Science for Humanitarian Emergencies and Resilience (SHEAR) scoping study:

Annex 4 - Current initiatives and research priorities for the Caribbean

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Report Summary

This report was commissioned to provide evidence based recommendations on priorities for future research on weather related risk assessments and early warning systems and their integration into decision making in the Caribbean.

Section 1 of the report provides background information on weather and climate related hazards experienced in the Caribbean while highlighting some of the challenges currently faced by disaster mangers and other decision-makers. Information on the regional response to these events has also been provided.

A gap analysis regarding weather and climate related interventions can be found in Section 2. The current state of risk assessments and early warning systems is compared to future plans in order to highlight existing shortfalls. Reference is made to a comprehensive assessment of the institutional and technical needs of the Caribbean region to support multi-hazard early warning systems and risk assessment commissioned by the World Meteorological Organization (WMO).

Section 3 collates recently completed and ongoing projects, initiatives and programmes that directly or indirectly support weather and climate risk assessments and early warning systems in the Caribbean. Resource links have been provided should more information on the projects be required.

There are four main frameworks which govern and guide disaster management and climate related interventions in the Caribbean. These regional frameworks are presented in Section 4. Further, recommendations for future risk assessment and early warning interventions have been provided.

Section 6 lists the references cited within this report.

SECTION 1

Introduction

The Caribbean Institute for Meteorology and Hydrology (CIMH) has undertaken this work to contribute to the Science for Humanitarian Emergencies and Resilience (SHEAR) scoping study that forms part of the outputs of an initiative for the Climate and Environment Team (CET), Research and Evidence Division of the Department for International Development (DFID). The objective of the work is to provide evidence based recommendations on priorities for future research on weather related risk assessments and early warning systems and their integration into decision making in the Caribbean by:

(i) Considering current gaps in research and development
(ii) Identifying relevant ongoing research and development initiatives
(iii) Identifying possible future research and development initiatives

Background

The Caribbean consists of an archipelago of Small Island Developing States (SIDS) that border the northern and eastern portions of the Caribbean Sea and the countries along the north coast of South America and east coast of Central America. From the perspective of natural disasters, the Caribbean region is often described as one of the most at risk regions in the world due to:

(i) Its frequent exposure to tropical storms and strongly convective weather systems
(ii) Its location along active fault and subduction zones that promote volcanic activity, strong earthquakes and occasionally tsunamis.

When superimposed on the topography, geology, settlement patterns and economic base of most territories in the region, these hazards often result in loss of life, significant annual socio-economic losses and population displacement that can be permanent in some instances (e.g. in Montserrat following the eruption of the Soufriere volcano in the 1990s). In addition to these fast onset hazards, the region is challenged with slow onset hazards often associated with climate, such as drought, that are expected to be exacerbated by long term climate change and increasing climate variability.

Severe weather and climate

The historical challenges faced by the Caribbean with respect to weather are well documented. Over the past 25 years, strides have been made to reduce losses associated with severe weather hazards, especially wind hazards. However, as demonstrated by recent events, more effort and investment is required. For example, Hurricane Ivan in 2004 inflicted damage of the order of 200% of Gross Domestic Product (GDP) on the island of Grenada. Much of this damage, (over 90% of buildings were impacted), which resulted from high wind speeds associated with the event, in part emphasized that while building codes in the region had improved, many older structures on Grenada had not been improved to meet the new standards. This may also reflect issues associated with enforcement of national building standards.

In 2010, Hurricane Tomas as a Category 1 storm, inflicted losses of the order of 60% of GDP on the island of Saint Lucia. A significant portion of this damage resulted from severe flooding and landslides caused by the high rainfall associated with the system. In addition to the socio-economic losses associated with Hurricane Tomas, 13 people lost their lives as a result of the unprecedented landslides produced by the system. The CIMH reported that the return period for the peak 24-hour rainfall accumulation associated with the system exceeded 1 in 200 years. Hurricane Tomas exposed limitations in the region's early warning systems as it pertains to rainfall forecasting, alerting and propagation to downstream risk forecasting. In addition, the aftermath of Hurricane Tomas exposed risks in the Saint Lucia water systems that were previously not considered. In particular, it was realized that the John Compton Dam and its related distribution systems that represent the primary source of potable water on the island were susceptible to severe landslides.

While large tropical systems threaten the Caribbean region on an annual basis, not all states are directly impacted by these systems on an annual basis. It is generally the case that all states in the Caribbean are impacted annually by localized weather systems including deep convective rainfall systems associated with tropical depressions and waves. While the impacts of these systems can be local with little socio-economic impact, there are examples in recent years where such localized events have produced significant social and economic impacts and, in some cases, loss of life. For example, a localized weather system over the eastern portion of St. Vincent on the night of 11 to 12 April 2011 produced approximately 200 mm of rainfall in a three hour period at Perseverance in the eastern part of the island (Farrell and Payne, 2011). This system, which was not forecasted by local authorities and for which no warnings were issued, generated significant flooding and landslides over portions of the north-east coast of the island damaging bridges and roads in the impacted area. This event occurred within six months of the passage of Hurricane Tomas. The combined loss for both events was approximately US$ 90 million. In May 2013, severe weather over Dominica resulted in a large number of landslides across the island that destroyed portions of the transport infrastructure across the island. As a result of this damage, two persons lost their lives after driving into a ravine produced after a section of the road they were traveling on had washed away.

Climate represents a slow onset hazard that poses significant risks to the socio-economic development of Caribbean SIDS. Drought is currently viewed as the most significant climate hazard in the Caribbean owing to its impacts on the climate sensitive economies of the region. Since 1990 droughts in the Caribbean have occurred in 1994 to 1995, 1997 to 1998, 2002 to 2003, 2004 to 2005 and 2009 to 2010. These cycles of drought largely coincide with El Niño Southern Oscillation (ENSO) events and the behaviour of the North Atlantic Oscillation (NAO). Much of the socio-economic impacts experienced in the Caribbean owing to drought have been in the areas of agriculture and food security and the availability of water resources. Other less significant impacts due to drought have been experienced in the areas of health, energy and recreational industries among others (Farrell et al., 2010).

The impacts of drought on socio-economic development in the Caribbean are evident in two recent drought events: the 2004 to 2005 and 2009 to 2010 droughts. The ENSO experienced in the Caribbean during 1997 to 1998 wreaked havoc on agricultural production in the Caribbean with the World Food Programme (WFP) and the Food and Agricultural Organization (FAO) in August 1998 agreeing to make US$20.5 million available to Cuba for 615,000 drought-affected people (FAO, 1998). The alteration of drought and torrential rainfall and flooding in the Caribbean during 1997 and 1998 caused major losses in all farm activities and in some cases severe food supply problems. Apart from Cuba, other significantly impacted countries included Haiti, Jamaica, the Dominican Republic and Guyana. The FAO noted that in the Dominican Republic, drought and major storms during the period caused by the ENSO resulted in significant increases in food prices that triggered social upheaval.

While the impacts of the 1997 to 1998 ENSO on agriculture and food production in the Caribbean are often discussed, the ENSO also produced significant flooding and landslides on Caribbean SIDS. Of particular interest is the Matthieu landslide dam and lake that formed overnight on 25 November 25 1997 following a massive landslide that blocked the Matthieu River. The dam and lake persisted until 28 July 2011 when, after an above average start to the wet season, water levels behind the dam rose causing eminent failure (Farrell, 2011). The climate related risks associated with the stability of the Matthieu watershed had largely gone unnoticed. However, following the failure the need for weather and climate early warning systems for the watershed has been recognized and is being addressed. The Matthieu experience highlighted the regions needs for climate early warning and forecasting systems to address the risks posed by geological hazards.

The drought of 2009 to 2010 represented the most significant drought reported in the Caribbean. Rainfall records provided evidence that drying conditions in the southern Caribbean began around April/May 2009 and continued until April 2010. The situation brought into question the region's resilience to drought and in particular raised questions about the lack of adequate national and regional drought early warning systems and the lack of effective national and regional policies governing the response to drought. The record showed that while the onset of drying conditions in the region were reflected in the data collected by the National Meteorological Services in the region, the lack of capacity in many Services to convert climate data into actionable climate information to drive decision-making was lacking. The three month Precipitation Outlook for the region produced by the CIMH predicted the initiation and persistence of drying conditions across the region. Unfortunately, the information conveyed by this product was not acted on in a timely manner. In October 2009, the CIMH alerted the Directors of National Meteorological Services (NMSs) in CMO Member States of its drought concerns. However, significant national action on drought conditions only began in January 2010 with the issuance of warning and alerts well after concerns were raised in climate sensitive sectors. The region's performance in relation to the drought raised further concerns with regards to the region’s resilience to drought as climate change projection models for the Caribbean region suggest the future climate over the region will be conducive to increasingly frequent episodes of long intensive droughts.

Several positives emerged from the 2009 to 2010 drought. The social and economic hardships experienced by the region during the drought attracted the interest of the Caribbean Community (CARICOM) Heads of Government who requested Regional Institutions to prepare a report on the drought event outlining strategies and policies to increase the region's resilience to drought and other climate hazards. The report prepared by the Caribbean Environmental Health Institute (CEHI) and the CIMH is contained in CEHI and CIMH (2010). In January 2010, the CIMH introduced the Caribbean Drought and Precipitation Monitoring Network (CDPMN) under the Caribbean Water Initiative (CARIWIN). The tool, which is based on the Standardized Precipitation Index (SPI), proved useful for forecasting the intensity and end point of the drought and remains an effective tool for producing climate forecasts for the region. On the heels of this initiative, the CIMH also piloted the introduction of the National Water Monitors which were demonstrated on Barbados.

The aftermath of the drought also saw the re-emergence of the Caribbean Climate Outlook Forum (CariCOF) in 2011 after going dormant in the late 1990s due to waning interest among regional and international stakeholders. Since its re-emergence, the CariCOF process has been well supported by national, regional and international stakeholders and has delivered training and climate forecasts to climate sensitive sectors in the Caribbean. While CariCOF is proving its value to the region, the initiative is only able to support one forum per year and that is at the start of the wet season. It is the desire of the organizers of

the CariCOF to host a COF immediately before the start of the dry season given the region's susceptibility to long and intense dry periods.

Since the 2009 to 2010 drought, the region has developed a model drought policy under a Brazil/CARICOM/Caribbean Disaster and Emergency Management Agency (CDEMA) initiative that has been approved in Saint Lucia and is currently awaiting approval in Jamaica and Grenada. This policy is to be promoted in other countries in the region. In addition, the region has devoted considerable resources under the Caribbean Agro-Meteorological Initiative (CAMI) to improve farm management, agriculture productivity and food security in the region through the production and provision of more targeted agro-meteorological information (including climate warnings) to farmers. The CAMI project also produced a policy brief entitled *"Tapping into the Potential of Weather and Climate Services: A New Asset for Caribbean Food Security"* that outlines key issues and recommendations to transform agriculture in the region. The policy brief will in part guide the CIMH's interventions in agriculture and food security under the Global Framework for Climate Services (GFCS).

Other planned efforts to support weather and climate early warning systems in the Caribbean include investments in climate early warning systems and capacity building by the Global Climate Change Alliance (GCCA), the Reducing Risk to Human and Natural Assets Resulting from Climate Change (RRACC) project and the Strategic Programme for Climate Resilience (SPCR). Section 3 provides more information on these projects in addition to other projects, initiatives and programmes. The integration of these new efforts with existing and past initiatives will provide a level of sustainability for climate early warning systems in the Caribbean.

Risk Insurance

Risk transfer mechanisms are increasingly being used to support adaptation to severe weather, climate change and climate variability. The development of risk transfer mechanisms in the Caribbean to allow countries to adapt to the severe losses associated with extreme hazards commenced following the severe impacts of Hurricane Ivan on Grenada in 2004. With the support of the World Bank and the Government of Japan, the region established the Caribbean Catastrophe Risk Insurance Facility (CCRIF) to provide financial liquidity to qualifying member states immediately following significant losses from defined hazards that currently include high winds associated with hurricanes and earthquakes. In 2013, the CCRIF introduced an excess rainfall product to address the growing losses associated with extreme rainfall events.

The establishment of risk transfer mechanisms has been generally seen as a positive step for the future. However, developing the individual insurance policies for countries is highly dependent on the availability of credible historical data to define the return period of the hazard events and the availability of historical damage and loss data for hazards to support the development of vulnerability curves that match damage and loss with the specified return periods. Unfortunately, such data are currently sparse in the Caribbean although they are ongoing efforts to improve this situation through concerted efforts to now collect and track such information after events. Increased capacity is required to develop more robust and new approaches to support development and evaluation of the underlying methodologies used to construct risk transfer mechanisms.

SECTION 2

Research and development gap analysis

The World Meteorological Organization (WMO) with support from regional and national stakeholders in the Caribbean conducted a comprehensive assessment of the institutional and technical needs of the Caribbean region to support multi-hazard early warning systems and risk assessment during the period 2010 to 2011. Outcomes of the assessment are presented in WMO (2012). The document provides information including, but not limited to, (i) mapping of institutions in the region involved in risk assessment and early warning systems, (ii) a selection of national and regional projects and initiatives relevant to risk assessment and early warning systems and (iii) collation of gaps, needs and recommendations that emerged from the regional consultation process. Section 2 reinforces and builds on the gaps and initiatives documented in WMO (2012).

Weather and climate related hazards

The Caribbean region is exposed to a number of natural hazards which generate significant economic loses annually. The main hazards which contribute to a reduction in GDP are due to weather, climate and hydrological events. These include severe weather (cyclonic and non-cyclonic), climate variability (rainfall and temperature extremes), flooding (pluvial, fluvial and coastal) and landslides. There have been numerous projects and programmes aimed at risk reduction both at national and regional scales that have been implemented in recent years with varying levels of success. In addition, significant risk reduction interventions are currently being executed and implemented by national and regional actors. Several of these initiatives have been highlighted in Section 3.

Tables 1 to 4 map the current state of risk assessment and early warning system activities in the Caribbean region against the ideal state and thus highlights critical needs and gaps that need to be addressed as part of future plans. A comprehensive gap identification and analysis requires the visualization of the linkages between components of various interventions. Currently, this is being addressed through the implementation of the Caribbean DEWETRA platform under the Enhancing Resilience to Reduce Vulnerability in the Caribbean (ERC) project.

Current state	Future plans
• Mostly qualitative forecasts provided by the meteorological services • Impacts forecasting is not widely practiced • Numerical weather prediction outputs available for the Caribbean but not utilized ubiquitously • Weather radar outputs available for the Caribbean but capacity building is required to take full advantage of their operational capability • Inefficient communication between meteorological service, hydrological service and disaster management office • Inefficient dissemination of information to the public • Human and technical capacity challenges at meteorological service, hydrological service and disaster management office • Resource constraints regarding future numerical weather prediction model development • Drought monitoring and climate outlook products available • Limited dissemination of regional drought monitor information • Limited dissemination of regional climate outlooks • Unavailability of historical observed climate data at national scale • Inadequate station locations for weather and climate monitoring • Coarse resolution of modelled climate data at regional and national scales • Challenges with the quantification of drought/climate risk • Limited institutionalization of warning protocols and procedures	• Improved computational resources to increase Numerical Weather Prediction (NWP) forecast lead times • Incorporation of the use of numerical weather prediction , satellites and weather radars into standard operating procedure • Operational sustainability of weather radars • Operational sustainability of numerical weather prediction models • Efficient early warning systems • Improved communication of risk across stakeholders • Legislative frameworks which incorporate risk assessments and early warning protocols pertaining to severe weather • Conversion for meteorological services to climate services • Improvements in the collection and collation of loss and damage information • Development of vulnerability curves • Weather related frequency analysis and mapping • Weather related risk analysis and mapping • Further improvements to weather monitoring networks and archiving capabilities • Development of national climate products • Weather related frequency analysis and mapping • Weather related risk analysis and mapping • Legislative frameworks which incorporate risk assessments and early warning protocols

Table 1 Severe weather

Current state	Future plans
• Drought monitoring and climate outlook products available • Limited dissemination of regional drought monitor information • Limited dissemination of regional climate outlooks • Unavailability of historic observed climate data at national scale • Inadequate station densities for weather and climate monitoring • Coarse resolution of modelled climate data at regional and national scales • Challenges with the quantification of drought/climate risk • Limited institutionalization of warning protocols and procedures	• Further promotion of the Caribbean Drought and Precipitation Monitoring network • Further sensitization of drought/precipitation monitoring tools across critical sectors • Further improvements to climate monitoring networks and archiving capabilities • Regional and local downscaling of climate information • Development of national climate products • Climate related frequency analysis and mapping • Climate related risk analysis and mapping • Legislative frameworks which incorporate risk assessments and early warning protocols

Table 2 Climate

Current state	Future plans
• Unavailability of observed hydrological data at national scale • Low quality digital topographic and bathymetric data • Inadequate station densities (rainfall and water levels) • Inadequate hydrological monitoring programmes • Limited institutional capacity to maintain hydrological networks • Resource constraints regarding the development of hydrological models • Inefficient documentation of significant historic flooding events • Flood early warning systems have been installed in pilot areas • Short lead times for flood forecasts • Inefficient dissemination of information to the public • Inadequate flood frequency maps • Challenges with the quantification of flood risk • Limited institutionalization of warning protocols and procedures	• Improved hydrological and physiographic data availability • Rescued and digitized hydrological data • Optimized hydrological monitoring networks • Sustained national hydrological monitoring programmes • Professional development and built capacity • Robust hazard and risk analyses at national and community scales • Improvements to flood forecasting models • Sustainable comprehensive early warning systems • Improved dissemination of information to the public • Robust flood frequency analysis and mapping • Robust flood risk analysis and mapping • Legislative frameworks which incorporate risk assessments and early warning protocols

Table 3 Floods

Current state	Future plans
• Inadequate rainfall station densities • Absence of soil moisture monitoring • Limited monitoring of soil properties • Limited information on soil properties and geology • Landslide early warning systems are not typically available • Inefficient dissemination of information to the public • Challenges with the quantification of landslide risk • Limited institutionalization of warning protocols and procedures	• Establishment of rainfall monitoring networks for landslide monitoring • Use of remote sensing for landslide mapping • Use of satellite derived rainfall estimates to support the establishment of rainfall triggers • Incorporation of NWP information, weather radar data and rainfall observations to support early warning • Improvements is available data on watershed hydrologic properties • Established rainfall threshold at critical sites • Landslide hazard and risk mapping

Table 4 Landslides

SECTION 3

Current projects, initiatives and programmes

Table 5 provides a comprehensive list of recently completed and ongoing regional projects, programmes and initiatives that support weather and climate risk assessments and early warning. These projects seek to address some of the gaps previously identified. However, they do not provide information on nationally executed interventions.

Real-Time Flood Forecasting Project

Description:
The Real-time Flood Forecasting (RTFF) project proposes to develop a robust, reproducible, and transparent approach to flood forecasting that couples a semi-distributed hydrological model capable of capturing changes in watershed characteristics to a numerical weather prediction model. The project has been funded through the Japan-CARICOM Friendship and Cooperation Fund with the CARICOM Secretariat as the executing agency and the CIMH as the implementing agency.

Objective:
Improved flood forecasting for the Caribbean by increasing lead times for decision makers

Related outputs:
Real time flood forecasting tool for decision-makers in the Caribbean involved in flood management and disaster preparedness in support of flood early warning

Status:
Ongoing

Resources:
http://www.cimh.edu.bb/?p=projects
http://63.175.159.26/~rffp

Enhancing Resilience to Reduce Vulnerability in the Caribbean Project

Description:
The "Enhancing Resilience to Reduce Vulnerability in the Caribbean" (ERC) Project being implemented by the Caribbean Institute for Meteorology and Hydrology (CIMH) in partnership with the Executing Agency, the United Nations Development Programme (UNDP) Barbados and the OECS, focuses on enhancing regional and national capacities for disaster risk reduction

Objective:
To strengthen national and regional disaster risk reduction mechanisms associated with natural, environmental and technological hazards, within the broader context of hydrometeorology and climate change; and for effective disaster recovery through capacity building for early warning systems and institutional collaboration for disaster management and response.

Related outputs:
Sustainable network for real time decision support centers to facilitate early warning and post disaster recovery established and fully integrated into national and regional planning.

Support to enhancing regional tsunami public awareness programme in support of the early warning systems through the establishment of the Caribbean Tsunami Information Centre (CTIC).

Status:
Ongoing

Resources:
http://63.175.159.26/erc/home/

Caribbean Satellite Disaster Pilot Project

Description:
The Caribbean Satellite Disaster Pilot (CSDP) project is being led by the NASA Goddard Spaceflight Center/SGT. It was developed in the context of GEO Task DI-06-09 which addresses the use of satellites for risk management through all phases of the disaster cycle at a regional level.

Objective:
The demonstration of the effectiveness of satellite imagery to strengthen regional, national and community level capacity for mitigation, management and coordinated response to natural hazards

Identification of specific satellite-based products that can be used for disaster mitigation and response on regional and national levels.

Related outputs:
Phase 1 - Sensor Web satellite-based flood Prediction and warning – Caribbean-wide
Phase 5 - Integration of satellite data into local operational flood warning and response systems

Status:
Ongoing

Resources:
http://portal.gdacs.org/tabid/250/Default.aspx?FItemID=227%26ModID=880&ei=AfKgUt-EPIf1kQeZ44CoBw&usg=AFQjCNEp4iPGvxehkC6xcMHEFevgB0B4bg

Regional Risk Reduction Initiative

Description:
The Regional Risk Reduction Initiative (R3i) sought to address the risk and exposure of 11 English and Dutch overseas countries and territories in the Caribbean region by providing a network of regional infrastructure, programmes, policies and protocols to strengthen the capacity to predict and prepare for natural hazards, thus improving resilience and reducing risk and subsequent loss.

Objective:
Increased capacity in hazard mapping and associated vulnerability assessments to further incorporate into spatial information systems to inform planning and development processes.

Related outputs:
Increased capacity for hazard mapping and vulnerability assessments in OCTs

Improvement to alerting systems for early warning through the implementation of the Common Alerting Protocol (CAP)

Status:
Completed 2012

Resources:
http://www.undp.org/content/barbados/en/home/operations/projects/crisis_prevention_and_recovery/R3i/

Caribbean Disaster Management Phase II

Description:
The Caribbean Disaster Management Project Phase II (CADM II) was jointly implemented under the CARICOM/Japan Technical Cooperation Agreement by the CIMH, the CDEMA and IDEA Consultants, Inc with financial support from the Japan International Cooperation Agency (JICA).

Objective:
To mitigate disaster damages in CDEMA Participating States through the enhancement of community resilience to flood hazard.

Related Outputs:
The commissioning of Early Warning Systems for flood hazards at five pilot locations

The development of community-based indicative flood hazard maps

Status:
Completed

Resources:
http://www.cdema.org/publications/CADMPhase2Flyer.pdf

Caribbean Drought and Precipitation Monitoring Network

Description:
The Caribbean Drought and Precipitation Monitoring Network was launched in January 2009 under the Caribbean Water Initiative (CARIWIN). The concept was born out of the need to mitigate and respond to the creeping phenomenon, drought. This is facilitated through the production and dissemination of SPI and Decile drought indices.

Objective:
Improved monitoring of the occurrence of drought and above average rainfall

Related outputs:
Standardized Precipitation Index (SPI) and Decile maps at regional and local scales
Short term and seasonal precipitation forecasts

Status:
Ongoing

Resources:
http://63.175.159.26/~cdpmn/cdpmn.html

Caribbean Regional Climate Outlook Forum

Description:
Regional Climate Outlook Forums (RCOFs) are viewed as critical building blocks in the Global Framework for Climate Services (GFCS) of the World Meteorological Organization (WMO). The GFCS seeks to extend RCOFs to all vulnerable regions of the world such as the Caribbean, of which the entire population is exposed to water- and heat-related natural hazards. The Caribbean RCOF is being supported by the Regional Climate Centre located at the CIMH.

Objective:
Identify of gaps in information and technical capability
Facilitate research cooperation and data exchange within and between regions
Improve coordination within the climate forecasting community
Delivery of user defined climate services

Related outputs:
3, 6 and 12 month climate outlooks in support of slow onset events

Resources:
http://63.175.159.26/~crcof/

Caribbean Agrometeorological Initiative

Background:
The Caribbean Institute for Meteorology and Hydrology (CIMH) in partnership with the Caribbean

Agricultural Research and Development Institute (CARDI) World Meteorological Organization (WMO) and National Meteorological and Hydrological Services (NMHSs) of ten Caribbean member States have received a grant from the European Union through the African Caribbean and Pacific Group of States (ACP) Science and Technology (S&T) Programme for the Caribbean Agrometeorological Initiative (CAMI).

Objective:
Increase and sustain agricultural productivity at the farm level in the Caribbean region through improved dissemination and application of weather and climate information using an integrated and coordinated approach.

Related outputs:
Provision of information through the regional network of Meteorological and Agricultural Services and research institutes on predictors of the rainy season potential and development of effective pest and disease forecasting systems for improved on-farm management decisions

Status:
Ongoing

Resources:
http://63.175.159.26/~cimh/cami/

Global Climate Change Alliance

Description:
The Global Climate Change Alliance (GCCA) seeks to strengthen dialogue and cooperation on climate change between the European Union (EU) and developing countries most vulnerable to climate change, in particular Least Developed Countries (LDCs) and Small Island Developing States (SIDS), which are hardest hit by the adverse effects of climate change.

Objective:
The GCCA provides technical and financial support to targeted developing countries to integrate climate change into their development policies and budgets and to implement adaptation and mitigation interventions

Related outputs:
Improved capacity for disaster risk reduction by the integration of disaster risk reduction and climate change adaptation strategies into development agendas

Status:
Ongoing

Resources:
http://www.gcca.eu/national-programmes/caribbean/gcca-jamaica

Higher Education for Development - Caribbean Region Climate Adaptation

Description:
The Caribbean Region Climate Adaptation (CRCA) initiative is a higher education collaboration which is focused on building capacity to manage water resources and climate risks in the Caribbean.

Objective:
To improve the knowledge and skills of the University of the West Indies (UWI) Centre for Resource Management and Environmental Studies (CERMES) and the CIMH to manage water resources and climate related risks.

Related outputs:
Increased capacity at CIMH and CERMES

Status:
Ongoing

Resources:
https://researchfunding.duke.edu/detail.asp?OppID=11680

Reducing the Risk to Human and Natural Assets Resulting from Climate Change

Description:
The ultimate goal of the Reducing the Risk to Human and Natural Assets Resulting from Climate Change (RRACC) initiative is the establishment of a permanent, relevant marine monitoring and forecasting system that allows decision makers and other stakeholders to address climate change impacts and contributes to the sustainable development goals of OECS Member States. This initiative is being funded under the climate change programme of the USAID.

Objective:
To assist Barbados and the OECS countries in their efforts to adapt to the impact of climate change. Focus will be on adaptation measures in the areas of coastal/marine zone management and freshwater.

Related outputs:
Improved monitoring network in Barbados and the OECS

Status:
Ongoing

Resources:
http://www.oecs.org/our-work/projects/rracc

Caribbean Climate Online Risk Adaptation tool

Description:
The Caribbean Climate Online Risk and Adaptation tooL (CCORAL) was designed to engender a risk management ethic in decision making. It takes a pragmatic approach, promoting the right tools and techniques to fit the context of Caribbean decision making, available time and resources and uncertainty about climate variability and change.

Objective:
To improve climate related decision making

Identification of actions that minimize climate related loss, take advantage of opportunities and build climate resilient development in their countries.

Related outputs:
CCORAL Toolbox - Online support tool for climate resilient decision making

Status:
Completed

Resources:
http://ccoral.caribbeanclimate.bz/about/

CaribRiskCluster

Description:
The countries of the Caribbean all confronted with the same natural risks. The prevention and management of these risks is an absolute requirement for both the safeguarding of human lives and the protection of the economic and social development. The CaribRiskCluster intends to end the current regional partitioning, and integrate Martinique in the Caribbean disaster management dynamic.

Objective:
To strengthen a concerted and coordinated regional approach by sharing expert skills, and warning

and natural risks prevention resources, in the Caribbean area

Related outputs:
Implementation of Météo-France "SHERPA" initiative. SHERPA is a secured WEB platform (Extranet) to share and make available products and information useful to the analysis, and to the forecasting of potentially dangerous meteorological phenomena in the Caribbean.

Resources:
http://www.caribriskcluster.net/

Caribbean Weather Information Generator

Description:
The project is funded by the Climate and Development Knowledge Network (CDKN) and work will be carried out in partnership with the Caribbean Community Climate Change Centre (Belize), University of East Anglia (UK), University of the West Indies (Jamaica) and the Institute of Meteorology (Cuba). Managers and policy makers in the Caribbean require knowledge of the likely impacts and hazards arising from climate change that are specific to their geographical location and that are relevant to their planning time-horizons (e.g. the short term, 2030s, or the longer term, 2080s). However, current climate model projections of the weather are of limited use in this respect due to scale and bias issues. Sophisticated downscaling providing locally relevant unbiased climate change information remains sporadic. Clear guidance for managers and policy makers for the utilization of such information is also limited.

Objective:
To provide locally relevant information on the weather impacts of climate change for a range of time horizons

Training for stakeholder technical staff in the use of such weather information

The development of support networks within the region and development of partnerships with UK research institutes specializing in the management of a range of hazards and impacts.

Related outputs:
A web service for the adaptation and provision of leading weather-generator models from the EARWIG and the UKCIP09 climate knowledge systems to provide locally relevant weather projections based on the best available observed data and climate model outputs for the region.

Status:
Ongoing

Resources:
http://www.cariwig.org/

Strengthening Disaster Risk Management in the Rural Sector of the CARICOM States

Description:
Leaders of the Caribbean Community (CARICOM) met in Brazil on April 26, 2010 for the first ever CARICOM-Brazil Summit. The aim of the Brazil Summit was to foster a closer collaboration and cooperation between Brazil and CARICOM. The Summit agreed on cooperation between Brazil and CARICOM in a number of areas, including Disaster Management and Civil Defence. This led to the Government of Brazil funding the initiative "Latin America and the Caribbean against Hunger 2025"

Objectives:
Strengthen humanitarian assistance initiatives

Foster best practices for the reduction of risks related to disasters

Mitigate and respond to social, man-made and natural disasters

Assist with reconstruction efforts in CARICOM Member States.

Related outputs:
Development and piloting of drought monitoring and management programme

Developing and piloting of a micro-insurance initiative in Haiti and one other CARICOM state confronted with disaster risks

Technical exchanges of tools and expertise related to disaster risk reduction in the rural sector

Status:
Ongoing

Resources:
http://www.cdema.org/publications/CARICOM_Brazil_FAO_Cooperation_on_DRR_Project_Brief.pdf

Caribbean Risk Management Project

Description:
The Caribbean Risk Management Project builds on previous work started in the Caribbean regarding the development of Risk Management Guidelines for decision makers, but is intended to be more attuned to the needs and special circumstances of the Caribbean region given the prevailing conditions. It will also incorporate the development of new tools and risk management methodologies.

Objective:
To embed risk assessment into decision-making and management systems across the region in finance and planning.

Related outputs:
Revised risk management framework for the Caribbean taking into account the latest developments in climate risk management techniques

Status:
Ongoing

Resources:
http://www.caribbeanclimate.bz/ongoing-projects/2012-2013-caribbean-risk-management-project.html

Caribbean Disaster Risk Management Programme

Description:
The project is in the form of a responsive fund which supports initiatives led by organizations such as the Caribbean Disaster Emergency Management Agency (CDEMA) that improve coordination and disaster preparedness at local, national, and regional levels and that encourage the integration of disaster risk management into policies, planning, and decision-making in the public and private sectors.

Objective:
Increase the capacity of regional organizations, national governments and local communities in the Caribbean to respond to and manage natural disasters such as hurricanes and floods and to reduce their impact on the people of the region.

Related outputs:
Significant institutional strengthening of the Caribbean Disaster Emergency Management Agency (CDEMA) Co-ordinating Unit and upgrading of the National Disaster Operations Center

Model framework for community vulnerability assessment produced and tested

Tangible reduction in exposure to disaster risk in eleven participating communities in response to locally identified needs

Status:
Ongoing

Resources:
http://www.acdi-cida.gc.ca/cidaweb/cpo.nsf/vWebProjSearchEn/257BA550E43E2BEC85257C2A003B8533

Database Management System

Description:
The Database Management System for Regional Integrated Observing Network for Environmental Change in the Wider Caribbean (DMS) project is being executed by the Caribbean Community Climate Change Centre (CCCCC) with the financial support of the Inter-American Development Bank (IDB). The goal of the project is to build regional capacity to respond to the challenges and adverse impact of climate change in the Caribbean.

Objective:
To develop a regional operational Database Management System to facilitate the open access to data products useful for observing environmental change in the wider Caribbean, in support of a regional observing network.

Related outputs:
Improved access to data, data products and decision support tools for addressing climate and other environment changes at the regional and national level

Increased regional and national level institutional capacity for knowledge based decision making and for mainstreaming climate information into this process

A framework for the establishment and operational implementation of an integrated regional observation network for monitoring environmental change in the Caribbean.

Status:
Ongoing

Resources:
http://www.caribbeanclimate.bz/ongoing-projects/idb-data-management-system-dms.html

Caribbean Catastrophe Risk Insurance Facility

Description:
The Caribbean Catastrophe Risk Insurance Facility (CCRIF) is a risk pooling facility, owned, operated and registered in the Caribbean for Caribbean governments. It is designed to limit the financial impact of catastrophic hurricanes and earthquakes to Caribbean governments by quickly providing short term liquidity when a policy is triggered.

Objective:
To provide a risk transfer mechanism that quickly provides short term liquidity when a policy is triggered.

Related outputs:

Hurricane coverage (wind)
Excess rainfall coverage

Status:
Ongoing

Resources:
http://www.ccrif.org/

Strategic Programme for Climate Resilience

Description:
The Pilot Programme for Climate Resilience (PPCR) under the Strategic Programme for Climate Resilience (SPCR) is being funding by the Inter-American Development Bank and the World Bank Group and implemented by the Caribbean Community Climate Change Centre (CCCCC). The PPCR is being executed through regional and national programmes and is intended to pilot and demonstrate approaches for the inclusion of climate risk and resilience into development policies and planning and to scale up and leverage current climate resilience investment especially through ongoing initiatives. The programme seeks to address the key challenges related to the regional vulnerability to climate change including but not limited to gaps in regional climate monitoring systems, unclear protocols for the exchange of climate relevant data among agencies and the need for downscaling of global climate models for applicability in the Caribbean region in support of planning and decision making.

Objective:
To address data availability and analysis, data storage and exchange, climate monitoring, climate change and climate impact modelling and the improvement of climate adaptation challenges.

Related outputs:
Improved geospatial data and management for climate change adaptation planning

Downscaling and expanding climate projection models and high resolution maps

Status:
Ongoing

Resources:
http://www.caribbeanclimate.bz/ongoing-projects/2009-ppcr-caribbean.html

Strengthening Hydrometeorological Operations and Services in the Central America and the Caribbean

Description:
The Ministry for Foreign Affairs of Finland (MFA) provided 500,000 Euros to carry out a needs assessment and feasibility study project entitled *"Strengthening Hydrometeorological Operations and Services in the Central America and the Caribbean (SHOCS)"*. The Project was implemented by the Finnish Meteorological Institute (FMI) under the direction of the *Association of Caribbean States* (ACS), in collaboration with WMO and CMO. Before the end of Phase I and continuing through much of 2013, a Phase II was formulated between the MFA of Finland, FMI and the other members of the Project Board.

Objective:
Enhance the role and strengthen the capacity of National Meteorological and Hydrological Institutions and Disaster Management Agencies in ACS Member States in the provision of early warning services and preparedness to mitigate impacts of natural hazards.

Related outputs:
Improved operational capacity of the Caribbean SIDS weather observation network

Improved capacity for communication of risk information and early warnings

Status:
Ongoing

Resources:
http://www.cmo.org.tt/

CARIBSAVE Climate Change Risk Atlas

Description:

Climate change is a serious and substantial threat to the economies of Caribbean nations, the livelihoods of communities and the environments and infrastructure across the region. The CARIBSAVE Climate Change Risk Atlas (CCCRA) Phase I, funded by UKaid from the Department for International Development and the Australian Agency for International Development (AusAID), was conducted from 2009 – 2011. The CCCRA successfully used evidence-based, inter-sectoral approaches to examine climate change risks, vulnerabilities and adaptive capacities and develop pragmatic response strategies to reduce vulnerability and enhance resilience in 15 countries across the Caribbean (Anguilla, Antigua & Barbuda, The Bahamas, Barbados, Belize, Dominica, The Dominican Republic, Grenada, Jamaica, Nevis, Saint Lucia, St. Kitts, St. Vincent & the Grenadines, Suriname and the Turks & Caicos Islands).

Objective:
The CCCRA provides robust and meaningful new work in the key sectors and focal areas of: Community Livelihoods, Gender, Poverty and Development; Agriculture and Food security; Energy; Water Quality and Availability; Sea Level Rise and Storm Surge Impacts on Coastal Infrastructure and Settlements; Comprehensive Disaster Management; Human Health; and Marine and Terrestrial Biodiversity and Fisheries.

Related outputs:
Full climate change risk profiles for 15 countries

Climate Change Risk Profile Summary Documents and Snapshots for 15 countries

Status:
Completed

Resources:
http://www.caribbeanclimate.bz/closed-projects/2009-2011-the-caribsave-climate-change-risk-atlas-cccra.html

Managing Water Resources in Arid and Semi-arid Regions of Latin America and the Caribbean

Description:
The Managing Water Resources n Arid and Semi-arid Regions of Latin America and the Caribbean (MWAR–LAC) project is funded by the Flanders-UNESCO Science Trust Fund (FUST) and is implemented by the UNESCO International Hydrological Programme (IHP) in collaboration with the Water Center for Arid and Semi-Arid Zones in Latin America and the Caribbean (CAZALAC) located in la Serena, Chile, which belongs to the network of Category II centers under the auspices of UNESCO.

Objectives:
Improved water governance as a basis to attain integrated water resources management

Use of modern techniques and methodologies to asses and improve water use efficiency

Hydro-climatic risk management including decision making

Related outputs:
Regional drought portal

Caribbean drought atlas

Status:
Ongoing

Resources:
http://www.cazalac.org/mwar_lac/index.php?id=3

Caribbean Disaster Risk Atlas

Description:

The Caribbean region is highly vulnerable to occurrence of natural hazards such as hurricane, flooding and earthquakes. Impacts can result in the loss of life and livelihoods in addition to crippling socio-economic development. In order to improve on the current risk management practices the Caribbean Disaster Risk Atlas Project was designed to build capacity in the Region to analyse disaster risk in terms of potential losses and to enable the development of comprehensive risk management strategies.

Objective:
To provide an interactive disaster risk atlas for flooding and seismic hazards

Related outputs:
High resolution risk maps that provide spatial data on the risk from floods and earthquakes in selected areas of the Caribbean

Platform to disseminate information pertaining to risk to assist with creating regional capacity for risk analysis, mainstreaming disaster risk into policy development and decision-making.

Status:
Not clear

Resources:
http://myspot.mona.uwi.edu/marcom/uwinotebook/entry/4670#.Uqg-aaLD_IA

Table 5 Projects, initiatives and programmes

SECTION 4

Risk assessment and early warning systems

Regional policies and frameworks

Several Institutions of CARICOM are currently engaged in supporting climate early warnings systems in the Caribbean and for propagating such early warnings to various climate sensitive sectors. These Institutions include the Caribbean Community Climate Change Centre (CCCCC), the Caribbean Meteorological Organization (CMO) and its training, research and development Organ the CIMH and the Caribbean Disaster Emergency Management Agency (CDEMA). Other agencies and Institutions, including the Caribbean Agriculture Research and Development Institute (CARDI), and non-governmental organizations (NGO) are engaged with these core institutions to propagate early warning information into actionable information to risk inform decision-making in weather and climate sensitive sectors to build regional resilience to weather and climate hazards. Effective and sustainable resilience building therefore requires a clear and agreed to objective and strong collaboration between CARICOM, its Institutions, national institutions and agencies and the NGO community to risk rank and prioritize the actions required to achieve the objective. Opportunities for such comprehensive interactions are few and far between often owing to a lack of funding. Despite the lack of funding, collaborations between regional and national institutions and agencies and the NGO community have increased over the last 10 years.

The approach to disaster risk reduction and climate change in CARICOM Member States has been outlined in three key documents and declarations: (i) the Liliendaal Declaration on Climate Change and Development agreed to by the CARICOM Heads of Government; (ii) the Implementation Plan for *the 'Regional Framework for Achieving Development Resilient to Climate Change'* (the Regional Framework) for the period 2011 to 2021 developed by the CCCCC and approved by the CARICOM Heads of Government in 2011; and the Comprehensive Approach to Disaster Management in the Caribbean (CDM) originally proposed by CDEMA in 2001. The fourth approach currently being introduced in the Caribbean is the GFCS. All the policies and frameworks indicate the need for capacity building at all levels and the need for weather and early warning systems across all sectors and at all levels.

CARICOM – Liliendaal Declaration on Climate Change and Development

The CARICOM Heads of Government endorsed the Liliendaal Declaration on Climate Change and Development in 2009 that defines the national and international position of CARICOM Member States on the issue of long-term climate change in the 21st Century noting that a number of declarations made in the document can only be achieved by transformational change. Two key aspects of the Declaration relevant to this report are:

(i) Adaptation and capacity building must be prioritized and a formal and well-financed framework established within and outside the United Nations Framework Convention on Climate Change (UNFCCC) to address the immediate and urgent, as well as long term, adaptation needs of vulnerable countries, particularly Small Island Developing States and the Least Developing Countries.

(ii) The need for financial support to SIDS to enhance their capacities to respond to the challenges brought on by climate change (including increasing climate variability) and to access the technologies that will be required to undertake needed mitigation actions and to adapt to the adverse impacts of climate change.

CCCCC – Regional Framework for Achieving Development Resilient to Climate Change

The CARICOM Heads of Government in 2012 approved the Implementation Plan for the 'Regional Framework for Achieving Development Resilient to Climate Change' (the Regional Framework) for the period 2011 to 2021 that addresses the Region's approach for coping with long-term climate change as outlined in the 2009 Liliendaal Declaration on Climate Change and Development. The Implementation Plan:

(i) Seeks to guide the identification and prioritization of actions by regional and national stakeholders under each strategic element and goal area of the Regional Framework through the use of risk management approaches to decision making
(ii) Considers responsibilities and functional co-operation between regional organizations and national governments
(iii) Recognizes that there are existing significant resource and capacity challenges that hold back the region's sustainable development and growth and processes known as the 'three-ones' to assist in resource mobilization and co-ordination of actions
(iv) Proposes a monitoring and evaluation (M&E) framework

CDEMA – Comprehensive Disaster Management

The CDEMA Comprehensive Approach to Disaster Management (CDM) framework originally introduced in 2001 sought to ensure that CDM principles were integrated into the development process of CDEMA Participating States. The 2001 version of the CDM identified five Intermediate Results that support achieving the objective of the CDM: (i) building stronger regional and national institutions to promote CDM; (ii) strengthening research, education and training to build an adequate base of information and knowledge; (iii) incorporation of CDM into the programmes of major regional institutions and that of their clients; (iv) preparedness, response and mitigation capacity is enhanced and integrated; and (v) incorporating hazard information into development planning and decision making.

The Enhanced CDM Strategy and Framework for the period 2007-2012 expanded the original approach to comprehensive disaster management. In particular, the Enhanced CDM articulated four key outcomes:

1. ***Outcome 1*** – Enhanced institutional support for CDM Programme implementation at the national and regional levels.
   - In particular, the outcome aimed to strengthen CDEMA and national organizations to support CDM implementation and to encourage regional governments and donors to integrate CDM principles into their activities.
2. ***Outcome 2*** – An effective mechanism and programme for management CDM knowledge has been established.
   - This outcome aimed to establish a Disaster Risk Reduction Centre for the region as well as to support mechanisms for fact-based policy and decision making. The outcome also sought to develop a strategy and curriculum for building a culture of safety in addition to strengthening training materials for CDM.

3. ***Outcome 3*** – Disaster risk management has been mainstreamed at national levels and incorporated into key sectors of national economies (including tourism, health, agriculture and nutrition)
    - Achieving this outcome required CDM to be the roadmap for building resilience and for the public and private sectors to take action on disaster risk management. Achieving the outcome also required the disaster risk management to be included in the actions of vulnerable sectors and for hazard information and disaster risk management to be incorporated into sectoral policies, laws and planning.
4. ***Outcome 4*** – Enhanced community resilience in CDEMA states/territories to mitigate and respond to the adverse effects of climate change and disasters.
    - Achieving this objective required preparedness, response and mitigation capacity to be enhanced in all sectors for local level management and response as well as improved coordination between disaster organizations and the research community. Achieving the objective also required early warning systems for disaster risk reduction to be enhanced at the community and national levels and for more detailed products and services to support hazard identification and related vulnerabilities at all scales. It is also required gender considerations to be taken into account for all disasters.

The Enhanced CDM is to be replaced by the Updated CDM which will be effective from 2014 to 2024. The goal of the Updated CDM is to realize “Safer, more resilient and sustainable CDEMA Participating States through Comprehensive Disaster Management”. Seven outcome areas are envisaged:

(i) National, regional and sectoral institutions with adequate/minimum standards of capacity to deliver the CDM program
(ii) Knowledge management which is applied for fact-based decision-making
(iii) Disaster resilience which is enhanced within key sectors of the economy
(iv) Operational readiness at regional, national, sectoral and local levels
(v) A clearly established and understood nexus between climate change adaptation and disaster risk reduction with programming and governance harmonised
(vi) Community resilience which has been enhanced for the most vulnerable with gender concerns addressed at all stages and levels
(vii) Resource allocation which underpins the ability to deliver the strategy

CIMH Global Framework for Climate Services

The GFCS provides the region with additional opportunities to address climate early warning systems in the areas of disaster risk reduction, water resources management, agriculture and food security and health. The GFCS integrates with several of the climate related efforts previously described and provides a mechanism for sustaining many of the climate and weather early warning systems. Much of this will be coordinated and executed by the CIMH which has entered the demonstration phase to host the WMO Regional Climate Centre (RCC) for the Caribbean. As of December 2013, implementation of the GFCS in the Caribbean has begun with a regional level consultation and the commencement of national stakeholder consultations. Such an approach is not only applicable to climate events since it provides the opportunity for the coordinated approach to weather related interventions with a focus on the provision of products and services.

Building resilience

Risk assessments

Considerable gaps with respect to data collection exist especially considering the information that is required for a robust risk assessment. The quantification of risk usually requires (i) the determination of exceedance probabilities related to the hazard and (ii) data on social and economic losses to support vulnerability assessments across sectors. The determination of exceedance probabilities requires consistent historic data specific to the hazard being analysed. For example, it is suggested that the observation years should be twice the value of the return period being estimated for robust frequency analysis. Such criteria would limit the suitability of some data sets for the estimation of large return periods. Regional frequency analysis provides an attractive option for the estimation of large return periods. The methodology allows for the merging of data from homogeneous regions in order to lengthen data series. This approach has already started through the MWAR-LAC project where regional frequency analysis is being used to generate drought frequency maps for Caribbean countries and may have to be applied to other data sets in order to improve the quality of data available.

Vulnerability data are limited. Collection and collation of sector and hazard specific losses are not routine. Further, information on property values and population census data tend not to be easily accessible in a user-friendly format. Thus the development of vulnerability curves remains challenging especially for weather and climate related hazards. In 2012, the Institute for Sustainable Development, University of the West Indies, Mona Campus launched the Caribbean Risk Atlas Project. The objective of the project was to build capacity in the Region by analysing disaster risks in terms of potential losses related to flooding and earthquakes for three pilot locations. It remains unclear whether any significant outputs apart from those produced for earthquake related risks have been generated to date. However, the approach should be one to be improved and replicated especially for the development of national risk profiles associated with weather and climate related hazards.

Early warning systems

It is evident that there are a number of regional projects and initiatives that support early warning for weather and climate related hazards. As indicated earlier, the information provided in Section 3 does not consider national level interventions which in some cases contribute significantly to risk reduction. An example of this is the flood early warning system that has been installed in the Rio Cobre watershed located in Jamaica. This system comprises of a number of strategically placed rain gauges and water level recorders which send data via telemetry to the Water Resources Authority (WRA). The information is used to support the decision to close the Bog Walk Gorge thus preventing public access. Water levels in the Bog Walk Gorge crest very quickly. This has led to loss of life and property on occasion. Therefore, the system was designed to mitigate future loses.

Similar systems have been designed throughout the Caribbean through various projects and initiatives. However, their effectiveness is limited due to the size, shape and topography associated with the watersheds primarily of the volcanic islands of the eastern Caribbean. Relying on warnings from hydrometric networks does not allow decision makers with significant lead time in most cases. A more comprehensive approach would be to integrate the use of numerical weather prediction models (NWPs) and the outputs from weather radars with early warning systems. The CIMH produces 48 hour forecast four times daily with a 4 km domain resolution covering the Caribbean using the Weather Research and Forecasting (WRF) model developed by National Center for Atmospheric Research (NCAR) and is currently working on using the rainfall forecast data to produce hydrological forecast through the RTFF project. The CMO Headquarters Unit was instrumental in the procurement and installation of weather radars in Guyana, Trinidad, Barbados, Belize and Grand

Cayman. These along with the existing weather radars in French Guyana, Martinique and Guadeloupe provide comprehensive coverage over the Caribbean. The development of nowcasting capabilities would complement the early warning information generated from models and hydrometric networks towards a comprehensive flood early warning strategy for the islands of the Caribbean.

Regional drought monitoring and outlook products have been made available through the Caribbean Drought and Precipitation Monitoring Network. Attempts to generate similar information through the development of national water monitors have proven unsuccessful due to the unavailability of suitable data for the analysis. As such early warning information is largely available at the regional scale. However, more useful information can be generated should continuous data be available nationally.

Multi-Hazard Early Warning Systems (MHEWS) and DEWETRA

The concept of Multi-Hazard Early Warning Systems (MHEWS) has been discussed in the region through various consultations. MHEWS allow for the coordination of warning protocols, information dissemination and response mechanisms regardless of the nature of the hazard. Therefore, it allows for standardization of early warning applications across all sectors. WMO (2012) identified the need for strengthening of national and regional institutional capacities and cooperation among national emergency management offices (NEMOs), national hydro-meteorological services (NHMSs) and other disaster management stakeholders particularly with respect to a multi-hazard and a multi-sectoral approach to risk assessment and early warning. This challenge is partly being addressed through the establishment of the Caribbean DEWETRA platform. The Caribbean DEWETRA platform is a real-time, web-based, data fusion platform that supports disaster management activities through the integration of dynamic observed and forecasted hazard data and static exposure data while providing tools for scenario building, impact assessments, crowd sourcing and alert dissemination in support of decision-making. The platform has been developed through the ERC project which primarily focused on the integration of hydro-meteorological data. However, the platform can be used to simultaneously manage data from multiple hazards provided including slow onset events. As highlighted earlier, the CIMH has begun producing climate monitoring and outlook products that support early warning for slow onset hazards such as drought. Some of these products are currently being disseminated through the Caribbean DEWETRA platform.

The platform also provides a facility for continuous monitoring during rescue and recovery operations. For example, an operational version of the platform was rapidly developed in Italy and deployed within two days for use during the rescue and recovery efforts following the passage of Typhoon Haiyan across the Philippines. It was used by the international community to support damage and risk assessments, asset deployment and continuous monitoring of weather conditions. The Caribbean DEWETRA platform has the potential to be used in a similar capacity in the future.

Mainstreaming of the use of this platform for the management of weather and climate data has begun. The platform has the capacity to be expanded for inclusion of multiple hazards in support of MHEWS development. Fusing weather and climate data among others supports the further identification of gaps and needs for targeted future sustainable investment. Continued investment in the Caribbean DEWETRA platform will allow for the platform to be sustained and mainstreamed in addition to improving the culture of data management for decision-making in the region.

Data collection and management strategies

Data availability has limited the impact of past risk assessments and early warning interventions in the Caribbean. It is likely that this problem will persist in the future if a comprehensive approach is not taken regarding the collection and management of data in the region. Boyce (2011) provided a comprehensive data collection and management strategy for the Commonwealth of Dominica. This report was facilitated through the Global Environmental Facility Special Programme for Adaptation to Climate Change (GEF SPACC) initiative executed by the CCCCC.

The strategy outlined the components for an effective data monitoring, collection and management plan including, but not limited to, (i) network design, (ii) station locations, (iii) site selection and maintenance, (iv) data processing and (v) database management. Strategies such as those proposed for the Commonwealth of Dominica should be expanded for regional application in order to provide a path forward for sustainable data collection. However, the strategy would have to migrate to policy to assure its effectiveness at the national level. Designated agencies should be mandated to include data management activities into their standard operating procedures in order to ensure sustainable management of data in the region. Sustained collection would enhance and further inform weather and climate related risk assessments and early warning procedures. Further investments in hydro-meteorological networks are required.

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