFCCC, 2012. Decision 3/CP.18: Approaches to address loss and damage associated with climate change impacts in developing countries that are particularly vulnerable to the adverse effects of climate change to enhance adaptive capacity.

UNFCCC, 2012 a. A literature review on the topics in the context of thematic area 2 of the work programme on loss and damage: A range of approaches to address loss and damage associated with the adverse effects of climate change. UNFCCC. Subsidiary Body for Implementation (SBI), FCCC/SBI/2012/INF.14.

UNFCCC, 2011. Decision 7/CP.17 Work programme on loss and damage.

UNFCCC, 2010. Decision 1/CP16: The Cancun Agreements: Outcome of the work of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention.

UNFCCC 2007. Decision 1/CP. 13: Bali Action Plan. FCCC/CP/2007/6/Add.1. http://unfccc.int/resource/docs/2007/cop13/eng/06a01.pdf

UNGA, 2015. Draft outcome document of the United Nations summit for the adoption of the post-2015 development agenda, 12 August 2015.

Warner, K. et al., 2013. Innovative Insurance Solutions for Climate Change: How to integrate climate risk insurance into a comprehensive climate risk management approach. Report No. 12. Bonn: UNU-EHS.

Warner, K. and Zakieldeen, S.A., 2011. Loss and damage due to climate change: An overview of the UNFCCC negotiations, European Capacity Building Initiative.

World Bank, 2013. Building Resilience: Integrating climate and disaster risk into development. Lessons from World Bank Group experience. The World Bank, Washington DC.

World Bank, 2005. Grenada: A Nation Rebuilding – An assessment of reconstruction and economic recovery one year after Hurricane Ivan. The World Bank, Washington DC.

Web references

BMZ. G7 initiative – website consulted Oct 2015: www.bmz.de/g7/en/index.html

Government of St. Vincent and the Grenadines. Press release www.gov.vc/index.php?option=com_content&view=article&id=1133:parliament-supplementary-estimates&catid=43:government-news&Itemid=159 and http://thevincentian.com/ulp-million-for-recovery-in-after-the-floods-p5282-107.htm

NOAA. Global warming and hurricanes – website consulted Oct 2015: www.gfdl.noaa.gov/global-warming-and-hurricanes

NOAA. Atlantic Hurricane Season – website consulted Oct 2015: www.nhc.noaa.gov/data/tcr/index.php?season=2014&basin=atl

US NCA. Changes in Hurricanes – Website consulted Oct 2015: http://nca2014.globalchange.gov/report/our-changing-climate/changes-hurricanes

UN. Press Conference By Under-Secretary-General For Humanitarian Affairs To Launch Flash Appeals For Haiti, Grenada (1 October 2004) – website consulted Oct 2015: www.un.org/press/en/2004/egeland041001.doc.htm

UNDESA. Sustainable Development Knowledge Platform – website consulted Oct 2015: https://sustainabledevelopment.un.org/topics/sids/memberstates

World Bank. Country Data – Grenada – website consulted Oct 2015: http://data.worldbank.org/country/grenada

WMO. WMO Disaster Risk Reduction Programme – website consulted Oct 2015: www.wmo.int/pages/prog/drr/index_en.html

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