

**Strengthening of Risk Assessment and
Multi-hazard Early Warning Systems for
Meteorological, Hydrological and Climate
Hazards in the Caribbean**



**World
Meteorological
Organization**

Weather • Climate • Water

WMO-No. 1082

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This Report has been prepared within the framework of the WMO Disaster Risk Reduction Programme (DRR Programme), engaging a number of WMO Technical Programmes² and the WMO regional office for RA IV, based in Costa Rica.

¹ Antigua and Barbuda, Aruba, the British Caribbean Territories of Anguilla and the Cayman Islands, the Bahamas, Belize, Canada, Cuba, Curaçao and Sint Maarten, the Dominican Republic, Finland, France, Grenada, Guyana, Jamaica, Saint Kitts and Nevis, Saint Lucia, Suriname, Trinidad and Tobago, and the United States.

² Under the coordination of the WMO DRR Programme, the following WMO Technical Programmes contributed to this work:

- (a) The World Weather Watch (WWW) Programme, including the WMO Integrated Global Observing System (WIGOS), the Global Telecommunication System-WMO Information System (GTS-WIS), and the Global Data-processing and Forecasting System (GDPFS);
- (b) The World Climate Programme (WCP), including the World Climate Data and Monitoring Programme (WCDMP) and the World Climate Applications and Services Programme (WCASP);
- (c) The Applications of Meteorology Programme (AMP), including the Public Weather Services Programme (PWSP), the Marine Meteorology and Oceanography Programme (MMOP), the Agricultural Meteorology Programme (AgMP), the Quality Management Framework (QMF), and the Tropical Cyclone Programme (TCP);
- (d) The Education and Training Programme (ETRP), the Technical Cooperation Programme (TCOP), and WMO VCP.

EXECUTIVE SUMMARY

An overview of the Caribbean region

When viewed as an entity, the Caribbean area presents a complex picture, unique in many of its physical, climatic and socio-economic characteristics. Its many island and coastal States and territories vary widely in size and topography. Based on per capita income, the Caribbean countries/territories are classified as middle-income except for Cuba, Guyana and Haiti, which are classified as low-income countries. Their official languages include English, French, Spanish and Dutch (together with a number of local languages and dialects) and their governmental, legal and institutional systems reflect differing historical associations with European nations. These realities must be accommodated in any region-wide efforts to improve DRR.

Much of the Caribbean weather and climate is strongly influenced by the seasonal variations of the inter-tropical convergence zone (ITCZ) and the El Niño Southern Oscillation (ENSO). The threat presented by tropical storms and hurricanes represents a particular concern for most States and territories during the summer and autumn months, although the degree of exposure and vulnerability to their impacts varies across the region. However, the influences of the ITCZ and extra-tropical weather systems also expose the region to hazards such as heavy rains, strong winds, large waves and swells, and these result in coastal flooding that is not directly linked to tropical storms or hurricanes.

In the Caribbean region between 1980 and 2007, nearly 98 per cent of disasters, 99 per cent of casualties and 99 per cent of economic losses related to natural hazards were caused by recurrent meteorological, hydrological and climate-related events, primarily tropical cyclones and storm surges, floods, droughts and extreme temperatures. These are all expected to be further exacerbated as a result of climate change. The Intergovernmental Panel on Climate Change (IPCC) *Fourth Assessment Report: Climate Change, 2007* (IPCC, 2007; detailed in Appendix 1, Table 10) concludes that small islands, including those in the Caribbean, face some of the highest levels of threats and risks from climate change, particularly associated with these aforementioned events, rising sea levels and marine-related hazards.

A country-level survey conducted by WMO between 2006 and 2007 found that the hazards affecting most of the Caribbean region are tropical cyclones, flash floods, thunderstorms or lightning, storm surges, coastal flooding, droughts, landslides or mudslides, strong winds, river flooding and earthquakes. Other hazards, though serious in some Caribbean countries/territories, are less widely experienced.

The Caribbean countries/territories share some broad similarities (low availability of resources, high debt, a small but rapidly growing population, remoteness, susceptibility to natural disasters, excessive dependence on imports and vulnerability to global developments) making them, as a collective, all vulnerable to meteorological, hydrological and climate-related hazards and impacts of climate change, as detailed in a recent Caribbean Catastrophe Risk Insurance Facility (CCRIF) briefing document (Young and Lyahen, 2009). Overall, the economies in the region are characterized by a limited diversification and a high level of openness. The main sectors are tourism, transport, agriculture and finance, with the exception of Trinidad and Tobago, where the oil industry represents close to 30 per cent of the gross domestic product (GDP). All these key sectors are highly vulnerable to meteorological, hydrological and climate-related hazards and consequently they should be integrated into any comprehensive DRR approach in the region.

Motivation and objectives of this assessment

With over 30 years of regional cooperation in tropical cyclone forecasting and warnings, facilitated by WMO, the Caribbean region has demonstrated the benefits of regional cooperation to reduce the impacts of meteorological and hydrological hazards. Extensive cooperation in DRM has been developed under the Comprehensive Disaster Management (CDM) of CDEMA, underpinned by the Hyogo Framework for Action

(HFA) 2005–2015.³ Building on this, during the Training and Coordination Workshop on Multi-hazard Early Warning Systems (22–25 March 2010, San Jose, Costa Rica) (detailed in Appendix 1, Table 6) the following needs were identified for the region:

- (a) The need to strengthen national and regional institutional capacities and cooperation among NMSs, DRM agencies and other DRR and early warning system (EWS) stakeholders within the context of risk assessment and EWS, with a multi-sectoral, multi-hazard approach to meteorological, hydrological and climate-related hazards;
- (b) The need to improve coordination between hydrometeorological systems (building on the existing regional coordination for tropical cyclones watch and warnings) and responsible agencies and early warning networks concerned with other hazards (for example, tsunamis and the Caribbean Tsunami Warning Centre, under development through the Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG/CARIBE EWS)).

During 2010–2011, WMO (including its Members and WMO RA IV), with support from regional and international partners, conducted a comprehensive assessment of the institutional and technical capacities and needs of the Caribbean region to support Multi-hazard Early Warning Systems (MHEWS) and risk assessment. The outcomes of this assessment are presented in this Report. They provide the foundation for future capacity development projects and for the improvement of existing capacities, and a support for other projects and developments in the region.

Countries/territories included in the assessment

The following island countries/territories of the Caribbean were engaged in this assessment: Antigua and Barbuda, Aruba, the Bahamas, Barbados, Bermuda, the British Caribbean Territories (Anguilla, the British Virgin Islands, the Cayman Islands, Montserrat, the Turks and Caicos Islands), Cuba, Curaçao and Sint Maarten, Dominica, the Dominican Republic, the French West Indies (Guadeloupe, Martinique, Saint Barthélemy and Saint Martin), Grenada, Haiti, Jamaica, the Dutch municipalities (Bonaire, Saba, Sint Eustatius), Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, and Trinidad and Tobago, as well as three coastal States – Belize, Guyana and Suriname (hereafter and as appropriate referred to collectively as the Caribbean countries/territories).

Methodology and specific topics considered

A systematic approach has been adopted by WMO to assess the capacities, gaps and needs in risk assessment and MHEWS, particularly with respect to the provision of information and services for meteorological, hydrological and climate-related hazards in the Caribbean. The assessment has involved a systematic analysis of critical partnerships and cooperation of NMSs within the national and regional institutional frameworks in DRR. It has evaluated the processes for the development and provision of critical products and services for meteorological, hydrological and climate-related hazards to support risk assessment, MHEWS, sectoral planning and financial risk transfer markets to reduce and manage risks for the protection of the lives and livelihoods of people. The study has also considered the core capacities of NMSs, as well as the operational cooperation between NMSs and other technical agencies and centres at the national, regional and international levels. More specifically, the assessment considered the following issues: national and regional governance and institutional frameworks; national DRR and MHEWS stakeholders; service delivery and feedback mechanisms; products and service development; core operational components, including coordination mechanisms with other national technical and sectoral agencies involving provision of information to DRR and EWS stakeholders; coordination and cooperation with global and regional specialized centres supporting the region.

³ In 2005 the United Nations convened the Second World Conference on Disaster Reduction in Kobe, Hyogo, Japan. During this conference the Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters was negotiated and adopted by 168 countries, shifting the paradigm for DRM from post-disaster response to a more comprehensive approach that would also include prevention and preparedness measures (source: <http://www.unisdr.org/2005/wcdr/intergover/official-doc/L-docs/Hyogo-framework-for-action-english.pdf>).

The assessment is based on information from primary and secondary sources. Primary sources have included four surveys of the institutional and technical capacities, six training and technical workshops, and 22 national visits. The process has engaged senior management and experts from NMSs and DRM agencies and has involved consultations with regional and international partners and centres. Secondary sources have included reviews of literature and surveys from local, regional and international sources.

This assessment provides detailed information and analysis, including:

- (a) A mapping of the institutions in the region involved in the topics considered in this assessment;
- (b) A mapping of a selection of regional/national projects relevant to this assessment and the topics considered;
- (c) Detailed analysis of the operational relations of NMSs with other technical organizations and DRM agencies, within and across countries/territories;
- (d) Documentation of gaps, needs and recommendations that emerged from the consultation for improvements in the following areas:
 - (i) Governance and institutional aspects in risk assessment and MHEWS at national and regional levels, and related institutional agreements and standard operating procedures (SOPs) within Quality Management Systems (QMSs);
 - (ii) Operational cooperation for development of requirements, dissemination, feedback mechanisms related to meteorological, hydrological and climate-related hazards, and EWSs engaging NMSs and their stakeholders such as DRM agencies;
 - (iii) The development of NMS products and services to support DRM agencies:
 - a. Hazard analysis products to support risk assessment;
 - b. Historical and real-time data products;
 - c. Improvement of forecast and warning products;
 - d. Technical advice;
 - (iv) Reinforcement of NMS core capacities to meet the needs of DRM agencies and other stakeholders engaged in risk assessment and MHEWS:
 - a. Observational and monitoring capacities;
 - b. Forecasting capacities;
 - c. Database management and sharing;
 - d. Telecommunication networks;
 - e. Comprehensive QMSs;
 - (v) Technical and management training programmes for the staff of NMSs and their stakeholders;
 - (vi) Cooperation of NMSs with other technical agencies, and development of related agreements under the institutional framework of MHEWSs and SOPs;
 - (vii) Public outreach and educational programmes.

Next steps and priorities for a phase I capacity development project

The results of the consultations highlighted the need for a more coordinated approach to strengthen institutional capacities at national and regional levels to support risk assessment and MHEWS for meteorological, hydrological and climate-related hazards in the Caribbean. This will require stronger cooperation with a multi-sectoral, multi-hazard, multi-level approach within the context of the priorities in DRR, and adaptation planning in the countries/territories in the region, to ensure:

- (a) Legal and institutional arrangements supporting DRR and MHEWS are well established;
- (b) Risk assessment capacities are developed and applied multi-sectorally for planning and decision-making;
- (c) Quality Management Systems and SOPs are developed between NMHSs and other EWS stakeholders to ensure effective execution of MHEWSs;
- (d) Operational meteorological, hydrological and climate-related services to support DRR are strengthened at national and regional levels with consideration of user needs and requirements within various sectors;
- (e) The efficient coordination of MHEWSs at both national and regional levels.

To achieve these objectives, it was recommended that, as the next steps, the following issues should be addressed:

- (a) The recommendations presented in this Report should be reviewed and prioritized for implementation by the WMO Management Group. The Management Group should consider grouping the prioritized recommendations such that they can be implemented in a logical manner and targeted for rapid success.
- (b) Based on identified priorities, an implementation plan should be developed for this initiative that defines a series of capacity development projects that could be implemented. This plan should include timelines, milestones and deliverables.
- (c) The capacity development projects established should possess national and regional dimensions to address the needs identified. They should build on existing institutional mechanisms, capacities and relevant projects (recently completed or in-progress) in the region.
- (d) Annual DRR and climate adaptation regional and national multi-stakeholder forums (engaging technical and scientific, as well as management networks) need to be established given the important connections between climate and DRM issues. These structures need to be linked to existing events and platforms (the RA IV Hurricane Committee, the CDEMA-CDM forum, and the like) to achieve a more coordinated approach to the implementation, planning, progress monitoring and evaluation, and resource mobilization of this initiative.
- (e) A resource mobilization strategy should be developed with a view to longer-term development. The sustainability of the Caribbean region needs to be considered in terms of the requirements of capacity development, based on recommendations in this Report and prioritized by the WMO Management Group, and building on a more coordinated approach engaging internal (for example, government budgeting and cost-recovery models) and external (for example, donors and development banks) funding sources. This is to be achieved as part of the cross-programme resource mobilization strategy of WMO with other partners, as stressed during the Sixteenth World Meteorological Congress.
- (f) Specific needs for strengthening the monitoring and forecasting of all priority hazards in the region should be addressed through a strong regional cooperation framework, and demonstrated through the development of concrete projects for strengthening risk assessment and MHEWS in the Caribbean, in coordination and cooperation with end-users such as DRM agencies.

A preliminary phase I project concept was identified during the last stage of the consultations. This project is to include two components:

Component 1: Governance and institutional frameworks for risk assessment and MHEWS at national level

Component 1 objectives:

- (a) Facilitate dialogues on national policy/legislation, and workshops in the field of risk management for the strengthening of meteorological, hydrological and climate-related services;
- (b) Identify the roles and responsibilities of NMSs as reflected in national policy, legal frameworks and institutional coordination mechanisms, within a DRM framework (in partnership with CDEMA, the Organization of American States (OAS) and other partners engaged in this area, including non-members of these organizations, such as the Dutch Caribbean municipalities).

Component 2: Operational MHEWS capacity development with national and regional components

Component 2 objective:

Develop and demonstrate operational capacities in MHEWS for severe weather (heavy precipitation) and flooding (flash floods and coastal inundation). These capacities must span all components of regional cooperation in national MHEWS, including monitoring and forecasting, risk analysis, dissemination and communication, development or strengthening of SOPs for emergency contingency planning, and activation of emergency plans based on warnings issued on the levels of risks.

The issues that require detailed consideration for the design of the phase I proposal are outlined in this Report (refer especially to 7).

CHAPTER 1 – INTRODUCTION

Adoption of HFA 2005–2015 by 168 countries during the Second United Nations World Conference on Disaster Risk Reduction (2005, Kobe, Hyogo, Japan) has led to a paradigm shift in DRM, from a post-disaster response to a comprehensive and strategic approach encompassing risk identification, risk reduction and risk transfer. The second high-priority area of HFA stresses the need for “identifying, assessing and monitoring disaster risks and enhancing early warning”. Taking this into consideration, it is clear that the DRM strategy of any nation should include development of the following:

- (a) Risk assessment to quantify and understand the risks associated with natural hazards and their impacts;
- (b) Risk reduction through preparedness (including EWSs for safety of lives) and prevention (including medium- to long-term sectoral planning and risk management in areas such as land zoning, infrastructure development, agriculture, energy, water resource management and transportation);
- (c) Risk transfer through the utilization of financial instruments and markets (for example, catastrophe and weather-indexed insurance) to transfer the economic impacts of disasters at various levels and decision timescales.

These components must be underpinned by appropriate legal frameworks and policies, organizational coordination and cooperation mechanisms, and appropriate allocation of resources. Furthermore, effective sharing of information and knowledge is required among all the relevant players, supported by education and training programmes (see Figure 1).

Given the extensive socio-economic impacts associated with meteorological, hydrological and climate-related hazards, availability of information relating to these factors is critical for risk assessment and the development of strategies for risk reduction and transfer. Risk assessment requires quality-assured historical and real-time data on hazards, socio-economic impact data and the capacity to utilize hazard and risk-analysis tools. Analysis of hazard patterns from historical data is necessary but not, however, sufficient for risk assessment. The changing patterns of climate-related hazards, when associated with climate

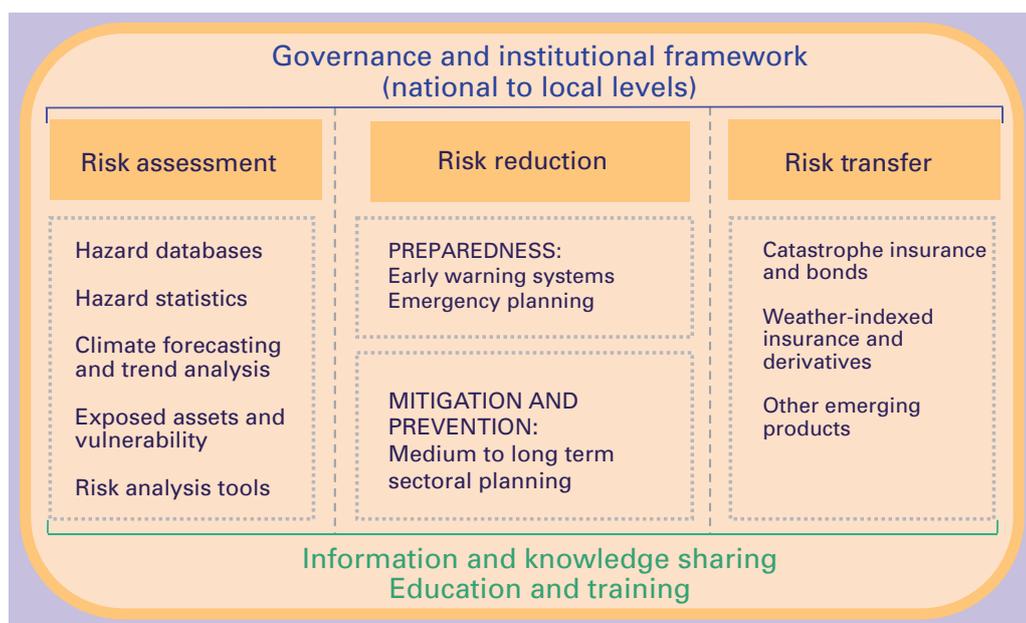


Figure 1. Components of an effective disaster risk management framework as derived from HFA

change, are posing challenges to longer-term strategic planning, investments and specifications (for example, infrastructure planning and retrofitting based on building codes). A risk of flooding occurring considered previously to be once every 100 years may become once every 30 years. Such climate analysis tools for assessing changes in the severity, frequency, and occurrences of these hazards at seasonal, inter-annual, decadal, and longer periods need to become available operationally and to be applied for risk assessment, reduction and transfer strategies. This is necessary to reduce and redistribute the economic impacts of disasters at various levels and decision timescales (short-term operational to long-term strategic planning). All sectors require a wide range of products and services relating to meteorological, hydrological and climate-related information, at different temporal and spatial scales, and with different information content.

The United Nations International Strategy for Disaster Reduction (UNISDR) definition of EWS is, “The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss” (see: <http://www.unisdr.org/we/inform/terminology>). The systems have been demonstrated to be effective tools for reducing loss of life through improved emergency preparedness and response. Furthermore, as stated in a recent World Bank–United Nations publication (World Bank–United Nations, 2010), spending on improving weather forecasting and data sharing for MHEWS has high returns on investment. Effective MHEWS should comprise four operational components:

- (a) Hazard detection, monitoring and forecasting;
- (b) Analysis of risks and incorporation of risk information in emergency planning and warnings;
- (c) Dissemination of timely and authoritative risk-based warnings;
- (d) Community emergency planning and preparedness and the ability to activate emergency plans to prepare and respond.

These four components need to be coordinated across many agencies at both national and community levels for the system to work. Failure in one component or lack of coordination between agencies would lead to the failure of the whole system. Furthermore, roles and responsibilities of various public- and private-sector stakeholders must be reflected in the national to local regulatory frameworks and planning. A well-defined MHEWS is a system that not only targets a number of hazards, but in so doing seeks to take optimum advantage of the collective capacities of all stakeholders involved. It leverages resources, monitoring and prediction networks, risk-analysis capacities, communications and dissemination networks, and preparedness and response systems through well-defined coordination structures and protocols (Golnaraghi, 2012). This ensures the greatest possible efficiency, effectiveness, interoperability and sustainability for the system as a whole. In this respect, NMHSs⁴ have vital contributions to make to support informed decision-making within a comprehensive strategy to reduce the impacts of disasters caused by natural hazards. A fundamental mission of NMSs is to contribute to the protection of the lives and livelihoods of people by providing early warnings of meteorological, hydrological and climate-related hazards and related information to reduce risks.

Many countries have built their MHEWS on these four operational components, but implementation of each MHEWS varies from country to country. However, a detailed synthesis of seven good practices in MHEWS published by WMO has revealed that, despite the socio-economic, cultural and environmental differences, and despite the individualized approaches to the operation of their MHEWS, the countries/territories have incorporated 10 common characteristics that have led to reductions in losses of life and property from meteorological and hydrological hazards within their respective jurisdictions (Golnaraghi et al, 2010; Golnaraghi, 2012). These are highlighted in the Box below as guiding principles for assessment, evaluation and development of MHEWS.

⁴ The term “NMHS” is used by WMO as a collective term that applies to the operations of the National Meteorological and Hydrological Services. However, this term does not necessarily imply that the two Services (that is, the National Meteorological Services and the National Hydrological Services) are combined in a single organization. In the Caribbean region the majority of the National Meteorological and Hydrological Services are separate. To this end, in this report we refer to the National Meteorological Services and utilize the acronym NMS to clarify that these services are separate from the hydrological services. In fact, in many countries/territories in the region, hydrological issues may not be addressed under one specific institution, and the various responsibilities may be dispersed among various agencies and ministries, such as utilities and water works. One of the recommendations of this assessment is the need to map the hydrological network within the countries/territories as a high priority.

With over 30 years of regional cooperation in tropical cyclone forecasting and warnings, facilitated by WMO, the Caribbean region has demonstrated the benefits of regional cooperation to reduce the impacts of these phenomena. However, during the Training and Coordination Workshop on Multi-hazard Early Warning Systems with Focus on Institutional Partnerships and Coordination (22–25 March 2010, San Jose, Costa Rica) (WMO, 2010; see Appendix 1, Table 6) two particular needs were identified for the Caribbean region:

- (a) The need to strengthen national and regional institutional capacities and cooperation among NMSs and other stakeholders in DRR, such as DRM agencies, to support risk assessment and MHEWS for meteorological, hydrological and climate-related hazards;
- (b) The need to improve coordination among hydrometeorological warning systems (building on the existing regional coordination for tropical cyclones) and those for other hazards (for example, tsunamis).

A comprehensive assessment of the institutional and technical capacities, gaps and needs of the Caribbean region to support MHEWS and risk assessment was conducted by WMO in 2010–2011. The objective was to facilitate capacity development in a systematic way by leveraging existing capacities, projects and developments in the region. The outcomes of this assessment are presented in this Report. It is hoped they will provide the foundation for future capacity development in the region.

The following island countries and territories of the Caribbean were engaged in this assessment: Antigua and Barbuda, Aruba, the Bahamas, Barbados, Bermuda, the British Caribbean Territories (Anguilla, the British Virgin Islands, the Cayman Islands, Montserrat, the Turks and Caicos Islands), Cuba, Curaçao and Sint Maarten, Dominica, the Dominican Republic, the French West Indies (Guadeloupe, Martinique, Saint Barthélemy and Saint Martin), Grenada, Haiti, Jamaica, the Dutch municipalities (Bonaire, Saba, Sint Eustatius), Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, and Trinidad and Tobago, as well as three coastal States – Belize, Guyana and Suriname (hereafter and as appropriate referred to as the Caribbean countries/territories).

This assessment was carried out by WMO in cooperation with its Members and a number of regional and international agencies and partners. The assessment was based on information from primary and secondary sources. Primary sources included four surveys of institutional and technical capacities, six training and technical workshops, and 22 national visits, engaging senior management and experts from NMSs and DRM agencies, and consultations with regional and international partners and centres. The secondary sources have included reviews of literature and surveys from local, regional and international sources. This is detailed in 3.3, and in Appendix 1, Tables 6–10.

This Report presents the findings of the assessment, including:

- (a) A selection of regional projects in the Caribbean relevant to the assessment (see 4);
- (b) An assessment of the capacities, gaps and needs to support risk assessment and MHEWS in the Caribbean within an end-to-end service delivery framework (see 5);
- (c) A summary of the high-priority recommendations from this assessment (see 6);
- (d) The next steps and priorities for a phase I capacity development project (see 7).

Ten guiding principals for successful MHEWS (Golnaraghi, 2012)

To date, good practices have been documented in seven examples of MHEWS for meteorological and hydrological hazards. These include: the Bangladesh Cyclone Preparedness Programme; the Cuba Tropical Cyclone EWS; the French Vigilance System, which includes an example from the French West Indies; the Warning Management of the Detacher Wetterdienst; MHEWSs in Japan and of the United States NOAA–NWS; the Shanghai Multi-hazard Emergency Preparedness Programme, which provides an example of good practice for megacities. The documentation of these examples was carried out by teams of experts from relevant ministries and agencies in the respective countries and will appear in a forthcoming publication. A detailed synthesis of the good practices documented has revealed 10 principles common to the implementation of EWS in all cases, irrespective of political, social and institutional factors in each country:

- (a) There is a strong political recognition of the benefits of EWS that is reflected in harmonized national to local DRM policies, planning, legislation and budgeting;
- (b) Effective EWSs are built upon four components:
 - (i) Hazard detection, monitoring and forecasting;
 - (ii) Risk analysis and incorporation of risk information in emergency planning and warnings;
 - (iii) Timely dissemination and authoritative warnings;
 - (iv) Community planning and preparedness, and the ability to activate emergency plans to prepare and respond, with coordination across agencies, at national to local levels;
- (c) Early warning system stakeholders are identified and their roles, responsibilities and coordination mechanisms clearly defined and documented within national to local plans, legislation, directives and memorandums of understanding (MOUs), including those of the technical agencies such as NMHSs;
- (d) Capacities for EWSs are supported by adequate resources (for example, human, financial and material) across national to local levels, and the system is designed and implemented taking into account factors for long-term sustainability;
- (e) Information on hazard, exposure and vulnerability is used to undertake risk assessments at different levels, and is taken as being critical input into emergency planning and development of warning messages;
- (f) Warning messages are:
 - (i) Clear, consistent and include risk information;
 - (ii) Designed assuring that the link between threat level and emergency preparedness and response actions is clear (for example, the use of colour and flags) and that this is understood by the authorities and the population;
 - (iii) Issued from a single (or unified), recognized and authoritative source;
- (g) Warning dissemination mechanisms are able to reach the authorities, other EWS stakeholders and the population at risk in a timely and reliable fashion;
- (h) Emergency response plans are developed with consideration for the levels of hazard/risk, the characteristics of the exposed communities (for example, urban, rural, ethnic populations, tourists, and vulnerable groups such as women, children, the elderly and the hospitalized), the coordination mechanisms and the various EWS stakeholders;
- (i) Training on risk awareness, hazard recognition and related emergency response actions is integrated into formal and informal educational programmes, and linked to regular drills and tests across the system to ensure operational readiness at any time;
- (j) Effective feedback and improvement mechanisms are in place at all levels of EWS to provide systematic evaluation and ensure system improvement over time.

The lessons learned from these good practices can be adapted by countries that require multi-hazard risk management. The specific design and implementation of EWS strategies varies according to the specific culture, socio-economic conditions, institutional structure, capacity and available resources for sustainability of the system.

CHAPTER 2 – ABOUT THE CARIBBEAN

2.1 RISKS ASSOCIATED WITH METEOROLOGICAL, HYDROLOGICAL AND CLIMATE-RELATED HAZARDS IN A CHANGING CLIMATE IN THE CARIBBEAN

2.1.1 Overview of the Caribbean region

When viewed as an entity, the Caribbean area presents a complex picture, one that is near-unique in many of its physical, climatic and socio-economic characteristics. Its many island countries/territories and coastal States vary widely in size and topography. Based on per capita income, the Caribbean countries/territories are classified as middle-income except for Cuba, Guyana and Haiti, which are classified as low-income. Official languages in the region include English, French, Spanish and Dutch (with a number of local languages and dialects) and the governmental, legal and institutional systems reflect differing historical associations with European nations. These realities must be accommodated in any efforts to improve DRR across the region.

Despite these differences, the Caribbean countries/territories share broad similarities, including low availability of resources, high debt, a small but rapidly growing population, remoteness, susceptibility to natural disasters, excessive dependence on imports and vulnerability to global developments. This makes them, collectively, vulnerable to meteorological, hydrological and climate-related hazards, and to the impacts of climate change, as described in a recent CCRIF briefing document (Young and Iyehen, 2009).

Overall, the economies in the Caribbean region are characterized by a limited diversification and a high level of openness. The service sector represents two thirds of GDP on average, reaching 90 per cent in many island States (Caribbean Community, 2010). Most of the economies of the Caribbean countries/territories are service driven, with the two main sectors being tourism and finance. Exceptions to this are Trinidad and Tobago, where the oil industry represents close to 30 per cent of GDP, Guyana, where the agricultural sector represents one third of GDP, and Haiti, the poorest nation of the Americas, which is mostly characterized by small-scale subsistence farming employing two thirds of the Haitians, and few industries. It is noteworthy that Trinidad and Tobago mining and quarrying represents close to 90 per cent of this sector within the Caribbean Community (CARICOM), and that Jamaican agriculture alone represents close to 40 per cent of the total agricultural GDP of CARICOM. Specifically, the key economic sectors in the Caribbean region are as follows:

- (a) **Tourism:** The Caribbean region is the most tourism-dependent in the world, with the travel industry providing almost 1 million direct and indirect jobs and contributing to a quarter of the region's foreign exchange earnings (Pulwarty et al, 2010; see Appendix 1, Table 10). Many Caribbean countries/territories have developed large tourism industries owing to their year-round warm climates, beaches and natural beauty, as well as their proximity to the United States. The rise of tourism has sparked an indirect growth in many other domestic industries such as construction, and many other service- and tourism-related enterprises (United States International Trade Commission, 2008; see Appendix 1, Table 10).
- (b) **Transport:** The extreme openness of the Caribbean small economies in terms of international trade of goods and services as well as tourist transportation makes maritime and aviation sectors key for their economies. In addition, with its geographic location at the crossroads of the principal global trade routes, which pass between East and West through the Panama Canal and North and South between South and North America, a number of ports on the Caribbean are strategically positioned as regional hubs (Economic Commission for Latin America and the Caribbean (ECLAC), 2009; see Appendix 1, Table 10). The cruise and yachting markets have also been growing rapidly over the last decade.
- (c) **Agriculture:** Agriculture employs approximately 30 per cent of the Caribbean labour force, with direct contributions ranging from 10 to 35 per cent of GDP.

All these key sectors are highly vulnerable to meteorological, hydrological and climate-related hazards and consequently should be integrated into any comprehensive DRR approach in the region.

2.1.2 Hydrometeorological and climate hazards in the Caribbean

In the Caribbean region between 1980 and 2007, nearly 98 per cent of disasters, 99 per cent of casualties and 99 per cent of economic losses related to natural hazards were caused by recurrent meteorological, hydrological and climate-related events. Primarily these were tropical cyclones and storm surges, floods, droughts, and extreme temperatures, all of which are expected to be further exacerbated as a result of climate change (IPCC, 2007; see Appendix 1, Table 10).

Extending from just north of the Equator across the Tropic of Cancer, and with the Atlantic Ocean to the east, much of the Caribbean weather and climate is strongly influenced by the seasonal variation of ITCZ and ENSO. The easterly trade winds are a significant feature of the wind regime over much of the area, with the more northern islands also being affected by mid-latitude frontal systems. The threat presented by tropical storms and hurricanes represents a particular concern for most States and territories during the summer and autumn months. However, as discussed later, the degree of exposure and vulnerability to their impacts varies across the region. The influences of ITCZ and extra-tropical weather systems also expose the region to hazards such as heavy rains, strong winds, large waves and swells, and these result in coastal flooding that is not directly linked to tropical storms or hurricanes.

A country-level survey conducted by WMO in 2006–2007 as part of the DRR Programme found that the hazards affecting most of the Caribbean region are tropical cyclones, flash floods, thunderstorms or lightning, storm surges, coastal flooding, droughts, landslides or mudslides, strong winds, river flooding and earthquakes (Figure 2). Other hazards, though serious in some Caribbean countries/territories, are less widely experienced (WMO report *Capacity Assessment of National Meteorological and Hydrological Services in Support of Disaster Risk Reduction*, 2006; see Appendix 1, Table 6).

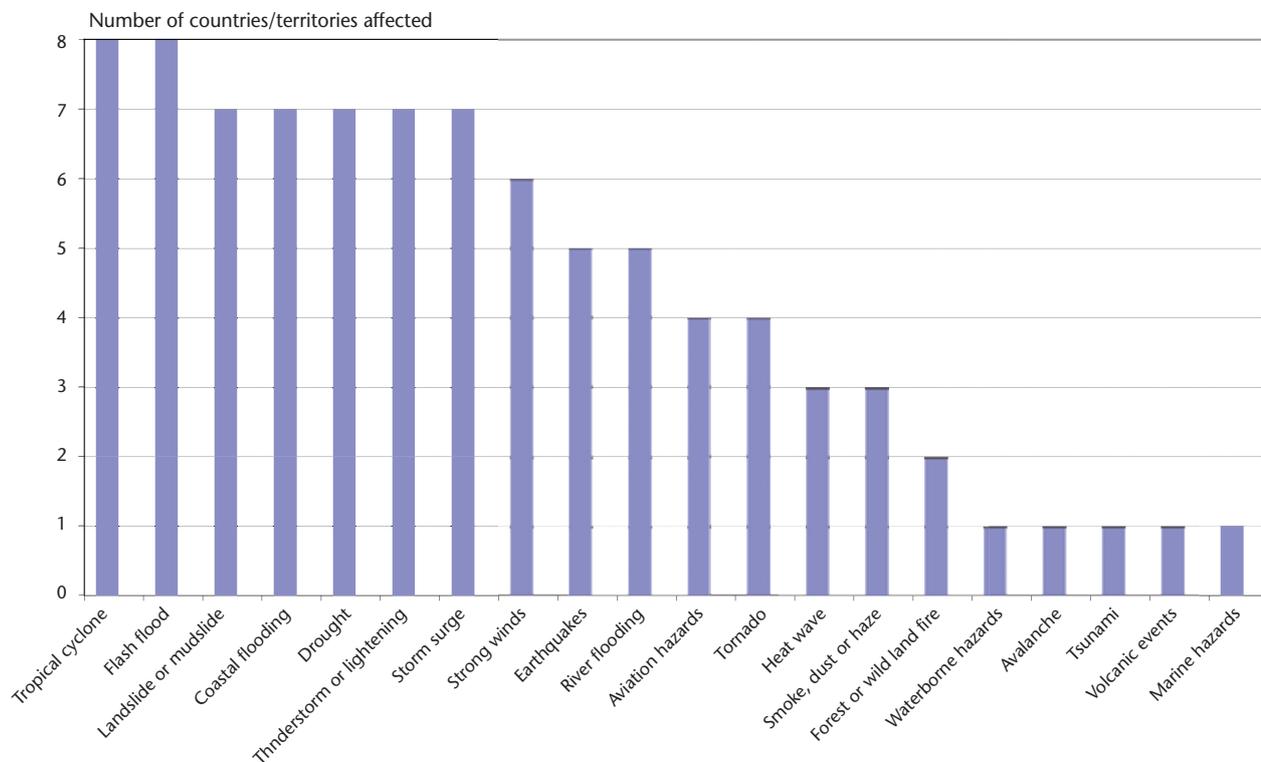


Figure 2. Number of responding Caribbean countries/territories that affirmed being affected by specified hazards

Source: WMO report, 2006 (Appendix 1, Table 6)



Figure 3. Tracks of tropical cyclones that have affected the Caribbean region from 1990 to 2010 and their intensities; H5–H3: major hurricane; H2–H1: hurricane; TS: tropical storm; TD: tropical depression; ET: extra-tropical storm; N/A: unknown type

Source: NOAA, <http://www.csc.noaa.gov/hurricanes/#>

Risks associated with hazardous meteorological and tropical phenomena most frequently arise from strong winds, heavy rains and thunderstorms, and large waves and storm surges. These can in turn cause slow-onset floods in continental areas, flash floods on mountainous islands, landslides, coastal inundation and wind-generated impacts. For many years, disaster prevention and preparedness efforts in most Caribbean countries/territories have placed emphasis on the impacts of tropical cyclones. Historical records suggest that tropical cyclones that affect the region each year, primarily from June to November, pose a real threat. Between 1990 and 2010, 86 named tropical cyclones (tropical storms or hurricanes) and more than 23 major hurricanes have affected the Caribbean (Figure 3). However, not all of the Caribbean countries/territories are subject to the same degree of risk from these tropical systems. The frequency of impact for tropical cyclones or hurricanes varies considerably across the region. In the case of the southernmost islands such as Barbados, Curaçao, or Trinidad and Tobago, the frequency of impact is more than 20 years. In contrast, countries/territories such as Cuba, Haiti and the Bahamas are impacted more frequently, in some cases even by several tropical cyclones in the same season.⁵ Moreover, the coastal nations of Guyana and Suriname are not directly affected by tropical cyclones due to their location near the equator. The main threats for the continental countries/territories arise from heavy and persistent equatorial-type rainfall over large river basins or from coastal inundation.

Tropical cyclones are classified by wind strength (see Box, following). Even tropical cyclones with wind strengths of less than 80 kilometres per hour, considered to be weak, can cause heavy rain, floods, and landslides or mudslides. Tropical storm *Jeanne* in 2004, for example, caused extreme rainfall over Haiti and killed more than 3 000 people. Moreover, hazards such as heavy rains that are not associated with tropical cyclones can have far-reaching consequences and may occur throughout the year. The flash flood in Sint Maarten in July 2005 and the flash flood in Martinique in early May 2009 represent examples of the latter situation. In addition, as suggested earlier, continental countries such as Belize, Guyana and Suriname are affected by river flooding along their large river systems and especially along the coastal plains, where flooding is caused by a combination of precipitation and high tides that inhibit drainage.

⁵ For example, *Fay*, *Gustav*, *Ike* and *Paloma* all made landfall in Cuba in 2008.

Classification of tropical cyclones in the Caribbean region

Classification of tropical cyclones in the Atlantic, Caribbean and the Gulf of Mexico include:

Tropical depression: A tropical cyclone in which maximum sustained wind speeds are up to 62 kilometres (38 miles) per hour;

Tropical storm: A tropical cyclone in which maximum sustained wind speeds range from 63 kilometres (39 miles) to 117 kilometres (73 miles) per hour;

Hurricane: A tropical cyclone in which wind speeds equal or exceed 118 kilometres (74 miles) per hour; the term is used in the Atlantic and eastern and central Pacific Oceans. Hurricanes are further designated by categories on the Saffir–Simpson scale.

The Saffir–Simpson Hurricane Wind Scale is a categorization on a scale of 1 to 5 based on the hurricane's intensity at the indicated time (see Table below). The scale alerts the public about the possible impacts of hurricanes of various intensities and provides examples of the type of damage and impacts in the United States associated with winds of the indicated intensity. In general, damage rises by about a factor of four for every category increase. Hurricanes in categories 3, 4 or 5 are known as major or intense hurricanes. The scale does not address the potential for other hurricane-related impacts, such as storm surge, rainfall-induced floods and tornadoes. It should also be noted that these general descriptions of wind-caused damage are to some degree dependent upon the local building codes in effect, and how well and how long they have been enforced.

<i>Category of hurricane</i>	<i>Impacts</i>
1: Sustained winds of 118–153 km (74–95 m) per hour	Very dangerous winds that will produce some damage
2: Sustained winds of 154–177 km (96–110 m) per hour	Extremely dangerous winds that will cause extensive damage
3: Sustained winds of 178–209 km (111–130 m) per hour	Devastating damage will occur
4: Sustained winds of 210–250 km (131–155 m) per hour	Catastrophic damage will occur
5: Sustained winds of > 250 km (> 155 m) per hour	Catastrophic damage will occur

Source: NOAA, <http://www.nhc.noaa.gov/sshws.shtml>

All Caribbean countries/territories are also vulnerable to swells, including storm tides, associated with tropical cyclones, as defined in document WMO/TD-No. 494 (WMO, 2011), which can cause substantial damage along coastlines even when the coast is several hundreds of kilometres away from the track of the weather system. An example is the impact of Hurricane *Lenny* in 1999, which caused major damage on the western coasts of all the islands of the Lesser Antilles, as well as on the islands of Aruba, Bonaire, and Curaçao and Sint Maarten, and along the northern South American coastline. Northernmost Caribbean islands may also experience very strong swells originating from intense mid-latitude storm systems situated thousands of kilometres to the north, generally between January and April. This very energetic swell can bring 4- to 6-metre breaking waves that are capable of causing heavy damage on the north coasts of the Greater Antilles and the northern Lesser Antilles (Saint Martin, Anguilla and Guadeloupe).⁶

Climatic hazards of longer duration, such as heat waves (such as occurred in Barbados in 2006) and droughts (for example, in 2009–2010 in the Lesser Antilles, 2006 in Cuba, and 1997 in Guyana) may also occur in any country/territory in the Caribbean region. Droughts are often related to El Niño, as there is a good correlation between El Niño and dryness in the Lesser Antilles. Therefore, the Caribbean countries/territories are recurrently affected by deficiencies in rainfall, especially during the dry season, and require close monitoring of drought and careful water-resource management. For example, the 2009–2010 drought in the region caused production to be reduced by 43 per cent for the banana harvest on Dominica, by 20 per cent for the agricultural production in Saint Vincent and the Grenadines, and by 25–30 per cent for the onion and tomato yields in Antigua and Barbuda (UNISDR, 2011).

Mention must also be made of tsunamis resulting from geological activity (usually earthquakes). These can present a threat to nations in the Caribbean. While not classified as weather-related hazards, the impacts and consequences of tsunamis are somewhat similar to those associated with storm surges. The systems and infrastructure for tsunami warnings include some elements that are also common to EWS for meteorological, hydrological and climate-related hazards. There may, therefore, be some potential for synergy between hydrometeorological and tsunami warning systems in pursuing the development of an efficient, comprehensive risk assessment and MHEWS for the Caribbean region.

2.1.3 Vulnerability of the Caribbean to meteorological, hydrological and climate-related hazards

The vulnerability of individual Caribbean countries/territories to hazards related to meteorological and hydrological phenomena varies with their respective exposure to these hazards. The potential for damage and losses depends on a range of factors. Whether or not a country has mountains or high-altitude areas, for example, represents a major variable in determining the vulnerability to heavy rains. The likelihood of landslides or flash flooding is greater on islands with steep slopes and torrential rivers, such as Dominica, Guadeloupe, Sint Maarten and Hispaniola (Haiti and the Dominican Republic). Other islands, such as Anguilla, Antigua and Barbuda, Barbados and Curaçao are less rugged, though still vulnerable to flooding because of low-lying areas. Sandy islands such as the Bahamas, the Turks and Caicos Islands or the Cayman islands are particularly exposed to strong swells and winds and are, therefore, very vulnerable to storm surges. The coastal nations of Guyana and Suriname are specific cases in that 90 per cent of the population lives and works in low-lying coastal areas below mean sea level, making them very sensitive to flooding from both river- and ocean-related hazards.

Vulnerability also depends on human and economic activities, on the effectiveness of national to local planning, and on the overall capacities of the individual country/territory. Haiti provides a striking illustration of such vulnerability. In this country a single heavy rainfall led to a catastrophic event that occurred during Tropical Storm *Jeanne* in 2004, when more than 3 000 deaths were reported as a consequence of the heavy rains. The devastation of Grenada following the passage of Hurricane *Ivan* in 2004 is another powerful illustration of the reality of small-island vulnerability. In this case, in less than eight hours, the country's vital socio-economic infrastructure, including housing, utilities, tourism-related facilities, and subsistence and commercial agricultural production suffered incalculable damage. The

⁶ An example of such a situation was the significant northerly swell of 17 March 2008, which caused damage along the coastal areas of Guyana and Suriname.

island's two principal foreign exchange earners – tourism and nutmeg production – suffered heavily. More than 90 per cent of hotel guest rooms were either completely destroyed or damaged, while more than 80 per cent of the island's nutmeg trees were lost. The total losses were estimated at 212 per cent of Grenada GDP. Regarding urban planning in the Caribbean, more than half of the population live within 1.5 kilometres of the shoreline. In many regions of small islands, such as along the north coast of Jamaica, and along the west and south coasts of Barbados, continuous corridors of development now occupy practically all of the prime coastal lands. Fishing villages, government buildings and important facilities such as hospitals are frequently located close to the shore. As a consequence, all the population and the main infrastructures of the country are highly vulnerable to hurricane and subsequent coastal flooding and storm surges.

Finally, vulnerability is also related to preparedness and awareness. In areas that are impacted by frequent tropical cyclones, these are heightened with regard to this particular hazard. However, where hazards are less frequent, the cumulative impact of small recurrent disasters over decades has been shown to be greater than that from a once-in-a-century event.

2.1.4 Climate change impacts in the Caribbean

The IPCC *Fourth Assessment Report: Climate Change 2007* (IPCC, 2007; see Appendix 1, Table 10) concludes that small islands, including those in the Caribbean, face some of the highest levels of threats and risks from climate change. The potential impacts of climatic change in the Caribbean region, with a projected increase in global air temperature of 1.5°C to 2°C by 2050, are as follows:

- (a) A decreased length of the rainy season and an increased length of the dry season by 6–8 per cent by 2050;
- (b) Increased frequency of approximately 20 per cent of intense rains 2050;
- (c) Sea level rise of 30–50 cm by 2050.

The rate of increase in air temperature in the Caribbean region during the twentieth century exceeded the global average. The percentage of days having very high maximum or minimum temperatures has increased considerably since the 1950s, while the percentage of days with cold temperatures has decreased. This trend is expected to continue, with a projected temperature increase of 0.94°C to 4.18°C for the period 2040–2069 compared to the period 1961–1990.

Regarding hurricane activity in the region, although there is as yet no convincing evidence in the observed record of changes in tropical cyclone behaviour, a synthesis of the recent model results indicates that, for the future warmer climate, peak wind speed and mean and peak precipitation intensities will increase. The number of intense cyclones is likely to increase, although the total number may decrease on a global scale.

According to the IPCC report, the Caribbean region experienced an estimated mean relative sea-level rise of 1 millimetre per year during the twentieth century and a rise of up to 0.5 metres is predicted for the period 2030–2050. On average, up to 38 per cent of the current total beach area could be lost with such a rise in sea level, with lower narrower beaches being the most vulnerable.

The projected impacts of climate change in the Caribbean have the potential to increase the risks of water stress, beach erosion, coastal flooding, intensities of storm surges and the development of water-related epidemics. In this scenario, the sectors of tourism, water, DRM, health and urban planning, as well as agriculture, would be significantly threatened by climate change.

2.2 EXAMPLES OF GOOD PRACTICES IN MULTI-HAZARD EARLY WARNING SYSTEMS IN THE REGION

The Fifteenth World Meteorological Congress in 2007 requested that WMO, in cooperation with its Members and partners, promote the systematic documentation of good practices in MHEWS. It was requested that this be applied particularly to institutional and operational aspects of MHEWS for extremes of weather, water and climate, and that there should be a synthesis of the lessons learned and the factors

that had contributed to their successes. To date, seven cases of good practices have been documented and analyzed through extensive consultations and efforts.⁷ This process has involved the following actions:

- (a) Two international MHEWS symposia to establish the criteria for the identification of good practices and for the processes of documentation and synthesis;
- (b) A documentation process engaging many national agencies and ministries from each of the seven countries presented in the present Report;
- (c) A detailed synthesis process involving consultations with a cadre of experts and practitioners in EWS from around the world.

As stated, two of the seven cases of good practices documented, from Cuba and the French West Indies, are from the Caribbean region. Lessons learned from these cases point to the need for integration of EWS into development, preparedness and planning at all levels of society. This provides the basis for a holistic and systematic approach to the design and evaluation of EWS, including improvement and sustainability. It provides government officials, heads of agencies and their operational staff, as well as other stakeholders in EWS, with detailed information on policy and legal frameworks, institutional coordination and collaboration, and operational aspects of EWS. The approach demonstrates that EWS should be an integral part of the broader DRR policies and development in the countries (see Box, Introduction).

2.3 CARIBBEAN STAKEHOLDERS AND REGIONAL MECHANISMS SUPPORTING DISASTER RISK REDUCTION

In the Caribbean region, there are a number of regional institutions and mechanisms supporting DRR. The organizations described in the following paragraphs have been identified as being key stakeholders.

Caribbean Community

This is an organization of 15 Caribbean nations and dependencies (Appendix 1, Table 1). The Organization's main purposes are to promote economic integration and cooperation among its Members, to ensure that the benefits of integration are equitably shared, and to coordinate foreign policy. Its major activities involve coordinating economic policies and development planning, devising and instituting special projects for the less-developed Members, operating as a regional single market for many of its Members (CARICOM Single Market), and handling regional trade disputes. The Secretariat headquarters is based in Georgetown, Guyana. The Organization has the following objectives:

- (a) Improved standards of living and work;
- (b) Full employment of labour and other factors of production;
- (c) Accelerated, coordinated and sustained economic development and convergence;
- (d) Expansion of trade and economic relations with third States;
- (e) Increased levels of international competitiveness;
- (f) Organization for increased production and productivity;
- (g) Achievement of a greater measure of economic leverage and effectiveness of Member States in dealing with third States, groups of States and entities of any description;
- (h) Improved coordination of Member States' foreign and foreign economic policies;
- (i) Improved functional cooperation, including the following: more efficient operation of common services and activities for the benefit of its peoples; accelerated promotion of greater understanding among its peoples and the advancement of their social, cultural and technological development; intensified activities in areas such as health, education, transportation and telecommunications.

Among others, the following entities established by, or under the auspices of CARICOM are recognized as institutions or associate institutions of the community (their membership is listed in Appendix 1, Table 1):

- Caribbean Agriculture Research and Development Institute (CARDI);
- Caribbean Community Climate Change Centre (CCCCC);
- CDEMA;

⁷ The seven cases include Bangladesh, the megacity Shanghai, Cuba, France (the French West Indies), Germany, Japan and the United States.

- Caribbean Environment Health Institute (CEHI);
- CMO;
- CIMH;
- Caribbean Telecommunications Union (CTU);
- Caribbean Development Bank (CDB);
- Organization of Eastern Caribbean States (OECS).

Caribbean Disaster Emergency Management Agency

The CDEMA is a regional intergovernmental agency responsible for disaster management. It was established in 2009 through an agreement of the Heads of Conference of CARICOM. It replaces the previous Caribbean Disaster Emergency Response Agency (CDERA), established in 1991. The agency has the following functions:

- (a) Mobilising and coordinating disaster relief;
- (b) Mitigating or eliminating, as far as practicable, the immediate consequences of disasters in participating States;
- (c) Providing immediate and coordinated response by means of emergency disaster relief to any affected participating State;
- (d) Securing, coordinating and providing to interested intergovernmental and non-governmental organizations reliable and comprehensive information on disasters affecting any participating State;
- (e) Encouraging:
 - (i) The adoption of disaster loss reduction and mitigation policies and practices at national and regional levels;
 - (ii) Cooperative arrangements and mechanisms to facilitate the development of a culture of disaster loss reduction;
- (f) Coordinating the establishment, improvement and maintenance of adequate emergency disaster response capabilities among the participating States.

Within the context of CDM (the CARICOM risk-reduction strategy aligned with the HFA) CDEMA, as the lead regional agency, in collaboration with key sector partners and countries, is advancing efforts to mainstream DRR with a multi-sector approach (for example, in the tourism and agricultural sectors). An example of this strategy includes a regional risk-reduction strategy for the tourism sector, which has been developed and signed off by the Caribbean Tourism Organization, and which includes not only CARICOM Member States but several other countries, as shown in this present Report.

The governance of CDEMA is comprised of three organs with specific functions specified in the agency's agreements. These are the Council, the Technical Advisory Committee (TAC) and the Coordinating Unit. The Council, which is the supreme policy-making body, is comprised of the Heads of Government of the participating States and meets annually to review the work of the agency, approving its work programme, key policies and administrative budget. This organ includes a subcommittee known as the Management Committee of Council (MCC), responsible for administrative oversight issues. The Technical Advisory Committee is comprised of national disaster coordinators and invited key regional technical institutions engaged in disaster management (for example, CIMH, the University of the West Indies (UWI) Seismic Research Centre, CCCCC and UWI Centre for Disaster Risk Reduction) serving in a technical advisory capacity to the agency. The Coordinating Unit is the CDEMA secretariat and is headquartered in Barbados.

Since 2001, CDEMA has focussed its attention on CDM, the regional framework for disaster management aiming to strengthen capacities at the regional, national and community levels for the mitigation and management of, and coordinated response to natural and anthropological hazards, including the effects of climate. This strategy aims at the management of all hazards through all phases of the disaster management cycle and involving all sectors – public, private and civil society. The strategy is aligned to HFA and has been endorsed by all CDEMA Member States and accepted by ACS, which should assure that it is promoted in the Latin American States of ACS.

The CDM strategy has four strategic outcome areas. These are:

- (a) Institutional support and strengthening;

- (b) Knowledge management;
- (c) Mainstreaming DRM into key economic sectors;
- (d) Building community resilience.

At the crux of CDM, therefore, is a well-informed and aware public, and activities to achieve full compliance with CDM are at the heart of the CDEMA operation. This operation includes:

- (a) Institutional strengthening for disaster management organizations;
- (b) Training for disaster management personnel;
- (c) Development of model national CDM policy and disaster legislation for adaptation and adoption by participating States;
- (d) Development of model training courses and products;
- (e) Development of model policies and guidelines for use in emergencies;
- (f) Contingency planning;
- (g) Resource mobilization for strengthening disaster management programmes in participating States;
- (h) The mainstreaming of disaster management into key sectors such as tourism, agriculture, health education and civil society;
- (i) Improving emergency telecommunications and warning systems;
- (j) Development of disaster information and communication systems;
- (k) Improvement in the areas of education and public awareness.

Notably, with the revised results-based CDM strategy, the CDM Coordination and Harmonization Council (CDM CHC) has also been established as a governance mechanism for CDM oversight. This council brings together key stakeholders from amongst development partners, as well as those at the national, sectoral and regional level. The functions of CDM CHC are to:

- (a) Provide overall guidance to CDM development and implementation;
- (b) Facilitate the effective coordination and harmonization of the CDM implementation process;
- (c) Facilitate learning and knowledge management of CDM amongst key stakeholders.

The development and strengthening of EWS capacities at regional level should be in alignment with the CDM strategy. Notably, the CDM strategy has identified this as a priority output area.

Caribbean Meteorological Organization

As a specialized agency of CARICOM, the CMO coordinates joint scientific and technical activities in weather-, climate- and water-related sciences in 16 English-speaking Caribbean countries/territories. The supreme body of CMO, the Caribbean Meteorological Council, meets once per year to define policy for the organization. As weather and climate know no national boundaries, cooperation at a regional and international scale is essential for the development of meteorology and operational hydrology, as well as to reap the benefits from their applications. The framework for such regional and international cooperation is provided by CMO. The headquarters of CMO is in Port of Spain, Trinidad and Tobago, and operates the following facilities:

- (a) The CMO Upper-air Network: In partnership with NOAA–NWS, CMO operates a network of rawinsonde stations that make daily soundings of the atmosphere. The observational data from these stations are shared and used by all CMO Members and the international meteorological community.
- (b) The CMO Weather Radar Network: The CMO has established a network of weather radars, located in Antigua and Barbuda, Barbados, Belize, Guyana, Jamaica, and Trinidad and Tobago. A project funded to a level of €3 million by the European Union (EU) has been instigated to replace the old radars by a new network of Doppler weather radars. These will link up with existing radars of other Caribbean countries/territories to form an electronic radar composite of the Caribbean.
- (c) Regional Meteorological Telecommunication Network (RMTN): The CMO routinely assists its Member States in establishing or upgrading the RMTN as part of the overall global network operated by WMO.
- (d) Regional Hurricane Warning System: The NMSs of CMO Member States collaborate very closely in operating an EWS for any tropical storms, hurricanes and other severe weather that affect the region. The CMO Hurricane Warning System is operated as part of a wider regional system operated by WMO.

Caribbean Institute for Meteorology and Hydrology

The CIMH is the education, training, and research arm of CMO. Its overall objective is to assist in improving and developing NMHSs as well as increasing the awareness of the benefits of meteorology and hydrology for the economic well-being of CIMH Member States. This is achieved through training, research, investigations, and the provision of related specialized services and advice. The institute is located at Husbands, in the Parish of Saint James, Barbados. The institute was designated as a Regional Training Centre (RTC) by WMO in 1978, in recognition of the high standard of its training programmes, and is also a WMO Centre of Excellence in Satellite Meteorology and a Regional Instrument Repair and Calibration Centre for CMO Member States of the Caribbean (Caribbean Regional Instrument Centre – CARIC). It is also the Regional Climate Data Archiving Centre. Students from all parts of the Caribbean, and sometimes beyond, are trained in such branches of meteorology as weather observing, forecasting, radar and satellite meteorology, instrument maintenance, agrometeorology, climatology and operational hydrology. The primary functions of the institute are as follows:

- (a) Provide facilities for the training of various categories of meteorological and hydrological personnel;
- (b) Operate as a centre of research in meteorology and hydrology and associated sciences;
- (c) Operate as contractor and consultant on various meteorological and hydrological projects;
- (d) Maintain a service for the upkeep, repair and calibration of meteorological instruments;
- (e) Provide advice to participating governments on meteorological and hydrological matters;
- (f) Collect, analyse and publish meteorological and hydrological data;
- (g) Act as the regional training and technical resource for the implementation of the Emergency Managers Weather Information Network (EMWIN) in non-NMS locations in support of ICG/CARIBE EWS.

Caribbean Community Climate Change Centre

The Caribbean region's response to climate change is coordinated by CCCCC. Officially opened in August 2005, CCCCC is the key node for information on climate change issues and on the region's response to managing and adapting to climate change in the Caribbean. It is the official repository and clearing house for regional climate change data, providing climate change-related policy advice and guidelines to CARICOM Member States through the Secretariat. In this role, CCCCC is recognized by the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Environment Programme (UNEP), and other international agencies as the focal point for climate change issues in the Caribbean. It has also been recognized by the United Nations Institute for Training and Research (UNITAR) as a Centre of Excellence.

Caribbean Catastrophe Risk Insurance Facility⁸

Acting as a risk-pooling facility, CCRIF is 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. It is the world's first and, to date, only regional fund utilizing parametric insurance, giving Caribbean governments the opportunity to purchase earthquake and hurricane catastrophe coverage. This facility represents a paradigm shift in the way governments treat risk, with Caribbean governments leading the way in pre-disaster planning. Following its development through funding from the Government of Japan, CCRIF was capitalized through contributions to a multi-donor trust fund by the Government of Canada, the EU, the World Bank, the Governments of the United Kingdom and France, the Caribbean Development Bank and the Governments of Ireland and Bermuda, as well as through membership fees paid by participating governments. Sixteen governments are currently Members of CCRIF: Anguilla, Antigua and Barbuda, the Bahamas, Barbados, Belize, Bermuda, the Cayman Islands, Dominica, Grenada, Haiti, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago, and the Turks and Caicos Islands.

⁸ Source: <http://www.ccrif.org/>

The CCRIF supports its Members in the development and implementation of strategies for DRM that build on existing mechanisms, institutions, tools and capacities. As part of its corporate social responsibility, and as a key regional entity, CCRIF is committed to increasing the focus of Caribbean governments on DRR as part of national planning efforts. Key areas of support include:

- (a) Design and implementation programmes, in collaboration with other regional organizations, to strengthen Caribbean governments' disaster response and mitigation capacity;
- (b) Engagement in programmes and actions that are designed to develop institutional enabling environments and regional supporting mechanisms for knowledge sharing, the scaling up of good practices, capacity building and technology;
- (c) Development of strategic alliances, through MOUs and other agreements and cooperation mechanisms with regional institutions to reduce the existing vulnerabilities in the small island States of the region.

The CCRIF does not use a traditional model for loss estimation in which the payment is dependent on the total amount of coverage a government buys and the deductible selected (for example, a loss adjuster visits each claim and decides what the cost of repair is, relative to the original replacement value of the building). For CCRIF, the loss is calculated through an index or model in which hazard levels (for example, wind, storm surge and waves for hurricanes, ground shaking for earthquakes) are used as a proxy for losses. To this end, access to hazard information is critical for the design and settlement of the contracts. It is important to note that the object of CCRIF is not to cover the entire loss faced by affected States, but to provide, in the case of a major adverse event, short-term liquidity to cover governments to fund both disaster response and basic government functions.

Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Early Warning System for the Caribbean and Adjacent Regions

Established in 2005, ICG/CARIBE EWS is a subsidiary body of UNESCO–IOC. It is currently comprised of 27 Members from the Caribbean and adjacent regions (including countries and territories) that have officially designated Tsunami National Contacts (TNCs) and/or Tsunami Warning Focal Points (TWFPs). The structure coordinates international tsunami warning and mitigation activities, including the communication of timely and understandable tsunami bulletins in the Caribbean. Comprehensive tsunami mitigation programmes require complementary and sustained activities in tsunami-hazard risk assessment, tsunami warning and emergency response, and preparedness. Four working groups within ICG/CARIBE EWS ensure various activities within the Regional Risk Reduction Initiative (R3I):

- Working Group 1: Monitoring and detection systems and warning guidance;
- Working Group 2: Hazard assessment;
- Working Group 3: Warning, dissemination and communication;
- Working Group 4: Preparedness, readiness and resilience.

Because some NMSs in the region operate 24-hours-per-day 7-days-per-week (24/7) warning systems with rapid communications and distribution systems, some Caribbean countries/territories have named their NMSs as the national TWFP for the country's internal warning system. It must, however, be recognized that tsunamis are non-meteorological events and that, for the most part, the real expertise lies in other agencies that may not operate such continuous warning systems. Therefore, for tsunami warnings to be effective at the national level, there must be the involvement of all stakeholders in the development of policy, warning protocols, public education and action plans.

2.4 THE WORLD METEOROLOGICAL ORGANIZATION NETWORK SUPPORTING THE CARIBBEAN

Within the United Nations, WMO is the specialized agency responsible for:

- (a) Coordination of climate and weather research;
- (b) Development of standards and technical advances;
- (c) Operational cooperation and coordination among its Member States for the observation, analysis, data exchange, and forecasting of weather, climate, water and related environmental conditions;

- (d) Capacity development at national and regional levels for the provision of meteorological, hydrological and climate services to support decision-making for safety of lives, livelihoods and property.

These responsibilities are assured through:

- (a) Ten sponsored and four co-sponsored scientific and technical international programmes;
- (b) Eight technical commissions, composed of a network of over 1 500 leading research and operational experts designated by WMO Member States to establish methodologies, procedures and standards;
- (c) A globally and regionally coordinated operational network;
- (d) A network of 30 RTCs.

The World Meteorological Organization presently has 189 Member States, each represented through their Permanent Representative, usually the director of the respective NMHS. The institutional structure of WMO is comprised of the following elements:

- (a) The World Meteorological Congress, the supreme body of the Organization that meets every four years;
- (b) The Executive Council, the executive body of the Organization, which is responsible to Congress for the coordination and oversight of the programmes of the Organization;
- (c) Six RAs, regional groupings of WMO Member States, and their related regional offices;
- (d) The WMO Secretariat, headed by the WMO Secretary-General, with headquarters in Geneva, Switzerland, where the offices of all the sponsored and co-sponsored programmes of WMO are located. Further details are provided about WMO governance, institutional structure, regional network and global functions in Appendix 1, Tables 3 and 4, and Figure 4.

Information on the WMO membership and its coordinated network supporting the Caribbean region is provided in Appendix 1, Tables 2 and 5. The following structures are implicated:

WMO RA IV

World Meteorological Organization RAs facilitate the development of regional strategies for the development and sharing of meteorological, hydrological and climate-related data, information and technical capacities that all Members in the region can benefit from. These regional strategies are developed in alignment with those established by the socio-economic groupings in the region. Member States of RA IV come from Central and North America and the Caribbean. With regard to the Caribbean island countries/territories, all are RA IV Members with the exception of three: Grenada, Saint Kitts and Nevis, and Saint Vincent and the Grenadines. Regional Association IV has a management group and several task teams that are working on various thematic and technical areas, including DRR, hydrological matters and the WMO Integrated Global Observing System (WIGOS).

WMO RA IV Hurricane Committee

The RA IV Hurricane Committee was established in 1978 as the regional component of the WMO TCP. This regional body works under the Hurricane Operational Plan (HOP) with a view to ensuring the most effective cooperation and coordination between the countries in preparing and issuing meteorological forecasts and warnings of all tropical cyclones affecting the area. The plan records the agreements reached on the sharing of responsibilities for the warning services and their infrastructures throughout its region. The plan defines the observing, forecasting and warning responsibilities of all cooperating Members and deals with other related items, such as terminology and communications. The RA IV Hurricane Committee serves as a valuable source of information for the operational services. It focuses on:

- (a) Responsibilities of Members;
- (b) Tropical cyclone products of the Regional Specialized Meteorological Centre–Miami (RSMC–Miami);
- (c) Surface- and upper-air observations;
- (d) Radar and satellite information and products;
- (e) Aircraft reconnaissance;
- (f) Communication.

The RA IV Hurricane Committee also has a Technical Plan, including an implementation programme, setting out the coordinated steps to be taken by Members for future development to meet regional needs. Identified areas include upgrading forecasts and warning services for hurricanes and associated floods, as well as for related disaster prevention and preparedness measures, and supporting activities in training and research. The Technical Plan has several components: the meteorological component for observing, monitoring, forecasting and warning; the hydrological component for hydrological forecasting, studies, maps, services and facilities; the disaster reduction and preparedness component; the training component; the research component. The HOP and the Technical Plan are updated yearly to incorporate new facilities, advances and developments during the annual meeting of the RA IV Hurricane Committee.

WMO RSMC–Miami

The RSMC–Miami (NOAA National Hurricane Center) is responsible for tropical and subtropical cyclone advisories for the North Atlantic Ocean, the Caribbean Sea, the Gulf of Mexico and the North Pacific Ocean eastward from 140°W, agreed by consensus among WMO Members. The centre provides forecasts and guidance to 30 WMO Member States and issues marine forecasts and graphical products for portions of the Atlantic and the Eastern Pacific. The RSMC–Miami has put in place coordination mechanisms with all its Members in case of tropical cyclone threat and possible impact. It also hosts and teaches a two-week international workshop on tropical cyclones for government meteorologists. The Director of the United States National Hurricane Center serves as chair of the WMO RA IV Hurricane Committee.

For more information on RSMC–Miami, please refer to the document WMO/TD-No. 494 (WMO, 2011). This document lays out the responsibilities of Members and the tropical cyclone products of RSMC–Miami, amongst other topics such as ground radar observations, satellite surveillance, aircraft reconnaissance, surface- and upper-air observations and communications.

WMO Regional Training Centre

The CIMH was designated as an RTC by WMO in 1978 in recognition of the high standard of its training programmes. CIMH is also a WMO Centre of Excellence in Satellite Meteorology and is also a Regional Instrument Repair and Calibration Centre. It is also the Regional Climate Data Archiving Centre. For further information, refer to 2.3.

WMO Centre of Excellence in Satellite Meteorology

In the Caribbean region this role is fulfilled by CIMH (see 2.3).

WMO Regional Climate Centre

Over the years, WMO has facilitated the establishment of Regional Climate Outlook Forums (RCOF) as multi-stakeholder mechanisms, engaging national, regional and international climate experts, sectoral practitioners and policy makers. Through an interactive process, RCOFs and associated Regional Climate User Forums have the following functions:

- (a) Develop consensus regional climate outlooks;
- (b) Identify the requirements for regional climate information products and services;
- (c) Foster multi-disciplinary sectoral cooperation to improve the quality of climate information products and services.

Furthermore, building upon the sustainable cooperation model of the WMO global operational network in recent years, WMO has initiated the designation of Regional Climate Centres (RCCs) as centres of excellence that are mandated to provide WMO Member States with regional tools, products and services to support their national development strategies. In July 2010, the United States NOAA sponsored a meeting at CIMH in which WMO participated and encouraged the establishment of an RCOF for the region. It is

under consideration that CIMH become the RCC for the English-speaking Caribbean. An RCC network is being considered for the Spanish-speaking Caribbean and Central America. Furthermore, an RCC network is being considered engaging Canada, Mexico and the United States.

WMO–Coordination Group for Meteorological Satellites (CGMS) Virtual Laboratory for Training and Education in Satellite Meteorology (VLab)

The WMO–CGMS VLab is a global network of specialized training centres and meteorological satellite operators working together to improve the utilization of data and products from meteorological and environmental satellites. As part of the global VLab, two satellite operators and training centres, WMO–CGMS Barbados and WMO–CGMS Costa Rica, are designated to support the needs and requirements of the WMO Members in the Caribbean. Significant amounts of space-based data and diagnostics are available, which are not currently utilized in the development of services to support sectoral applications, as the needs and requirements of the sectors have not been established.

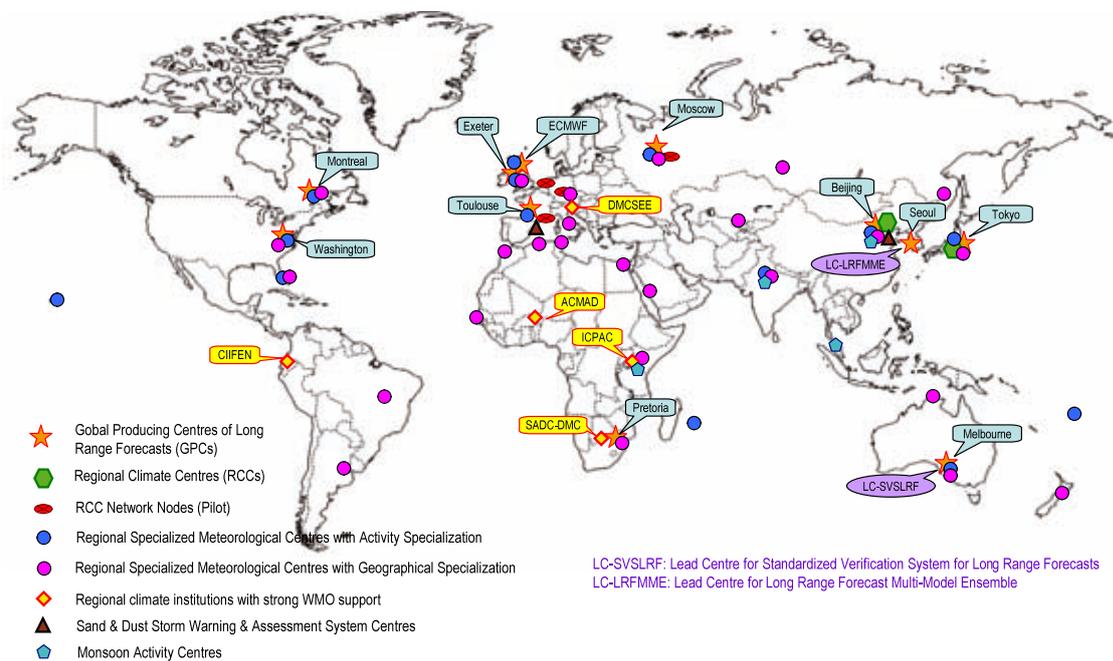


Figure 4. The WMO global and regional specialized centres

CHAPTER 3 – METHODOLOGY FOR THE ASSESSMENT

During the Training and Coordination Workshop on Multi-hazard Early Warning Systems (22–25 March 2010, San Jose, Costa Rica) (WMO, 2010; see Appendix 1, Table 6) the following needs were identified for the Caribbean region:

- (a) The need to strengthen national and regional institutional capacities and cooperation among NMSs, DRM agencies and other DRR and EWS stakeholders within the context of risk assessment and EWS, with a multi-sectoral, multi-hazard approach for meteorological, hydrological and climate-related hazards;
- (b) The need to improve coordination between hydrometeorological systems (building on the existing regional coordination for tropical cyclones watch and warnings) and responsible agencies and early warning networks concerned with other hazards (for example, tsunamis and the Caribbean Tsunami Warning Centre (CTWC), under development through ICG/CARIBE EWS).

With regard to these needs, a comprehensive assessment of the institutional and technical capacities, gaps and needs of the Caribbean region to support MHEWS and risk assessment was conducted by the WMO in 2010–2011. The purpose of this comprehensive assessment is to serve as a basis to support ongoing initiatives to strengthen risk assessment and EWS for meteorological, hydrological and climate-related hazards, and to facilitate a systematic development of capacity in the region. This assessment was carried out through the methodology described in the following sections.

3.1 FRAMEWORK FOR A SERVICE DELIVERY AND COOPERATION OF NATIONAL METEOROLOGICAL SERVICES WITH VARIOUS STAKEHOLDERS IN DISASTER RISK REDUCTION AND MULTI-HAZARD EARLY WARNING SYSTEMS

To conduct this analysis, WMO adopted a systematic approach that is shown schematically in Figure 5. The approach involved a systematic assessment of critical partnerships and cooperation of NMSs within the national and regional institutional frameworks in DRR.

The analysis evaluates the process for the development and provision of critical products and services to support risk assessment, EWSs, sectoral planning and financial risk transfer markets to reduce and manage risks for the protection of the lives and livelihoods of people. The analysis also considers the core capacities of NMSs, as well as the operational cooperation between NMSs and other technical agencies and centres at the national, regional and international levels. Specifically, the following issues are considered:

- (a) National and regional governance and institutional frameworks: DRR and EWS must be underpinned by appropriate policy, legal and institutional frameworks at national to local levels. These frameworks should define and align:
 - (i) Strategic development priorities;
 - (ii) The roles and responsibilities of the various DRR and EWS stakeholders;
 - (iii) Organizational aspects of the mechanisms of coordination and cooperation;
 - (iv) Allocation of resources.

Furthermore, given that natural hazards do not respect political boundaries, the development of capacities at the national level also requires the development of regional strategies and institutional frameworks for regional cooperation among countries/territories for the implementation of the common areas of interest.

- (b) National DRR and EWS stakeholders: There are many DRR and EWS stakeholders, ranging from the public sector, such as DRM agencies and various line ministries, to local communities, non-governmental organizations (NGOs), the media, the private sector and the general public. All have various requirements and needs for meteorological, hydrological and climate-related products and services to support their risk assessment and decision-making processes.

strengthened regional coordination, cooperation and further strengthening of the capacities of regional centres that can benefit the Caribbean countries/territories. Such leveraging can be realized through regional products and services. This will involve improved coordination, harmonization and interoperability of observing systems, improved sharing and exchange of data and good practices, and the leveraging of technical resources and cascading best tools and methodologies for mapping, forecasting and analysis.

3.2 SCOPE OF THE ASSESSMENT

Geographic scope

The Caribbean countries/territories that participated in this assessment include: Antigua and Barbuda, Aruba, the Bahamas, Barbados, Bermuda, the British Caribbean Territories (Anguilla, the British Virgin Islands, the Cayman Islands, Montserrat, the Turks and Caicos Islands), Cuba, Curaçao and Sint Maarten, Dominica, the Dominican Republic, the French West Indies (Guadeloupe, Martinique, Saint Barthélemy and Saint Martin), Grenada, Haiti, Jamaica, the Dutch municipalities (Bonaire, Saba, Sint Eustatius), Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, and Trinidad and Tobago, as well as three coastal States – Belize, Guyana and Suriname.

Institutional scope

Within the framework presented in 3.1, this assessment Report focuses on the institutional cooperation between NMSs and DRM agencies, as two of the key stakeholders in EWS. The Report focuses on the needs and requirements of DRM agencies for meteorological, hydrological and climate-related products and services, and on the capacities, gaps and needs of NMSs in meeting these requirements, within the context of risk assessment and MHEWS (represented by item 2 in Figure 5).

Hazard scope

The country-level DRR survey conducted by WMO in 2006–2007 indicated that tropical cyclones, high waves and storm surges, coastal flooding, flash and river flooding (depending on the island), strong winds, thunderstorms and lightning, droughts, landslides or mudslides, earthquakes and tsunamis are among the high-impact hazards of concern to countries/territories in the region. This assessment is primarily focused on the meteorological, hydrological and climate-related hazards.

Thematic scope

Thematically, this assessment primarily focuses on:

- (a) National and regional institutional capacities and cooperation among NMSs and DRM agencies, in the context of risk assessment and EWS with a multi-hazard approach;
- (b) Coordination among hydrometeorological warning systems (building on the existing regional coordination for tropical cyclones) and other hazards (for example, tsunamis).

In this respect, the Report addresses the following:

- (a) The national and regional DRR and EWS governance and institutional frameworks (represented by item 1 in Figure 5), in 5.1;
- (b) Service delivery and feedback mechanisms between NMSs and DRM agencies (items 2 and 3 in Figure 5), in 5.2;
- (c) NMS products and services (item 4 in Figure 5), in 5.3;
- (d) NMS core operational components (item 5 in Figure 5), in 5.4.

The Report also addresses, to a lesser extent, the needs of NMSs for products and services from hydrological and oceanographic services (item 6 in Figure 5), from RSMCs (item 7 in Figure 5), and the related

coordination mechanisms. As the Caribbean region has more than 30 years of experience in effective cooperation in tropical cyclone watch warning systems (WWS), this Report reviewed the needs and requirements to strengthen and extend these capacities at the national and regional levels to address other hazards with the objective of achieving an effective MHEWS.

3.3 SOURCES OF INFORMATION FOR THE ASSESSMENT

This assessment was carried out by WMO through a number of primary and secondary sources. The primary sources are detailed in Appendix 1, Tables 6 and 7 and include the following elements:

- (a) Four questionnaires and surveys facilitated by WMO (Table 6):
 - (i) The 2006 WMO DRR Programme country-level disaster prevention and mitigation survey;
 - (ii) The 2010 WMO DRR Programme questionnaire for the training workshop on MHEWS with a focus on institutional partnership and coordination;
 - (iii) The 2010 WMO DRR Programme questionnaire for the technical cooperation workshop for the development of the Caribbean regional cooperation in MHEWS;
 - (iv) The 2011 WMO DRR Programme survey questionnaire to assess forecasting and observing capacities of the national meteorological, hydrological and marines services to support MHEWS in the Caribbean region;
- (b) Workshops and meetings in the region, including the following (refer to Table 6 for Website details):
 - (i) Training Workshop on Multi-hazard Early Warning Systems with Focus on Institutional Partnerships and Cooperation, San Jose, Costa Rica, 22–25 March 2010;
 - (ii) Technical Cooperation Workshop for the Development of the Caribbean Regional Cooperation Programme in Multi-hazard Early Warning Systems, Christ Church, Barbados, 2–5 November 2010;
 - (iii) Consultations with the directors of NMSs during the Fiftieth Session of the Caribbean Meteorological Council, George Town, Grand Cayman, Cayman Islands, 22–23 November 2010;
 - (iv) National Disaster Coordinators and Meteorologists Dialogue Advancing Multi-hazards Early Warning Systems in the Caribbean, Fifth Caribbean Conference on Comprehensive Disaster Management, Montego Bay, Jamaica, 6 December 2010;
 - (v) Strengthening Regional Cooperation to Support Forecasting with Multi-hazard Approach in RA IV, George Town, Cayman Islands, 7 March 2011;
 - (vi) Regional Association IV Workshop on Hurricane Forecasting and Warning and Public Weather Services, Special Session on Disaster Risk Reduction and Early Warning Dissemination and Communication Issues in Central America and the Caribbean, Miami, Florida, United States, 21 March–1 April 2011;
- (c) Consultations with WMO Members, and regional and international agencies in the Caribbean (Table 7), including 22 national visits engaging coordinated meetings with directors of DRM agencies, directors of NMSs and representatives of the hydrological institution or water resource authority in each country/territory covered by the Report, as well as meetings with international and regional organizations and institutions active in DRR in the Caribbean.

The secondary sources of information are detailed in Appendix 1, Tables 8–10, including:

- (a) A review of the various projects and activities that are underway in the Caribbean in the areas of risk assessment, MHEWS and DRR (Table 8);
- (b) Related assessments that have been undertaken by other agencies (Table 9);
- (c) A literature review of national, regional and international sources (Table 10).

Mapping and synthesis of the secondary sources of information relevant to this assessment are provided in Appendix 1, Table 11. While there have been numerous studies already conducted in the region, this mapping indicated that a number of information gaps pertaining to risk assessment and MHEWS remained. These gaps were addressed through the primary sources, with the results outlined in the sections that follow.

CHAPTER 4 – SELECTION OF OTHER RELEVANT PROJECTS

As a first step in this assessment, relevant regional projects that have been recently completed or are in progress were identified and analyzed with respect to their objectives, expected outcomes, stakeholder engagement, and relevance to risk assessment and MHEWS. These are listed in Appendix 1, Table 8 (secondary sources of information for this assessment). Note, however, that this list is not an exhaustive list of all relevant projects in the region. Some of the key projects that are highly relevant to the objectives of this assessment are described in this chapter. Any future capacity development project in the region in areas of risk assessment and MHEWS should consider the outcomes of these various projects and build upon them.

Caribbean Disaster Management Project (CADM II)

This project is implemented by CDEMA and funded by the Japan International Cooperation Agency (JICA) for its phase II (2009–2012), with CIMH, the University of the West Indies and the University of Guyana supporting the implementation. The overall objective is to mitigate disaster damages through enhancement of community resilience to the flood hazard in the CDEMA Member countries. The project has four distinct objectives as follows:

- (a) Establish and strengthen a system for flood-hazard mapping;
- (b) Improve the capability for community disaster management;
- (c) Improve the capacity of CDEMA as a disaster information warehouse/clearing house;
- (d) Reinforce recognition of the importance and usefulness of hazard maps and disaster management plans among the CDEMA Member States.

Pilot projects are being implemented in Dominica, Grenada, Saint Lucia, Belize and Guyana. Three pilots were completed in 2007 in CADM Phase I – Barbados, Saint Vincent and the Grenadines, and Trinidad and Tobago.

This project is particularly relevant to the strengthening of risk assessment capacities in the Caribbean.

Caribbean Risk Management Initiative (CRMI)

The CRMI is an umbrella programme designed to build capacity across the Caribbean region for the management of climate-related risk. It was launched in 2004, and phase II began in 2010. The first phase of CRMI was led by the Cuba and Barbados/OECS UNDP country offices, in close collaboration with partners and other UNDP country offices in the region. Phase II is being coordinated by the UNDP regional office for Latin America and the Caribbean based in Panama. The beneficiaries include Antigua and Barbuda, the Bahamas, the British Caribbean Territories, Barbados, Cuba, the Dominican Republic, Grenada, Haiti, Jamaica, Saint Lucia, Saint Vincent and the Grenadines, and Trinidad and Tobago. The CRMI focuses on increasing capacity through south–south collaboration and the identification and exchange of existing technical capacities. Another key strategy of this programme is the documentation and dissemination of best practices and lessons learned in different aspects. These aspects include those related to DRM and adaptation to climate change, as well as early recovery in SIDS. Dialogue and closer engagement between climate scientists and the more operational community of disaster managers is also encouraged. In this capacity, CRMI focuses on the following objectives:

- (a) Increased capacity for climate risk management;
- (b) Risk reduction and climate change adaptation integrated into development planning;
- (c) Increased investments in climate risk management.

The CRMI has been funded by various donors, such as the Italian Ministry of the Environment, Land and Sea, the Norwegian Ministry of Foreign Affairs, the UNDP Spanish Trust Fund, the UNDP Gender Thematic

Trust Fund (GTTF), UNDP core funding from the Regional Bureau for Latin America and the Caribbean (RBLAC), and the Bureau for Crisis Prevention and Recovery (BCPR).

This project is particularly relevant to the strengthening of disaster and climate risk management by improving knowledge sharing and good practices, and to the strengthening of dialogue and cooperation among various communities in the Caribbean region.

Caribbean Overseas Countries and Territories (OCTs) Regional Risk Reduction Initiative (OCT R3I)

This initiative covers the British and Dutch overseas countries/territories of the Caribbean region (Anguilla, Aruba, Bonaire, the British Virgin Islands, the Cayman Islands, Curaçao and Sint Maarten, Montserrat, Saba, Sint Eustatius, and the Turks and Caicos Islands). The project seeks to address the risk and exposure of these small islands by providing a network of regional infrastructure, programmes, policies and protocols to strengthen their capacity to predict and prepare for natural hazards. This will, it is hoped, improve resilience and reduce risk and subsequent loss. The R3I project is funded by the European Commission to the level of € 932 000, covering a period of three years (2009–2011), and is under consideration for extension into 2012. By the end of the project it is expected that there will be the following results:

- (a) Increased capacity in hazard mapping and associated vulnerability assessments, to be incorporated to an increasing degree into spatial information systems to inform planning and development processes;
- (b) A regional EWS pilot for OCTs, based on the International Telecommunications Union (ITU) automated alert protocol for warnings;
- (c) Increased capacity for built-in response, rescue and recovery, to shorten recovery periods through the use of risk assessment and mitigation practices for development planning;
- (d) Strengthened local disaster management structures and capacities in terms of tools and best practices to support comprehensive DRM;
- (e) Greater cooperation and coordination between OCTs, with documentation and dissemination of best practices.

Intraregional learning and the sharing of tools, knowledge and best practices are emphasized by R3I to enhance the countries'/territories' individual and collective capacities. The project will, among other activities, support OCT disaster management and Geographic Information System (GIS) departments with modelling, simulation and planning, and build on the related experience and knowledge in the Cayman Islands. Further plans include the integration of results of modelling into quantitative multi-hazard vulnerability maps. This will complete and/or initiate building vulnerability studies and improve quantitative risk assessment of critical infrastructure to support the investment in hazard mitigation strategies.

This project is particularly relevant to the development of methodologies for risk assessment and warning dissemination components of EWS and is being implemented based on the expertise in Anguilla for the ITU Common Alert Protocol (CAP) standard-based alert and warning communications.

Caribbean Hazard Mitigation Capacity Building Programme (CHAMP)

This is a three-year project funded by the Canadian International Development Agency (CIDA), implemented by CDERA and executed by OAS. The project aims to improve regional capacity to reduce vulnerability to the effects of natural hazards by assisting countries in the Caribbean region with the development of comprehensive, national hazard-vulnerability reduction initiatives. This will be done through the development of national hazard-mitigation policies, the creation of appropriate policy implementation programmes through comprehensive hazard-mitigation planning frameworks, and the development and implementation of safer building training and certificate programmes (for example, the programme Hazard Mapping and Common Digital Databases for Hazard Mapping and Vulnerability Assessment). The activities of CHAMP will be carried out in the four pilot States of Belize, the British Virgin Islands, Grenada and Saint Lucia.

This project is particularly relevant to the strengthening of emergency preparedness policies and risk assessment capacities in the Caribbean.

Enhancing Resilience to Reduce Vulnerability in the Caribbean

The project Enhancing Resilience to Reduce Vulnerability in the Caribbean (ERRVC) is a UNDP initiative covering Barbados and OECS (including Anguilla, Antigua and Barbuda, the British Virgin Islands, Dominica, Grenada, Montserrat, Saint Kitts and Nevis, Saint Lucia, and Saint Vincent and the Grenadines) that takes an integrated approach to reducing vulnerability and enhancing resilience to climate change and natural hazards, drawing on Italian and Caribbean expertise in enhanced civil protection. This project is funded by the Italian Development Cooperation to the level of €5.5 million, covering a period of three years (2009–2011). This period is likely to be extended to 2012 or 2013. The project is implemented by CIMH, with support from CDEMA, UNESCO–IOC ICG/CARIBE EWS, the CIMA Research Foundation, and other local and regional partners. The project focuses on knowledge sharing, building linkages across Caribbean institutions, capacity development, and advancing the linkages between climate change and DRR. By the end of the project it is expected that there will be:

- (a) A network of real-time decision support centres for EWS through real-time sharing and use of meteorological and hydrological data;
- (b) Strengthened national disaster management mechanisms.

Initial emphasis has been on the first component. This has involved the establishment of a platform to support meteorological officials and disaster managers in the respective countries. The Italian civil protection model will be a vital source of learning and for the adaptation of best practices. The importance of volunteerism in disaster management will also be highlighted, with capacities being built to enhance this aspect of community involvement.

This project is particularly relevant to the strengthening of risk information to support warning messages and informed decision-making for emergency preparedness and response. A critical aspect of this project is the development of risk-based tools for warning and improved cooperation among engaged national and regional agencies.

Strengthening Hydrometeorological Operations and Services in the Caribbean SIDS

The project SHOCS was established in summer 2010 jointly by FMI and ACS. The key purpose of the project is to increase the capacity of ACS for the strategic planning of the entire DRR process, as well as to enhance the capacities of the NMHSs and DRR agencies. The project is targeted specifically at the Caribbean SIDS to provide services and preparedness against natural hazards. The project relies heavily on the partnership between FMI and ACS, and on cooperation between recognized stakeholders in the Caribbean, particularly CMO and its training centre CIMH, CDEMA, and WMO. The overall objective of the project is for the Caribbean societies to be better prepared for the adverse effects of natural disasters and the harmful impacts of climate change. Project activities will be implemented to produce two broad results:

- (a) Completed feasibility study assessment of Caribbean SIDS with recommendations and an action plan for concrete steps of development;
- (b) Improved capacity of the staff of ACS, NMHSs and the civil protection agencies in the ACS Member States for MHEWS, DRR and QMS.

This project is particularly relevant to the strengthening and/or development of QMS in NMSs, this being necessary to support the application of DRR and the establishment of SOPs between NMSs and DRM agencies within the context of EWS.

The United States of America/RA IV–WIGOS Demonstration Project (US/RA IV–WIGOS)

This project is a comprehensive, coordinated and sustainable network of observing systems, based on all the WMO programme's observational requirements. It ensures availability of required information and

facilitates access by the WMO Information System (WIS). Four broad objectives are included in US/RA IV–WIGOS:

- (a) To improve the management and governance of component systems;
- (b) To increase the interoperability between the various systems;
- (c) To apply the objectives to atmospheric, oceanic and terrestrial/hydrological domains;
- (d) To ensure that broader governance frameworks and relationships with other international initiatives are sustained and strengthened.

It is expected that US/RA IV–WIGOS will provide the opportunity to better utilize existing and emerging observation capabilities, thus facilitating accomplishment of required changes. In particular, it is expected that the project will:

- (a) Develop strategies to guarantee the interoperability of systems, including meeting documented standards for data quality of systems and instruments of observation;
- (b) Evaluate existing and emerging capabilities before developing, acquiring, and/or deploying new observing systems or sensors, and when designing cost-effective composite observing systems;
- (c) Develop strategies to satisfy observational requirements of WMO programmes and international partners through the process of the WMO Rolling Requirements Review (RRR);
- (d) Develop a strategy for the production, editing and management of metadata, including instrumentation platform and data discovery;
- (e) Promote the exploitation of existing platforms and the employment of the multi-sensor platform concept to the maximum possible extent;
- (f) Coordinate the response to requirements, plans and activities with all WMO technical commissions, regional associations and programmes.

This project is particularly relevant to the strengthening of the capacities of monitoring and data sharing and the development of regional standards for data, metadata and data products in the Caribbean.

The Carib–HYCOS Project

This is a regional component of the World Hydrological Cycle Observation System (WHYCOS), an initiative launched in 1993 by WMO with the aim of developing water resources information systems to assist Members to improve their water management, and to mitigate the impact of water-related disasters such as floods and droughts. The Carib–HYCOS project started in 2008 with the specific aim of reinforcing national capabilities in water resources management and of promoting international cooperation (exchange of data, technology and expertise). It is currently focusing on Caribbean island countries/territories, including Antigua and Barbuda, Barbados, Cuba, Dominica, the Dominican Republic, Guadeloupe, Haiti, Jamaica, Martinique, Santa Lucia, and Trinidad and Tobago. The supervising agency of the project is WMO, while the Institut de recherche pour le développement (IRD) of France is the executing agency, assisted by, for the English- and Spanish-speaking countries, respectively, CIMH and the Instituto de Meteorología (INSMET) of Cuba. The project is being co-financed by three donors, the General Council of Martinique, European Funds for Regional Development (FEDER) and the Regional Council of Martinique, for a total of € 317 000, with estimated in-kind contributions of € 200 000 from IRD and €400 000 from participating countries.

The specific objectives of the project are to:

- (a) Modernize hydrometeorological networks within the Caribbean;
- (b) Improve the knowledge of regional hydrometeorological phenomena and changes in the environment;
- (c) Facilitate the exchange of reliable and homogeneous data on water resources and the environment.

This project is particularly relevant to the strengthening of hydrological monitoring and data-sharing capacities in the Caribbean.

The CMO Weather Radar Network

This project involves a network of weather radars located in Barbados, Belize, Guyana, Jamaica, and Trinidad and Tobago. The project has been implemented by CMO with funding of €3 million from the EU.

The objective is to replace the old radars by a new network of Doppler weather radars that will link up with existing radars of other Caribbean countries/territories to form an electronic radar composite across the Caribbean. So far, new radars have been installed in Barbados, Belize, Guyana, and Trinidad and Tobago, and Météo-France Martinique will create a mosaic of the four new radars, together with the five that are already installed in French Guiana, Martinique, Guadeloupe, the Dominican Republic and Jamaica. The next steps of the project will focus on:

- (a) Engagement of stakeholders by the NMSs to assess what products need to be delivered and the frequency of delivery;
- (b) Delivery of radar data to Météo-France Martinique for the creation of the mosaic;
- (c) Further radar training (theoretical and practical) to the NMSs by CMO.

This project is particularly relevant to the strengthening and harmonisation of radar networks and the sharing of radar data in the Caribbean.

Increasing the Capacity of CIMH as a Caribbean Regional Instrument Centre

This project engages the institutes FMI and CIMH to strengthen the latter's capacity to meet the terms of reference for a Regional Instrument Centre (RIC). In recent years, there has been a significant turnover of staff in the instruments section of CIMH due to retirements and the need for a more effective succession planning. As a result, this section of CIMH has now largely young and relatively inexperienced staff. This project supports CIMH to gain capacity as a modern WMO RIC, and to fulfil its obligations set forth in the revised terms of reference for RICs. The project will aim to:

- (a) Improve CIMH capacity to help sustain high-quality meteorological observations within its region in the Caribbean;
- (b) Set in place the monitoring and calibration procedures of meteorological instruments at CIMH;
- (c) Lay ground towards future development of QMS-compatible standards for sustainable meteorological observation networks in the Caribbean.

CHAPTER 5 – ASSESSMENT OF CAPACITIES, GAPS AND NEEDS

Information from first and secondary sources was synthesized and mapped according to the different components of the framework presented in Figure 5. This information is presented in Appendix 1, Table 11 to support the analysis presented in this assessment.

5.1 GOVERNANCE AND INSTITUTIONAL FRAMEWORKS IN DISASTER RISK REDUCTION AND EARLY WARNING SYSTEMS

This section discusses the national and regional governance and institutional frameworks applicable to DRR and EWS (refer to Figure 5, item 1, and Appendix 2 for country profiles).

5.1.1 Stakeholders in disaster risk reduction and Multi-hazard Early Warning Systems in the Caribbean

In the Caribbean, DRR stakeholders range from national governments, with their disaster management and civil protection authorities, natural resources, and social and economic departments, to local organizations and the media. They include various regional and international organizations and institutions that are involved in DRR across the region. They encompass both scientific and technical agencies that provide scientific data, early warnings of hazards and other products. Also included are DRM, civil protection and other government departments or agencies, and private-sector and humanitarian organizations that must undertake specific actions to reduce risks, drawing on the products provided by the scientific institutions.

National stakeholders

At the national level, key Caribbean scientific/technical stakeholders include NMSs and national agencies with expertise in hydrology, oceanography, geophysics and other relevant disciplines. Where operational actions to prepare for, prevent or mitigate disasters are concerned, key government stakeholders include political leaders, DRM and civil protection authorities, and ministries, such as those of public health, agriculture and food security, transportation, infrastructure, and others that may be directly impacted by disastrous events. Important private-sector interests include companies that operate airlines, shipping and transportation. The humanitarian sector includes institutions such as IFRC and others that contribute to response and recovery in disaster situations.

Regional Stakeholders

At the regional level, there are many disaster risk stakeholders that play important roles. Appendix 1, Table 1 lists the membership of the major regional organizations and institutions in the Caribbean region. Some contribute expertise, products and services to assist Caribbean countries/territories in risk assessment and early warning. Others support prevention, preparedness and response measures at the national level through provision of organizational, logistical or other support capabilities or financial aid. Among these, several have been identified as key stakeholders that must be involved in any effort to enhance risk assessment and MHEWS in the area. An outline of these is as follows:

- (a) The regional centres and agencies of CARICOM, such as CDEMA, CMO and its technical and training branch, CIMH; CCCCC, UWI and CCRIF;
- (b) The management group of WMO RA IV and its DRR task team, together with other related RA IV task teams, for example the hydrological issues and WIGOS task teams; WMO RA IV Hurricane Committee and the WMO RSMC for the region – the Miami Hurricane Center;

- (c) Regional institutions such as OAS and ACS;
- (d) Regional development banks and donor institutions, such as the Eastern Caribbean Donor Group, CDB and the Inter-American Development Bank (IDB).

International stakeholders

The international dimension is also important in relation to DRR in the Caribbean region. International stakeholders include implementing agencies such as WMO, UNESCO–IOC, UNISDR, UNDP, and IFRC. Bilateral donors and development banks include the World Bank, IDB, the United States Agency for International Development Office of Foreign Disaster Assistance (USAID OFDA), CIDA, the Ministry of Foreign Affairs of Finland, the Agencia Española de Cooperación Internacional para el Desarrollo (AECID) of Spain, JICA, the United Kingdom Department for International Development (DFID), the EU, and others. These international agencies bring specialized capacities and resources to assist in addressing the challenges presented by disaster risk reduction.

5.1.2 Policies and legal frameworks for disaster risk reduction and Multi-hazard Early Warning Systems in the Caribbean

Based on the outcomes of this assessment, it is indicated that all but one of the Caribbean countries/territories has a framework in place that provides legal authority to their DRM agency and clearly defines the agency's mandate. Many Caribbean countries/territories also have other relevant legal acts in place, including acts that mandate powers in emergency situations and acts that establish the succession of senior government and service executives. However, the substance of these legislative authorities varies widely from country to country and, in some instances, the legal framework is clearly out of date and the assessment highlights the need for revision. In the particular case of CDEMA Members, model legislation has been drafted. The implementation of this model legislation is at different stages in various countries/territories in the Caribbean. It has already received assent by legislatures in Saint Lucia, the British Virgin Islands, Montserrat, and St Kitts and Nevis (see Appendix 2 for detailed information).

It is important to note that only two out of seven islands for which documentation is available have legislation in place that clearly defines the NMS role and mandate. Furthermore, six out of seven respondents to the WMO 2006 survey indicated that their NMS had a need for clearer and better-defined policy and legislation. The overall policies and legal frameworks supporting DRR and EWS in the different Caribbean countries/territories are summarized in Appendix 1, Table 12.

Priorities to strengthen policies and legal frameworks

In the light of these findings, the highest priorities to strengthen policies and legal frameworks are considered to be to review and update existing policies, legislation and legal frameworks in support of DRR and MHEWS. The resulting legal structures should reflect the roles and responsibilities of the various stakeholders outlined above.

5.2 DEVELOPMENT OF INSTITUTIONAL COORDINATION AND USER-INTERFACE MECHANISMS

This section discusses national EWS stakeholders and service delivery and feedback mechanisms (refer to Figure 5, items 2 and 3).

5.2.1 Institutional arrangements among National Meteorological Services and disaster risk management agencies to support Multi-hazard Early Warning Systems in the Caribbean

All Caribbean countries/territories that were examined have a full-time DRM agency with professional staff, with the exception of Bermuda, where disaster management is among the responsibilities of the

Bermuda Police Service. Elsewhere, the disaster management office is either a full government department or a unit within a parent ministry. Most often the ministry concerned is the Ministry for National Security (the case, for example, in Cuba (termed the Ministry of the Armed Forces), Dominica, Grenada and Saint Kitts) although it may also be the Ministry for Land and Environment (Jamaica), or the Ministry of Home Affairs (Barbados). Given the small size of many Caribbean countries/territories, the human resources available for DRM vary widely. The DRM agencies of Aruba, Montserrat and Barbados, for example, are reported to have only two permanent professional staff, while the Cuban agency employs hundreds of people.

All assessed countries/territories for which information was available at the time of writing also have a disaster coordination mechanism in place. In most, but not all cases this is backed by a National Disaster Plan. Planning is generally oriented toward frequently recurring hazards, most often tropical cyclones. In many instances disaster plans are not reviewed and updated regularly.⁹ The NMS is represented on the DRM coordinating mechanism in all Caribbean countries/territories, although the specifics of the linkages between the DRM agency and the NMS remain somewhat unclear in many instances. Appendix 1, Table 13 provides an overview of the different disaster management agencies in the Caribbean and their respective capacities.

As underlined earlier, effective and efficient cooperation between NMSs, DRM agencies and other stakeholders is vital for disaster prevention, preparedness and real-time management of weather-related crises. Across the Caribbean region, there are three different cases of support mechanisms for the provision of meteorological, hydrological and climate-related products and services to DRM agencies. The three cases are:

- (a) Case I: the DRM agency is supported by the NMS of its own country/territory (Figure 6);
- (b) Case II: the DRM agency is supported by the NMS of its own country/territory, but the NMS has limited capacity (for example, no forecast and warning office) and needs assistance from the NMS of another country/territory to fulfil its mandate to support the DRM agency (Figure 7);
- (c) Case III: the DRM agency is supported by the NMS of another country/territory (Figure 8).



Figure 6. Case I support structure – the DRM agency is supported by the NMS of its own country/territory.

These three cases, including a listing of the countries/territories, are also detailed in Appendix 1, Tables 14–16.

In the examples presented by cases II and III, the NMSs concerned are faced with additional complexities and challenges in managing their operational cooperation with other NMSs and DRM agencies.

In the past, the activities of most NMSs in the Caribbean were based on aeronautical requirements. The orientation of NMSs towards providing meteorological support to meet the needs of DRM agencies is somewhat recent. As a result, not all mechanisms, requirements and challenges are well established and understood by both sides. Moreover, in most Caribbean countries/territories, DRM agencies are in the

⁹ Reference should be made to the programme being implemented by CDEMA at this time concerning multi-hazard contingency plans in 10 CDEMA participating States, funded by the African, Caribbean and Pacific Group of States (ACP) and the EU. This will be completed by 2013. Between four to six States possess plans reaching some minimum level and another two States will require some support.

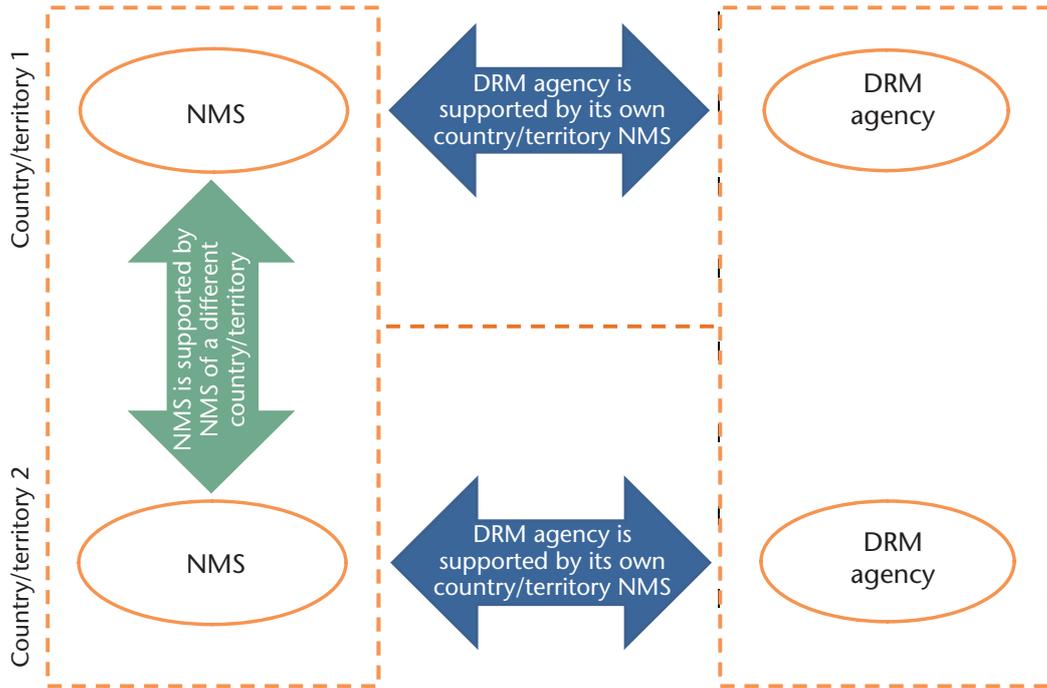


Figure 7. Case II support structure – the DRM agency is supported by the NMS of its own country/territory, but the NMS has limited capacities and needs assistance from the NMS of another country/territory.

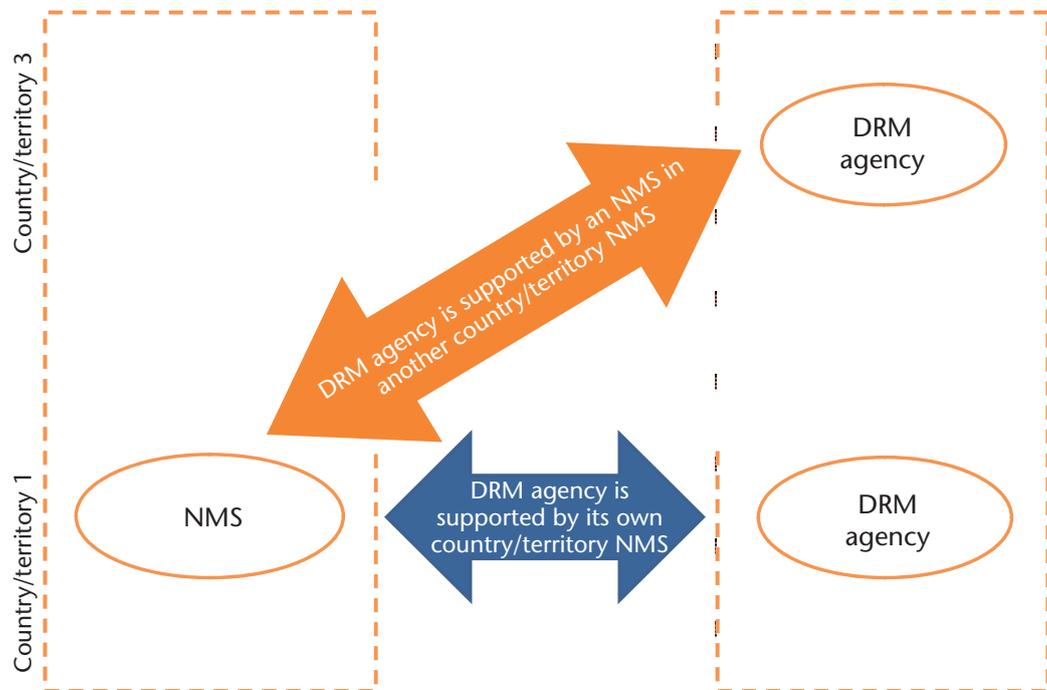


Figure 8. Case III support structure – the DRM agency is supported by the NMS of another country/territory.

process of being developed with limited human resources. It seems clear that some Caribbean countries/territories would benefit from a clearer definition of the roles and responsibilities of NMSs and other EWS stakeholders in relation to different types of hazards, particularly where hazards other than tropical cyclones are concerned.

5.2.2 Dissemination of products and services

Dissemination mechanisms are crucial for effective product and service delivery (refer to Figure 5, item 3). Even the best forecasts and the most accurate warning products may be of little value if they are not delivered to the right stakeholders in timely manner. It is essential that NMSs ensure that their capacities for delivery are sufficient, especially in case of dissemination of severe weather watches and warnings. It is also essential to establish who is responsible to issue what to whom. Where dissemination of warning products is concerned, there are three basic approaches that are utilized in the Caribbean region, these being:

- (a) The NMS disseminates warning information to all stakeholders. This is the case in Cuba, Antigua and Barbuda, and Curacao and Sint Maarten. In addition, some NMSs also have to ensure effective dissemination to several other islands.
- (b) The NMS disseminates warning products uniquely in the form of scientific information to the DRM agency. The DRM agency in turn has the mandate to ensure broad dissemination to other stakeholders and to the public. This is the most common approach in the region (for example, in Belize, Trinidad and Tobago, and Saint Lucia).
- (c) The NMS and the DRM agency provide warning products to their respective stakeholders, following coordination and agreement. This is the approach in the French West Indies, the Bahamas, Jamaica and Suriname. In addition, NMSs also disseminate warning products to communities at the local level.

It has been stressed that the dissemination systems could benefit from an improvement of the coordination between DRM agencies and NMSs. This may especially be the case for Caribbean countries/territories with case II and III support mechanisms, in which the DRM agency must rely on an NMS from another country for meteorological and hydrological forecasts, watches and warnings. Moreover, during consultation visits, it was suggested that there is a significant need for the development or improvement of dissemination mechanisms at the national level for tsunami warnings. This is particularly the case for those warnings issued through the current Pacific and West Coast/Alaska Tsunami Warning Centres, and eventually the Caribbean Tsunami Warning Centre under development through ICG/CARIBE EWS.

In those Caribbean countries/territories that have an NMS, the primary dissemination methods are through fax, e-mail and the NMS Website. Dissemination is mostly via computer-based e-mail distribution lists, with File Transfer Protocol (FTP) being rarely used to feed user-specific dissemination systems automatically. Caribbean countries/territories could benefit from an automated dissemination platform that is integrated with the NMS production system, as is currently the case in the French West Indies. A large majority of the Caribbean countries/territories host their e-mail through external commercial entities.

Telephone answering machines are often used as a method for providing information to the public, especially in the case of severe weather. However, these systems are not always free of charge for the public. In addition, some Caribbean countries/territories have also started to develop product dissemination through other, newer information and communication technologies, such as SMS and social media. Dissemination of SMS, for example, is used in Antigua and Barbuda, Saint Lucia, Trinidad and Tobago, and the French West Indies and is based on private–public partnerships between NMSs and the mobile service providers. Trinidad and Tobago, and Antigua and Barbuda have started to use virtual social networking facilities such as Facebook or Twitter to disseminate warning products.

A number of Caribbean countries/territories are implementing the CAP system as a standard tool for warning dissemination based on clearly defined protocols. For example, the CAP system of Anguilla is the first pilot. It was implemented in 2007 and 2008, and has shown positive benefits. The policy stipulates who is authorized to activate warnings and for which type of incident. This system is now in its final phase, which will develop the capability for enabling multilingual, all-hazards alert and warning to a diverse population.

This will be in several alert-dissemination modes, taking into account the hearing, site and mobility of impaired persons. The system is being used as a model platform to be replicated and extended to a regional CAP warning network, involving three other Caribbean countries/territories (Curaçao and Sint Maarten, Montserrat, Aruba).

In addition, EMWIN systems have been installed in many countries/territories in the region, in both NMS and DRM agencies, as well as the TWFPs of the Dutch and United Kingdom countries/territories. However, according to this assessment, the systems seem to be underutilized for meteorological warnings. It should be noted that EMWIN is the platform identified by ICG/CARIBE as a means to receive tsunami warnings, which alters if a GFS telephone is not available. Such is the case in many of the territories that do not have an NMS that is operational 24/7.

Public Websites are one of the primary means of dissemination in the Caribbean. Most forecast and warning products from Caribbean countries/territories are available on the Internet (except for the Turks and Caicos Islands). Some of the official national Websites are hosted and managed within the country/territory itself, while others are managed remotely or shared (Appendix 1, Table 17). In this context, special consideration should be given to those Caribbean countries/territories without NMSs, to ensure that forecast and warning products on the Internet meet their needs. It was highlighted during country visits that Caribbean countries/territories could benefit from a regional approach to Web server solutions, with standardized and harmonized specifications, allowing for country/territory-specific flexibility and management.

The availability of forecast and warning information on the Internet is of great importance, especially during intense hazardous events such as tropical cyclones. During such events, the number of Website hits can multiply by a factor of from 10 to 100, and the most important Websites may become inaccessible. It has been highlighted that the NMSs and DRM agencies need to ensure that critical facilities for dissemination are in working order, especially just prior to potentially high-impact weather. It was stressed during consultations that there is a need for server capacities and bandwidth to be improved in several Caribbean countries/territories, with the possibility of "mirror sites" to ensure continued accessibility. It was also suggested that a strategy for improving public meteorological Website capacities at the national level should prioritize technical training on Website management, including backup routines.

Communication through the media, especially live communication on radio or television, is an essential component of dissemination to the public at large. Simplicity, credibility and efficiency of the message are important to ensure the greatest impact. In most Caribbean countries/territories, real-time media (television and radio) is considered to be of the highest priority for dissemination of warning information directly to the public. In several Caribbean countries/territories (for example, the Bahamas, Cuba, the Dominican Republic and the French West Indies), warnings are perceived to carry more authority and credibility when the message is delivered by a meteorologist, especially when messages are illustrated with graphic animations of satellite, radar or tropical cyclone tracks. The Cuban NMS, for example, has a specific system in place that enables direct broadcasting on national television channels from the forecasting office. Accompanying illustrations are produced with a dedicated media Corobor workstation.

Ideally, warning messages and related information should be delivered either by meteorologists trained in media presentation or by journalists trained in meteorology. This should be accompanied by visual information, such as storm tracks or radar information, to add value and aid understanding. Caribbean forecasters have highlighted that the media would benefit from training on specific vocabulary, terminology, probabilistic approaches and the challenges that come with meteorological forecasting. The training should include an understanding of potential hazards and their impacts for their specific country or territory. This would add credibility to media communication of severe weather forecasts and warnings. Equally, they have stressed that meteorologists who are likely to appear on television or talk on the radio would benefit from training on the presentation of scientific information to a lay public. Almost all the Caribbean countries/territories have identified that they would benefit from bilateral training and workshops involving both the meteorological services (and especially the forecasters) and the media. In this case, a regional approach could enable wider exchange throughout the region, particularly with countries with demonstrated good practices. Furthermore, several Caribbean

countries/territories expressed the need to target specific populations with regard to communication of warnings, with visitors being a prime example in the case that tourism is of high importance (necessitating multilingual warning products).

5.2.3 Feedback mechanisms

There is need for the establishment of feedback mechanisms that enable systematic evaluation and improvement of the various components of MHEWS, including feedback to NMSs with respect to the provision of their products and services. As identified in countries possessing good practices in EWS, feedback mechanisms make a vital contribution to increasing bilateral and multi-sectoral understanding, and facilitating continual improvement of the service delivery by NMSs. Such mechanisms include routine or post-event meetings, workshops, training and simulation exercises. Feedback from DRM agencies as the main users is crucially important for continual improvement of the support that NMSs provide. Once again, special attention is merited for Caribbean countries/territories, where the feedback procedures are more complex, notably NMS case categories II and III that encompass not only support of their own country/territory, but also that of others.

In the small islands of the Caribbean region, there are few well-organized mechanisms for feedback. Preference is given rather to informal means of institutional communication (for example, through individual conversations or telephone calls). There are a number of Caribbean countries/territories, however, where comprehensive post-event feedback with all DRM stakeholders is a systematic practice, and this practice has sometimes led to major improvements in operational cooperation between NMSs and key stakeholders. In Saint Lucia, Tropical Storm *Debby*, which brought heavy rain and caused several landslides, killing four people and injuring more than 600 in 1994, and the 1996 October floods, led to the implementation of coordination mechanisms between the DRM agency and the NMS. Damaging waves from Hurricane *Lenny* in 1999 highlighted the weaknesses of the procedures in the French West Indies. The resulting feedback from civil protection agencies played an important role in the implementation of new procedures of coordination. Furthermore, in the aftermath of Hurricane *Ivan* in Grenada and the Cayman Islands in 2004, improvements were implemented that saved lives the following year, when Hurricane *Emily* made landfall in Grenada. However, from both the DRM and meteorological viewpoints, it is clear that identification of weaknesses in operational cooperation through post-disaster feedback should be complemented with drills and exercises. Examples include the annual exercises that are carried out in several islands (for example, Cuba, the Cayman Islands, and the French West Indies) to identify the weaknesses in particular aspects of comprehensive EWS.

During the consultation process, it was identified that there is a need for improved cooperation mechanisms between the DRM agencies and NMSs, through the implementation of specific SOPs for real-time coordination and feedback. Only two Caribbean countries/territories in the region, the French West Indies and the Dominican Republic, have operational mechanisms and procedures in place (for example, defined user needs, feedback processes, continual improvement) that are well defined through comprehensive International Organization for Standardization (ISO) and QMS certification. There are workshops, conferences and specialized training with DRM certification in some Caribbean countries/territories (for example, Jamaica and Cuba) that bring together key DRM stakeholders and NMSs. These initiatives are highlighted as good practices in the region. There is a clear need in the region for strengthened bilateral or regional cooperation for the sharing of good practices.

In the case of islands without meteorological services, focal points have been established (generally air traffic controllers) to support the operational link between the responsible forecasting office of another island and the local DRM agency. For Caribbean countries/territories with case II and case III support mechanisms, specific SOPs should be developed to frame the operational cooperation between the DRM agency of the Caribbean country/territory without an NMS and the responsible NMS of another country/territory (for example, for Antigua and Barbuda, the Bahamas, Barbados, Curaçao and Sint Maarten, Guadeloupe, and Trinidad and Tobago). It has, furthermore, become apparent that some DRM agencies from these Caribbean countries/territories are not supported by the closest forecasting and warning centre, which could lead to confusion.

5.2.4 Highest priorities for service delivery to support Multi-hazard Early Warning Systems in the Caribbean

Institutional arrangements among NMHSs and DRM agencies to support MHEWS

A detailed overview of the capacities, gaps and needs for institutional cooperation between NMSs, DRM agencies and key EWS stakeholders is shown in Appendix 1, Table 18. The highest priorities for strengthening the mechanisms of cooperation and coordination between MHEWS stakeholders as expressed by participating Caribbean countries/territories are to:

- (a) Develop multi-sectoral institutional mapping, capacities and linkages among all the MHEWS stakeholders as the basis for the development of SOPs and relevant agreements;
- (b) Develop specific agreements (MOUs, and the like) and SOPs, under a QMS framework, between the agencies based on their institutional mandates and roles;
- (c) Improve ongoing MHEWS stakeholders' workshops and trainings at national or/and regional level to increase understanding of roles and capacities among NMSs, DRM agencies and other stakeholders engaged in risk assessment and MHEWS;
- (d) Develop, for Caribbean countries/territories under case II and case III, additional specific SOPs, depending on the various interfaces and levels of complexity with respect to the relations of NMSs and DRM agencies within and outside the country/territory;
- (e) Document good practices of countries/territories throughout the region, and develop a list of expertise and a roster of experts in the region;
- (f) Strengthen institutional cooperation in the region with specific goals and cooperation mechanisms (for example, stronger cooperation between CMO–CIMH and CDEMA). It is highlighted that development of projects such as the DEWETRA Platform (developed for the Italian National Department of Civil Protection by the CIMA Research Foundation) may provide such opportunities.

Dissemination mechanisms

Capacities, gaps and needs have been identified in Appendix 1, Table 19. The highest priority needs identified by the participating Caribbean countries/territories include:

- (a) Strengthening of dissemination mechanisms between NMSs and DRM agencies through:
 - (i) Strengthened regionally harmonized protocols (for example, CAP);
 - (ii) Integrated tools or systems with automated processes;
 - (iii) Strengthened backup systems (including agreements for backup between different Caribbean countries/territories) and up-to-date means;
- (b) Improvement of the capacities of NMSs for comprehensive management of their public Websites;
- (c) Increasing the credibility and the impact of live media communication through:
 - (i) Bilateral workshops and training with forecasters and media specialists and/or journalists;
 - (ii) Specific integrated tools or systems dedicated for television broadcast;
- (d) Targeting of specific populations (for example, tourists, youth).

Feedback mechanisms

Capacities, gaps and needs have been identified in Appendix 1, Table 19. The highest priority needs that have been identified by the participating Caribbean countries/territories include enhancement of feedback mechanisms by conducting:

- (a) Coordinated drills and exercises for multi-MHEWS stakeholders, especially for countries/territories with case II and case III support mechanisms;
- (b) Systematic post-event evaluations of MHEWS stakeholders' interactions.

5.3 DEVELOPMENT OF NATIONAL METEOROLOGICAL SERVICES PRODUCTS AND SERVICES TO MEET THE NEEDS OF MULTI-HAZARD EARLY WARNING SYSTEMS STAKEHOLDERS

This section discusses NMS products and services to support national EWS stakeholders (refer to Figure 5, item 4). If NMSs are to meet the needs of DRM agencies, other EWS stakeholders and the public,

they must ensure the quality, relevance, timeliness and overall effectiveness of the products and services they deliver. This assessment focuses on the capacities of NMSs in relation to the production and delivery of EWS-related products and services, and on the level of cooperation and interaction between these services and other technical institutions that support DRM.

5.3.1 Hazard-analysis products to support risk assessment

Hazard assessment and mapping, combined with exposure and vulnerability analysis, is the foundation of risk assessment. Many socio-economic sectors, such as water, agriculture, fisheries, health, forestry, transport, tourism and energy, are highly sensitive to weather and climate extremes. Decision-makers in these sectors are increasingly concerned by the adverse impacts of climate variability and change, but are inadequately equipped to make effective use of climate information to manage current and future climate risks. There is considerable potential for strengthening support to decision-makers through effective risk assessment (see Box, following).

In many countries/territories, institutional capacities and cooperation for risk assessment need to be developed or strengthened. Effective DRM must be founded on scientifically sound risk assessment to quantify and understand the risks associated with natural hazards and their impacts. Risk assessment requires quality-assured historical and real-time data on hazards along with socio-economic impact data. Furthermore, there is need for the development of disaster-impact depositories for various sectors. There is also a need for tools for hazard and risk analyses for quantification of exposures and vulnerabilities (for example, casualties, construction damages, crop yield reduction and water shortages).

Analysis of hazard patterns from historical data is necessary but not sufficient for risk assessment. Changing patterns of climate hazards are posing challenges to longer-term strategic planning and investment (for example, infrastructure planning and retrofitting based on building codes and specifications) based on historical records alone (for example, a 100-year flood may become a 30-year flood). Consequently, climate analysis tools for assessing changes in severity and frequency, and occurrences of meteorological, hydrological and climate-related hazards at seasonal, interannual, decadal, and longer climate change timelines need to become available operationally and be applied during risk assessment.

With adequate knowledge of risk, countries can develop or improve risk management using:

- (a) EWS and preparedness;
- (b) Medium- and long-term sectoral planning (for example, land zoning, infrastructure development, agricultural management and water resource management);
- (c) Utilization of weather-indexed insurance and financing mechanisms to reduce and transfer the economic impacts of disasters at various levels and decision timelines (operational to strategic).

All sectors require a wide range of meteorological, hydrological and climate information products and services, at different temporal and spatial scales, and with different information content. These information products include data products, forecasts, outlooks and analyses, and research products.

Agencies of DRM and other EWS stakeholders depend on NMHSs for hydrometeorological hazard information. Specifically, the analysis has indicated that in many countries/territories historical meteorological and hydrological records remain paper-based and at risk of being lost due to decay and maintenance conditions. To this end, there is urgent need to digitize and perform quality control on the data and metadata and make them accessible through effective data management systems.¹⁰

Hazard analysis should not only focus on the synoptic scale but must also be downscaled to address associated hazards such as strong winds, heavy rains or damaging waves. Downscaling requires the application of high-resolution data on topography and altimetry, modelling capacities, either in-country or through shared centres of excellence, and good observing networks with quality-controlled data. These

¹⁰ A grant of approximately US\$ 300 000 has been approved by CDB for CIMH to digitize and perform quality control on the data and metadata and make them accessible through an effective data management system, including training in the CMO Member States.

Opportunities for risk assessment as the foundation for effective DRR within a changing climate

It has been demonstrated that EWSs can be effective tools for reducing loss of life through improved emergency preparedness and response. However, the emergence of climate prediction and forecasting tools provides unprecedented opportunities to provide outlooks and warnings with longer lead times. These lead times can be used for improved sectoral planning, for example, supply/demand management and risk management practices in agriculture, urban planning and water resource management, and, ultimately, for protection of livelihoods. World Climate Conference-3 (WCC-3) stressed the importance of climate information for the support of DRR and the clear linkages with DRR as a critical component of climate adaptation and the Global Framework for Climate Services (GFCS). Since its adoption in 2005, HFA has provided clear priorities for action and justification for the need for cooperation at national, regional and international levels to significantly reduce the impacts of natural hazards.

requirements underline the need for close cooperation with other technical agencies and well-trained personnel. It is essential to leverage opportunities across different hazard risks, such as storm surges and tsunamis, and to integrate changing hazard patterns resulting from climate variability and change.

The present assessment has revealed that most Caribbean countries/territories have access to hazard analyses through publications (for example, an atlas of probable storm surge height and the maximum envelope of water (MEOW) for a region (see West Florida Regional Planning Council, 2010) that focuses on storm surge hazard). This information, however, is coarse and static. Specific studies on hazard return frequency are also available in many Caribbean countries/territories (for example, Antigua and Barbuda, the French West Indies and Saint Kitts have information on the return frequency of high waves and storm surges associated with tropical cyclones). Statistical information on tropical cyclones is also produced in several Caribbean countries/territories based on the RSMC hurricane database. Jamaica, identified as an island with good practices in risk assessment, has undertaken downscaled hazard analysis and mapping for several rivers and coastal hazards (for example, storm surge for Kingston and Montego Bay). Cuba and the French West Indies have completed high-resolution risk assessment for the entire islands to the level of streets or ground parcels. Finally, specialized regional or international bodies have the capacities to provide downscaled statistical information on tropical cyclone hazards.

In most Caribbean countries/territories, DRM agencies and NMSs have stressed the need for additional information and for hazard analyses to be updated at a higher resolution. In the case of larger countries/territories this should be extended to cover the complete territory or the main vulnerable areas. Such analyses should encompass hazards that are not necessarily related to tropical cyclones, including rain-fall, swell and waves. In particular, specific needs were identified for:

- (a) Digitization and quality control of paper-based meteorological and hydrological historical records;
- (b) High-resolution data on topography and altimetry: currently, some Caribbean countries/territories have GIS ground databases, and where these exist the resolution is often too low. A French campaign with a light detecting and ranging (LIDAR) survey has been achieved in Martinique, and some Caribbean countries/territories expressed the view that this type of survey could be extended to other Caribbean countries/territories;
- (c) Modelling capacities for NMSs, at least at the regional level or through shared centre(s) of excellence, especially for tropical cyclone initialization;
- (d) A good observing network, with quality-controlled data to underpin statistical analysis and to verify model outputs.

5.3.2 Data products

Data products are central to many of the activities that support DRM agencies and EWS stakeholders, with the user community including an expanding range of interested parties and decision makers. Such

products encompass both raw data (for example, raw observations and radar information) and added-value products generated through data analysis, statistical methods and special filtering or formatting processes. Since there is no complete, regional meteorological database in the Caribbean, it is currently difficult for stakeholders to obtain access to regional data products for regional applications such as climate change related risks. According to CIMH, while few data products were available in the past, the situation is changing and more products are becoming available for national use.¹¹ For its part, CMO has endorsed the need to strengthen the development and use of processing systems to transform data into useful information, under the US/RA IV–WIGOS Demonstration Project.

During consultations and workshop discussions, it was stressed that accurate identification of stakeholders' needs with respect to data products would assist in strengthening relationships between NMSs, the DRM agencies and other EWS stakeholders in the Caribbean. As a related matter, several NMSs expressed needs for access to technical capacities in order to implement automated or semi-automated data product servers (for example, FTP client and Web facilities) with the objective of providing DRM agencies and other stakeholders with access to credible, quality-controlled data products (such access is currently quite rare in the region). More particularly, some NMSs identified that they could benefit from specific systems and tools to make data products more accessible and user-friendly, ideally accompanied by training on statistical methodology and high-level data management.¹²

5.3.3 Forecast and warning products

Forecasts and warning products are central to the provision of real-time support to DRM and other agencies in the case of severe weather. It is important that these products meet the needs of both the agencies and the general public. Combined products with text, illustrations and graphics are increasingly appreciated, as visual communication has a high impact. Such products must be formatted to fit the dissemination means (for example, by fax, SMS, Internet and e-mail). In the context of EWS, it is useful for forecasting and warning products to integrate meteorological and hydrological information and include recommendations for protecting life and property.

All Caribbean countries/territories with forecasting capacities provide forecast bulletins, including special bulletins for severe weather, and warnings to their stakeholders (including nearby dependent States) and the public. In the case of tropical cyclone watches and warnings, bulletins and guidance taken directly from RSMC–Miami are, in some Caribbean countries/territories, forwarded to national stakeholders and the public, sometimes with light reformatting. Most bulletins issued by NMSs are text bulletins and are produced on single PCs with MS Office software. Except in cases in which NMSs have a special system for production (for example, Meteofactory in the French West Indies, Smartmet in Jamaica, and Trinidad and Tobago, Metlab in the Bahamas and the Cayman Islands, the Forecast Engine in Curaçao and Sint Maarten), no use is made of graphics. As pointed out earlier, several NMSs in the region (Antigua and Barbuda, the Bahamas, Barbados, Curaçao and Sint Maarten, Guadeloupe) provide forecast and warning services to other Caribbean countries/territories (in the context of case II and case III support mechanisms – see Appendix 1, Tables 14–16).

Each country/territory with an NMS has a Website for the display of forecasts and warnings (Appendix 1, Table 17). Graphical products, such as those displaying tropical cyclone tracks, are sometimes downloaded from other Websites (especially the RSMC–Miami Hurricane Center) and then displayed on the NMS Website or distributed to stakeholders. The forecast offices have highlighted that there is a need for an end-to-end system for the production of forecasts and warnings, including integrated graphics for

¹¹ Data products produced by CIMH are based on its archived database, which is quality assured. The database is currently undergoing more robust testing and will be expanded based on the outcomes of the CIMH/CDB data-rescue initiative which is currently ongoing.

¹² There is currently a collaboration between CIMH, CCCCC/UNITAR and the University of Reading on the delivery of the Statistics in Applied Climatology (SIAC) programme in the Caribbean. A number of regional personnel recently completed the e-SIAC (an e-learning course), with the Caribbean participants achieving the highest percentage of passes ever noted globally. The f-SIAC (follow-up) for the Caribbean is currently being planned. Experts at CIMH are to deliver more of these programmes in the Caribbean in the future.

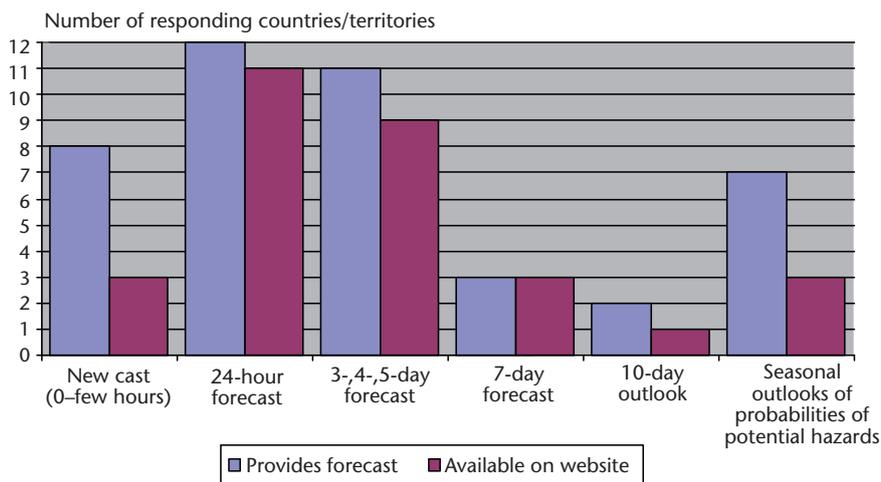


Figure 9. Type of meteorological forecast products provided by NMSs and their Website availability

Source: WMO 2011 technical survey, see Appendix 1, Table 6

dissemination support. The system needs to have the flexibility for the fine-tuning of products and to be sustainable.

The WMO technical survey of 2011 (Appendix 1, Table 6) revealed that the majority of the responding Caribbean countries/territories produce and make available forecasts as nowcasts, 24-hour, and 3-, 4- and 5-day forecasts. A little more than half of the responding countries/territories reported that they also produce seasonal outlooks (Figure 9). With regard to specialized forecasts for various sectors, the responding Caribbean countries/territories indicated that the majority of NMSs provide specialized forecasts and warnings to the air transport and tourism sectors (Figure 10).

Where drought monitoring and warning are concerned, CIMH provides products at both regional and country levels through the Caribbean Drought and Precipitation Monitoring Network (CDPMN). These products, as previously noted, are based on the Standard Precipitation Index (SPI) and on short-term or seasonal rainfall forecasts. The need has been expressed to improve awareness and understanding of

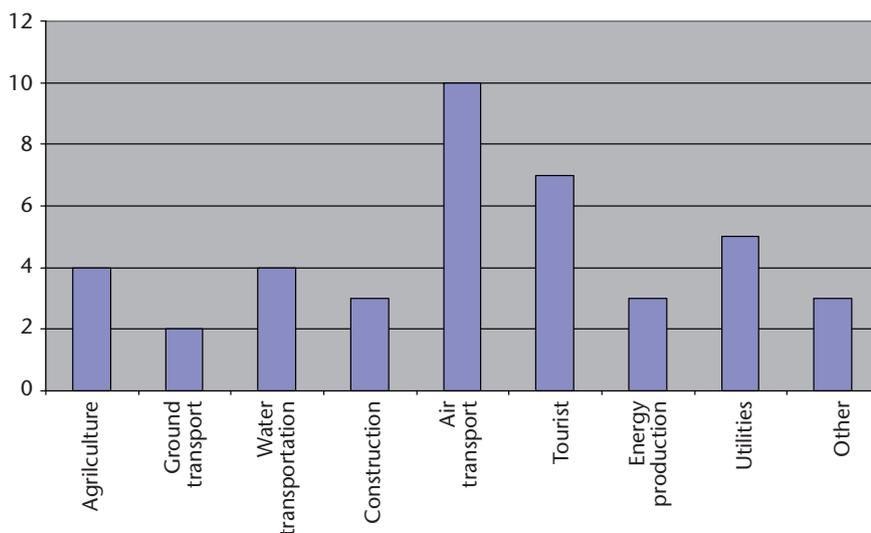


Figure 10. Number of responding Caribbean countries/territories indicating their provision of specialized forecasts and warnings to various sectors

Source: WMO 2011 technical survey, see Appendix 1, Table 6

these products for better use at national levels, and to extent their distribution to non-English-speaking Caribbean countries/territories.¹³

5.3.4 Expertise and advisory services

Experts in EWS play an important role in supporting DRM agencies and stakeholders in a large variety of activities. These are related to decision-making, such as urban planning or real-time risk assessment, or to mutual understanding and exchange. In most Caribbean countries/territories that have an NMS, the Director or the WMO Permanent Representative is the expert involved in the national DRM framework, although in some Caribbean countries/territories the head of the forecast office has been designated in this role. The expert plays an important role in the crisis management committee, embodying the link between real-time hazard analysis, monitoring process and real-time risk assessment. Some NMSs have expressed a need for meteorologists serving as DRM focal points to receive specific training on the activities and processes of the national DRM agency.

5.3.5 Highest priorities with regard to product and service development

An overview of the capacities, gaps and needs for product and service development is presented in Appendix 1, Tables 20 (national aspects) and 21 (regional aspects). The highest priorities identified by the participating Caribbean countries/territories include:

- (a) Hazard analysis and risk assessment: Development of a risk-based, multi-agency mechanism at the national (when relevant and possible) and regional levels to identify the needs and requirements for meteorological, hydrological and climate products and services, such as:
 - (i) Data products;
 - (ii) Hazard analyses (statistical and forward looking);
 - (iii) Forecasts and warnings;
 - (iv) Technical advice and operational support;
- (b) Improvement of data products through:
 - (i) Improved knowledge of stakeholders' needs for the development of user-centred products and services;
 - (ii) Strengthened development and use of processing systems to transform data into useful information, under the US/RA IV–WIGOS Demonstration Project;
 - (iii) Development of specific systems, tools or applications for data formatting, statistical data, diagrams, and the like;
 - (iv) Installation of an automated data server to provide real-time and non-real-time data access to institutions and other stakeholders;
 - (v) Development of integrated, quality-controlled and sustainable GIS databases with metadata and climatological data rescue and exchange mechanisms at national and regional levels;
- (c) Improvement of hazard-analysis products to support risk assessment, through:
 - (i) Access to hazard modelling capacities;
 - (ii) Access to long time series of observations at national and regional levels, which should include meteorological and hydrological information, metadata and hazard information with sufficient spatial coverage;
 - (iii) Access to high-resolution topography and bathymetry;
 - (iv) A regional programme that would include training, sharing and transfer of tools, methodology and good practices through training and workshops, and development of a list of regional resources for modelling, training and product development;
 - (v) Strengthening the relationships between NMSs, DRM agencies and stakeholders, through training and workshops on hazard analysis and risk assessment;
 - (vi) Strengthening the provision of specific hazard analysis into the risk assessment process in countries with case II and case III support mechanisms;
- (d) Improvement of forecast and warning products through:
 - (i) A strengthening of real-time coordination mechanisms among technical institutions and DRM

¹³ These products are available to the public on the CIMH Website: <http://www.cimh.edu.bb/>.

- agencies to provide input into forecast and warning products;
- (ii) Development of a user-centred approach, including development/strengthening of methodologies and mechanisms for user feedback during product development and operational phases;
 - (iii) Adoption of a regional approach for the sharing of expertise and tools needed in forecast and warning production systems;
 - (iv) An expansion of the distribution of CDPMN products to all Caribbean countries/territories and improved awareness and understanding of these products.

5.4 CORE CAPACITIES OF NATIONAL METEOROLOGICAL SERVICES TO SUPPORT MULTI-HAZARD EARLY WARNING SYSTEMS IN THE CARIBBEAN

As observed earlier, it is essential that NMSs possess adequate core capacities and sufficient technical support if they are to support DRM agencies and EWS stakeholders with the products and services mentioned earlier (refer to Figure 5, item 5). These capacities comprise different areas that are related, respectively, to the past (climatology, data management and data rescue), the present (observation networks and monitoring) and the future (operational forecasting, seasonal forecasts). It has been highlighted that the Caribbean region would benefit from the establishment of core minimum requirements for meteorological services, and from the improvement of coordination among different projects and programmes in the region that are supporting the development of these core capacities (for example, the Carib–HYCOS and US/RA IV–WIGOS projects).

In addition, each NMS needs a clear framework within which to ensure efficiency and effectiveness in the management of its activities in support of EWS. This includes the utilization of clearly defined SOPs along with qualified and trained human resources. A comprehensive user-oriented QMS ensures that different processes within the NMS, including control and feedback mechanisms, are documented, coordinated and continually improved over time. The implementation of a comprehensive QMS will contribute to the efficiency of cooperation between NMSs, DRM agencies and other EWS stakeholders. As stressed earlier, where human resources are concerned ongoing capacity development and training is essential, not only for forecasters but for all other staff working in fields such as computer engineering, statistics, communication and management. Furthermore, multi-agency training and knowledge transfer between DRM agencies, NMSs and the media are equally essential.

5.4.1 Observation and monitoring networks and systems

Real-time hydrometeorological observation networks and systems are essential for the monitoring of all weather-related hazards, supplying essential data that enable forecasters to adapt and update forecast and warning information in a timely manner. Quality-controlled observations are also needed for the verification and calibration of numerical models. Climatological networks complement real-time networks by providing improved spatial coverage that is essential for hazard and risk assessments, particularly for slow-onset hazards (droughts, heat waves and climate change) and for downscaling processes. In the Caribbean, real-time observational networks are comprised of local or national networks and also regional networks possessing sharing and exchange processes. The national or local land-based surface observation networks rely heavily on automatic weather stations (AWSs), whose spatial coverage varies across the region. In addition, coastal marine observation networks with wave riders around the French West Indies, and moored buoys in the nearby Atlantic and Caribbean Sea supply accurate information on waves.

All Caribbean countries/territories that have NMSs maintain their own observational networks although, as indicated, the extent of spatial coverage varies widely between them. Where real-time observations are concerned, some Caribbean countries/territories, especially in the Lesser Antilles, have a limited number of AWSs (for example, one AWS in Saint Vincent, two in Barbados, two in Dominica, three in Antigua and Barbuda, and nine in Guyana) while others have a larger number (for example, 40 in Martinique). Even though the number of AWSs is generally larger in the Greater Antilles (more than 80 in Cuba), this does not mean that coverage is sufficient for their needs, in particular to support the wide range of activities of NMSs in the context of EWS. The installation in Haiti of six AWSs is currently being funded by WMO, with the technical support of the Dominican Republic. Some Caribbean countries/territories (for example,

Jamaica, Martinique and Saint Lucia) have implemented through regional or national cooperation special observation networks coupled with automated systems for warnings of heavy rain and flooding. Currently, Caribbean countries/territories without NMSs have no real-time AWSs in place, with the exception of Saint Martin and Saint Barthélemy, both of which have one AWS at each airport that is monitored and maintained by Guadeloupe. This situation has been identified as a major gap with regard to hazard monitoring in the region.

Newer observational technologies, such as weather radar, significantly increase the abilities of NMSs to track and predict hazards such as thunderstorms and other convective systems that often generate high winds, heavy rainfalls and flash floods. The Caribbean region has benefited from the implementation of several new radars in Guyana, Trinidad, Barbados and Belize, and this has led to major improvements in regional and national monitoring capacities. The Caribbean Radar Project, which endeavours to ensure seamless radar coverage of the Caribbean region, will be completed soon. The next steps will target remaining gaps in regional radar coverage by including existing radars from Curaçao and Sint Maarten, Cuba, Jamaica and possibly the Cayman Islands, where a radar is in the process of being installed. Lightning detection systems can add value to the observational coverage provided by radars and other networks. At present, lightning information in the Caribbean is provided by the World Wide Lightning Location Network, a private Website from the University of Washington, or through the long-range lightning network of the United Kingdom Met Office. The latter makes use of a dedicated system that has been recently upgraded by the installation of a sensor in the Cayman Islands that is not, however, available to all Caribbean countries/territories. All of the lightning data and information are somewhat coarse, with location uncertainties varying from 10 to 100 kilometres, and a level of detection that is often insufficient.

Marine activities related to transportation, fishing and tourism are vitally important for the island and coastal Caribbean countries/territories. These activities are also exposed to marine hazards such as high waves and swells, storm surges, coastal inundation and tsunamis. The region's NMSs currently benefit from observational data provided by a number of moored buoys maintained in the nearby Atlantic Ocean and in the Caribbean Sea by the United States and France. Only the French West Indies have coastal observations from wave riders (three in the proximity of Martinique, and two for Guadeloupe) that enable accurate measurement of waves (height, frequency and energy) and swell. Some islands such as Trinidad and Tobago, Saint Lucia, and Martinique have, however, installed tide gauges.¹⁴

In addition to their real-time observing stations, several Caribbean NMSs also operate non-real-time or climatological observation networks that enable them to acquire data on, for example, rainfall and temperature, that are useful for climatology, hazard and risk analysis, post-event assessments and slow-onset hazards monitoring.

The main Caribbean observational gaps and needs that have been described in the US/RA IV–WIGOS Demonstration Project documentation are as follows:

- (a) Large spatial and temporal gaps in real-time and climatological datasets, and uncertainty about continuity of observations;
- (b) Insufficient long-term data archiving and reporting;
- (c) Inadequate data integration and interoperability, and insufficient coordination and cooperation in data sharing.

Consequently, there is a broad requirement for real-time and climatological observational networks to be strengthened in the Caribbean. This is especially the case in the context of climate change and risk assessment, and in those Caribbean countries/territories that do not have an NMS. The following particular issues have been highlighted:

- (a) Overall efficiency and coordination need to be improved, particularly between institutions that have implemented observation networks (real-time or otherwise) that measure the same types of meteorological data;

¹⁴ There are tide gauges in Barbados, Grenada, Antigua and several other countries that were installed as part of the Mainstreaming Adaptation to Climate Change project. Some of these report to global databases. In addition, the UNESCO–IOC ICG/CARIBE EWS is also either upgrading or installing new stations in the region.

- (b) The monitoring network for coastal marine hazards, such as storm surge or swell, has also been identified as needing improvement;
- (c) Requirements have been cited for additional radar information (rainfall intensity, rain accumulation and radial wind), complemented by observational data from long-range or regional high-resolution lightning networks;
- (d) Maintenance has been identified as an area that presents difficulties, with additional support being required, including assistance with spare parts and with the maintenance of radar and marine equipment. It has been suggested that maintenance issues should be integrated in an overall sustainability plan for observational networks that also includes training and implementation of methodologies (for example, for calibration and optimization of networks). It should be noted that some Caribbean countries/territories already use non-conventional observational instruments such as Webcam;
- (e) Some Caribbean countries/territories have underlined the need to improve the observation dissemination process to ensure that all data from AWS is transmitted in real-time throughout the region.

5.4.2 Operational forecasting systems

Several components need to be in place, including the technical capacities of the forecasting office, qualified human resources and regional coordination mechanisms, to enable forecasters to produce quality products and services. In the area of technical capacities, it is essential that the forecaster has access to a wide variety of observational data, numerical model output (including global models, both deterministic and probabilistic, and regional models for atmosphere and waves) at the highest available resolution and frequency, and with multiple parameters, levels and verification times. Regional coordination and cooperation based on regional or subregional synoptic guidance can enable each forecasting office to focus on downscaling issues for its own territories, and can also ensure coherency and credibility.

Within the context of EWS, the support from forecasting offices to DRM agencies and stakeholders should be considered as one of the highest priorities. This support should focus specifically on the main hazards that could directly affect Caribbean countries/territories. To meet the need of DRM agencies and other EWS stakeholders, operational forecasting should not be limited to the primary meteorological hazards (tropical cyclones, tropical waves, and the like), or their associated meteorological hazards such as strong winds and heavy rainfalls, but should focus also on related hazards such as flash floods, slow-onset floods, landslides and coastal inundations, all at national to local scales.

Technical forecasting capacities

Most Caribbean countries/territories rely on specific workstations that receive information either directly from the WMO GTS, or by way of special requests to numerical weather prediction (NWP) servers in the United States or the United Kingdom. The French West Indies have a dedicated link with France to receive a full package of information (that is, satellite products and images, and NWP products from the European Centre for Medium-Range Weather Forecasts (ECMWF) and France) on the integrated forecasting system Synergy. Some forecasting offices are equipped with Coober workstations (for example, Antigua and Barbuda, Barbados, Saint Lucia and Trinidad) while others utilize the Metlab system (for example, the Bahamas, Curaçao and Sint Maarten, the Cayman Islands). Both of these latter systems are somewhat limited in terms of upgrading capacity and overall functionality. It was identified that Cuba and the French West Indies are the only Caribbean countries/territories that have the capacity to run a regional model. All Caribbean countries/territories have access to regional outputs from the CIMH models (Mesoscale Model 5 (MM5) and Weather Research and Forecasting (WRF)) via the institute's Website.

Currently, most forecasting offices also rely on products and services from various public Websites (in the majority, Websites from the United States) for their expertise. Though much information is available through these channels, it is usually of low resolution and has limited functionality. With the exception of Haiti and the Dominican Republic, it was identified that none of the Caribbean countries/territories currently

utilize specific forecasting guidance systems for severe weather or flood guidance. In the case of Haiti and the Dominican Republic, both have access to the Flash Flood Guidance System through the Hydrological Research Center Website (San Diego, United States). It should be noted that Belize also has access to the Central American Flash Flood Guidance (CAFFG) System.

The capacities of the forecasting system depend heavily on the information that is broadcast by the GTS. It was stated by NMSs that there is a need to have better access to a large variety of real-time information from numerical models or satellites to build their expertise, if possible, through a sole dedicated national or regional system. In particular, most forecasting offices expressed the view that the products available through the GTS should be updated both in number and variety. This is especially the case for NWP products (for example, more parameters, including thermodynamic parameters, and more levels, ensemble products and wave model outputs with better resolution) to benefit to the maximum extent from numerical models. The DRM agencies have expressed the need for improved lead times for warnings of hazards not related to tropical cyclones. To fulfil this mandate, forecasting offices would benefit from improved downscaling capacities, from national threats to potential local impacts. In this context, operational cooperation with other technical agencies, such as hydrological institutes, including National Hydrological Services (NHSs), is essential.

The Caribbean countries/territories also stressed a need to strengthen their capacities for downscaling regional information on climate change, and monthly or seasonal forecasts of slow-onset hazards such as droughts or heat waves, to the national level. Additionally, it was mentioned that specific methodologies that are developed could be shared throughout the region (for example, the drought index).

A list of Websites from which NMS respondents to the WMO 2011 survey are able to obtain image products from global product centres to support forecasting is provided in Appendix 1, Table 22.

Regional aspects and coordination issues

The RA IV Hurricane Committee, through its HOP and Technical Plan, aims to provide a framework for the most effective cooperation in the region by preparing and issuing meteorological forecasts and warnings of all tropical cyclones affecting the area, and by ensuring real-time coordination. A crucial operational role is fulfilled by RSMC–Miami in the region for analysis and forecasts over the North Atlantic at a synoptic scale. This is especially true for tropical cyclones. The centre coordinates with other forecasting centres in the region to issue warnings at the national level, in the case that a tropical cyclone is forecast to directly impact one of the islands. This role, however, only concerns tropical cyclones at the regional scale. An essential role in the region is also played by CIMH, which supports the forecasting capacities of CMO Member States by providing knowledge transfer, expertise and training, and by supplying regional numerical weather output twice daily. Even though CIMH is not an operational centre, it coordinates Web conferences for sharing and coordinating real-time expertise through the “visit view” system and more recently the Caribbean DEWETRA system. These virtual, on-line meetings on forecasting and warning issuance are not, however, organized on a regular basis with all the forecast offices in the Caribbean region. Finally, the French forecasting coordination centre in Martinique ensures real-time coordination and guidance for the French West Indies and French Guiana via specific guidance products and conference calls at least three times every 24 hours.

Many Caribbean countries/territories have highlighted the need to strengthen real-time coordination based on consensus and guidance products, especially between neighbouring forecasting offices. It has also been suggested that the role of CCCCC could be increased in relation to monthly and seasonal forecasting outputs for slow-onset hazards such as droughts or heat waves. Equally, it has been stressed that the role of regional centres needs to be strengthened, especially in relation to provision of forecasting guidance products and tools, and for real-time coordination for all types of hazards.

Training aspects

A need has been expressed for the improvement of technical capacities for operational forecasting to be accompanied by ongoing training on new technologies (for example, the latest satellite products),

numerical models, operational use of radar, new methodologies for consensus and guidance, and marine forecast issues. As the regional training centre, CIMH plays an important role in training on forecasting in the CMO Member States. This is complemented by training courses, workshops or secondments run by other institutions, especially NOAA. It has been suggested that non-English-speaking Caribbean countries/territories could benefit from an expansion of the scope of CIMH that could facilitate interaction and knowledge exchange among all the countries/territories of the region. It has also been identified that the region could benefit from the sharing of good practices through training sessions, workshops and cross-training programmes for forecasters (for example, bilateral exchange between NMSs). As a further suggestion, a need has been expressed for online training programmes (for example, the Cooperative Programme for Operational Meteorology, Education and Training (COMET)) to be downscaled and adapted to the specific challenges of the Caribbean countries/territories, and in particular those of the smallest islands.¹⁵

5.4.3 Hydrometeorological data management and exchange systems

At the national level, database management, with well-defined mechanisms for collection, quality control, exchange and sharing, is essential for cooperation and coordination between all the technical institutions involved in EWS data management. The goal for these institutes (including water resource agencies, agriculture and forestry institutions) is to share a unique GIS database. At the regional level, it is also important to strengthen exchange and collection through official agreements, harmonized formats and standard procedures, based on existing or projected databases (for example, those of CIMH, the National Water Information System (NWIS) and the Carib-HYCOS project, among others).

In most Caribbean countries/territories, NMSs manage their own databases for meteorological and climatological data archiving. However, in the case of SIDS it was highlighted that the capacities in terms of human resources, procedures and methodologies need to be strengthened and better defined. Since different, generally not up-to-date systems (for example, CLICOM, CLIDATA or CLIMSOFT) are used throughout the region, the need for upgrade and harmonization of software has been widely expressed. In several Caribbean countries/territories, the database for meteorological data is isolated with no or little exchange between institutions. In other Caribbean countries/territories (for example, Antigua and Barbuda, and Saint Lucia), work is being done to establish a single database at national level for all environmental data, including hazard, hydrological, meteorological and ground data. Thus, in this domain it seems that a useful first step would be the development of an inventory of meteorological, hydrological and hazard data that is available at national and regional level. This is felt to be especially necessary for countries with case II and III support mechanisms. The inventory should include metadata and details of the format, for example, database, disks or paper. This process would require, at both national and regional levels, the mapping of all stakeholders involved in risk assessment and MHEWS data management, and the identification of institutions responsible for the hydrometeorological data.

The need for national GIS databases with long time series has been widely expressed in the Caribbean. The region's NMSs would benefit from additional capacity to improve or implement a GIS database of meteorological and climatological data, associated metadata and hazard data, with comprehensive quality control and harmonized protocols to facilitate regional exchange. They would also benefit from specific procedures for data rescue to improve the reliability and durability of statistical and climatological information.

Generally, data from WMO-referenced synoptic stations are disseminated and exchanged through the WMO GTS. Other observations from national networks are normally not accessible from outside the country or even outside the NMS. Several Caribbean countries/territories need to increase their capacities to disseminate more information from the data they collect. Regional mechanisms for data exchange currently exist through CIMH, which collects and manages data from CMO Members. However, processes could be improved and observation data that are exchanged could be expanded to other Caribbean

¹⁵ COMET and CIMH are developing a suite of online courses to support a B.Sc. programme.

countries/territories. It was mentioned by CIMH that the institute is working on a more strategic approach for data collection, archiving and quality assurance to improve and sustain the system.

Regional programmes such as Carib–HYCOS or US/RA IV–WIGOS could help fill the gaps outlined above and optimize regional database management and exchange. Moreover, where data quality is concerned, it should be noted that capacities exist in the region for instrument calibration, particularly in the regional instrument calibration laboratory at CIMH and also in Cuba (including wind tunnel, barometer, thermometer and hygrometer calibration).

5.4.4 Product development processes within National Meteorological Services

For successful product development, it is essential to have a specific process that includes the assessment of user needs, the incorporation of feedback, and the capacity for production and dissemination. Integrated production systems that facilitate product development processes do exist but are rare in the Caribbean region. It was identified through consultations that user needs are often not clearly defined with respect to the type, content and format of products that are required. Furthermore, in most SIDS, capacities for product development would benefit from a strengthening of human resources, and of capacities in tools, software and workstations. Product development activity SOPs do exist in those Caribbean countries/territories working with a comprehensive QMS (the Dominican Republic, the French West Indies). However, in other Caribbean countries/territories there is an expressed need for the development of such SOPs.

During the consultations, most of the NMS also expressed a need for the improvement or implementation of integrated production systems to facilitate product development, including Website products. In this context, a regional umbrella for production systems at the national level could be useful and could lead to the optimization of resources and the sharing of capacities, specifically for software training and the maintenance and upgrading of the system.

5.4.5 Information technology and telecommunication capacities

The capacity of NMSs to support DRM agencies and other disaster risk stakeholders depends heavily on their internal national capacity in telecommunications and IT infrastructure and networks. The regional aspect is, however, also of great importance, especially with regard to the capacities, services and overall backup procedures of the GTS Regional Meteorological Telecommunication Network (GTS–RMTN). All Caribbean countries/territories rely heavily on the GTS–RMTN for data and product exchange. However, some countries/territories do not have a GTS in working order (for example, Cuba and Haiti). In addition, most of them also rely on the Internet for accessing data and products (for example, observations from national networks, radar and NWP products) and for dissemination of forecasts, and watches and warnings. However, NMSs highlighted that there is a need for improved Internet access through higher bandwidth and increased reliability.

Concerning the WMO GTS, the view has been expressed that the region needs to anticipate potential changes within the RMTN dissemination process. A comprehensive assessment has recently been initiated by the United States for WMO RA III and RA IV that should bring clear guidance on the improvements required for internal and external telecommunication systems throughout the Caribbean region. It has also been identified that some comprehensive telecommunication backup systems appear to be in place to support cooperation between islands in the event of an emergency, particularly through agreements established within the context of the HOP of WMO RA IV. Some Caribbean countries/territories have established specific backup arrangements with other Caribbean countries/territories or the United States for forecasts and warnings, and for essential products and means of dissemination. In these cases the details are arranged bilaterally. As an example, SOPs may state that Barbados will take over the responsibility of Antigua and Barbuda, and/or Saint Lucia, and that Antigua and Barbuda will take over the responsibility of Barbados with respect to the islands and coastal waters of Dominica, while the United States will take over the responsibility of the Bahamas and Jamaica, and so forth. For their part, the French West Indies use specific networks and lines (established though an MOU with a telecommunications company) between Toulouse and Martinique, and Guadeloupe and French Guiana, with full redundancy.

Several Caribbean countries/territories have specific agreements or MOUs with providers of mobile telecommunication. Most also indicated that they would benefit from the development of public/private partnerships for the dissemination of warnings (SMS, voice messages) by mobile telephone, as well as for data collection. It should be noted that Carib-HYCOS carried out a similar project in cooperation with the Digicel Company that addressed data collection at the regional level.

5.4.6 The requirement for National Meteorological Services for comprehensive Quality Management Systems

It was identified during the assessment process that the Caribbean countries/territories would benefit from QMSs that cover all aspects of the different support mechanisms between NMSs and DRM agencies. Concerning Caribbean countries/territories with case II and case III support mechanisms, the QMS should address the complexities associated with the support, by the NMS, of one or multiple DRM agencies and stakeholders in other countries/territories. In such situations, each mechanism should be documented with the involvement of all participating stakeholders.

It was noted during the consultations that there is a strong tendency to rely on informal rather than formal procedures and agreements within the region, particularly on the smallest islands. The NMSs of the Dominican Republic and the French West Indies have, however, comprehensive QMSs in place and are also ISO certified. Other Caribbean countries/territories utilize some SOPs, but these are in many cases incomplete and do not sufficiently document the processes within the organization. Moreover, some SOPs only focus on specific, technical aspects, for example, tropical cyclone warnings. Encouragingly, most NMSs report that they have established contingency plans to ensure continuity of service in case of emergencies. For their part, DRM agencies indicate that they have disaster plans that define the roles and responsibilities of all the institutions and stakeholders involved in risk management, including NMSs.

Through the assessment process, it became evident that NMSs rely heavily on regional plans and regulations. The HOP, which is managed under the WMO RA IV Hurricane Committee, is utilized by all Caribbean countries/territories as a basis for their operational activities. The HOP states the agreements reached on the sharing of responsibilities for the warning services and their infrastructures throughout the region, and defines the observing, forecasting and warning responsibilities of all cooperating Members. The plan also deals with other related items such as terminology and communications. The Technical Plan sets out the coordinated steps to be taken by Members for future development to meet regional needs for upgrading forecasts and warning services. This applies to hurricanes and associated floods, as well as to related disaster prevention and preparedness measures and supporting activities in training and research.

Caribbean NMSs also rely on international regulations and recommendations, typically coming from WMO and the International Civil Aviation Organization (ICAO). Most of the Caribbean NMSs have acknowledged that, historically, their focus has been on the provision of meteorological assistance to aviation, indicating that they are currently in transition to align meteorological activities to DRM needs. In this context, NMSs have expressed the need for continued efforts to improve cooperation to acquire a better knowledge of the existing needs and challenges of DRM.

Currently, ICAO requires that all NMSs providing aeronautical assistance and information have a QMS and are ISO certified. Most Caribbean countries/territories have expressed a need for assistance with the implementation of a QMS for activities in this area. Some Caribbean countries/territories have also indicated the need for a wider QMS that would cover all EWS-related activities. Furthermore, NMSs with a mandate to support other countries/territories through case II and case III support mechanisms have highlighted the need for a specific QMS that covers these mechanisms.

Finally, Caribbean countries/territories that have good practices in QMS indicated that they are willing to collaborate with other countries/territories to share their experiences, methodologies and results.

5.4.7 Human resource capacities and training

Several NMSs are well staffed in relation to the activities they carry out and the size of their countries/territories. Others have indicated a critical need for more qualified meteorologists, especially those without official forecasting capacities, such as the NMSs of Dominica or Saint Vincent and the Grenadines. Furthermore, some NMSs highlighted that they need meteorologists with higher qualifications or masters degrees to work on research and development, this being needed to improve efficiency and support in the context of EWS.

5.4.8 Highest priorities with regard to the core and overarching capacities of Caribbean National Meteorological Services

A detailed list of the capacities, gaps and needs related to the core capacities of Caribbean NMSs to support EWS is presented in Appendix 1, Table 23 (national aspects) and Table 24 (regional aspects). An overview of the capacities, gaps and needs with regard to the overarching capacities of these NMSs is shown in Table 25. In these areas, the highest priorities identified by the participating Caribbean countries/territories are outlined in the following points:

- (a) The strengthening of observational and monitoring capacities through:
 - (i) An improvement of coverage in time and space, with special attention to case III countries/territories without real-time observation networks, and also to climatological and marine observations;
 - (ii) The strengthening of coordination among technical agencies that manage their own hydrometeorological networks, for better interoperability and real-time exchange;
 - (iii) A sustainability plan for observing networks (for example, maintenance plans, spare parts, quality-control methods, training);
 - (iv) The installation of non-conventional monitoring and observation instruments such as Webcams;
 - (v) Improved sharing of regional observation data that are crucial for severe weather monitoring, such as radar, wave-rider or lightning data and integrated regional observation networks (based on the Carib-HYCOS project, the US/RA IV-WIGOS Demonstration Project, and the like);
 - (vi) The strengthening of human capacity requirements for sustainability and maintenance of the observing networks;
- (b) The strengthening of forecasting capacities through:
 - (i) An upgraded forecasting system (for example, data flow, software and workstations) to facilitate easy and integrated access to a wider variety of numerical products, intelligent forecasting guidance systems and monitoring observations (national and regional);
 - (ii) Training of forecasters in the latest methodologies and analysis techniques, including probabilistic and deterministic model outputs and radar/satellite interpretation;
 - (iii) At national level, strengthening of real-time coordination with other technical agencies, such as NHSs;
 - (iv) At regional level, strengthening of real-time exchange and forecast coordination, especially in the case of neighbouring forecast offices in case II Caribbean countries/territories;
 - (v) A strengthened role for regional centres to provide forecasting guidance tools and products for all meteorological, hydrological and marine hazards, including slow-onset hazards and climate change, and to develop coordination mechanisms;
 - (vi) Strengthened national capacities for downscaling of regional products to address slow-onset hazards and climate change at the national level;
- (c) The improvement of database management and sharing through:
 - (i) Improvement of the knowledge of availability, location and types of existing observations and data at national and regional levels;
 - (ii) Strengthening, at national and regional levels, of capacities for the implementation of quality-controlled and sustainable GIS databases with metadata, long time series (data rescue) and exchange mechanisms, through specific agreements or MOUs between all the stakeholders managing EWS data;
 - (iii) Grouping of meteorological, hydrological, marine and other environmental data relevant to MHEWS;

- (iv) Specific training on building historical databases (for example, on homogenization, data rescue and metadata), on development of hazard-analysis products and on utilization of modelling outputs;
- (v) Increasing the capacities of NMSs for product development by strengthening production systems with in-quality management framework principles;
- (d) The improvement of telecommunication networks through:
 - (i) The strengthening of transmission systems for exchange and data collection at national to regional levels;
 - (ii) Implementation/enhancement of reliable systems for backup and redundancy;
 - (iii) The upgrading of telecommunications and Internet capacities;
 - (e) The development and implementation of a comprehensive QMS through certification of NMSs and development of SOPs with other technical institutions, with consideration for QMS principles;
- (f) The strengthening of NMS technical training programmes related to the support of EWS through:
 - (i) Cross-training programmes (for example, bilateral exchange of forecasters) and e-learning;
 - (ii) Regular workshops and bilateral training at national or/and regional levels between NMSs, DRM agencies and other stakeholders;
 - (iii) Training and workshops for regional sharing and transfer of tools, methodologies and good practices with regard to historical databases and hazard analysis;
 - (iv) Technical training for Webmasters to improve the local or national capacities for Website management;
 - (v) Bilateral workshops and training between forecasters and the media to improve communication efficiency;
 - (vi) Up-to-date and regular training programmes on current forecasting methodologies, data, tools and products;
 - (vii) Regional training with exchange of good practices on QMS methodologies and tools.

5.5 OPERATIONAL RELATIONSHIPS WITH OTHER TECHNICAL AGENCIES

This section discusses coordination mechanisms between NMSs and other national technical and sectoral partners involved in the implementation of EWS (refer to Figure 5, item 6). Within each country/territory, effective operational relationships, particularly with NHSs, are crucial in the region, because heavy rainfall and/or lack of rain are real and common threats. Input from hydrological expertise in the forecasting process is valuable to support DRM agencies in a more comprehensive way. Where marine hazards such as tsunamis, storm surges and damaging swells are concerned, observational data and advice from agencies with oceanographic and seismic expertise are, correspondingly, important to the production and dissemination of effective early warnings.

Product and service delivery in support of EWS can benefit from direct cooperation between NMSs and other technical agencies, especially NHSs and marine or oceanographic services. Since most hazards in the region have hydrological consequences, input from the relevant hydrological institution is crucially important for forecast and warning product development. Such input enhances the ability of NMSs to provide comprehensive watch and warning bulletins (for example, a heavy rainfall warning coupled with potential flooding information). In larger countries such as the Dominican Republic, Belize or Suriname, a separate NHS generally exists and there is a good relationship with the NMS, especially in the case that hydrologists have been appointed to work in the meteorological office. Guyana and Belize each have one single institution that is responsible for both meteorological and hydrological matters, with qualified people on both sides. Other technical agencies working in the field of environment or ocean surface can also play a role in this context. During consultations with stakeholders, it was identified that interaction between NMSs and other technical agencies in most Caribbean countries/territories would benefit from a strengthening of collaboration and coordination with regard to forecast and warning development, real-time data exchange and joint communication.

With respect to case II support structures, in which the NMS receives support from an NMS in another country/territory, it is crucial that special arrangements and SOPs are developed to specify the support and services needed by the NHS, or the DRM agency should there be no hydrological service.

During consultations, a number of good practices were identified in the region in countries/territories possessing a combined NMHS (for example, Guyana and Belize). However, in the case of Belize, the Integrated Water Resources Management legislation has recently been passed, enabling the development of the National Water Authority to oversee management and governance of water resources. This is expected to lead eventually to the separation of services. In most of the other Caribbean countries/territories, a national water resource authority is responsible for some hydrological aspects, including technical expertise and data networks. Good practices were also evident in countries such as Cuba and the Dominican Republic, in which there is strong and effective collaboration and coordination between separate meteorological and hydrological services (in the case of the Dominican Republic, a hydrologist is working within the NMS). Work is in progress in the French West Indies and French Guiana between Météo-France and the Direction of the Environment to set up a “meteo-hydro watch team” in French Guiana, Martinique and Guadeloupe. The objective of this project is to strengthen collaboration and coordination for real-time management as well as for research and development. Elsewhere, operational coordination (especially real-time) is often a challenge and is mostly facilitated by a DRM agency.

At a regional level, CIMH has designated a regional advisor to support all CMO Members. However, as CIMH is not a 24/7 operational centre, support is limited for hydrological hazards with short lead times, such as flash floods. The institute is currently working on a Real-time Flood Forecasting Project based on the combined use of hydrological modelling, integrated precipitation forecasts and real-time observations from radar, meteorological and hydrological networks. The Flash Flood Guidance System (FFGS) that has recently been adapted for Haiti and the Dominican Republic combines both meteorological and hydrological information (as well as ground data) and can thus be used in real time by meteorologists and hydrologists to support DRM agencies.

During workshops and consultation visits, NMSs stressed the need to strengthen coordination with hydrological experts for activities related to forecasting and warning. This would, for NMSs, result in better access to hydrological information for real-time purposes, for batch processing or for studies. In addition, attention was drawn to a requirement for integrated tools or workstations in the region that combine meteorological and hydrological data (information from radar, raingauges, limnimeters, and the like) and numerical model outputs (rainfall/river flow modelling) for expertise, monitoring and forecasting (especially nowcasting).

5.5.1 Highest priorities with regard to operational relationships with other technical agencies

The highest priorities identified by the participating Caribbean countries/territories concerning operational relationships with other technical agencies are as follows:

- (a) The mapping of experts and agencies responsible for hydrological services (monitoring, forecasting, and the like) and establishment of a more robust cooperation network in the region; leveraging the region’s institutes and projects, such as CIMH, Carib-HYCOS, JICA CADM II, the DEWETRA platform, the Caribbean Water Initiative (CARIWIN), the Caribbean Risk Atlas project, and the Japan-CARICOM Advanced Flood Forecasting System for the Caribbean;
- (b) The mapping of institutional capacities and linkages among all relevant technical agencies as the basis for the development of SOPs and agreements;
- (c) The development of specific SOPs and agreements for case II Caribbean countries/territories for operational and technical support among the other technical agencies;
- (d) The development of additional specific SOPs and agreements for case III Caribbean countries/territories between the respective NMSs and technical agencies in the supported countries/territories.

5.6 STRENGTHENING OF MULTI-HAZARD EARLY WARNING SYSTEMS AT NATIONAL AND REGIONAL LEVELS

This section discusses coordination and cooperation with RSMC-Miami (refer to Figure 5, item 7). The Caribbean region’s NMSs and DRM agencies are supported by regional centres, agencies and networks (Figure 11). The organizations that support NMSs include RSMC-Miami, CMO and CIMH, each providing

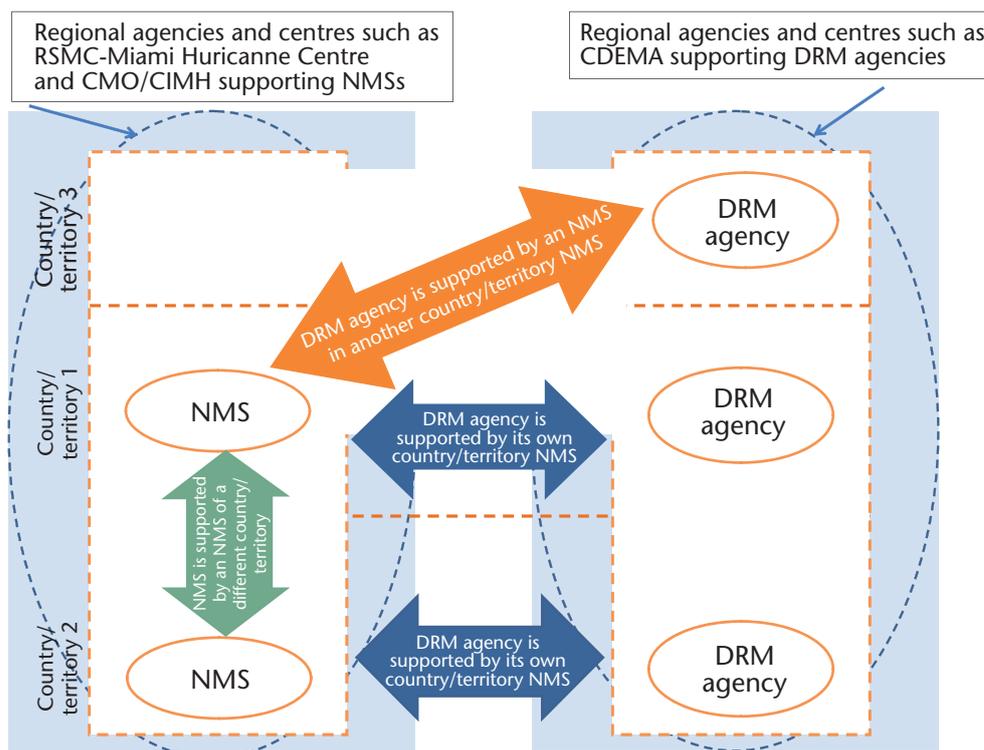


Figure 11. Regional coordination and support for Caribbean countries/territories of case I, II and III

different services. The DRM agencies are supported by entities such as CDEMA, with its focus on providing a system of comprehensive disaster management for the CARICOM Member States.

5.6.1 National aspects

During consultations it was observed that most Caribbean countries/territories carry out monitoring and forecasting for the diversity of potential weather-related hazards. For some of these hazards, specific procedures exist for the issuance of special advisories or warning bulletins. It was identified, however, that not all hazards are managed by making use of the same comprehensive MHEWS (for example, aeronautical hazards, or marine hazards such as storm surge). In most cases, an MHEWS is dedicated specifically to tropical cyclones (and sometimes heavy rain) and is linked, in all cases, to the WWS of RSMC–Miami.

Many NMSs have noted that their MHEWS would benefit from incorporating the specific characteristics of their country/territory, including country size, topography, bathymetry and local vulnerability. Furthermore, many Caribbean countries/territories indicated that they would also benefit from the implementation of a downscaled and more tuned system of the regional WWS for tropical cyclones. This would involve, for example, the adaptation of lead time to the needs of the DRM agencies and the hazard's features. Additionally, NMSs also noted that they would benefit from managing different hazards under the same MHEWS framework.

Some NMSs also expressed the need to improve the downscaling of watches and warnings on some hazards, such as coastal flooding, flash floods or heavy rains. Currently, most Caribbean countries/territories issue their watches and warnings either for the entire country or for the provincial territories, without taking account of local differences. There are some exceptions where specific warning protocols for varying levels of hazard and risk exist.

It was identified during consultations that most Caribbean countries/territories do not use methods based on clear criteria for their MHEWS. In most cases, the MHEWS is based on the location of the main feature

(for example, a tropical storm) and the lead time. Some Caribbean countries/territories mentioned the need to develop protocols for geographic zones of elevated monitoring, accompanied by specific alerts to disaster management authorities related to these zones. In some cases the Caribbean countries/territories would benefit from the establishment of watch and warning thresholds (for example, 150 millimetres per 12 hours for rainfall, or 3.5 metres in height for waves).

As mentioned earlier in this Report, NMSs expressed the view that it is critical to maintain close real-time collaboration with other technical agencies, especially during hazard events, to coordinate issuance of watches and warnings. It is also crucial to strengthen real-time coordination mechanisms not only between NMSs and DRM agencies, but also between neighbouring NMSs and between neighbouring DRM agencies. This coordination must take into account specific cases where an NMS is not operational 24/7, or where it does not exist (that is, in the case III situation), especially during rapidly developing hazardous meteorological features (as in, for example, the recent case of Hurricane *Tomas*). This could be done through SOPs specific for real-time coordination, involving NMSs, DRM agencies and focal points (but taking into account, for the latter, the frequent turnover of staff and the difficulties to contact them).

Following the recommendations of the Costa Rica MHEWS Workshop (see Introduction and Chapter 3) pertaining to experiences and opportunities for linking hydrometeorological systems and NMSs with systems for other hazards, the opportunities for leveraging these capacities need to be explored systematically by:

- (a) Mapping the institutions and their roles and mandates nationally and regionally;
- (b) Identifying key forums for exploring the opportunities along the four components of EWS (monitoring and forecasting, risk analysis, communication and dissemination, and emergency preparedness and response).

As recommended at the Costa Rica MHEWS Workshop, these issues need to be further explored through the hydrometeorological warning mechanism coordination platforms, such as WMO RA IV and its related working groups (such as the WMO RA IV Hurricane Committee), and ICG/CARIBE EWS (see 2.3). During the consultations with the Caribbean countries/territories, the president of WMO RA IV and the chairs of ICG/CARIBE EWS supported the need to facilitate such discussions and further stressed the importance of exploring opportunities for leveraging of these capacities.

Some NMSs (for example, the French West Indies, and Trinidad and Tobago for flood hazard) use colour-coded watches and warnings indicating thresholds and certain actions. Different levels or phases of alert are used by some DRM agencies (for example, two levels in Antigua and Barbuda, three in Cuba, the Dominican Republic, and Trinidad and Tobago) depending on the warning issued by the NMSs. Several Caribbean countries/territories indicated that their watches and warnings are not well known by the population and that they would benefit from communication and education campaigns, focusing on all aspects of MHEWS (type of hazard, level of danger, individual behaviour, collective measures, and the like).

5.6.2 Regional coordination in Multi-hazard Early Warning Systems

In the Caribbean islands the regional WWS of tropical cyclones (tropical depressions, tropical storms and hurricanes) is managed by RSMC–Miami. The centre is crucial in that it supports all of the Caribbean countries'/territories' MHEWSs in the region for tropical cyclones. It is important to note that RSMC–Miami does not issue watch or warnings at the national level, but coordinates with NMSs to ensure the issuance of warnings in all the Caribbean countries/territories that are forecasted to be directly affected. It was identified during the consultations that Caribbean countries/territories would benefit from regional or subregional procedures or mechanisms for the coordination between different forecasting and warning centres for hazards other than tropical cyclones.

It was also noted during consultations that CIMH organizes conference calls to coordinate warnings for severe weather among the CMO Members, though not on a 24/7 operational basis. This is, however, a new service and still in experimental mode. Within the Lesser Antilles, the islands of the French West Indies have a subregional WWS for several hazards. The coordination is currently limited to the French islands only, but a project (Sherpa) is in progress at Météo-France, with the support of the civil protection and

other institutions, for the coming two years to extend real-time coordination to other neighbouring countries/territories. In Haiti, a real-time coordination mechanism for watch and warning services has been in place since June 2010, a joint effort between the French regional centre and the Centre national de météorologie (CNM) of Haiti.

Many Caribbean countries/territories expressed the need for a regional or subregional coordinated multi-hazard WWS. The system should be one that considers existing systems such as RSMC WWS, and that focuses not only on tropical cyclones but also on heavy rain, damaging waves, strong winds and possibly other hazards. Regional bodies have also expressed an interest in a potential involvement in such a process. This need has been highlighted as essential for neighbouring Caribbean countries/territories.

With regard to tsunami warnings, the regional body for this hazard, ICG/CARIBE EWS, mentioned the need to identify national focal points and institutions that are responsible for tsunami warnings at national level (85 per cent have been nominated). As the official regional centre for tsunami warning, CTWC, is not yet in place, Barbados provides interim information to English-speaking Caribbean countries/territories.¹⁶

The MHEWS process also requires a strong relationship between NMSs and DRM agencies, with regional sharing of good practices. It has been recommended to strengthen the relationship between CMO and CDEMA in this regard, by including DRM agencies in CMO meetings and vice versa as often as possible. This, however, may not facilitate the process beyond CDEMA membership, and other mechanisms for collaboration need to be identified. This could possibly be through ICG/CARIBE EWS, CRMI, the annual Comprehensive Disaster Management Conference, and other mechanisms to include the Dutch and French islands, Bermuda, Cuba and other non-English-speaking countries/territories in the Caribbean.

5.6.3 Highest priorities with regard to Multi-hazard Early Warning Systems regional and national aspects

A detailed overview of the capacities, gaps and needs of Caribbean countries/territories with regard to WWS is presented in Appendix 1, Table 26 (national aspects) and Table 27 (regional aspects). The highest priorities, as expressed by the participating Caribbean countries/territories, include:

- (a) Strengthening of real-time coordination at national level with other technical agencies, such as hydrological and coastal institutions, and improved multi-sectoral input for warning and decision making, with an impact-oriented approach;
- (b) Sharing of good practices and transfer of knowledge and experience on WWS in the region, through workshops and training;
- (c) Implementation or strengthening of comprehensive and multi-level criteria-oriented WWS for the relevant meteorological, hydrological and coastal marine hazards that meet the needs of DRM agencies and other stakeholders (in terms of lead time, national constraints, and the like);
- (d) Implementation of mechanisms and procedures for real-time coordination between Caribbean countries/territories (especially among small neighbouring territories), taking into account existing regional systems (such as RSMC–Miami for tropical cyclones) and the role of regional centres;
- (e) The need for a yearly regional meeting of NMSs and DRM agencies with the objective of developing/maintaining coordination mechanisms among the Caribbean islands;
- (f) Leveraging of opportunities across hydrological, meteorological and tsunami warning systems.

5.6.4 Public outreach and educational programmes

Public education on hazards and associated risks is essential for improved understanding and awareness by the public to ensure effective response to weather-related hazards and warnings. Collaboration between technical institutions, DRM agencies and other regional or international partners can facilitate the development of specific education materials, with local input and illustrations. The tailoring of public education to the needs of different population groups has been highlighted as a major need throughout the region,

¹⁶ A Caribbean Tsunami Warning Programme has been established at the Puerto Rico Seismic Research Network. It is anticipated that this will evolve into a Caribbean Tsunami Warning Centre by 2014.

especially for Caribbean countries/territories that have not recently been affected by a tropical cyclone or other weather-related hazards. However, risk culture is an important part of society in many of the Caribbean countries/territories that have school programmes on meteorological hazards, especially tropical cyclones. These educational programmes sometimes start in kindergarten and continue through to university. In some islands (for example, Cuba, Jamaica, Martinique, Trinidad and Tobago), school programmes have been developed in close collaboration with the NMSs and the DRM agencies. This has made it possible for teachers to address the topic in a comprehensive way, covering themes that include meteorological hazards, personal behaviour, forecasting challenges and communication.

Several NMSs stated during discussions that they could benefit from a list of existing educational programmes in the region. In addition, some NMSs have expressed the need for the development of programmes and dissemination mechanisms that are adapted to the needs of vulnerable groups in society, such as isolated families, the elderly and tourists. It was noted during consultations that international educational materials and programmes from other countries (for example, the University Corporation for Atmospheric Research (UCAR)–NOAA COMET programme) are utilized either through the Internet or shared through CD/DVD. However, it was also pointed out that NMSs as well as DRM agencies would benefit from the adaptation of these international educational programmes to local needs, by using examples from local events, places and culture to maximize their effect. Several NMSs advocated that the broadcasting of radio or television campaigns focusing on hazards and risks should be developed to move beyond a focus on tropical cyclones, to include other hazards that pose a significant threat. Additionally, since regional bodies, such as CDEMA, and international institutions such as IFRC play an important role in public awareness and education, some NMSs expressed the view that partnerships with these organizations could develop, at the regional or national levels, to produce multimedia materials such as short television programmes, DVDs, e-programmes and the like.

5.6.5 Highest priority issues related to public outreach and educational programmes

The following highest priority public outreach and educational issues were identified:

- (a) Development and/or adaptation of multimedia educational programmes on all hazards and risks, with specific attention to vulnerable groups in society and to local needs, by making use of local examples;
- (b) Development of partnerships with DRM agencies and other national and international organizations to facilitate the production of educational materials.

CHAPTER 6 – SUMMARY AND RECOMMENDATIONS

In this section, high-priority recommendations from this assessment process are summarized.

6.1 OPERATIONAL COOPERATION BETWEEN NATIONAL METEOROLOGICAL SERVICES, DISASTER RISK MANAGEMENT AGENCIES AND OTHER STAKEHOLDERS

High-priority recommendations in this field are as follows:

- (a) Multi-sectoral institutional mapping capacities and linkages should be developed among all the MHEWS stakeholders as the basis for the development/strengthening of SOPs and relevant agreements;
- (b) Workshops and trainings for MHEWS stakeholders should be developed and improved at national and/or regional levels to enhance the understanding of the roles and capacities of NMSs, DRM agencies, NHSs and other stakeholders engaged in risk assessment and MHEWS;
- (c) Specific agreements, MOUs and SOPs should be developed within a QMS framework among the agencies, based on their institutional mandates and roles;
- (d) Caribbean countries/territories under case II and case III support mechanisms will need additional specific SOPs, depending on the various interfaces and levels of complexity with respect to the relations of the NMSs and DRM agencies within and outside of the country/territory;
- (e) Good practices of countries/territories throughout the region should be documented, together with the development of a list of expertise and a roster of experts in the region;
- (f) Institutional cooperation in the region needs to be strengthened with specific goals and cooperation mechanisms (for example, further strengthening of cooperation between CMO–CIMH and CDEMA).

6.2 DISSEMINATION AND FEEDBACK MECHANISMS RELATED TO METEOROLOGICAL, HYDROLOGICAL AND CLIMATE-RELATED HAZARDS AND EARLY WARNING SYSTEMS

High-priority recommendations in this area are as follows:

- (a) Dissemination mechanisms between NMSs and DRM agencies need to be strengthened through:
 - (i) Strengthening of regionally harmonized protocols (for example, CAP);
 - (ii) Implementation of integrated tools or systems with automated processes;
 - (iii) Strengthening of backup systems (including agreements for backup between different Caribbean countries/territories) and implementation of up-to-date means;
- (b) Capacities of NMSs for comprehensive management of their public Websites must be improved;
- (c) The credibility and impact of live communication via the media must be improved through:
 - (i) Bilateral workshops and training with forecasters and media specialists and/or journalists;
 - (ii) Specific integrated tools or systems dedicated for television broadcast;
- (d) Specific populations (for example, tourists, youth, isolated populations) need to be targeted;
- (e) Feedback mechanisms must be improved by conducting:
 - (i) Coordinated multi-stakeholder EWS drills and exercises, especially for countries/territories with case II and case III support mechanisms;
 - (ii) Systematic post-event evaluations of EWS stakeholder interactions.

6.3 NATIONAL METEOROLOGICAL SERVICES PRODUCT AND SERVICE DEVELOPMENT TO SUPPORT DISASTER RISK MANAGEMENT AGENCIES

High-priority needs in this area have been identified as follows:

- (a) Hazard analysis and risk assessment: Development of a risk-based, multi-agency mechanism to identify the needs and requirements for meteorological, hydrological and climate-related products and services, such as:
 - (i) Data products;

- (ii) Hazard analyses (statistical and forward looking);
- (iii) Forecasts and warnings;
- (iv) Technical advice and operational support;
- (b) Improvement of data products through:
 - (i) Improved knowledge of stakeholders' needs for the development of user-centred products and services;
 - (ii) Strengthening of the development and use of processing systems to transform data into useful information, under the US/RA IV–WIGOS Demonstration Project;
 - (iii) Development of specific systems, tools or applications for data formatting, statistical data, diagrams, and the like;
 - (iv) Installation of an automated data server to provide real-time and non-real-time data access to institutions and other stakeholders;
 - (v) Development of integrated, quality-controlled and sustainable GIS databases with metadata, climatological data rescue and exchange mechanisms at national and regional levels;
- (c) Improvement of hazard-analysis products to support risk assessment through:
 - (i) Access to hazard-modelling capacities;
 - (ii) Access to long time series of observations at national and regional levels, which should include meteorological and hydrological information, metadata and hazard information, with sufficient spatial coverage;
 - (iii) Access to high-resolution topography and bathymetry;
 - (iv) A regional programme that would include training, sharing and transfer of tools, and methodology and good practices, accomplished through training and workshops, and including development of a list of regional resources for modelling, training and product development;
 - (v) Strengthening of the relationship between NMSs, DRM agencies and stakeholders, through training and workshops on hazard analysis and risk assessment;
 - (vi) Strengthening of the provision for specific hazard analysis into the risk assessment process in countries with case II and III support mechanisms, between DRM agencies and the supporting NMSs from another island;
- (d) Improvement of forecast and warning products through:
 - (i) Strengthening of real-time coordination mechanisms among technical institutions and DRM agencies to provide input on forecast and warning products;
 - (ii) Development of a user-centred approach, including development/strengthening of methodologies and mechanisms for user feedback during product development and operational phases;
 - (iii) Adoption of a regional approach for the sharing of expertise and tools needed in forecast and warning production systems;
 - (iv) Expansion of the distribution of CDPMN products to all Caribbean countries/territories and development of increased awareness and understanding of these products.

6.4 REINFORCEMENT OF THE CORE CAPACITIES OF NATIONAL METEOROLOGICAL SERVICES TO MEET THE NEEDS OF DISASTER RISK MANAGEMENT STAKEHOLDERS

High-priority needs in this area have been identified as follows:

- (a) Strengthening of observational and monitoring capacities through:
 - (i) Improvement of coverage in time and space, with special attention to be paid to countries/territories with case III support mechanisms without real-time observation networks, and to climatological and marine observations;
 - (ii) Strengthened coordination among technical agencies that manage their own hydrometeorological networks, for better interoperability and real-time exchange;
 - (iii) A sustainability plan for observation networks (for example, a maintenance plan, supply of spare parts, quality-control methods, training);
 - (iv) Installation of non-conventional monitoring and observing instruments, such as Webcams;
 - (v) Improved sharing of regional observation data that are crucial for severe weather monitoring, such as radar, wave rider or lightning data, and integrated regional observation networks (based on the Carib–HYCOS project, the US/RA IV–WIGOS Demonstration Project, and the like);

- (b) Strengthening of forecasting capacities through:
 - (i) Upgrading of the forecasting system (of data flow, software and workstations), to facilitate easy and integrated access to a wider variety of numerical products, intelligent forecasting guidance systems and monitoring observations (national and regional);
 - (ii) Training of forecasters in the latest methodologies and analysis techniques, including probabilistic and deterministic model outputs and radar/satellite interpretation;
 - (iii) At national level, strengthening of real-time coordination with other technical agencies, such as NHSs;
 - (iv) At regional level, strengthening of real-time data exchange and forecast coordination, especially in the case of neighbouring forecast offices in case II Caribbean countries/territories;
 - (v) Strengthening of the role of regional centres to provide forecasting guidance tools and products for all meteorological, hydrological and marine hazards, including slow-onset hazards and climate change, and of their role to develop coordination mechanisms;
 - (vi) Strengthening national capacities for the downscaling of regional products to address slow-onset hazards and climate change at the national level;
- (c) Improvement of database management and sharing through:
 - (i) Improvement of the knowledge of availability, location and types of existing observations and data at national and regional levels;
 - (ii) Strengthening, at national and regional levels, of capacities for the implementation of quality-controlled and sustainable GIS databases, with metadata and long time series (data rescue), and exchange mechanisms through specific agreements or MOUs between all the stakeholders managing EWS data;
 - (iii) Grouping of meteorological, hydrological, marine and other environmental data relevant to MHEWS;
 - (iv) Specific training on the building of historical databases (for example, on homogenization, data rescue, metadata), development of hazard-analysis products and utilization of modelling outputs;
 - (v) An increase in the capacities of NMSs for product development by strengthening production systems within quality management framework principles;
- (d) Enhancement of telecommunication networks through:
 - (i) Strengthening of transmission systems for exchange and data collection at national to regional levels;
 - (ii) Implementation/improvement of reliable systems for backup and redundancy;
 - (iii) The upgrade of telecommunications and Internet capacities;
- (e) Development and implementation of a comprehensive QMS through QMS certification of NMSs and development of SOPs with other technical institutions, with consideration for the principles of QMS;
- (f) Strengthening of NMS technical training programmes related to EWS through:
 - (i) Cross-training programmes (for example, with a bilateral exchange of forecasters) and e-learning;
 - (ii) Regular workshops and bilateral training at national or/and regional levels between NMSs, DRM agencies and other stakeholders;
 - (iii) Training and workshops for regional sharing and transfer of tools, methodologies and good practices with regard to historical databases and hazard analysis;
 - (iv) Technical training for Webmasters to improve the local or national capacities for Website management;
 - (v) Bilateral workshops and training between forecasters and the media to improve communication efficiency;
 - (vi) Up-to-date and regular training programmes on current forecasting methodologies, data, tools and products;
 - (vii) Regional training with exchange of good practices on QMS methodologies and tools.

6.5 COOPERATION WITH OTHER TECHNICAL AGENCIES

High-priority needs in this area have been identified as follows:

- (a) Mapping of experts and agencies responsible for hydrological services (monitoring, forecasting, and the like) and establishment of a more robust cooperation network in the region, leveraging CIMH as well as Carib-HYCOS;

- (b) Mapping of institutional capacities and linkages among all relevant technical agencies as the basis for development of SOPs and agreements;
- (c) For case II Caribbean countries/territories, the development of specific SOPs and agreements for operational and technical support from the other technical agencies;
- (d) For case III Caribbean countries/territories, the development of additional specific SOPs and agreements between their NMSs and technical agencies in the supported countries/territories.

6.6 MULTI-HAZARD EARLY WARNING SYSTEMS REGIONAL AND NATIONAL ASPECTS

High-priority needs in this area have been identified as follows:

- (a) Strengthening of real-time coordination at national level with other technical agencies, such as NHSs and coastal institutions, and improved multi-sectoral input for warning and decision making, with an impact-oriented approach;
- (b) Sharing of good practices and transfer of knowledge and experiences on regional WWS by means of workshops and training;
- (c) Implementation or strengthening of comprehensive and multi-level criteria-oriented WWS, for the relevant meteorological, hydrological and coastal marine hazards, that meet the needs of DRM agencies and other stakeholders (in terms of lead time, national constraints, and the like);
- (d) Implementation of mechanisms and procedures for real-time coordination between Caribbean countries/territories (especially among small neighbouring territories), taking into account existing regional systems (for example, RSMC–Miami for tropical cyclones) and also the role of regional centres;
- (e) Establishment of a yearly regional meeting of NMSs and DRM agencies to develop/maintain coordination mechanisms among the Caribbean Islands;
- (f) Leveraging opportunities across hydrological, meteorological and tsunami warning systems.

6.7 PUBLIC OUTREACH AND EDUCATIONAL PROGRAMMES

High-priority needs in this area have been identified as follows:

- (a) Development and/or adaptation of multimedia educational programmes on all hazards and risks, with specific attention to vulnerable groups in society and to local needs, and by making use of local examples;
- (b) Development of partnerships with DRM agencies and other national and international organizations to facilitate the production of educational materials;
- (c) Development of public education programmes with suitable trained human and physical resources within NMHSs, DRM agencies and other stakeholders.

CHAPTER 7 – NEXT STEPS AND PHASE I PROJECT PRIORITIES

The outcome of the consultations underlines the need for a more coordinated approach to the strengthening of institutional capacities to support risk assessment and EWS for meteorological, hydrological and climate-related hazards in the Caribbean. This is required at both national and regional levels, and implies stronger cooperation with a multi-sectoral, multi-hazard, multi-level approach, within the context of the priorities of DRR and adaptation planning in the countries/territories in the region. The objective is to ensure that:

- (a) Legal and institutional arrangements in support of DRR and EWS are well established;
- (b) Risk assessment capacities are developed and applied multi-sectorally for planning and decision-making;
- (c) Procedures for QMSs and SOPs are developed between NMHS and other stakeholders to ensure effective execution of MHEWS;
- (d) Operational meteorological, hydrological and climate-related services in support of DRR are strengthened at national and regional levels, and that this is accomplished with consideration of user needs and requirements within the various sectors;
- (e) Coordination of MHEWS is efficient at both national and regional levels.

To achieve these objectives, it has been recommended that as the next steps the following issues should be addressed:

- (a) The recommendations presented in this Report should be reviewed and prioritized by the WMO Management Group for implementation. The Management Group should consider how the prioritized recommendations can be grouped and implemented in the most logical and efficient manner possible.
- (b) Based on the identified priorities, a plan of implementation should be developed that defines a series of capacity development projects. This plan should include timelines, milestones and deliverables.
- (c) Defined capacity development projects should possess national and regional dimensions to address the needs and gaps identified, building wherever possible on existing institutional mechanisms, capacities and relevant projects (recently completed and in-progress) in the region.
- (d) Annual DRR and climate adaptation regional and national multi-stakeholder forums (engaging technical and scientific as well as management networks) need to be established, given the important linkages between climate and DRM issues. The forums should be linked wherever possible to existing events and platforms (such as the forums of the RA IV Hurricane Committee, CDEMA-CDM, and others) for a more coordinated approach to the implementation, planning, resource mobilization, monitoring and evaluation of this initiative.
- (e) A resource mobilization strategy should be developed with a view to the longer-term development and sustainability of the Caribbean region. This resource mobilization needs to be considered for the requirements of capacity development, based on the recommendations in this Report, and prioritized by the WMO Management Group, as well as building on a more coordinated approach engaging internal (for example, government budgeting and cost-recovery models) and external (for example, donors, development banks) funding sources. This is to be achieved as part of the cross-programme resource mobilization strategy of WMO with other partners, as stressed during the Sixteenth World Meteorological Congress.
- (f) Specific needs for strengthening monitoring and forecasting of all priority hazards in the region should be addressed within a framework of strong regional cooperation, and solutions achieved through concrete projects developed for the strengthening of risk assessment and MHEWS in the Caribbean region, in coordination and cooperation with end-users such as DRM agencies.

PHASE I CAPACITY DEVELOPMENT PROJECT CONCEPT AS IDENTIFIED FROM THE CONSULTATIONS

A preliminary phase I project concept was identified during the last stage of the consultations. This project is to include two components.

Component 1: Governance and institutional frameworks for risk assessment and MHEWS at the national level

Component 1 objectives:

- (a) Facilitate dialogues on national policy/legislation, and workshops in the field of risk management for the strengthening of meteorological, hydrological and climate-related services;
- (b) Identify the roles and responsibilities of NMSs as reflected in national policy, legal frameworks and institutional coordination mechanisms, within a DRM framework (in partnership with CDEMA, OAS and other partners engaged in this area, including non-members of these organizations, such as the Dutch Caribbean municipalities).

Component 2: Operational EWS capacity development with national and regional components

Component 2 objective:

Develop and demonstrate operational capacities in EWS for severe weather (heavy precipitation) and flooding (flash floods and coastal inundation). These capacities must span all components of regional cooperation in national EWS, including monitoring and forecasting, risk analysis, dissemination and communication, development or strengthening of SOPs for emergency contingency planning, and activation of emergency plans based on warnings issued on the levels of risks.

The design of the phase I proposal should be carried out with consideration for a number of factors. These factors include:

- (a) The design, planning, governance and implementation of the capacity development project(s) will be carried out through a transparent multi-stakeholder consultation between NMSs, national DRM agencies and other sectoral stakeholders, and well as other relevant regional and international partners for further development and buy-in;
- (b) Relevant partners (national, regional and international) should be identified and engaged in the planning, implementation, resource mobilization and development of the project governance from the early stage;
- (c) The capacity development project(s) will be aligned with the elements of the CDEMA–CDM framework;
- (d) Criteria for country/territory selection for the project(s) should be developed on the basis of multiple benefits and governments' and agencies' receptivity and their active participation in, and contributions to the project(s);
- (e) Concrete experiences and lessons learned from good practices in MHEWS documented by WMO, from the region or globally, such as French examples in the French West Indies, in Cuba, Italy, the United States, Japan, Bangladesh, and others, should provide significant insight and expertise in all aspects of the projects;
- (f) Mapping of all relevant existing projects, activities and institutional capacities in the region, and a determination of all the leveraging opportunities, should be explored;
- (g) An interdisciplinary team of key institutions to shape and lead the process through regional and international partnerships.

Country type	Country name	Organization													
		ACS	OAS	CARICOM	Caribbean Forum	OECS	CDEMA	Alternativa Bolivariana para las Américas (ALBA)	CMO-CIMH	CDB	EU				
	Bonaire*	AM(NA)													
	Curaçao	AM													
	Saba*	AM(NA)													
	Sint Eustatius*	AM(NA)													
	Sint Maarten	AM													
BCT	Anguilla			AM		AM						M		M	
	Bermuda			AM											
	British Virgin Islands			AM				AM						M	
	Cayman Islands			AM										M	
	Montserrat			M					M					M	
	Turks and Caicos Islands	AM		AM										M	

* = Status as OCT, to be reviewed in 2015

ACP = African, Caribbean and Pacific States

AM = Associate member

AM(FR) = Associate member as France

AM(NA) = Associate member as Netherlands Antilles (to be disbanded 10/10/2010)

BCT = British Caribbean territories

FR OR = French outermost regions

M = Member

NL OCT = Dutch overseas countries and territories

Table 2. The WMO membership status of Caribbean countries/territories

<i>WMO membership status</i>	<i>Country/territory</i>
Member	Antigua and Barbuda
	Bahamas
	Barbados
	Belize
	Cuba
	Dominica
	Dominican Republic
	France – French Guiana (RA III) – Guadeloupe – Martinique – Saint Barthélemy – Saint Martin
	Guyana (RA III)
	Haiti
	Jamaica
	The Netherlands (RA VI) – Aruba – Bonaire – Saba – Sint Eustasius
	Saint Lucia
	Suriname (RA III)
	Trinidad and Tobago
	United Kingdom – Bermuda
	Member territory
Curaçao and Sint Maarten	
Not member	Grenada
	Saint Vincent and the Grenadines

Table 3. Institutional structure of WMO

<i>Institutional component</i>	<i>Description</i>
WMO Congress	The World Meteorological Congress is the supreme body of the Organization and assembles delegates of Members once every four years to participate in the Congress. The function of this assembly is as follows: to determine general policies for the fulfilment of the purposes of the Organization; to consider membership of the Organization; to determine the general, technical, financial and staff regulations; to approve long-term plans and budget for the following financial period; to elect the President and Vice-Presidents, and members of the Executive Council; to appoint the Secretary-General.
WMO Executive Council	The WMO Executive Council is the executive body of the Organization, which meets annually, implements decisions of Congress, coordinates the programmes, examines the utilization of budgetary resources, considers and takes action on recommendations of RAs and technical commissions and guides their work programme, provides technical information, counsel and assistance in the fields of activity of the Organization, and studies and takes action on matters affecting the WMO mandate.
WMO RAs	Through the six RAs, WMO works closely with its 189 Member States to facilitate the development of regional strategies. This organizational structure facilitates the development and sharing of meteorological, hydrological and climate-related data, and information and technical capacities, that all Member States in the respective regions can benefit from. The regional strategies are developed in alignment with the socio-economic regional strategies established by the socio-economic groupings in the region. The regions covered by the six WMO RAs are as follows: <ul style="list-style-type: none"> – RA I: Africa – RA II: Asia – RA III: South America – RA IV: Central America, North America and the Caribbean – RA V: The Pacific – RA VI: Europe
WMO Secretariat	The WMO Secretariat has its headquarters in Geneva. Regional offices are located in Geneva; field offices are located in the various WMO Regions and there are two liaison offices in New York and Brussels. The Secretariat is headed by the Secretary-General.
WMO Technical Commissions	The eight Technical Commissions are composed of experts who are designated by Members. The Commissions are responsible for studying meteorological, hydrological, and climatological operational systems, applications and research. They establish methodology and procedures. Technical Commissions have been established for: <ul style="list-style-type: none"> – Basic systems – Instruments and methods of observation – Atmospheric sciences – Aeronautical meteorology – Agricultural meteorology – Oceanography and marine meteorology (with UNESCO–IOC) – Hydrology – Climatology
WMO-sponsored programmes	<ul style="list-style-type: none"> – WWW Programme – WCP – Atmospheric Research and Environment Programme (AREP) – AMP, including TCP, AgMP, MMOP, PWSP, and AeMP – Hydrology and Water Resources Programme (HWRP) – ETRP – TCOP – Regional Programme (RP), including six RAs (refer to WMO RAs, above) – Space Programme (SAT) – DRR Programme

<i>Institutional component</i>	<i>Description</i>
WMO technical co-sponsored programmes	<ul style="list-style-type: none">– IPCC, co-sponsored by UNEP and WMO– World Climate Research Programme (WCRP), co-sponsored by the International Council for Science (ICSU) and WMO, and, since 1993, also by UNESCO-IOC– Global Climate Observing System (GCOS), co-sponsored by ICSU, UNESCO-IOC, UNEP and WMO– Global Ocean Observing System (GOOS), co-sponsored by ICSU, UNESCO-IOC, UNEP and WMO

Table 4. Definitions and mandatory functions of WMO global and regional centres

<i>Centres</i>	<i>Definition</i>	<i>Functions</i>
World Meteorological Centres (WMCs)	Centres applying sophisticated high-resolution global NWP models and preparing meteorological products for distribution to Members and other GDPFS centres	<ul style="list-style-type: none"> (a) Preparation and distribution of global (hemispheric) analysis products; (b) Preparation and distribution of short-, medium-, extended- and long-range forecasts and products with a global coverage (but presented separately, if required, for the tropical belt, the middle and high latitudes, or any other geographical area according to Members' requirements); (c) Preparation and distribution of climate-related diagnostic products, particularly for tropical regions; (d) Verification and inter-comparison of products; support for the inclusion of research results into operational models and their supporting systems; provision of training courses on the use of WMC products
RSMCs with geographical specialization	Existing national or regional centres that have accepted responsibilities by multilateral or regional agreement, or centres implemented by a joint cooperative effort by several countries in a region	<ul style="list-style-type: none"> (a) Provides the interface between WMCs and National Meteorological Centres (NMCs) by formatting and distributing global products to meet the needs in a particular region; (b) Provision of regional analysis and forecasting products for 12–48 hours, for designated areas; (c) Provides meteorological assistance to United Nations humanitarian missions in the event that the relevant associated NMC is facing an emergency, or is in catastrophic distress and out of service; (d) Coordination with other RSMCs as appropriate
RSMCs with activity specialization	Existing national or regional centres that have accepted specific responsibilities by multilateral or regional agreement, or centres implemented by a joint cooperative effort by several countries in a region	<ul style="list-style-type: none"> (a) Provision of advisories for tropical cyclones, severe storms and other dangerous weather phenomena; (b) Provision of tailored specialized products to service stakeholders in a particular area; (c) Provision of trajectories and atmospheric transport modelling products, including backtracking, in case of environmental emergencies or other incidents; (d) Provision of information on prolonged adverse weather conditions, including drought monitoring
Global Producing Centres (GPCs) for long-range forecasts	Centres designated by WMO for the provision of global long-range forecasts	Provision of global long-range forecasts from one month to two years

<i>Centres</i>	<i>Definition</i>	<i>Functions</i>
RCCs or RCC network	Centres designated by WMO for the provision of regional long-range forecasts and other regional climate services, or groups of centres that collectively provide these forecasts and services in a distributed network	<ul style="list-style-type: none"> (a) Operational activities for long-range forecasting: interpretation and assessment of relevant long-range forecasting products from GPCs; generation of regional and subregional tailored products and consensus statements on regional or subregional forecasts; provision of on-line access to RCC products/services for RCC stakeholders; assessment of the use of RCC products and services through feedback from stakeholders; (b) Operational activities for climate data services to support operational long-range forecasting and climate monitoring, such as climate diagnostics, establishment of an historical reference climatology, implementation of a regional climate watch that includes climate advisories and information for stakeholders; (c) Operational data services to support operational long-range forecasting and climate monitoring, such as the development of quality-controlled regional climate datasets and the provision of climate database and archiving services; (d) Training in the use of operational RCC products and services by providing information on methodologies and product specifications for mandatory RCC products, and guidance on their use and coordination of training for RCC stakeholders in interpretation and use of mandatory RCC products

Table 5. Network of WMO global and regional centres supporting the Caribbean

<i>WMO regional specialized centre</i>	<i>Location</i>	<i>Serving the following WMO Members</i>	<i>Website</i>
<i>WMO RSMCs and tropical cyclone and regional coordination committees in RA IV</i>			
RA IV Hurricane Committee		Antigua and Barbuda, Bahamas, Barbados, Belize, the British Caribbean Territories, Canada, Colombia, Costa Rica, Cuba, Curaçao and Sint Maarten, Dominica, Dominican Republic, El Salvador, France, Guatemala, Haiti, Honduras, Jamaica, Mexico, the Netherlands (representing Aruba, Bonaire, Saba and Sint Eustatius), Nicaragua, Panama, Saint Lucia, Trinidad and Tobago, United Kingdom, United States (RSMC–Miami Hurricane Center), Venezuela (Aruba is not currently a member of WMO)	
<i>Other WMO RSMCs and global centres</i>			
World Meteorological Centre and RSMC–Montreal, operated by the Meteorological Service of Canada	Montreal, Canada		http://www.ec.gc.ca/meteo-weather/default.asp?lang=En&n=07E09FE3-1
World Meteorological Centre and RSMC–Washington	Washington, United States		
World Meteorological Centre and RSMC–Miami Hurricane Center	Miami, United States		http://www.nhc.noaa.gov/
<i>WMO RCCs</i>			
No RCC is currently established	CIMH is being considered as a potential organization to become the RCC for the English-speaking Caribbean. An RCC network is being considered for the Spanish-speaking Caribbean and Central America. Furthermore, an RCC network is being considered engaging Canada, Mexico and the United States.		
<i>WMO–CGMS Virtual Centres</i>			
WMO–CGMS Barbados			http://www.wmo-sat.info/vlab/barbados/
WMO–CGMS Costa Rica			
<i>WMO RTCs</i>			
RTC–Barbados (incorporated within CIMH)	Barbados		http://192.91.247.60/etr/aspscripts/result_map_RTCS_n.asp?InstID_form==7

<i>WMO regional specialized centre</i>	<i>Location</i>	<i>Serving the following WMO Members</i>	<i>Website</i>
RTC–Costa Rica	University of Costa Rica, San José, Costa Rica		http://192.91.247.60/etr/aspscripts/result_map_RTCS_n.asp?InstID_form==11
RTC–Venezuela	Central University of Venezuela, Caracas Venezuela		http://192.91.247.60/etr/aspscripts/result_map_RTCS_n.asp?InstID_form==44
<i>WMO Regional Telecommunication Hubs (RTHs)</i>			
<i>WMO regional division</i>	<i>Centre</i>	<i>Zone of responsibility</i>	
Region IV WMC/RTH	WMC–Washington	North America, Central America and the Caribbean	

Table 6. Primary sources including surveys and workshops

<i>Surveys</i>			
<i>Title</i>	<i>Year</i>	<i>Countries/territories involved</i>	<i>Website</i>
Capacity Assessment of National Meteorological and Hydrological Services in Support of Disaster Risk Reduction	2006	Bahamas, Barbados, Cayman Islands, Dominican Republic, Haiti, Jamaica, the Dutch municipalities, Saint Lucia, Trinidad and Tobago	http://www.wmo.int/pages/prog/drr/natRegCap_en.html
Questionnaire for the Training Workshop on Multi-hazard Early Warning Systems with Focus on Institutional Partnership and Coordination	2010	Antigua and Barbuda, Bahamas, Barbados, Anguilla, British Virgin Islands, Cayman Islands, Turks and Caicos Islands, Dominica, Dominican Republic, Grenada, Jamaica, the Dutch municipalities, Saint Lucia, Trinidad and Tobago	http://www.wmo.int/pages/prog/drr/events/MHEWSCostaRica/index_en.html
Questionnaire for the Technical Cooperation Workshop for Development of the Caribbean Regional Cooperation Programme in Multi-hazard Early Warning Systems	2010	Antigua and Barbuda, Aruba, Curaçao and Sint Maarten, Dominica, Trinidad and Tobago, Cayman Islands, Montserrat, Turks and Caicos Islands, Sint Eustatius	http://www.wmo.int/pages/prog/drr/events/Barbados/index_en.html
Survey Questionnaire to Assess Forecasting and Observing Capacities of the National Meteorological, Hydrological and Marines Services to Support MHEWS in the Caribbean Region	2011	Antigua and Barbuda, Bahamas, Barbados, Belize, Bermuda, the British Caribbean territories, Cuba, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Curaçao and Sint Maarten, Saint Lucia, Sint Maarten, Suriname, Saint Vincent and the Grenadines, Trinidad and Tobago	http://www.wmo.int/pages/prog/drr/events/CaymanIslands/index_en.html (document 3)
<i>Workshops</i>			
<i>Title</i>	<i>Dates</i>	<i>Location</i>	<i>Website</i>
Training Workshop on Multi-hazard Early Warning Systems with Focus on Institutional Partnerships and Cooperation	22–25 March 2010	San Jose, Costa Rica	http://www.wmo.int/pages/prog/drr/events/MHEWSCostaRica/index_en.html
Technical Cooperation Workshop for Development of the Caribbean Regional Cooperation Programme in Multi-hazard Early Warning Systems	2–5 November 2010	Christ Church, Barbados	http://www.wmo.int/pages/prog/drr/events/Barbados/index_en.html
National Disaster Coordinators and Meteorologists Dialogue Advancing Multi-hazards Early Warning Systems in the Caribbean. Fifth Caribbean Conference on Comprehensive Disaster Management	6 December 2010	Montego Bay, Jamaica	http://www.wmo.int/pages/prog/drr/events/Jamaica/index_en.html

<i>Workshops</i>			
<i>Title</i>	<i>Dates</i>	<i>Location</i>	<i>Website</i>
Strengthening Regional Cooperation to Support Forecasting with Multi-hazard Approach in Regional Association IV	7 March 2011	GeorgeTown, Cayman Islands	http://www.wmo.int/pages/prog/drr/events/CaymanIslands/index_en.html
Regional Association IV Workshop on Hurricane Forecasting and Warning and Public Weather Services. Special Session on Disaster Risk Reduction and Early Warning Dissemination and Communication Issues in Central America and the Caribbean	1 April 2011	Miami, Florida, United States	http://www.wmo.int/pages/prog/drr/events/PWS-CAPMiami/index_en.html

Table 7. Primary sources including direct consultation with WMO Members and various agencies

<i>Countries/territories</i>	<i>Agencies/institutions</i>	<i>Interlocutors (e-mail)</i>
Trinidad and Tobago	CMO	Mr T. Sutherland, Director (tsutherland@cmo.org.tt) Mr G. De Souza, Science and Technology Officer (gde_souza@cmo.org.tt)
	ACS	Secretary-General
	UNDP	Mr H. Prince
	NMS	Mr E. Moolchan, Permanent Representative with WMO, Director (dirmet@tstt.net.tt)
	Office of Disaster Preparedness and Management (ODPM)	Mr M. Noel, Acting Director (dirmet@tstt.net.tt) Mr G. Robinson, Chief Officer (grobinson@mns.gov.tt)
	NMS	Forecasters and observers
Barbados	CDEMA	Ms E. Riley, Deputy Executive Director (liz.riley@cdema.org) Ms A. Grosvenor, Technical Manager (andria.grosvenor@cdema.org)
	UNDP	Ms M. Gyles McDonnough, UNDP Resident Coordinator (michelle.gyles.mcdonnough@undp.org) Mr I. King, National DRR Advisor (ian.king@undp.org) Mr A. Vacher, R3I Project Coordinator (alexandre.vacher@undp.org)
	CIMH	Mr D. Farrell, Principal (dfarrell@cimh.edu.bb) Mr A. Sealy, Lecturer (meteorology) (asealy@cimh.edu.bb) Ms K. Whitehall, Lecturer (climatology) (kwhitehall@cimh.edu.bb) Ms M. Pestaina-Jeffers, Senior Lecturer (meteorology) (margpj@cimh.edu.bb) Mr L. Pologne, Lecturer (meteorology) (lpologne@cimh.edu.bb) Mr S. Boyce, Lecturer (meteorology) (sboyce@cimh.edu.bb)
	NMS	Mr H. Lovell, Permanent Representative with WMO, Director (dirmet@sunbeach.net) Ms Snoces, Deputy Director (dirmet@sunbeach.net)
	Department of Emergency Management (DEM)	Ms J. Thomas, Director (jthomas@barbados.gov.bb)
	CIDA	Mr Y. Chakalall, Senior Development Officer (yuri.chakalall@international.gc.ca)
Dominica	NMS	Ms S. Etienne-Leblanc, Acting Director (metoffice@cwdom.dm) Mr M. Alexander, Meteorologist
	Office of Disaster Management (ODM)	Mr N. Isaac, Director (odmdominica@gmail.com)
	Dominica Water and Sewerage Company Ltd. (DOWASCO)	Mr G. Drigo Mr Durand

<i>Countries/territories</i>	<i>Agencies/institutions</i>	<i>Interlocutors (e-mail)</i>
Antigua and Barbuda	Meteorological Services	Mr K. Meade, Permanent Representative with WMO, Director (keithleym@yahoo.com) Mr D. Destin, Climatologist (dale_destin@yahoo.com)
	National Office of Disaster Services (NODS)	Mr P. Mullin, Director (nodsanu@gmail.com)
	Meteorological Services Operations Centre	Forecasters and computer engineers
Saint Lucia	NMS	Mr T. Auguste, Permanent Representative with WMO, Director (tauguste@gosl.gov.lc) Mr V. Descartes, Meteorologist (vdescartes@gosl.gov.lc)
	National Emergency Management Organization (NEMO)	Mr J. Dubois, Deputy Director (deputy@nemo.gov.lc)
	Water Resource Management Agency (WRMA)	Mr J.A. Mathurin (junior.mathurin@gmail.com)
Martinique	Direction Régionale de l'Environnement (DIREN)	Mr B. Capdeville, Chief of the Hydrological and Risk Department (bruno.capdeville@developpement-durable.gouv.fr) Mr P. Marras, Hydrologist (pascal.marras@developpement-durable.gouv.fr) Ms A. Comte, Environmental Risk Department (aude.comte@developpement-durable.gouv.fr) Mr D. Flamand, Environmental Data Department (david.flamand@developpement-durable.gouv.fr)
	Carib-HYCOS	Mr J.P. Bricquet, Project Coordinator, Institut de recherche pour le développement (jean-pierre.bricquet@ird.fr)
Cuba	Civil Defence; NMS; NHS; Environment Ministry	Mr T. Gutierrez, Permanent Representative with WMO (tomas.gutierrez@insmet.cu)
	UNDP	Ms B. Pesce-Monteiro, Resident Coordinator for the United Nations in Cuba
	National Forecast Centre	Mr J. Rubiera, Director (jose.rubiera@insmet.cu) Ms M.T. Llanes, Chief Forecaster (miguel.hernandez@insmet.cu)
Dominican Republic	Centro de Operaciones de Emergencias (COE); NMS	Mr C. Paulino Cardenas (paulinocarlosm@gmail.com) Ms G. Ceballos, Permanent Representative with WMO (gceballos_7@yahoo.com) Mr M. Campusano, Sub-Director (Lasose2002@yahoo.com)
	NMS	Ms C. Perez, Research Department (Caridad_prez@yahoo.es) Mr L.P. Jerez, Coordinator for Hydrology (jerez0550@gmail.com)
Bahamas (through a conference call)	National Emergency Management Agency (NEMA); NMS	Mr S. Russell, Director (stephenrussell@bahamas.gov.bs) Mr A. Rolle, Permanent Representative with WMO, president of WMO RA IV (rollearthur@gmail.com)

Table 8. Secondary sources, including regional programmes or projects relevant to MHEWS in the Caribbean

<i>Name or acronym</i>	<i>Implementing agencies</i>	<i>Dates/duration</i>	<i>Goals</i>	<i>Participating countries</i>	<i>Funding</i>
CADM II	CDEMA, CIMH	Phase II 2009–2012	The goal is to mitigate disaster damages through enhancement of community resilience to the flood hazard. http://www.cdema.org/index.php?option=com_content&view=article&id=111&Itemid=89	CDEMA Members; Pilot project for Dominica, Grenada, Saint Lucia, Belize, Guyana	JICA, US\$ 2.7 million
CRMI	UNDP	Phase II since 2010	The project is an umbrella programme designed to build capacity across the Caribbean region for the management of climate-related risk. http://www.undp.org/cu/crmi/en/index.asp Table of documents of reference downloadable at: http://www.undp.org/cu/crmi/en/drrdocs.asp	Antigua and Barbuda, Bahamas, the British Caribbean Territories, Barbados, Cuba, Dominican Republic, Grenada, Haiti, Jamaica, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago	Italy, Norway, UNDP, US\$ 2.8 million
R3I	UNDP	2009–2011	The goal is to address the risk and exposure of these small islands by providing a network of regional infrastructure, programmes, policies and protocols to strengthen their capacity to predict and prepare for natural hazards, thus improving resilience and reducing risk and subsequent loss. http://www.bb.undp.org/index.php?page=regional-risk-reduction-initiative	All OCTs	€4.9 million
CHAMP II	OAS, CDEMA	2005–2008	It is intended to assist countries in the Caribbean region with the development of comprehensive, national hazard-vulnerability reduction initiatives through the development of national hazard-mitigation policies, creation of appropriate policy implementation programmes through comprehensive hazard-mitigation planning frameworks, and the development and implementation of safer building training and certificate programmes (Hazard Mapping and Common Digital Databases for Hazard Mapping and Vulnerability Assessment; Quantitative Risk Assessment (the British Virgin Islands)). http://www.cdema.org/projects/champ/	CDEMA Members; Four pilot States: Saint Lucia, Grenada, British Virgin Islands, Belize	CIDA, CDEMA, US\$ 1.4 million

<i>Name or acronym</i>	<i>Implementing agencies</i>	<i>Dates/duration</i>	<i>Goals</i>	<i>Participating countries</i>	<i>Funding</i>
ERRVC	UNDP, CIMH	2009–2011	The goal is to reduce vulnerability and increase resilience to climate change, natural hazards and poverty at the regional, national and community levels within the Caribbean region.	Barbados and OECS	Italy, €3.5 million
SHOCS	Finland, ACS	Phase II 2010–2012	The objective is to improve preparedness for the adverse effects of natural disasters and harmful impacts of climate change and to decrease the number of casualties and economic losses due to natural hazards. It includes making investments in EWSs and rescue preparedness, and establishing the authority of NMHSs and civil protection agencies as contributors to DRR. http://www.acs-aec.org/Disasters/18th%20SC%20Disasters/English/SHOCS_ProjectDocument_FMI_ACS_eng.pdf	ACS Members	
US/RA IV–WIGOS	WMO, United States		The proposed US/RA IV–WIGOS Demonstration Project will endeavour to build an Integrated Atmosphere Observing System (IAOS) with enhanced interoperability features through the integration of various component systems, representing surface-based upper-air observations such as rawinsondes, airborne observations including Aircraft Meteorological Data Relay (AMDAR) from RA IV Member countries, and space-based observations derived from satellite soundings. Interoperability will be facilitated through metadata catalogues and archival sites consistent with evolving WIS architecture. http://www.wmo.int/pages/prog/www/wigos/documents/DP_USA.pdf	All the participating islands and countries except Guyana and Suriname, which are part of RA III, and Grenada, Saint Kitts and Nevis, and Saint Vincent and the Grenadines	
Carib–HYCOS	WMO, IRD	Since 2004	The goal is to assist NMHSs in the modernization and strengthening of their activities related to water resources, so as to provide them with more reliable systems and data for the issuance of more accurate short-, medium- and long-term forecasts. http://www.caraiibes-hycos.org	Antigua and Barbuda, Barbados, Curaçao and Sint Maarten, Dominica, Dominican Republic, the French West Indies, Haiti, Jamaica, Saint Lucia, Trinidad and Tobago	IRD, EU Members (Interreg IV), € €3.5 million

<i>Name or acronym</i>	<i>Implementing agencies</i>	<i>Dates/duration</i>	<i>Goals</i>	<i>Participating countries</i>	<i>Funding</i>
CMO Weather Radar Network	CMO, EU	2004	The project will replace old radars by a new network of Doppler radars that will link up with existing radars of other Caribbean countries/ territories, to form an electronic radar composite of the Caribbean.	CMO Members	EU, €13 million
ICG/CARIBE EWS-III	UNESCO-IOC	2006–2011	The goal is to provide efficient assistance on tsunami risk reduction to Member States in the Greater Caribbean region following the lessons learned from the Indian Ocean tsunami of 2004. The guidelines for ICG/CARIBE EWS activities are compiled in the CARIBE EWS Implementation Plan. http://www.ioc-tsunami.org/index.php?option=com_content&view=article&id=9&Itemid=15&lang=en	UNESCO-IOC Members	
CARIWIN	McGill University, CIMH	2006–2012	The project aims to improve existing capacity in these three pilot countries by involving local community organizations, water-user associations and regional and national networks. Several training courses will be held each year on the principles of Integrated Water Resources Management (IWRM), meteorological and hydrological data processing and management, the use of field instrumentation, and water policy. This project has partially supported CDPMN.	Guyana, Jamaica, Grenada	C\$ 1 million
Real-time Flood Forecasting Project	CIMH	3 years	The goal is to develop a robust, reproducible and transparent approach to flood forecasting that couples a physically based hydrological model, capable of capturing changes in watershed characteristics, to a numerical weather prediction model.	Barbados, Guyana, Jamaica	US\$ 101 000
Caribbean Disaster Pilot Project	Canadian Space Agency	3 years	The principle goals of the project are, first, to demonstrate the effectiveness of satellite imagery to strengthen regional, national and community-level capacity for mitigation, management and coordinated response to natural hazards. Second, it is intended to identify specific satellite-based products that can be used for disaster mitigation and response on a regional level. Third, capacity building activities should be identified that will increase the ability of the region to integrate satellite-based information into disaster management initiatives.	Barbados, Grenada, Jamaica, Saint Lucia, the British Virgin Islands	Funded by institutional grants and in-kind support

<i>Name or acronym</i>	<i>Implementing agencies</i>	<i>Dates/duration</i>	<i>Goals</i>	<i>Participating countries</i>	<i>Funding</i>
Caribbean Flood Risk Atlas	UWI Disaster Risk Reduction Centre	2 years	The goal of the project is to make available on-line spatial data on risk for hurricanes, earthquakes and floods in the Caribbean.	Barbados, Grenada, Jamaica, among others	US\$ 510 000
Caribbean Data Rescue Project	CIMH	1 year	The goal of the project is to develop the meteorological database of CIMH in order to facilitate more rigid and robust research, policy and decision-making in areas deemed essential to the socio-economic well-being of CMO Member States and the livelihoods of their peoples.	All 16 Member States of CMO	US\$ 290 000
<i>Programme information from the 2010 EU assessment (see also Tables 8 and 9)</i>					
Tsunami EWS	UWI	2006–2008	A principle goal is to strengthen the capacity of the Seismic Research Unit to detect, monitor and warn people at risk from tsunami and other related geologic hazards. A further goal is to launch a comprehensive public education campaign to be coordinated by CDEMA.	All islands	USAID, Trinidad and Tobago, US\$ 390 000
Tsunami EWS	UWI, CDEMA	2007–2009	The goals are to increase public awareness about tsunamis and other coastal hazards, and to improve notification of tsunamis and other coastal hazards to at-risk populations.	All islands	USAID, CDEMA, US\$ 828 000
Information and communication Technologies (ICTs) for Disaster Management	CDEMA	2007–2009	This project aims to improve the effectiveness of disaster management practices in the Caribbean region through the identification and testing of innovative ICT applications, including EWSs for fast-onset hazards.	CDEMA Members	International Development Research Centre (IDRC) (Canada), BDS 700 000
Caribbean Cluster for Natural Risks	Region Martinique	2008–2010	The main themes of the project are GIS, the sea (tsunamis, coastal erosion), seism, floods and drought. Identification of the main actors is required, together with their sensitization, mobilization and involvement. It is intended to establish groups of experts, followed by screening of projects and initiatives with innovative approaches, and the provision of Internet and directory support to actors and initiatives.	Cuba, Dominica, Haiti, Jamaica, Dominican Republic, Saint Lucia, Trinidad and Tobago, the French West Indies, Guyana	EU Interreg IV, Martinique, € 865 000
Enhancing Disaster Preparedness	Oxfam GB	2009–2011	The aim of the project is to contribute to disaster risk reduction in the Caribbean region by enhancing knowledge management of disaster preparedness integration in rural livelihoods and urban planning among community leaders, local governments and other key stakeholders.	Special focus on Haiti and Jamaica	Disaster Preparedness Programme of ECHO (DIPECHO), €700 000

<i>Name or acronym</i>	<i>Implementing agencies</i>	<i>Dates/duration</i>	<i>Goals</i>	<i>Participating countries</i>	<i>Funding</i>
Mainstreaming Adaptation to Climate Change Project	CCCCC	2003–2009	The objective is to facilitate the creation of an enabling environment in the small islands and coastal developing States of CARICOM for climate change adaptation.	CDEMA Members	World Bank
Implementation of Adaptation Measures in Coastal Zones	Countries	2006–2011	The objective is to implement specific (integrated) pilot adaptation measures addressing, primarily, the impacts of climate change on their natural resource base along coastal and near-coastal areas. A further objective is to produce knowledge of global value on how to implement adaptation measures in small island States that can be applied in other countries in the region.	Dominica, Saint Lucia, Saint Vincent and the Grenadines	World Bank Global Environment Facility (GEF) Project, US\$ 5.5 million
Mainstreaming Disaster Risk Management		2010	The first component of the project will engage local communities by implementing demonstrative community risk reduction projects. The second component will help to build capacity in key stakeholders in Member States of OECS concerned with planning and implementation of development projects. The technical cooperation will make significant use of some of the DRM tools that have been developed in the region. http://www.iadb.org/projects/project.cfm?id=RS-T1319&lang=en	OECS	IDB, US\$ 400 000

Table 9. Secondary sources, including other assessments carried out in the Caribbean relevant to MHEWS

<i>Institution</i>	<i>Dates</i>	<i>Type</i>	<i>Abbreviations</i>	<i>Title/Website</i>	<i>Countries involved</i>
CDEMA/OAS/ JICA/CIDA	2003	S	CHAMP I	Status of Hazard Maps, Vulnerability Assessments and Digital Maps in the Caribbean http://www.cdera.org/projects/ champ/docs/all_docs.shtml	CDEMA Members, Martinique
EU	2010	V	EU 2010	Current Actions and Initiatives in the Field of Civil Protection in order to Promote and Enhance the Regional Cooperation Mechanism	All islands included in the project
UNDP	2010	V	R3I	Regional Risk Reduction Initiative http://www.bb.undp.org/index. php?page=regional-risk- reduction-initiative	Caribbean OCTs
CDEMA	2006	V	CDM	CDM Audit	CDEMA Members
USAID Vulnerability Benchmarking Tool (BTool)	Since 2008	V, S	BT	http://www.cdera.org/cunews/ news/antigua/article_2067.php Saint Lucia report available at: http://stlucia.gov.lc/nemp/	OECS

V = Visits and interviews

S = Surveys

M = Meetings/workshops

Table 10. Secondary sources including studies, synthesis reports and articles

IPCC, 2007: Chapter 16: Small islands. In: <i>Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007: Impacts, Adaptation and Vulnerability</i> (M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, eds). Cambridge, Cambridge University Press, http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml#1 .
CARICOM, 2011: Selected economic indicators, 2011. http://www.caricomstats.org/handbookpub.html .
ECLAC, 2010: Economics of Climate Change in Latin America and the Caribbean. www.eclac.cl/publicaciones/xml/9/41909/2010-914-Summary_Climate_change_COVER.pdf .
United States International Trade Commission, 2008: <i>Caribbean region: Review of Economic Growth and Development</i> . Investigation No. 332-49, Publication 4000, http://www.usitc.gov/publications/332/pub4000.pdf .
EC–Caribbean Forum (CARIFORUM), 2008: European Community – Caribbean Region. Regional Strategy Paper and Regional Indicative Programme, 2008–2013. http://ec.europa.eu/development/icenter/repository/scanned_r9CARAI_rsp-2007-2013_en.pdf .
CDB, 2010: Biennial Social Development Report, 2010. http://www.caribank.org/titanweb/cdb/webcms.nsf/AllDoc/F198F4004C434579042577EC00478FD4/\$File/Biennial%20Social%20Report%20NOVEMBER%202010.pdf .
IDB, 2011: IDB Integrated Strategy for Climate Change Adaptation and Mitigation, and Sustainable and Renewable Energy. http://idbdocs.iadb.org/wsdocs/getdocument.aspx?docnum=35802849 .
ECLAC, 2009: <i>Maritime Sector and Ports in the Caribbean: the Case of CARICOM Countries</i> (R.J. Sanchez and G. Wilmsmeier). Santiago, CEPAL, http://www.eclac.org/publicaciones/xml/6/36706/lcl3008i.pdf .
Pulwarty, R.S., L.A. Nurse and U.O. Trotz, 2010: Caribbean islands in a changing climate. <i>Environment Magazine</i> , 52(6):16–27.
CCRIF, 2009: <i>Climate Change and Caribbean Economies: Implications, Adaptation and Risk Management</i> (S. Young and E. Iyahan). George Town.
Official governmental Websites of countries from the Caribbean region
UNISDR – Countries and National Platforms: http://www.unisdr.org/partners/countries .
PreventionWeb – Countries and Regions: http://www.preventionweb.net/english/countries/ .
CIA – The World Factbook: https://www.cia.gov/library/publications/the-world-factbook/ .

Table 11. Synthesis/mapping of information gathered from agencies and institutions in the Caribbean during visits and assessments

Country / Territory	Country / Territory status	Does Country / Territory have a NMS	Category of support Mechanism	Policy and legal framework supporting EWS	Operational cooperation between Meteorological Services and DRM agencies	Cooperation with other technical agencies (eg. Hydrological Services)	Product and Service delivery to support EWS and risk analysis				Core capacities of the Meteorological Services to support EWS			
							Hazard analysis	Data products, forecasts and warnings	Expertise and advisory service	Dissemination mechanisms	Monitoring and Observation networks	Operational forecasting	Data management and exchange	Products development
Antigua & Barbuda	Ind	YES	-	CDM E.U WMO2010	WMO2006 WMO2010 VISIT	WMO2006 WMO2011 RAIV-WIGOS	CHAMP I VISIT	WMO2006 WMO2011 VISIT	WMO2006 WMO2011 VISIT	WMO2006 WMO2011 VISIT	WMO2006 WMO2011 VISIT	WMO2006 WMO2011 VISIT	WMO2006 WMO2011 VISIT	
Bahamas	Ind	YES	-	E.UJ.2010 WMO2010	WMO2006 WMO2010	WMO2011 RAIV-WIGOS	CHAMP I WMO2010	WMO2011	WMO2011	WMO2011	WMO2011	RAIV-WIGOS	WMO2011	
Barbados	Ind	YES	-	CDM E.UJ.2010 WMO2010	WMO2006 WMO2010 VISIT	WMO2006 WMO2011 VISIT	CHAMP I VISIT	WMO2011	WMO2011	WMO2011	WMO2011	RAIV-WIGOS CAR-HY	WMO2011 VISIT	
Belize	Ind	YES	-	E.UJ.2010 WMO2010	WMO2006 WMO2010	RAIV-WIGOS CADM II CHAMP II RAIV-WIGOS	CHAMP I CHAMP II CADM II	RAIV-WIGOS	RAIV-WIGOS	RAIV-WIGOS	RAIV-WIGOS	CADM II RAIV-WIGOS	WMO2011 VISIT	
Cuba	Ind	YES	-	E.UJ.2010 WMO_Ews	WMO_Ews VISIT	WMO_Ews VISIT	RAIV-WIGOS	RAIV-WIGOS	WMO_Ews VISIT	WMO_Ews VISIT	WMO_Ews VISIT	CAR-HY RAIV-WIGOS	WMO2011 VISIT	
Dominican Rep	Ind	YES	-	E.UJ.2010	WMO2006 WMO2010	WMO2006 WMO2010 RAIV-WIGOS VISIT	CHAMP I	WMO2011	WMO2011	WMO2011	WMO2011	WMO2006 WMO2011 RAIV-WIGOS	WMO2011 VISIT	
Guyana	Ind	YES	-	E.UJ.2010 WMO2010	WMO2010	CADM II	CHAMP I CADM II	WMO2010	WMO2010	WMO2010	WMO2010	CADM II	WMO2011 VISIT	
Haiti	Ind	YES	-	E.UJ.2010 WMO2010*	WMO2006 WMO2010*	WMO2006 WMO2010*	CHAMP I WMO2010*	WMO2010*	WMO2010*	WMO2010*	WMO2010*	WMO2010*	WMO2010*	
Jamaica	Ind	YES	-	CDM E.UJ.2010 WMO2010	WMO2006 WMO2010	RAIV-WIGOS	CHAMP I WMO2010	WMO2006	WMO2006	WMO2006	WMO2006	CAR-HY	WMO2006	
St Lucia	Ind	YES	-	CDM E.UJ.2010 WMO2010 Btool	WMO2006 WMO2010 Btool VISIT	WMO2006 WMO2011 VISIT	CHAMP I Btool VISIT	WMO2011	WMO2011	WMO2011	WMO2011	RAIV-WIGOS CAR-HY	WMO2011 VISIT	
Suriname	Ind	YES	-	E.UJ.2010	WMO2010	CADM II RAIV-WIGOS CHAMP II	CHAMP II	WMO2011	WMO2011	WMO2011	WMO2011	CADM II RAIV-WIGOS	WMO2011 VISIT	

Please, refer to tables 2 and 3 for the acronyms
 In blue : Assessments
 In green : Projects or programmes
 In purple : WMO visits between July and September 2010 throughout the region
 In italic : Partial information

Country / Territory	Country / Territory status	Does Country / Territory have a NMS	Category of support Mechanism	Policy and legal framework supporting EWS	Operational cooperation Meteorological Services and DRM agencies	Cooperation with other technical agencies (eg. Hydrological Services)	Product and Service delivery to support EWS and risk analysis				Core capacities of the Meteorological Services to support EWS			
							Hazard analysis	Data products, forecasts and warnings	Expertise and advisory service	Dissemination mechanisms	Monitoring and Observation networks	Operational forecasting	Data management and exchange	Products development
Trinidad & Tobago	Ind	YES	I	CDM E.U.2010 WMO2010	WMO2006 WMO2010 VISIT	WMO2006 VISIT RAIV-WIGOS	WMO2011	WMO2006 WMO2011 WMO2010 RAIV-WIGOS VISIT	WMO2006 WMO2011 VISIT	WMO2011 VISIT	WMO2006 WMO2011 RAIV-WIGOS CAR-HY	WMO2011	WMO2011	
Cayman	B. oct	YES	I	E.U.2010	WMO2010	RAIV-WIGOS	WMO2011	WMO2010 WMO2011 RAIV-WIGOS	WMO2011	WMO2011	RAIV-WIGOS	WMO2011	WMO2011	
Curacao	D. oct	YES	I	E.U.2010 WMO2010 (a)	WMO2006 WMO2010 (a & b) R3/	WMO2006 RAIV-WIGOS	WMO2011	WMO2006 WMO2010 (a & b) RAIV-WIGOS	WMO2006 RAIV-WIGOS	WMO2011	WMO2006 RAIV-WIGOS	WMO2011	WMO2011	
Guadeloupe	F. or	YES	I	WMO2010 (a) WMO_Ews VISIT WMO2010 (a) WMO_Ews VISIT	WMO_Ews VISIT WMO_Ews VISIT RAIV-WIGOS	WMO_Ews VISIT RAIV-WIGOS	WMO2011	WMO_Ews VISIT RAIV-WIGOS RAIV-WIGOS	WMO_Ews VISIT RAIV-WIGOS CAR-HY	WMO_Ews VISIT	WMO_Ews VISIT RAIV-WIGOS CAR-HY	WMO2011	WMO2011	
Martinique	F. or	YES	I	WMO2010 (a) WMO_Ews VISIT	WMO_Ews VISIT RAIV-WIGOS	WMO_Ews VISIT RAIV-WIGOS	WMO2011	WMO_Ews VISIT RAIV-WIGOS RAIV-WIGOS	WMO_Ews VISIT RAIV-WIGOS CAR-HY	WMO_Ews VISIT	WMO_Ews VISIT RAIV-WIGOS CAR-HY	WMO2011	WMO2011	
Dominica	Ind	YES	I	CDM E.U.2010 WMO2010 (a) VISIT	WMO2010 CADM II RAIV-WIGOS	WMO2011	WMO2011	WMO2010 RAIV-WIGOS WMO2011	WMO2011	WMO2011	WMO2011 CAR-HY CADM II	WMO2011	WMO2011	
Grenada	Ind	YES Net Wmo	I	CDM E.U.2010 WMO2010 (a)	WMO2010 CADM II CHAMP II	WMO2011	WMO2011	WMO2010 (a & b) WMO2011	WMO2011	WMO2011	RAIV-WIGOS CADM II	WMO2011	WMO2011	
St Vincent & Gr	Ind	YES Net Wmo	I	CDM E.U.2010 WMO2010 (a)				WMO2010 (a & b)	WMO2010 (a & b)	WMO2010 (a & b)	WMO2010 (a & b)	WMO2011	WMO2011	
Aruba	D. oct	YES	I+II (?)	E.U.2010	WMO2010 (a & b)	RAIV-WIGOS		WMO2010 (a & b) RAIV-WIGOS	RAIV-WIGOS		RAIV-WIGOS	RAIV-WIGOS	RAIV-WIGOS	
St Maarten	D. oct	YES	I+II (?)	E.U.2010	WMO2010 (a & b)	RAIV-WIGOS	WMO2011	WMO2010 (a & b) WMO2011 RAIV-WIGOS	RAIV-WIGOS	WMO2011	RAIV-WIGOS	RAIV-WIGOS	WMO2011	

Please, refer to tables 2 and 3 for the acronyms

In green : Projects or programmes

In purple : WMO visits between July and September 2010 throughout the region

In italic : Partial information

In blue : Assessments

In bold : Good level of information

Country / Territory	Country / Territory status	Does Country / Territory have a NMS	Category of Support Mechanism	Policy and legal framework supporting EWS	Operational cooperation between Meteorological Services and DRM agencies	Cooperation with other technical agencies (eg. Hydrological Services)	Product and Service delivery to support EWS and risk analysis				Core capacities of the Meteorological Services to support EWS			
							Hazard analysis	Data products, forecasts and warnings	Expertise and advisory service	Dissemination mechanisms	Monitoring and Observation networks	Operational forecasting	Data management and exchange	Products development
St Kitts & Nev.	Ind	No Antigua Not Wmo	II	CDM E.U.2010		RAIV-WIGOS	CHAMP I							
Anguilla	B. oct	No Antigua	II	CDM E.U.2010 WMO2010 (a)	WMO2010 (a & b)	RAIV-WIGOS	CHAMP I R3I							
British Virgin Is.	B. oct	No Antigua	II	CDM E.U.2010		CHAMP II RAIV-WIGOS	CHAMP I R3I CHAMP II							
Montserrat	B. oct	No Antigua	II	CDM E.U.2010		RAIV-WIGOS	CHAMP I R3I							
Turks and Caicos	B. oct	No Bahamas	II	E.U.2010 WMO2010 (a)		RAIV-WIGOS	CHAMP I							
Saba/St Eustatius	D. oct	No Curacao	II	E.U.2010	WMO2010 (a & b)	RAIV-WIGOS	R3I							
Bonaire	D. oct	No Curacao	II	E.U.2010	WMO2010 (a & b)	RAIV-WIGOS	R3I							
St Martin/St Bart	F. or	No Guadeloupe	II	E.U.2010 VISIT	VISIT	VISIT RAIV-WIGOS						VISIT		

Please, refer to tables 2 and 3 for the acronyms

In green : Projects or programmes

In purple : WMO visits between July and September 2010 throughout the region

In italic : Partial information

In bold : Good level of information

Note:

Further details of the survey codes referred to in Table 11 are given in this Report in the following tables:

CADM II: Table 8;

CDM: Table 8;

CHAMP I: Table 9;

CHAMP II: Table 8;

E.U.2010: Table 9;

R3I: Table 8;

RAIV-WIGOS: US/RA IV-WIGOS, Table 8;

WMO2006: Table 6;

WMO2010(a): Table 6 (WMO Training Workshop);

WMO2010(b): Table 6 (WMO Technical Cooperation Workshop);

WMO2011: Table 6;

WMO-Ews: Table 6

Table 12. Overview of policies and legal frameworks supporting DRR and EWS incountries/territories in the Caribbean region

Country/ territory	Country/ territory status	Does the island have an NMS? If not, it is dependent on which NMS?	Legal framework establishing legal authority and role of different DRM agencies	Legal framework mandating powers in emergencies	Legislation in place for providing succession of senior officials?	Status of CDEMA model legislation (2006)	Has a national disaster fund been established?	Is there legislation defining the role of the NMS in DRR?	Perceived need for clearer and better-defined legislation and policy?
Antigua and Barbuda	ACP	Yes	2002 Disaster Management Legislation of Antigua and Barbuda		Yes		No		
Case 1 – DRM agency is supported by NMS of its own country/territory									
Defined policies and priorities (Antigua and Barbuda): Shelter policy									
Bahamas	ACP	Yes	2006 Disaster Preparedness and Response Act					No	Yes
Barbados	ACP	Yes	2006 Emergency Management Act		Yes	In drafting phase	Yes	No	Yes
Defined policies and priorities (Barbados): Disaster management, shelter, donations, relief and emergency housing assistance policy									
Belize	ACP	Yes	1999 National Emergency Management Act						
Cayman Islands	UK OCT	Yes	In drafting phase	1997 Emergency Powers Act		N/A			
Cuba	ACP	Yes	1994 Law on National Defence; 1997 Decree on the Civil Defence System; 1999 Resolution of the Ministry of Science, Technology and Environment	1997 Decree on the Civil Defence System		N/A		1999 Resolution of the Ministry of Science, Technology and Environment	
Curaçao	NL OCT	Yes	2005 Law on Disaster Response	2005 Law on Disaster Response		N/A		Yes	No

Country/ territory	Country/ territory status	Does the island have an NMS? If not, it is dependent on which NMS?	Legal framework establishing legal authority and role of different DRM agencies	Legal framework mandating powers in emergencies	Legislation in place for providing succession of senior officials?	Status of CDEMA model legislation (2006)	Has a national disaster fund been established?	Is there legislation defining the role of the NMS in DRR?	Perceived need for clearer and better-defined legislation and policy?
Dominica Republic	ACP	Yes	2002 Law on Risk Management			N/A		Yes	No
French Guiana	FR OR	Yes	2004 Law on Civil Defence			N/A	Yes	Yes	
Guadeloupe	FR OR	Yes	2004 Law on Civil Defence			N/A	Yes	Yes	
Guyana	ACP	Yes				N/A	Yes	Yes	
Haiti	ACP	Yes							Yes
Jamaica	ACP	Yes	1993 Disaster Preparedness and Emergency Management Act (revision in draft)				Yes	No	Yes
Defined policies and priorities (Jamaica): Disaster management, hazard mitigation, shelter and relief policies									
Martinique	FR OR	Yes	2004 Law on Civil Defence			N/A	Yes	Yes	
Saint Lucia	ACP	Yes	2006 Disaster Management Act	1995 Emergency Powers Act	No	Assented		Yes	Yes
Defined policies and priorities (Saint Lucia): Disaster management, disaster mitigation, shelter, donations, relief, school mitigation and emergency housing assistance polices. A recovery policy is being drafted.									
Suriname	ACP	Yes							
Trinidad and Tobago	ACP	Yes	1978 Disaster Measures Act		Yes	In drafting phase		No	Yes
Defined policies and priorities (Trinidad and Tobago): None									
Case II – DRM agency is supported by NMS of its own country/territory, but NMS has limited capacities and needs assistance from an NMS of another country/territory									
Aruba	NL OCT	Yes	Island Ordinance on Disaster Management – No Legislation			N/A		No	

Country/ territory	Country/ territory status	Does the island have an NMS? If not, it is dependent on which NMS?	Legal framework establishing legal authority and role of different DRM agencies	Legal framework mandating powers in emergencies	Legislation in place for providing succession of senior officials?	Status of CDEMA model legislation (2006)	Has a national disaster fund been established?	Is there legislation defining the role of the NMS in DRR?	Perceived need for clearer and better-defined legislation and policy?
Dominica	ACP	Yes	2006 Emergency Planning and Disaster Management Act	1987 Emergency Powers (Disasters) Act	No	Before parliament	No		
Defined policies and priorities (Dominica): Disaster management, shelter and emergency housing assistance. Disaster mitigation, donations and relief are in drafting process.									
Grenada	ACP	Yes	No legal framework	Emergency Powers Act		In drafting phase	No		
Defined policies and priorities (Grenada): Disaster mitigation and emergency housing assistance. Shelter and relief policies are being drafted.									
Sint Maarten	NL OCT	Yes				N/A			
Saint Vincent and the Grenadines	ACP	Yes	2006 National Emergency and Disaster Act	1970 Emergency Powers Act	Yes	Before parliament			
Defined policies and priorities (Saint Vincent and the Grenadines): Disaster management, disaster mitigation and recovery policies. Policies on shelter, donations, relief, school mitigation and emergency housing assistance are in the process of being developed.									
<i>Case III – DRM agency is supported by NMS of another country/territory</i>									
Anguilla	UK OCT	No, Antigua and Barbuda	2007 Disaster Act	In drafting phase, signed 2010	Yes	In drafting phase	Yes, replenished annually. Was initiated in 2006 at ECD 300 000, then reduced in 2009 to ECD 200 000. Annual funding is set aside to participate in CCRIF and has been maintained since 2007, with extended coverage for earthquake and flooding.	Yes, in the National Response Plan – weather monitoring and warning position action checklist and letter of understanding with the airport.	

Country/ territory	Country/ territory status	Does the island have an NMS? If not, it is dependent on which NMS?	Legal framework establishing legal authority and role of different DRM agencies	Legal framework mandating powers in emergencies	Legislation in place for providing succession of senior officials?	Status of CDEMA model legislation (2006)	Has a national disaster fund been established?	Is there legislation defining the role of the NMS in DRR?	Perceived need for clearer and better-defined legislation and policy?
Defined policies and priorities (Anguilla): National warning, relief distribution, shelter management, public education and outreach policies, and a national mitigation policy									
British Virgin Islands	UK OCT	No, Antigua and Barbuda	2003 Disaster Management Act		Yes	Assented	Yes		
Defined policies and priorities (British Virgin Islands): Disaster management, disaster mitigation and shelter policies have been defined. Policies for donations, relief, emergency housing assistance and recovery are being drafted.									
Bonaire	NL OCT	No, Curaçao				N/A			
Defined policies and priorities (Bonaire): Disaster management, shelter and emergency housing assistance policies									
Montserrat	UK OCT	No, Antigua and Barbuda	Disaster Preparedness and Response Act	In place (undefined)	Yes	Assented	No		
Saint Kitts and Nevis	ACP	No, Antigua and Barbuda	In place (undefined)	In place (undefined)	No	Assented	No		
Defined policies and priorities (Saint Kitts and Nevis): Disaster management, disaster mitigation, shelter and emergency housing assistance									
Saint Martin/ Saint Barthélemy	FR OR	No, Guadeloupe				N/A			
Saba/Sint Eustatius	NL OCT	No, Curaçao				N/A			
Turks and Caicos Islands	UK OCT	No, Bahamas	Hurricane Relief Ordinance	Emergency Powers Ordinance					

Table 13. Disaster management agencies in the Caribbean and their respective capacities

Country/ territory	DRM agency	Does the country/ territory have an NMS?	Case number	Parent government department/ ministry	Form of administration	Source of financing	National disaster committee with coordinator in place?	National disaster plan in place?	NMS represented in DRM coordination?	Specific disaster plans in place
Anguilla	Department of Disaster Management (DDM)	No, Antigua and Barbuda	III	Honourable Deputy Governor's Officer	Full government department	Budget line under parent office and private/public development partnership grants and donor funding	Yes	Yes	N/A	Hurricanes; land search and rescue; aircraft incidents; oil spills; major incidents; maritime search and rescue; media; shelter management; relief distribution; utilities reconstruction; large developers; pandemic flu
<p>Comments (Anguilla): The National Disaster Plan and the National Response Plan were developed and adopted by the National Disaster Management Committee in 2007. The National Disaster Plan is updated annually. The Disaster Act 2007 was enacted in March 2008. An entrustment to sign the CDEMA Agreement was received from the United Kingdom Foreign Office in 2010 and the Agreement approved and signed by Executive Council. In April 2009 the DDM developed the National Mitigation and Risk Reduction Strategy Plan to provide an integrated framework for the implementation of hazard-mitigation measures on national, sectoral and community levels in a structured holistic and comprehensive manner.</p>										
Antigua and Barbuda	NODS	Yes	I	Ministry of Social Transformation	Full government department	Separate budget head	Yes	Yes	Yes	Hurricanes; search and rescue (marine and land); aircraft incidents; oil spills; mass casualty incidents (MCI)
<p>Comments (Antigua and Barbuda): The coordination mechanisms and preparedness for the hurricane season were highlighted by NODS, but at the same time the Office emphasized its institutional weakness, citing not only the deficit of equipment and resources, but also the cost involved in subcontracting to private enterprises. The National Disaster Plan is updated less than once a year.</p>										
Aruba		Yes	II	Presidency			Yes		Yes, Departamento Meteorologico Aruba	
<p>Comments (Aruba): Risk assessment is undertaken with help from the Eindhoven Fire Department in the Netherlands. There are no community disaster committees, but the Disaster Management Organization (DMO) does visit communities to give talks to brief them on how they can be better prepared. Contingency plans are not routinely tested, except for that of the airport, which is tested biannually.</p>										

Country/ territory	DRM agency	Does the country/ territory have an NMS?	Case number	Parent government department/ ministry	Form of administration	Source of financing	National disaster committee with coordinator in place?	National disaster plan in place?	NMS represented in DRM coordination?	Specific disaster plans in place
Bahamas	NEMA	Yes	I	Office of the Prime Minister					Yes	
Barbados	DEM	Yes	I	Ministry of Home Affairs	Full government department	Separate budget head	Yes	Yes	Yes	Hurricanes; floods; land and marine search and rescue; aircraft incidents; oil spills; MCI; fire
Belize	NEMO	Yes	I	Ministry of Natural Resources and Environment	Full government department		Yes	Yes	Yes	Tropical cyclones
Bonaire	Rampenstaf Bonaire	No, Curaçao	III	Lieutenant Governor	Fire Department	Government	Yes	Yes	N/A	
<p>Comment (Bonaire): An inventory is kept by the Public Works Department of all equipment needed in the event of a disaster. Given the small size of Bonaire, most arrangements are made informally rather than through standardized procedures.</p>										
British Virgin Islands	DDM	No, Antigua	III	Governor's Officer	Full government department	Separate budget head	Yes	Yes	N/A	Hurricanes; floods; landslides; earthquakes; land and marine search and rescue; aircraft incidents; oil spills; hazardous materials (HAZMAT); MCI; fire; civil unrest; biohazards
<p>Comments (British Virgin Islands): The National Disaster Plan is not updated frequently (less than once a year, the last review indicated in the 2006 survey was in 2002).</p>										
Cayman Islands	Hazard Management Cayman Islands	Yes	I	Portfolio of Internal and External Affairs	Full government department	Separate budget head funded by central government	Yes		Yes	Hurricanes; floods; earthquakes; land and marine search and rescue; aircraft incidents; oil spills; MCI
<p>Comments (Cayman Islands): The DRM of the Cayman Islands appears to be very active in disaster preparedness and contingency planning. It has also established MOUs with most NGOs and private-sector organizations, and put in place SOPs for all aspects of disaster response.</p>										

Country/ territory	DRM agency	Does the country/ territory have an NMS?	Case number	Parent government department/ ministry	Form of administration	Source of financing	National disaster committee with coordinator in place?	National disaster plan in place?	NMS represented in DRM coordination?	Specific disaster plans in place
Cuba	Civil Defence	Yes	I	Ministry of Armed Forces	Full government department	National annual budget	Yes	Yes	Yes	
Comments (Cuba): Cuba has a strong policy of self-reliance and maintains important stocks of material and resources at national and local level for immediate response to disasters.										
Curaçao	Rampenstaf Curaçao	Yes	I	Prime Minister	Fire Department	Government budget	Yes	Yes	Yes, Meteorological Department of Curaçao (MDC)	Natural disasters (tropical cyclones, flooding); aircraft incidents; oil spills; marine incidents; transport and storage of HAZMAT
Comments (Curaçao): Progress on the development of specific contingency plans is reported to be slow due to lack of manpower.										
Dominica	ODM	Yes	II	Ministry of National Security	Department unit	Budget under parent ministry	Yes	Yes	Yes	Hurricanes; floods; landslides; earthquakes; land and marine search and rescue; aircraft incidents; oil spills; MCI; fire
Comment (Dominica): The National Disaster Plan is reviewed every 3 years.										
Dominican Republic	COE	Yes	I						Yes	
French Guiana	Service inter- ministériel de défense et de protection civile Guyana (SIDPC Gy)	Yes	I	Ministry of the Interior	Department unit reporting to the local official representative of the French Government	State budget	Yes	Yes	Yes	Flood
Grenada	National Disaster Management Agency (NaDMA)	Yes	II	Ministry of National Security	Department unit	Budget under parent ministry	Yes	Yes	Yes	Hurricanes; volcanic eruption; marine search and rescue; oil spills; MCI; civil unrest

Country/ territory	DRM agency	Does the country/ territory have an NMS?	Case number	Parent government/ department/ ministry	Form of administration	Source of financing	National disaster committee with coordinator in place?	National disaster plan in place?	NMS represented in DRM coordination?	Specific disaster plans in place
Comments (Grenada): Grenada does not currently have a national hazard-mitigation plan.										
Guadeloupe	SIDPC Guadeloupe	Yes	I	Ministry of the Interior	Department unit reporting to the local official representative of the French Government	State budget	Yes	Yes	Yes	Volcanic eruption; meteorological vigilance; tropical cyclones; tsunami (in progress); earthquakes; oil spills on shore and offshore
Comments (Guadeloupe): Responsibilities for risk reduction, preparedness and response are widely distributed within the government. All the French territories depend primarily on support from France in case of a major disaster.										
Guyana	Civil Defence Commission (CDC)	Yes	I	Office of the President	Full government department		Yes		Yes	
Haiti	Direction de la protection civile (DPC)	Yes	I						Yes	
Jamaica	Office of Disaster Preparedness and Emergency Management (ODPEM)– Ministry of Housing, Environment and Water	Yes	I	Ministry of Land and Environment	Statutory organization	Budget under parent ministry	Yes	Yes	Yes	Hurricanes; floods; earthquakes; oil spills; HAZMAT; MCI; fire; civil unrest
Martinique	SIDPC-Etat- major de zone Antilles (EMZA)	Yes	I	Ministry of the Interior	Department unit reporting to the local official representative of the French Government	State budget	Yes	Yes	Yes	Volcanic eruption; meteorological vigilance; tropical cyclones; tsunami (in progress); earthquakes; oil spills onshore and offshore

Country/ territory	DRM agency	Does the country/ territory have an NMS?	Case number	Parent government department/ ministry	Form of administration	Source of financing	National disaster committee with coordinator in place?	National disaster plan in place?	NMS represented in DRM coordination?	Specific disaster plans in place
<p>Comments (Martinique): Responsibilities for risk reduction, preparedness and response are widely distributed within the government. All the French Territories depend primarily on support from France in case of a major disaster.</p>										
Montserrat	Disaster Management Coordination Agency (DMCA)	No, Antigua	III	Governor's Office	Full government department	Separate budget head	Yes	Yes	N/A	Hurricanes; floods; landslides; volcanic eruption; land and marine search and rescue; aircraft incidents; MCI; fire
<p>Comments (Montserrat): The National Disaster Plan, Volcano Plan and Hurricane Plan are evaluated each year to adjust to the current situation.</p>										
Saba/Sint Eustatius	Rampenstaf Saba/Sint Eustatius	No, Curaçao	III	Lieutenant Governor	Fire Department	Government budget	Yes	Yes	Yes, MDC	
<p>Comments (Saba/Sint Eustatius): It appears that specific disaster plans have not yet been developed, approved or finalized.</p>										
Saint Kitts and Nevis		No, Antigua	III	Ministry of Defence and Security	Full government department	Separate budget head	Yes	Yes	N/A	Hurricanes; volcanic eruption; aircraft incidents; HAZMAT; fire; civil unrest
<p>Comments (Saint Kitts and Nevis): The National Disaster Plan is not updated frequently (the last update indicated in the 2006 survey was 1999).</p>										
Saint Lucia	NEMO	Yes	I	Office of the Prime Minister	Full government department	Separate budget head	Yes	Yes	Yes	Hurricanes; floods; landslides; earthquakes; volcanic eruptions; land and marine search and rescue; aircraft incidents; oil spills; HAZMAT; MCI; fire
Sint Maarten	Rampenstaf Sint Maarten	Yes	II	Prime Minister	Fire Department	Government budget	Yes	Yes	Yes, MDC	
<p>Comments (Sint Maarten): Existing contingency plans mostly focus on hurricane-related hazards</p>										

Country/ territory	DRM agency	Does the country/ territory have an NMS?	Case number	Parent government department/ ministry	Form of administration	Source of financing	National disaster committee with coordinator in place?	National disaster plan in place?	NMS represented in DRM coordination?	Specific disaster plans in place
Saint Martin/ Saint Barthélemy	SIDPC Saint Martin	No, Guadeloupe	III	Ministry of the Interior	Department unit reporting to the local official representative of the French Government	State budget	Yes	Yes	N/A	Meteorological vigilance; tropical cyclones; tsunami (in progress); earthquakes; oil spills on shore and offshore
<p>Comments (Saint Martin/Saint Barthélemy): Responsibilities for risk reduction, preparedness and response are widely distributed within the government. All the French territories depend primarily on support from France in case of a major disaster.</p>										
Saint Vincent and the Grenadines	NEMO	Yes	II	Ministry of Security	Full government department	Separate budget head	Yes	Yes	Yes	Hurricanes; floods; landslides; volcanic eruption; land and marine search and rescue; aircraft incidents; oil spills; MCI; fire; civil unrest
Suriname	National Coordination Centre for Disaster Relief (NCCR)	Yes	I		Full government department					
<p>Comments (Suriname): Intervention capacity is limited.</p>										
Trinidad and Tobago	ODPM	Yes	I	Ministry of National Security	Department unit	Budget under parent ministry	Yes	Yes	Yes	Hurricanes; floods; earthquakes; land and marine search and rescue; aircraft incidents; oil spills; MCI; fire; civil unrest
<p>Comments (Trinidad and Tobago): Budget is reported to be around US\$ 5 million per year.</p>										
Turks and Caicos Islands	Disaster Management and Emergencies	No, Bahamas	III	Governor's Office				Yes	N/A	
<p>Comments (Turks and Caicos Islands): The National Disaster Plan is updated annually.</p>										

Table 14. Case I: DRM agency is supported by the NMS of its own country/territory

<i>Country/ territory</i>	<i>DRM agency</i>	<i>Does the country/ territory have an NMS?</i>	<i>NMS gives support to the following NMS of another country/territory (case II)</i>	<i>NMS gives support to the following DRM agency/agencies of another country/territory (case III)</i>	<i>Responsible hydrological service</i>
Anguilla and Barbuda	NODS	Yes	N/A	Saint Kitts and Nevis; Antigua; British Virgin Islands; Montserrat	Antigua Public Utilities Authority
Aruba	Crisis Management Office, Aruba	Yes	N/A		None
Bahamas	NEMA	Yes	N/A	Turks and Caicos Islands	Water Sewage Company
Barbados	DEM	Yes	Dominica; Saint Vincent and the Grenadines	N/A	CIMH
Belize	NEMO	Yes	N/A	N/A	NMS
Cayman Islands	Hazard Management Cayman Islands (HMCI)	Yes	N/A	N/A	CIMH
Cuba	National Civil Defence	Yes	N/A	N/A	Instituto Nacional de Recursos Hidraulicos
Curaçao and Sint Maarten	Rampenstaf Curaçao	Yes	N/A	Bonaire; Saba; Sint Eustatius; Sint Maarten	Maneho Agrario i Peska
Dominican Republic	Civil Defence	Yes	N/A	N/A	Instituto Nacional de Recursos Hidraulicos
French Guiana	SIDPC Guiane Etat major interministériel de la zone de défense et de sécurité Guyane	Yes	N/A		Direction de l'environnement, de l'aménagement et du logement (DEAL) Guyane
Guadeloupe	SIDPC Guadeloupe	Yes	N/A	Saint Barthélemy; Saint Martin	DEAL Guadeloupe
Guyana	Civil Defence Commission (CIDC)	Yes	N/A	N/A	NMHS
Haiti	Direction de la Protection Civil	Yes	N/A	N/A	Service National des Ressources en Eaux
Jamaica	ODPEM	Yes	N/A	N/A	Water Resources Authority
Martinique	SIDPC-EMZA	Yes	N/A	N/A	DEAL Martinique

<i>Country/ territory</i>	<i>DRM agency</i>	<i>Does the country/ territory have an NMS?</i>	<i>NMS gives support to the following NMS of another country/territory (case II)</i>	<i>NMS gives support to the following DRM agency/agencies of another country/territory (case III)</i>	<i>Responsible hydrological service</i>
Saint Lucia	NEMO	Yes	N/A	N/A	Water Resources Management Agency
Suriname	NCCR	Yes	N/A	N/A	None
Trinidad and Tobago	ODPM	Yes	Grenada	N/A	Water Resources Agency

Table 15. Case II: DRM agency is supported by the NMS of its own country/territory, but the NMS has limited capacities and needs assistance from an NMS of another country/territory

<i>Country/territory</i>	<i>DRM agency</i>	<i>Does country/territory have an NMS?</i>	<i>NMS receives support from NMS of another country/territory</i>	<i>Responsible hydrological service</i>
Aruba	Crisis Management Office, Aruba	Yes		None
Dominica	ODM	Yes	Barbados (refer to Table 14)	Meteorological Office and Dominican Water and Sewage Company
Grenada	NaDMA	Yes; Not a WMO Member	Trinidad and Tobago (refer to Table 14)	National Water and Sewage Authority
Curaçao and Sint Maarten	Rampenstaf Sint Maarten	Yes; Not a WMO Member	Curaçao (refer to Table 14)	None
Saint Vincent and the Grenadines	NEMO	Yes; Not a WMO Member	Barbados (refer to Table 14)	Central Water and Sewage Authority

Table 16. Case III: DRM agency is supported by the NMS of another country/territory

<i>Country/territory</i>	<i>DRM agency</i>	<i>Does the country/territory have an NMS?</i>	<i>DRM agency depends on NMS from the following country/territory</i>	<i>Responsible hydrological service</i>
Anguilla	DDM	No	Antigua and Barbuda	None
Bonaire	Rampenstaf Bonaire	No	Curaçao and Sint Maarten	None
British Virgin Islands	DDM	No	Antigua and Barbuda	None
Montserrat	DMCA	No	Antigua and Barbuda	None
Saba/Sint Eustatius	Rampenstaf Saba/Sint Eustatius	No	Curaçao and Sint Maarten	None
Saint Kitts and Nevis	NEMA	No; Not a WMO Member	Antigua and Barbuda	None
Saint Martin/Saint Barthélemy	SIDPC	No	Guadeloupe	DEAL Guadeloupe
Turks and Caicos Islands	Department for Disaster Management and Emergency (DDME)	No	Bahamas	None

Table 17. Public meteorological Websites in Caribbean countries/territories

<i>Country/ territory</i>	<i>URL of the public Website for weather and warning information</i>	<i>In-country NMHS Website</i>	<i>Remote NMHS Website</i>	<i>Shared Website</i>	<i>Government Website</i>
<i>Case I: DRM agency is supported by the NMS of its own country/territory</i>					
Antigua and Barbuda	http://www.antiguamet.com	Yes		Yes	
Bahamas	http://www.bahamasweather.org.bs		Yes		
Barbados	http://www.cdera.org/weather/barbados/index.php			Yes (CDEMA)	
Belize	http://www.hydromet.gov.bz	Yes			
Cayman Islands	http://www.weather.gov.ky				Yes
Cuba	http://www.met.inf.cu	Yes			
Curaçao	http://www.meteo.an	Yes		Yes (Dutch Caribbean)	
Dominican Republic	http://www.onamet.gov.do	Yes			
French Guiana	http://www.meteo.gp		Yes (Guadeloupe)	Yes (French West Indies)	
Guadeloupe	http://www.meteo.gp	Yes		Yes (French West Indies)	
Guyana	http://www.hydromet.gov.gy				
Haiti	http://www.meteo-haiti.gouv.ht		Yes (Canada)		
Jamaica	http://www.metservice.gov.jm		Yes		
Martinique	http://www.meteo.gp		Yes (Guadeloupe)	Yes (French West Indies)	
Saint Lucia	http://www.slumet.gov.lc		Yes (regional server)		
Suriname	http://www.meteosur.sr	Yes			
Trinidad and Tobago	http://www.metoffice.gov.tt	Yes			Yes
<i>Case II: DRM agency is supported by the NMS of its own country/territory, but the NMS has limited capacities and needs assistance from the NMS of another country/territory</i>					
Aruba	http://www.meteo.aw	Yes	Yes (DRM agency buys support for aviation purposes only)	Yes (Dutch Caribbean)	
Dominica	http://www.weather.gov.dm				Yes
Grenada	http://www.weather.gd		Yes (regional server)		
Saint Vincent and the Grenadines	http://www.meteo.vc		Yes (regional server)	Yes (Curaçao)	
Sint Maarten	http://www.meteo.an		Yes (Curaçao)	Yes (Dutch Caribbean)	

<i>Country/ territory</i>	<i>URL of the public Website for weather and warning information</i>	<i>In-country NMHS Website</i>	<i>Remote NMHS Website</i>	<i>Shared Website</i>	<i>Government Website</i>
<i>Case III: DRM agency is supported by the NMS of another country/territory</i>					
Anguilla	http://www.antiguamet.com		Yes (Antigua and Barbuda)	Yes	
Bonaire	http://www.meteo.an		Yes (Curaçao)	Yes (Dutch Caribbean)	
British Virgin Islands	http://www.antiguamet.com		Yes (Antigua and Barbuda)	Yes	
Montserrat	http://www.antiguamet.com		Yes (Antigua and Barbuda)	Yes	
Saba/Sint Eustatius	http://www.meteo.an		Yes (Curaçao)	Yes (Dutch Caribbean)	
Saint Kitts and Nevis	http://www.antiguamet.com		Yes (Antigua and Barbuda)	Yes	
Saint Martin/ Saint Barthélemy	http://www.meteo.gp		Yes (Guadeloupe)	Yes (French West Indies)	
Turks and Caicos Islands	None				

Table 18. Institutional cooperation between NMSs and DRM agencies in the Caribbean – capacities, gaps and needs

<i>National and regional levels</i>	
<i>Capacities</i>	<i>Gaps and needs</i>
<p>(a) In several Caribbean countries/territories DRM agencies are just being developed, with only limited human resources.</p> <p>(b) In most Caribbean countries/territories, contingency plans of DRM agencies (or at higher levels) indicate the role of the NMS and the mechanisms for cooperation and coordination. However, the level of detail varies from island to island.</p> <p>(c) In several Caribbean countries/territories, the NMS relies on SOPs, especially for tropical cyclone forecast and warnings.</p> <p>(d) The mechanisms are well defined in Caribbean countries/territories that have ISO-certified QMS, such as the Dominican Republic and the French West Indies.</p> <p>(e) Yearly exercises on weather-related risk management are organized in several Caribbean countries/territories (Cuba, the Cayman Islands, the French West Indies) to identify areas for improvement, including the operational relationships between NMSs and DRM agencies.</p> <p>(f) In some countries/territories (for example, Jamaica, Cuba), workshops, conferences or training are organized between DRM agencies and NMSs, and sometimes with other technical institutions, to ensure that each body understands the needs, procedures and challenges of the others.</p>	<p>(a) NMSs need to improve their understanding of the challenges and needs of the DRM agencies.</p> <p>(b) Within the context of MHEWS, the capacities and limitations of NMSs must be well known and understood by DRM agencies.</p> <p>(c) Some Caribbean countries/territories with NMS case II or III are supported by an NMS that is not the closest to them. This situation could lead to confusion.</p> <p>(d) There is a need to develop multi-sectoral institutional mapping of capacities and linkages among MHEWS key stakeholders.</p> <p>(e) There is a need for training and workshops to improve the understanding of the roles and capacities among NMSs, DRM agencies and key EWS stakeholders.</p> <p>(f) There is a need for development of SOPs (under a QMS framework) in all the areas mentioned above (identification of key stakeholders, bilateral exchanges, feedback mechanisms). Caribbean countries/territories with case II and III support mechanisms will need several specific SOPs.</p> <p>(g) There is a need to collect information from countries/territories throughout the region on good practices and to develop a list of expertise.</p> <p>(h) There is a need to strengthen relationships at the regional level (for example, between CMO and CDEMA) by including DRM agencies in CMO meetings and vice versa, as often as possible.</p>

Table 19. Dissemination, feedback mechanisms and public outreach programmes of EWS in the Caribbean – national and regional aspects, gaps and needs

	<i>National and regional aspects</i>	
	<i>Capacities</i>	<i>Gaps and needs</i>
Dissemination mechanisms	<p>(a) In some Caribbean countries/territories, the NMS is the sole institution that disseminates warning information (for example, Curaçao and Sint Maarten, Antigua). In other Caribbean countries/territories, DRM authorities are in charge of warning dissemination, based on primary information from NMSs. The latter approach is most common across the region (for example, Belize, Trinidad, Saint Lucia). Warning information is sometimes delivered by both organizations to different stakeholders (for example, in the French West Indies and the Bahamas).</p> <p>(b) In some Caribbean countries/territories (for example, Jamaica and the French West Indies) warning bulletins are disseminated to national DRM agencies as well as to elements at the community level, through specific systems.</p> <p>(c) Procedures and agreements exist for dissemination backup by one island for another island, particularly through the HOP (reviewed annually by the RA IV Hurricane Committee).</p> <p>(d) Some Caribbean countries/territories receive primary information from the Pacific Tsunami Warning Center (PTWC) in Hawaii, through GTS, e-mail or SMS.</p> <p>(e) In all Caribbean countries/territories with NMSs, fax, e-mail and the Internet are primary dissemination methods. In most cases, they rely on PCs with Internet access and specific FTP connections. Automatic telephone answering machines are a complement for public information (not always free of charge).</p> <p>(f) Some Caribbean countries/territories have started to develop mobile telephone-based (SMS) dissemination, thanks to private–public partnerships (for example, Antigua, Saint Lucia, Trinidad and Tobago, the French West Indies).</p> <p>(g) Territories of the French West Indies use a complete automatic dissemination platform that is directly linked to the production system.</p>	<p>(a) The regional server for SIDS in Curaçao (NOAA–NWS programme), which hosts several national Websites, will be shut down soon due to financial reasons.</p> <p>(b) The capacity of Website servers is limited, causing Websites to be unavailable during severe weather events due to high-volume traffic.</p> <p>(c) There is a need to improve harmonization and coordination between DRM agencies and NMSs for watch and warning dissemination and for clarification of roles and responsibilities with regard to dissemination.</p> <p>(d) Testing and back up of dissemination mechanisms between Caribbean countries/territories that have specific mandates and agreements needs to be improved.</p> <p>(e) There is a need for an assessment of the wider use of CAP as a harmonized regional tool for warning dissemination.</p> <p>(f) There is a need for national-level implementation of a specific dissemination process for tsunami warnings as a component of the regional warning system, and for updating of the regional list of focal points for tsunami warnings.</p> <p>(g) The control and tracking mechanisms for end-to-end delivery from NMSs to DRM agencies needs to be strengthened.</p> <p>(h) There is a need for a multi-risk platform for dissemination with full redundancy (backup), automated procedures, control and traceability.</p> <p>(i) There is a need to develop procedures to ensure that critical dissemination facilities are in working order, especially just before potentially high-impact weather.</p> <p>(j) A regional approach should be developed to improve many Caribbean countries'/territories' capacities regarding the development and sustainability of their NMS Websites.</p> <p>(k) Mobile telephone-based dissemination in collaboration and partnership with private providers needs to be developed.</p>

	<i>National and regional aspects</i>	
	<i>Capacities</i>	<i>Gaps and needs</i>
	<p>(h) Some Caribbean countries/territories have started working on the implementation of the CAP, with a live system in place since 2007 (for example, Anguilla).</p> <p>(i) In addition to their basic dissemination mechanisms, some Caribbean countries/territories have started to use virtual social networks such as Facebook or Twitter (for example, Trinidad) to disseminate warning products.</p> <p>(j) All forecasts and warnings for all Caribbean countries/territories except the Turks and Caicos Islands are available on public Websites. Some sites are internally managed; others are hosted in other Caribbean countries/territories.</p>	<p>(l) There is a requirement to increase the use of the EMWIN system and CAP by both NMSs and DRM agencies, through regional exchange of good practices and extension of pilot projects.</p> <p>(m) There is a need to study how virtual social networks can play a role in warning dissemination.</p> <p>(n) There is a need to improve regional and national Website policies for a better public visibility (alternative solution for Web-server hosting, bandwidth, mirror sites) and to upgrade national capacities for Website management.</p> <p>(o) There is a need for better understanding of stakeholders' needs in relation to weather forecasts and warnings on the Web, especially in case III support mechanism islands with no NMS.</p>
Communications and media	<p>(a) In all Caribbean countries/territories, real-time media (television and radio) are considered to be the highest priority means of disseminating warning information directly to the public.</p> <p>(b) In some Caribbean countries/territories (for example, the Bahamas, Cuba, the French West Indies), meteorologists appear directly on television or speak live on radio in severe weather situations to deliver the main information with high credibility.</p> <p>(c) Cuba has its own system for direct broadcasts from the NMS on the national television channel, and uses specific software to provide graphical illustrations or movies.</p> <p>(d) In several Caribbean countries/territories, ham (amateur) and citizen band (CB) radios are used (for example, Saint Vincent, Martinique, the Bahamas) as secondary means of dissemination and communication, sometimes under specific MOUs or agreements with associations of ham radio or CB stakeholders.</p>	<p>(a) There is a need for bilateral and multilateral training and workshops involving the NMSs (especially forecasters) and the media to improve information delivery.</p> <p>(b) There is a need for specific, dedicated, up-to-date software to broadcast severe weather information on television, with animated graphics, satellite and radar imagery, and tropical cyclone tracks.</p> <p>(c) There is a need to improve communication of warnings to target specific populations, especially in tourist areas (multilingual issues).</p> <p>(d) There is a need for a regional training mechanism that enables forecasters and media from different islands to improve their bilateral coordination as well as the communication of severe weather and warnings to DRM stakeholders and the public.</p>

	<i>National and regional aspects</i>	
	<i>Capacities</i>	<i>Gaps and needs</i>
Feedback mechanisms	<p>(a) Informal feedback mechanisms exist in most Caribbean countries/territories; these are based on individual relationships, discussions and phone calls.</p> <p>(b) Several Caribbean countries/territories have systematic post-event feedback processes in place that have led to major improvements, in cooperation between NMSs and the DRM agencies (for example, for Hurricane <i>Ivan</i> in 2004 in the Cayman Islands and Grenada, for Hurricane <i>Lenny</i> in 1999 in the French West Indies, for Tropical Storm <i>Debby</i> in 1994 and for the floods of October 1996 in Saint Lucia).</p>	<p>There is a need to strengthen the mechanisms for continual improvement processes through clear and timely feedback procedures, including systematic post-event evaluations, and exercises involving all DRM stakeholders and NMSs.</p>

	<i>National and regional aspects</i>	
	<i>Capacities</i>	<i>Gaps and needs</i>
Public outreach and educational programmes in EWS	<p>(a) In most Caribbean countries/territories, school programmes (sometimes from kindergarten to university) include risk information, especially on tropical cyclones.</p> <p>(b) In some Caribbean countries/territories, specific school programmes on meteorological hazards and risk have been developed collaboratively between NMSs, DRM agencies and educational institutions (for example, in Cuba, Jamaica, Martinique, and Trinidad and Tobago).</p> <p>(c) In some Caribbean countries/territories, teachers are trained on meteorological and hydrological hazards and risks through specific training courses, workshops or conferences.</p> <p>(d) Some international meteorological educational programmes (for example, COMET) are available through online e-learning sites or on CD/DVD.</p> <p>(e) In some Caribbean countries/territories, radio or television campaigns on meteorological risk information are broadcast regularly. However, these focus mainly on tropical cyclones.</p> <p>(f) In some Caribbean countries/territories, CDs or DVDs are available for public information through schools, institutional on-going training, and conferences. These materials have been developed through collaboration among national or regional partners (for example, CDEMA) or international organizations (for example, IFRC).</p> <p>(g) In many countries/territories, regional institutions such as CDEMA, or international institutions such as IFRC, play an important role in public awareness, risk culture and preparedness.</p>	<p>(a) Education targeted at the general population was highlighted as a major gap in the Caribbean region, especially in islands not often affected by tropical cyclones.</p> <p>(b) There is a need to improve training mechanisms and materials for media, institutional trainers and teachers on meteorological hazards and their impacts.</p> <p>(c) Training mechanisms and educational materials that target specific vulnerable populations should be increasingly developed (for example, for women, children, isolated families, the elderly, tourists) on subjects such as meteorological hazards and their impacts.</p> <p>(d) There is a need for better collaboration between NMSs and DRM agencies for the development of educational programmes and information campaigns (for example, on hazard identification and preparedness methods) for the public.</p> <p>(e) The existing educational programmes at the national, regional levels need to be identified.</p> <p>(f) There is a requirement for NMSs, DRM agencies and other stakeholders to develop a public education programme supported by suitably trained staff and sufficient physical resources.</p>

Table 20. National-level product and service development by Caribbean NMSs in support of EWS – capacities, gaps and needs

	<i>National level</i>	
	<i>Capacities</i>	<i>Gaps and needs</i>
Data products	<p>(a) In most Caribbean countries/territories, data are delivered on demand to DRM agencies or stakeholders, sometimes under MOUs (Trinidad and Tobago, the French West Indies).</p> <p>(b) In most instances, raw data are delivered directly from the database. In some cases, value is added through statistics or special formatting.</p>	<p>(a) There is a need to enhance knowledge of stakeholders' needs to support the development of user-centred products and services.</p> <p>(b) The development and use of processing systems to transform data into useful information needs to be reinforced, within the context of the RA IV–WIGOS Demonstration Project.</p> <p>(c) There is a need for specific systems, tools or applications for data formatting, statistical data, diagrams, and the like.</p> <p>(d) An automated data server is needed to provide real-time and non-real-time data access to institutions and other stakeholders.</p>
Hazard analysis to support risk assessment	<p>(a) Some Caribbean countries/territories possess information resources (paper based or on CD) on hazard analyses of tropical storms, storm surges, and the like, that include return periods. These are normally low-resolution resources.</p> <p>(b) Cuba and the French West Indies have completed high-resolution multi-risk assessments for the entire islands, to the scale of streets or subdivisions.</p> <p>(c) The NMS of Martinique utilizes high-resolution topography and bathymetry data from LIDAR surveys that enable better resolution and accuracy for risk mapping.</p> <p>(d) For the French West Indies, a methodology for hazard analysis has been developed that identifies different danger thresholds that serve as the basic criteria for watches and warnings.</p>	<p>(a) There is often a lack of involvement of NMSs in the national risk assessment process.</p> <p>(b) Stakeholders' needs with regard to hazard analysis are not sufficiently well known.</p> <p>(c) The relationships between NMSs, DRM agencies and stakeholders need to be strengthened through training and workshops on hazard analysis and risk assessment.</p> <p>(d) There is need to develop or upgrade capacities for high-resolution hazard analysis and information through training and exchange of methodology and tools.</p> <p>(e) There is a need to strengthen observation networks for statistical computing and model verification.</p> <p>(f) There is a need to develop, upgrade or have access to modelling capacities to enable downscaling of hazard assessments.</p> <p>(g) High-resolution topography and coastal bathymetry is often lacking.</p> <p>(h) Risk maps need to be regularly updated to take into account changes in infrastructure, roads, urban equipment, and the like.</p> <p>(i) There is a need to develop a list of good practices, expertise and regional resources for modelling, training and hazard product development.</p> <p>(j) There is a need to leverage opportunities across hazard sectors, including climate variability and change, and also across different risks such as storm surges and tsunamis.</p> <p>(k) There is a need to improve access to, and usability and understanding of, risk assessment data products to achieve better decision making and planning.</p> <p>(l) There is a need for training on the methodology of hazard analysis to identify different danger thresholds that could serve as basic criteria for watches and warnings.</p>

	<i>National level</i>	
	<i>Capacities</i>	<i>Gaps and needs</i>
Forecasts and warnings	<p>(a) All Caribbean countries/territories with an NMS provide routine forecasts and warning bulletins, when required, for their country/territory and, in the case of specific agreements, for other countries/territories.</p> <p>(b) In all Caribbean countries/territories with a meteorological Forecast Office, forecast and warning products are available on their Internet sites.</p> <p>(c) RSMC–Miami provides tropical cyclone forecast and warning products that are utilized by Forecast Offices in the Caribbean countries/territories.</p> <p>(d) While mixed text and graphics products are developed in some Caribbean countries/territories, graphics, maps or charts from United States Websites are utilized by many Caribbean countries/territories.</p> <p>(e) In most of the countries/territories, forecast and warning products are produced on single PCs with normal office software. However, Antigua, and Curaçao and Sint Maarten have developed their own applications, and others use dedicated workstations such as Metlab (the Cayman Islands and the Bahamas), Smartmet (Trinidad, Jamaica) or Meteofactory (the French West Indies).</p> <p>(f) An upgraded version of Smartmet will be tested soon in the pilot countries with training planned for Jamaica and Trinidad.</p> <p>(g) CIMH provides drought monitoring and warning products at a regional scale and at country level through CDPMN, Caribbean Precipitation Outlook and the Caribbean Water Monitor.</p>	<p>(a) Forecast and warning products need to be improved through a user-centred approach, including development/strengthening of methodologies and mechanisms for user feedback during product development and operational phases.</p> <p>(b) There is a need for integrated tools or workstations for end-to-end forecast/warning production, with flexibility and easy management at the national level.</p> <p>(c) There is a need to improve awareness and understanding of CDPMN products for better use at the national level, and to extend use of CDPMN products to non-English speaking Caribbean countries/territories.</p>
EWS expertise and advisory services	<p>(a) In all Caribbean countries/territories with NMSs, meteorologists have been identified to serve as experts with regard to the needs of DRM.</p> <p>(b) In some Caribbean countries/territories, a meteorologist sits on the crisis management committee to provide expertise to decision makers in the case of meteorological threat or crisis.</p>	<p>(a) There is a need to identify meteorologists in each NMS who can act as a focal point for DRM.</p> <p>(b) Training needs to be provided for meteorologists acting as focal points for DRM.</p>
Cooperation with other technical agencies	<p>(a) Guyana and Belize have meteorological and hydrological services that are combined (NMHSs).</p> <p>(b) Good relationships exist between meteorological and hydrological services in Cuba and the Dominican Republic (a hydrologist works at the NMS).</p>	<p>(a) In many cases there is little collaboration and coordination between NMSs and other technical agencies.</p> <p>(b) There is a need to strengthen the relationship and the mechanisms with other technical institutions to improve product and service delivery.</p>

Table 21. Meteorological product and service development in support of EWS in the Caribbean – capacities, gaps and needs at the regional level

	<i>Regional aspects</i>	
	<i>Capacities</i>	<i>Gaps and needs</i>
Data products		<ul style="list-style-type: none"> (a) Currently, only a limited number of regional data products is available to NMSs and EWS stakeholders. (b) There is a need for a regional capacity for the development and dissemination of regional data products (for example, rainfall anomalies and heat waves).
Hazard analysis to support risk assessment	Several regional and international studies on tropical cyclone hazards have provided hazard atlases for certain Caribbean countries/territories (for example, storm surge atlases).	<ul style="list-style-type: none"> (a) A regional programme is required to develop a multi-hazard analysis with methodology and tools that is applicable to the regional level, as well as, in the form of downscaled information, to the national level. (b) There is a need to strengthen the relationship between DRM agencies and supporting NMSs from other islands (case II and case III support mechanisms) to ensure the input of specific hazard analyses into the risk assessment process. (c) Available regional centres of expertise in hazard analysis need to be documented for capacity building. (d) There is a need for a mechanism for the exchange of good practices in risk modelling.
Forecasts and warnings	<ul style="list-style-type: none"> (a) In most Caribbean countries/territories, tropical cyclone forecast and guidance products are taken directly from RSMC–Miami, without modification. (b) Martinique issues regional marine forecasts and warnings for the Lesser Antilles (50°W–70°W/10°N–20°N) in French and in English. 	There is a need for a regional approach to the sharing of expertise, and tools for forecast and warning production systems.
EWS expertise and advisory service	During each threat affecting a CDEMA Member’s country/territory, an EWS expert from CIMH joins the CDEMA team to bring expertise and advice to decision making. CIMH also supports CDEMA/UNDP Rapid Needs Assessment Teams.	

Table 22. Websites where NMS survey respondents obtain image products from global product centres

<i>Product/site name</i>	<i>Description</i>	<i>Geographical area</i>	<i>URL</i>
Morphed integrated microwave imagery at the Cooperative Institute for Meteorological Satellite Studies (CIMSS)–Total Precipitable Water (MIMIC–TPW)	Special sensor microwave imager/advanced microwave scanning radiometer for EOS (SSM/I/AMSRE)-derived total precipitable water – North Atlantic	Tropical Atlantic	http://cimss.ssec.wisc.edu/tropic/real-time/tpw2/natl/main.html
Real-time polar operational environmental satellite (POES) imagery	SSM/I Rain Rate Loop	West Atlantic and Caribbean	http://www.ssd.noaa.gov/PS/TROP/DATA/RT/watl-ssrr-loop.html
Ocean Prediction Center	Analysis and forecasts of meteorological conditions, ocean wind wave, swell, period and direction	Global, Atlantic Ocean, Pacific Ocean	http://www.opc.ncep.noaa.gov/Atl_tab.shtml
National Centers for Environmental Prediction (NCEP) Central Operations	Model analyses and forecasts from multiple models (such as the North American mesoscale model (NAM), the Global Forecast System (GFS), the Global Ensemble Forecast System (GEFS), wavewatch III (WW3))	North America, South America, western North Atlantic, Atlantic–Pacific	http://www.nco.ncep.noaa.gov/pmb/nwprod/analysis/ ; http://www.nco.ncep.noaa.gov/pmb/nwprod/analysis/namer/gfs/00/images/gfs_ten_006m.gif
The International Research Institute for Climate and Society	Regional climate monitoring; El Niño, La Niña and the Southern Oscillation; Precipitation outlook	Various regions globally, including North, Central and South America.	http://iridl.ldeo.columbia.edu/maproom/.Regional/ ; http://iridl.ldeo.columbia.edu/maproom/.ENSO/ ; http://portal.iri.columbia.edu/portal/server.pt?open=512&objID=944&PageID=7868&mode=2
Unisys weather portal	Provides a one-stop-shop of various analyses, model outputs, satellite and radar images from RSMC regional centres	North America, North Atlantic, Caribbean	http://weather.unisys.com/ ; http://weather.unisys.com/satellite/sat_vis.php?image=ir&inv=0&t=cur&region=ea&expanddiv=hide_bar
RSMC–Miami/NOAA–NWS Tropical Cyclone Center	Provides analysis and guidance products for tropical cyclone activity	North Atlantic	http://www.nhc.noaa.gov/
NOAA–NWS PTWC	Tsunami information and watches bulletins	The Atlantic (except United States, Canada, Puerto Rico and British Virgin Islands) and the Pacific (except Alaska, Washington, Oregon, California and Canada)	http://ptwc.weather.gov/ ; http://wcatwc.arh.noaa.gov/

<i>Product/site name</i>	<i>Description</i>	<i>Geographical area</i>	<i>URL</i>
NOAA–NWS West Coast and Alaska Tsunami Warning Center (WCATWC)	Tsunami warnings, advisories, watches and information bulletins for Puerto Rico and British Virgin Islands	United States East Coast and Gulf of Mexico, Canada, Puerto Rico and British Virgin Islands	http://wcatwc.arh.noaa.gov/
NOAA–NWS Hydrometeorological Prediction Center	Provides various analyses and model forecasts up to seven days	United States and extreme western Atlantic and extreme northwest Caribbean	http://www.hpc.ncep.noaa.gov/
National Aeronautics and Space Administration (NASA) Earth Science Office	Interactive global geostationary weather satellite images	North America and the tropical Atlantic	http://www.ghcc.msfc.nasa.gov/GOES/
Brazilian Ministry of Science and Technology Division of Satellites and Environmental Systems	Various satellite images and products	South America	http://satelite.cptec.inpe.br/acervo/goes_anteriores.jsp
Geostationary Satellite Server (GOES) NOAA Satellite and Information Service	Various GOES satellite images and products	North America, Caribbean and tropical Atlantic	http://www.goes.noaa.gov/
Aeronautica Civil of Colombia	Aviation weather information including satellite, pilot reports (PIREPS), significant meteorological information (SIGMETS) and the like	South America and Caribbean	http://190.24.131.232/satellite_image/loop?scroll_x=&scroll_y=&aoi=TWH&channel=IR&loop_speed=4
NOAA National Environmental, Satellite, Data and Information Service (NESDIS) (Central and South America)	GOES–10 imagery for sectors 1, 2, 3, 6, and 7	South America, Caribbean, Gulf of Mexico	http://rammb.cira.colostate.edu/ramsdisk/online/rmtc.asp#Sector%201
NOAA–NWS Climate Prediction Center	Monitoring of intraseasonal oscillations IR/200-hPa velocity potential anomalies	Global	http://www.cpc.ncep.noaa.gov/products/precip/CWlink/ir_anim_monthly.shtml
Climate Prediction Center: Madden–Julian Oscillation (MJO)	Monitoring and forecasting of the MJO	Global	http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/new.mjo3.shtml#current
NOAA–NWS Telecommunications Operations Center	GTS–RMTN IV facsimile charts	North and Central America, Caribbean and western Atlantic	http://weather.noaa.gov/fax/ ; http://weather.noaa.gov/fax/internl.shtml
NESDIS Center for Satellite Application and Research (STAR)	Advanced scatterometer (ASCAT) satellite surface-wind estimations	Ocean and sea areas globally	http://manati.orbit.nesdis.noaa.gov/datasets/ASCATData.php

<i>Product/site name</i>	<i>Description</i>	<i>Geographical area</i>	<i>URL</i>
Cooperative Institute for Meteorological Satellite Studies–University of Wisconsin–Madison Tropical Cyclone Team	Atmospheric motion vectors (AMV)		http://tropic.ssec.wisc.edu/real-time/windmain.php?&basin=atlantic&sat=wg8&prod=wwir&zom=&time
NOAA National Data Buoy Center	Recent marine meteorological observations and data	Atlantic, Caribbean, Gulf of Mexico	http://www.ndbc.noaa.gov/maps/Caribbean.shtml
NOAA–NWS Hydrometeorological Prediction Center	Caribbean precipitation forecasts (for days 1, 2 and 3)	Caribbean, Gulf of Mexico, western Atlantic	http://www.hpc.ncep.noaa.gov/international/crb_day1-3.shtml ; http://www.hpc.ncep.noaa.gov/mike/crb_gfs00.shtml
ECMWF	Various meteorological and hydrological forecasts, Ensemble Prediction System meteograms (EPSgrams), seasonal forecasts, reanalyses and ensembles	Global	http://www.ecmwf.int/
NOAA Air Resources Laboratory	Forecast model graphics (for example, meteograms, windgrams and stability time series). Meteorological information provided on this site is primarily to support the Hybrid Single-Particle Lagrangian Integrated Trajectory Transport and Dispersion (HYSPLIT) model. Data completeness or availability is not guaranteed. It is not a 24/7 operation.	Global	http://ready.arl.noaa.gov/READYcmet.php
United States Naval Research Laboratory Monterey Marine Meteorology Division	Merges important remote-sensing imagery and datasets derived from both geostationary and polar orbiter sensors that are of prime interest to tropical cyclone researchers. Capability to view the appropriate warning and track forecasts relevant to the times of the satellite datasets. Datasets are updated in near real time.	Tropical Atlantic, Pacific	http://www.nrlmry.navy.mil/TC.html

Table 23. Core capacities of Caribbean NMSs to support EWS at the national level and related gaps and needs

	<i>National level</i>	
	<i>Capacities</i>	<i>Gaps and needs</i>
Monitoring and observation networks	<p>(a) All the Caribbean countries/territories with NMSs have their own observation networks. Some have a limited number of real-time AWSs (for example, one in Saint Vincent, two in Barbados, two in Antigua and Barbuda, and two in Dominica) while others have a larger number (for example, 40 in Martinique and over 80 in Cuba).</p> <p>(b) In many Caribbean countries/territories, several networks measuring the same type of data are managed by different institutions and stakeholders.</p> <p>(c) Some Caribbean countries/territories (for example, Jamaica, Martinique, Saint Lucia) have implemented special observation networks coupled with an automated system for flash flood alerts.</p> <p>(d) The French West Indies manage an observation network of coastal wave rider buoys that enables accurate measurement of waves and swell. Some Caribbean countries/territories only have tide gauges (for example, Trinidad and Tobago, and Saint Lucia).</p> <p>(e) Capacities for instrument calibration exist in the region, especially in the regional instrument calibration laboratory at CIMH and in Cuba (the latter possessing a wind tunnel).</p> <p>(f) Some Caribbean countries/territories already use unconventional instruments for observing and monitoring, such as Webcam.</p>	<p>(a) None of the case III countries/territories, with the exception of Saint Martin and Saint Barthélemy, have observation networks.</p> <p>(b) There is a need to increase the spatial coverage of observation sites in most Caribbean countries/territories.</p> <p>(c) There is a need to improve the telecommunications process to ensure that all data from AWSs are transmitted in real time throughout the region.</p> <p>(d) There is a lack of coordination and cooperation in relation to interoperability of national level observation networks.</p> <p>(e) There is a need for better coordination between NMSs and other bodies which have meteorological networks, to target optimization and efficiency.</p> <p>(f) There is a need for additional resources and training for maintenance of observation sites and networks (for example, for staffing, staff training, funding and provision of spare parts).</p> <p>(g) There is a need for improved climatological observation networks to support slow-onset hazards such as drought and heat waves, and for work on climate change downscaling.</p> <p>(h) There is a need to further explore the use of unconventional observing equipment such as Webcams.</p> <p>(i) There is a need to develop a sustainability plan for all the national observing networks, including maintenance, spare parts, calibration, continuity and optimization.</p>

	<i>National level</i>	
	<i>Capacities</i>	<i>Gaps and needs</i>
Operational forecasting	<p>(a) All forecasting offices have some level of forecasting infrastructure such as observations, satellite, radar and NWP. However, the level of infrastructure (for example, workstations and access to networks) varies from country to country.</p> <p>(b) Some Caribbean countries/territories have integrated workstations such as Corobor, Synergie and Metlab, while others rely on products and services from various Websites (NOAA, CIMH, Météo-France).</p> <p>(c) All the Caribbean countries/territories have access to NWP products through GTS and/or Internet. However, the suite of products is limited due to bandwidth issues. Some Caribbean countries/territories can also download NWP from FTP servers in the United States or the United Kingdom.</p> <p>(d) All the islands have access to regional NWP from the CIMH models (MM5 and WRF) through the CIMH Website (display only).</p> <p>(e) Cuba and the French West Indies use their own national modelling capacities to run regional models.</p> <p>(f) Islands that are territories of European States have access to a wide variety of ECMWF products, including probabilistic and ensemble outputs. Countries/territories that are not in this category only have limited access.</p> <p>(g) The FFGS, developed by the Hydrological Research Center (HRC) under the Hydrological Programme of WMO, has recently been implemented for Haiti and the Dominican Republic.</p> <p>(h) The CIMH Advanced Flood Forecasting System couples NWP outputs with physically based distributed-parameter models to produce flood depth in Haiti. Similar products are planned for other Caribbean States.</p>	<p>(a) Most Caribbean countries/territories do not have a comprehensive and integrated forecasting system.</p> <p>(b) None of the Caribbean countries/territories have access to a severe weather guidance system with downscaling capacities, including marine hazards forecasts.</p> <p>(c) There is a need to access, in real time, a greater variety of information from numerical models and satellites, with more functionalities, possibly through a dedicated system.</p> <p>(d) There is a need to improve downscaling capacities from national threats to potential local impacts, including marine coastal risks, as in small islands forecasts are currently made for the whole country, or the whole province in larger Caribbean countries/territories.</p> <p>(e) There is a need to strengthen capacities for downscaling regional-scale monthly or seasonal forecast information to national needs.</p> <p>(f) There is a need to develop or improve forecaster cross-training programmes between islands.</p> <p>(g) There is a need to improve lead time for non-tropical-cyclone severe weather warning and forecast products for DRM agencies and stakeholders.</p> <p>(h) Protocols and zones of elevated monitoring and alerts need to be developed for disaster management authorities.</p> <p>(i) Increased numbers of qualified forecasters are required in many Caribbean countries/territories (for example, Aruba and Saint Vincent have only one forecaster each and Dominica has two).</p> <p>(j) There is a need to strengthen ongoing training on new technologies, products and methodologies related to forecasting and monitoring, including radar (operational use), NWP and marine issues, conducted by regional centres wherever possible.</p> <p>(k) There is a need to enhance feedback mechanisms from the forecasters to the regional or international centres providing NWP (for example, CIMH, NOAA and ECMWF).</p>

	<i>National level</i>	
	<i>Capacities</i>	<i>Gaps and needs</i>
Data management and exchange	<p>(a) In most of the Caribbean countries/territories, there are several databases for environmental data. Some Caribbean countries/territories are working on the establishment of a single national database.</p> <p>(b) In many Caribbean countries/territories, meteorological data are still manually collected, stored and transmitted.</p> <p>(c) Several different systems are used for data archiving in the region (for example, CLICOM, CLIDATA, CLIMSOFT).</p>	<p>(a) There is a need for a quality-controlled national GIS database of meteorological and hazard data, with harmonized protocols for exchange with the regional database.</p> <p>(b) There is a need to strengthen the relationship between DRM stakeholders and NMHSs (where they exist) with regard to data exchange.</p> <p>(c) There is a need to upgrade and harmonize software and tools for data archiving.</p> <p>(d) There is a need to strengthen human resources capacities dedicated to climatological data base management.</p> <p>(e) Data-rescue procedures and capacities need to be strengthened.</p> <p>(f) Processes to include metadata in the meteorological database need to be developed and implemented.</p>
Product development	<p>(a) Spanish-speaking countries/territories and the French West Indies have specific resources working on product development. These resources include dedicated and staffed departments which work under procedures that have been identified in a comprehensive QMS or set of SOPs.</p> <p>(b) Most meteorological products are developed for display on Websites.</p> <p>(c) The three French Départements Guadeloupe, Martinique and Guiana have a coordination unit for product development and a unique server in Martinique; products that have been developed for one Département can be utilized for another.</p>	<p>(a) Most SIDS have only limited capacities for product development in terms of human resources, software and workstations.</p> <p>(b) There is a need to improve or implement integrated production systems to help with product development.</p> <p>(c) There is a need for additional operational and software training on specific production systems (for example, Smartmet and MeteoFactory) to ensure flexibility for national adaptation and upgrade.</p> <p>(d) There is a need to improve capacities for Internet product development.</p>
IT and telecommunications	<p>(a) All the Caribbean countries/territories rely on the GTS-RMTN network.</p> <p>(b) All the Caribbean countries/territories depend greatly on Internet exchange for Web access and E-mails, with no backup capability.</p> <p>(c) The French West Indies have dedicated lines and networks connecting them with Toulouse (France).</p> <p>(d) Several Caribbean countries/territories have specific agreements or MOUs with providers of mobile telecommunications.</p>	<p>(a) There is a need to improve infrastructure capacities, including Internet, to support dissemination and data exchange at national and regional levels. This is required to ensure that DRM and public dissemination and relay of data from monitoring networks are operational 24/7.</p> <p>(b) There is a need to improve Internet access capacities (for example, higher or flexible bandwidth, and mirror sites).</p> <p>(c) There is a need to develop public and private partnerships for mobile phone dissemination (SMS, voice messages) of warnings, advisories and data transmission at a national or regional level (for example, the Carib-HYCOS project with Digicel).</p>

	<i>National level</i>	
	<i>Capacities</i>	<i>Gaps and needs</i>
Operational relationships with other technical agencies	<p>(a) There are four islands (Cuba, the Dominican Republic, Guadeloupe and Martinique) with NHSs that include risk management in their mandate.</p> <p>(b) In most other Caribbean countries/ territories, the water resources authorities are responsible for some hydrological aspects, including expertise and data networks.</p> <p>(c) In Barbados, CIMH is the official institution for hydrology. It also provides hydrological support, through regional advisors, to all CMO Members.</p> <p>(d) Work is in progress in the French West Indies to implement a similar organization to that in France, through a <i>cellule de veille hydrologique</i>, with meteorological and hydrological specialists working together on real-time forecasts and warnings.</p>	<p>(a) Meteorological and hydrological services are often in different institutions and coordination between them can present a challenge, especially in real time. Coordination of crises management is often undertaken via DRM agencies.</p> <p>(b) There is a need for real-time coordination to ensure timely input of hydrological expertise from NHSs, other hydrological institutions, or from a regional advisor (for example, CIMH) into a comprehensive forecast and warning process.</p> <p>(c) There is a need for tools or workstations that can integrate meteorological and hydrological data (from radar, raingauges, limnimeters, and the like), for monitoring and nowcasting.</p> <p>(d) There is a need for improved access for NMSs to existing hydrological information for real-time purposes or batch processing.</p>

Table 24. Core capacities of Caribbean meteorological organizations, institutions and services to support EWS – regional aspects, gaps and needs

	<i>Regional aspects</i>	
	<i>Capacities</i>	<i>Gaps and needs</i>
Monitoring and observation networks	<p>(a) The Caribbean Radar Project (EU, CMO, Météo-France) has led to great improvements in hazard monitoring in the region.</p> <p>(b) Some Caribbean countries/territories have access to the long-range lightning detection system of the United Kingdom Met Office or to information on Websites such as the World Wide Lightning Location Network (wwlln.net).</p>	<p>(a) Coordination needs to be improved between current regional projects that are providing meteorological observation equipment (for example, Carib-HYCOS, CADM, the Caribbean Radar Project).</p> <p>(b) There is a need to strengthen the coastal marine observation networks through an expansion of the existing French wave rider network to complement the United States buoys, and an increase of the number of tide gauges.</p> <p>(c) There is a need to fill gaps in regional radar information and to produce a complete mosaic for the Caribbean region, based on the existing one. A first step could be to include radars from Sint Maarten, Jamaica and Cuba, and activate a radar in the Cayman Islands (an EU-funded project).</p> <p>(d) Hydrometeorological data from radars needs to be shared more (for example, rainfall accumulation) and the radars need to be upgraded for Doppler capability (radial wind, false echoes).</p> <p>(e) There is a need for a high-resolution regional lightning network that would complement the existing low-resolution long-range networks.</p>

	<i>Regional aspects</i>	
	<i>Capacities</i>	<i>Gaps and needs</i>
Operational forecasting	<p>(a) A crucial operational role is played by RSMC–Miami for synoptic scale analysis and forecasts over the tropical North Atlantic.</p> <p>(b) A further crucial role is played by CIMH by supporting forecasting capacities (for example, through the regional numerical model) and by transferring knowledge and expertise to CMO Members (as an RTC).</p> <p>(c) A real-time flood forecasting project (RFFP) is being developed by CIMH based on the use of a hydrological model along with the integration of precipitation forecasts and real-time observations from radar, meteorological and hydrological networks.</p> <p>(d) There is a French Forecasting Coordination Centre in Martinique to ensure real-time coordination and guidance for the French West Indies and French Guiana.</p> <p>(e) In its capacity as RTC for CMO, CIMH regularly organizes regional technical workshops with other partners for CMO Members. In all the other Caribbean countries/territories (except Haiti), forecasters are trained within their own countries (for example, Cuba, the Dominican Republic), which may be, in the case of territories, on the mainland of countries to which they belong (France and the Netherlands).</p> <p>(f) Training for forecasters, in the form of courses, workshops and secondments, is available to many Caribbean countries/territories from RSMC–Miami and the United States NOAA–NWS.</p> <p>(g) Online training for tropical meteorology and forecasting from centres of excellence is available via Internet (for example, COMET).</p>	<p>(a) Coordination between RSMC–Miami and a responsible forecast office is only established when a tropical cyclone is forecast to directly impact one of the islands for which the forecast office has responsibility.</p> <p>(b) Web conferences have been initiated by CIMH for real-time coordination and provision of expertise through the “visit view” system; however, CIMH is not an operational centre.</p> <p>(c) There is a need for real-time coordination between neighbouring forecast offices.</p> <p>(d) There is a need for additional foreign language training to enhance capacities for exchange and coordination.</p> <p>(e) There is a need for a regional centre or platform to support NMSs with routine guidance, consensus forecasts and real-time coordination, especially for severe-weather forecasting, marine forecasting and monthly or seasonal forecasts.</p> <p>(f) The variety and number of NWP (for example, probabilistic products, dynamic parameters) and other products (for example, high-resolution satellite imagery and radar products) that are available on the GTS needs to be increased.</p> <p>(g) Regional training mechanisms need to be strengthened, through courses, workshops, staff exchanges (for example, through secondments) and e-learning.</p> <p>(h) The scope of CIMH should be expanded to non-English-speaking Caribbean countries/territories. This could facilitate interaction and knowledge exchange in operational activities and training among all Caribbean countries/territories.</p> <p>(i) The role of CCCCC should be developed in relation to monthly or seasonal forecasts for “long-lead” hazards and climate change-related risks.</p>

	<i>Regional aspects</i>	
	<i>Capacities</i>	<i>Gaps and needs</i>
Data management and exchange	<p>(a) Regional mechanisms for data exchange or sharing currently exist through CIMH, which collects and manages data from CMO Members.</p> <p>(b) In general, data from official WMO synoptic stations are disseminated to the region via the GTS.</p>	<p>(a) Weather stations, other than WMO official stations, are often not known by other Caribbean countries/territories and regional bodies. It is a challenge for CIMH to obtain all the meteorological information from its Members.</p> <p>(b) There is a need to develop an inventory of meteorological, hydrological and hazard data available at national and regional levels (especially in case II relationships), which should include metadata and the means of access (for example, real-time, database, disks or paper).</p> <p>(c) There is a need to strengthen the coordination and exchange of data between Caribbean countries/territories and regional centres to improve real-time and slow-onset monitoring.</p> <p>(d) There is need for a standardized, quality-assured GIS regional meteorological and hydrological database with protocols of exchange. The Carib-HYCOS project involving CIMH could partly address the issue by providing a good base for its implementation.</p>
Product development		<p>(a) Most Caribbean countries/territories have difficulties to find sufficient resources to work on product development.</p> <p>(b) There is need for a regional product development programme with associated training that can be applied at national level.</p>
IT and telecommunications	In all Caribbean countries/territories, GTS-RMNT is a crucial pillar for technical capacities such as monitoring and forecasting.	<p>(a) There is a need to anticipate potential changes to RMTN (related to the International Satellite Communications System (ISCS)/World Area Forecast System (WAFS)) dissemination.</p> <p>(b) There is a need to upgrade RMTN dissemination in terms of capacities (bandwidth, volume, speed) and data availability (for example, more NWP products and radar information).</p> <p>(c) There is a need to improve telecommunications backup procedures and agreements at regional or subregional levels.</p> <p>(d) Regional level partnerships need to be established with providers of mobile telephone services for SMS, GPRS and voice messages for the dissemination of warnings and advisories at the regional level.</p>

	<i>Regional aspects</i>	
	<i>Capacities</i>	<i>Gaps and needs</i>
Operational relationships with other technical agencies	Very little hydrological information is available at the national level for exchange with regional (for example, CIMH) and national agencies.	<ul style="list-style-type: none"> (a) There is a need to improve exchange mechanisms for hydrological data at regional levels, through regional collection or bilateral exchange. (b) There is a need for improved subregional or bilateral cooperation between NMSs and NHSs in countries sharing the same river basin in the continental region (French Guiana, Guyana, Suriname).

Table 25. Overarching capacities of Caribbean meteorological organizations, institutions and services to support EWS – national and regional aspects, gaps and needs

	<i>National and regional aspects</i>	
	<i>Capacities</i>	<i>Gaps and needs</i>
Quality Management Systems	<p>(a) The Dominican Republic and the French West Indies have a comprehensive QMS and are ISO certified. The Interregional Direction of Météo-France has a QMS for all the French territories.</p> <p>(b) In all of the Caribbean islands, the NMSs rely heavily on regional plans (for example, from the RA IV Hurricane Committee) and international documents (for example, from WMO or ICAO) as the framework for their activities.</p> <p>(c) Most of the NMSs have contingency plans to ensure continuity of service in case of emergency.</p> <p>(d) Contingency plans exist which frame the basic activities of the NMSs to support DRM in the context of MHEWS.</p>	<p>(a) In several countries/territories, activities are based on SOPs that do not cover all areas.</p> <p>(b) Many of the countries/territories do not have a comprehensive set of documents describing activities, procedures, operating modes, means involved and goals; some focus on specific tasks only; the oral tradition is very strong.</p> <p>(c) Feedback from stakeholders and institutions (for example, DRM agencies) occurs but is often informal and difficult to document. Thus, it is difficult to implement continuous improvement mechanisms.</p> <p>(d) There is a need for a region-wide programme for QMS implementation at national levels that will provide comprehensive harmonized procedures, and take into account the individual characteristics of the islands.</p> <p>(e) There is a need to have clearly defined operational procedures for NMS support to, first, other NMSs and, second, to DRM agencies in other Caribbean countries/territories.</p> <p>(f) There is a need for a mechanism for sharing QMS best practices among the Caribbean countries/territories.</p>

	<i>National and regional aspects</i>	
	<i>Capacities</i>	<i>Gaps and needs</i>
Human resources and training	<p>(a) Several NMSs are adequately staffed to undertake their activities (for example, Cuba, the Dominican Republic, Trinidad, Martinique and Guadeloupe).</p> <p>(b) In those islands without an NMS, there is often a focal point (for example, air traffic controllers) responsible for meteorological issues.</p> <p>(c) The CIMH is the RTC for CMO Member States; it also organizes regular regional technical workshops with partners.</p> <p>(d) In all of the countries/territories (with the exception of Haiti), forecasters are trained within their own countries (for example, Cuba and the Dominican Republic), which may be, in the case of territories, on the mainland of countries to which they belong (France and the Netherlands).</p> <p>(e) Forecasting training courses, workshops and secondments are made available to many Caribbean countries/territories by RSMC–Miami and the United States NOAA–NWS.</p> <p>(f) On-line training on tropical meteorology and forecasting is available on the Web (for example, COMET) from centres of excellence.</p>	<p>(a) Many countries/territories do not have an adequate number of qualified staff, particularly meteorologists.</p> <p>(b) There is a need for more qualified meteorologists in many countries/territories (for example, Dominica, Saint Vincent and the Grenadines).</p> <p>(c) There is a need for training of meteorologists in the areas of product development and service delivery.</p> <p>(d) There is a need for specific training of forecasters on DRM activities and challenges.</p> <p>(e) Interaction and knowledge transfer needs to be facilitated at the regional level through the expansion of the scope of CIMH to non-English-speaking Caribbean countries/territories.</p> <p>(f) There is a need to strengthen ongoing training programmes on new technologies, products and methodologies related to forecasting and monitoring, including radar (operational use), NWP and marine issues. When possible, these should be conducted by regional centres.</p> <p>(g) There is a need for additional resources and training for the maintenance of observation sites and networks.</p> <p>(h) There is a need for additional operational and software training on specific production systems (for example, Smartmet, MeteoFactory) in order to develop national capacities for adaptation and upgrade.</p> <p>(i) Cross-training programmes in forecasting need to be developed or reinforced between countries/territories.</p> <p>(j) Regional training mechanisms need to be reinforced through courses, workshops, exchanges, secondments and e-learning, to ensure they are adapted to the countries'/territories' forecasting needs.</p> <p>(k) There is a need for foreign language training of meteorologists to ensure effective coordination between different language groups.</p> <p>(l) There is a need for bilateral training and workshops involving NMSs, DRM agencies and key stakeholders.</p> <p>(m) There is a need for training on methodologies and tools for hazard and risk analysis.</p> <p>(n) Bilateral training and workshops involving NMSs (specially forecasters) and the media need to be developed to improve the way information is delivered.</p>

Table 26. National capacities, gaps and needs for MHEWS in the Caribbean

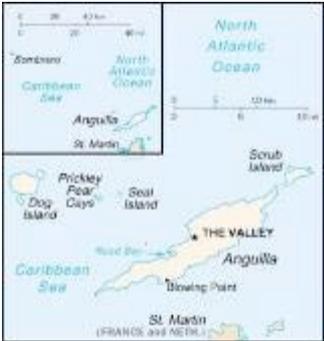
<i>National level</i>	
<i>Capacities</i>	<i>Gaps and needs</i>
<p>(a) Almost all the Caribbean countries/territories have adopted the same WWS for tropical cyclones as RSMC–Miami.</p> <p>(b) In all the Caribbean countries/territories, aeronautical hazards are managed under the ICAO framework and are not integrated into comprehensive WWSs for DRM. NMSs ensure that aeronautical warnings are aligned with public and marine warnings.</p> <p>(c) Trinidad and Tobago and the French West Indies have a standardized colour-coded WWS for several hazards.</p>	<p>(a) Many hazards and their consequences are taken into account in forecasting and monitoring, but not all are managed through a comprehensive WWS. In most countries/territories, a comprehensive WWS exists only for tropical cyclones and, sometimes, for heavy rain. Some SOPs do exist, and the boundary between specific procedures (warning bulletins, dissemination, phone calls) and the WWS is not very clear.</p> <p>(b) There is a need for national adaptation of the regional WWS for tropical cyclone information from RSMC–Miami.</p> <p>(c) Most Caribbean countries/territories take into account primary hazards (for example, heavy rain) in their WWS. However, there is a lack of consideration for related hazards such as landslides and flash floods.</p> <p>(d) There is a need for improvement of national WWS to include multiple hazards (primary and secondary), such as coastal marine hazards (storm surge, long swell), drought, heavy rain and flooding, landslides, mudslides, and the like.</p> <p>(e) There is a need for improvement of the downscaling of WWSs to local levels.</p> <p>(f) The risk of tsunamis has often been reported as requiring a specific WWS or specific procedures. Thus, the integration of these events into WWSs remains a major issue.</p> <p>(g) National focal points (under coordination of the CTWC) and institutions that are responsible for tsunami warnings at national level need to be identified.</p> <p>(h) There is a need for development or integration of a WWS for tsunamis at national level within the framework of the existing regional system, and with special consideration for islands either without NMSs or with NMSs that are not operational 24/7.</p> <p>(i) Few islands use a threshold-based methodology to manage hazards in their WWS. In most cases, WWSs are based on the geographic threat zone and the lead time for the main meteorological feature (tropical cyclone or waves, a cold front, and the like).</p> <p>(j) There is a need for studies to base WWS procedures on thresholds derived from risk assessments, past events and robust environmental databases.</p> <p>(k) There is a need to link WWS information to probabilistic forecasts for all the relevant hazards, to meet the needs of DRM agencies in term of progressive real-time preparedness.</p> <p>(l) The DRM agencies and other stakeholders should be more involved in the improvement of the WWS.</p> <p>(m) There is a need for improvement of coordination and collaboration between the NMSs and NHSs (for example, concerning heavy rainfall and possible hydrological consequences).</p> <p>(n) In several Caribbean countries/territories, WWSs are not well understood by the public, even though warning bulletins are issued.</p> <p>(o) There is a need for public education campaigns to increase public understanding of WWS criteria.</p>

Table 27. Regional aspects, gaps and needs for MHEWS in the Caribbean

<i>Regional aspects</i>	
<i>Capacities</i>	<i>Gaps and needs</i>
<p>(a) The unique regional WWS for all the countries/territories of RA IV is specifically targeted at named tropical cyclones and is managed by RSMC–Miami.</p> <p>(b) This regional WWS comprises a real-time coordination mechanism involving RSMC–Miami and countries/territories that are forecast to be directly impacted.</p> <p>(c) The French West Indies have a subregional, colour-coded WWS for the Lesser Antilles for tropical cyclones, heavy rain, thunderstorms, damaging waves and strong winds. Currently, it is coordinated only within the French islands, with input from the official WWS from RSMC–Miami during tropical cyclone events.</p> <p>(d) Real-time WWS coordination between the French regional centre in Martinique and the CNM of Haiti has been in place since June 2010.</p>	<p>(a) The regional WWS of RSMC–Miami is only for direct impact of named tropical cyclones. This WWS is not downscaled to localities where risks and vulnerabilities may be greater.</p> <p>(b) There is no regional harmonization and no real-time coordination between the different forecast and warning offices for hazards other than tropical cyclones. However, CIMH organizes conference calls with CMO Members to coordinate warnings for severe weather, though not on a 24/7 basis.</p> <p>(c) There is need for a harmonized regional or subregional multi-hazard WWS that takes into account existing systems (for example, RSMC–Miami).</p> <p>(d) There is need for real-time coordination in the region, at least between neighbouring islands, for multi-hazard WWS.</p> <p>(e) There is need for strengthened coordination between forecast warning centres and countries/territories that depend on their WWS services.</p> <p>(f) A regional platform for WWS guidance, information exchange and coordination is required.</p> <p>(g) The DRM agencies need to be involved in the process of harmonization of WWSs in the region.</p>

APPENDIX 2 – BRIEF OVERVIEW OF SOCIO-ECONOMIC AND INSTITUTIONAL ARRANGEMENTS

Anguilla



Anguilla is part of the British Caribbean OCTs and is one of the Leeward Islands.
 Size: 91 square kilometres, highest elevation 65 metres;
 Population: 14 436 (2010 estimation);
 GDP per capita (purchasing power parity – PPP): US\$ 12 200 (2008 estimation);
 GDP per sector: Agriculture: 4 per cent; industry: 18 per cent; services: 78 per cent.

Economy and finances

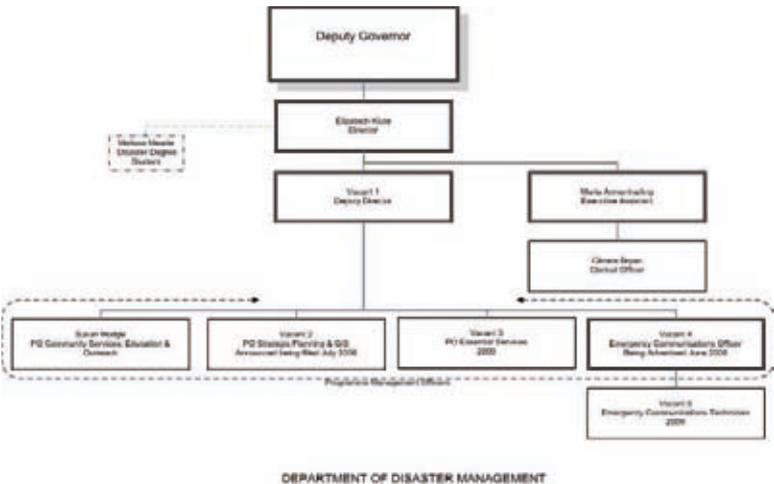
The island has few natural resources and the economy largely depends on tourism, foreign banking, lobster fishing and remittances from emigrants. As an overseas territory, Anguilla has in the past relied on the United Kingdom for financial assistance. The Government of Anguilla has limited public financing and plans to upgrade the physical and economic infrastructure through deficit financing.

Vulnerability to natural hazards

Anguilla is vulnerable to tropical cyclones, tsunamis, floods, earthquakes, coastal erosion, rising sea levels and sea penetrations and landslides. The low-lying topography and centrifugal drainage pattern of the numerous sinkholes increases the risk of damage from high winds and flooding. Several areas of the coast are also prone to erosion and landslides. Recent disasters include hurricanes *Earl* (2010), *Omar* (2008), *Lenny* (1999), *Marilyn* and *Luis* (1995), and *Donna* (1960), all of which generated considerable damage to infrastructure, which in turn impacted heavily on the economy of the island.

Institutional arrangements for DRM

The Anguilla DDM is the responsible organization. It has a staff of six and reports to the Deputy Governor (see Figure). It has competencies in the areas of community outreach, preparedness and education, mitigation, strategic planning and mapping (GIS), emergency communications, warning systems and Web services. In April 2009, the DDM developed the National Mitigation and Risk Reduction Strategy Plan to provide an integrated framework for the implementation of hazard-mitigation measures at national, sectoral and community levels in a structured holistic and comprehensive manner. The Anguilla National Warning System was designed and implemented during 2006–2008. Alerting protocols were drafted collectively with the fire and police departments, the IFRC and other agencies. The system is in need of development in the areas of policy and protocols for use,



thresholds of risk and associated alert levels, consideration for at-risk populations (for example, people with sight or hearing impairments), weekly and monthly testing and integration into everyday life.

Meteorological and hydrological services and capacities

There is no NMHS in Anguilla. The country receives its meteorological information from Antigua and Barbuda (an OECS arrangement). Minimal meteorological information is under the responsibility of air traffic controllers. The public generally relies on outside cable weather stations for news and forecasts regarding storm systems. The closest EMWIN system is at the airport of Antigua.

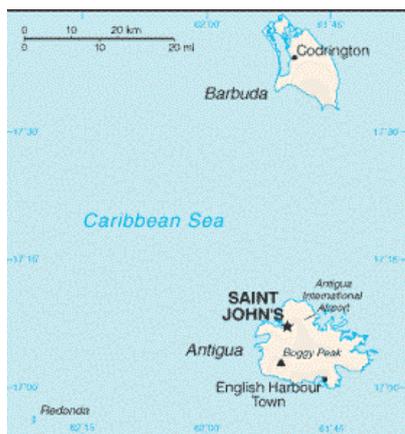
Other stakeholders

As a British overseas territory, Anguilla has access to direct United Kingdom support and technical assistance through DFID. Following Hurricane *Omar*, the country received grant funding from CDB oriented to the reconstruction of infrastructure. Another stakeholder is the Ministry of Social Development, which has been promoting a set of initiatives related to DRM. The Anguilla Red Cross Society is the only NGO directly involved in DRM.

Cooperation with the region

Anguilla is an associate member of CARICOM and OECS, and a de facto full member of CDEMA and of CMO–CIMH. It participates in several regional initiatives, such as CCRIF, R3I, and the Regional Disaster Risk Management for Sustainable Tourism in the Caribbean.

Antigua and Barbuda



Antigua and Barbuda is an independent country composed of several islands. It is located in the Lesser Antilles in the eastern Caribbean.

Size: 443 square kilometres;

Population: 85 632 (2010 estimation);

GDP per capita (PPP): US\$ 17 800 (2009 estimation);

GDP per sector: Agriculture: 3.8 per cent; industry: 22 per cent; services: 74.3 per cent.

Economy and finances

The country's primary economic activities are tourism, construction and light manufacturing, with tourism alone accounting for nearly 60 per cent of GDP. The economy has been severely hit by the global economic crisis, suffering from the collapse of its largest

financial institution and a steep decline in tourism, resulting in a significant increase in the country's national debt.

Vulnerability to natural hazards

Antigua and Barbuda are low-lying islands without mountains or rivers, with a significant area lying near or below sea level. The country is vulnerable to storm surge, damaging waves and coastal inundations, heavy rain (urban flooding) and droughts. The islands are on the tropical cyclone path and are affected almost annually. The last impact dates from the passage of Hurricane *Omar* in 2008, which caused coastal inundation and flooding from heavy rain.

Institutional arrangements for DRM

The responsible government agency is NODS. It reports to the Prime Minister's Office and has a staff of 13, four of whom are professionals. Projects are under the responsibility of the different ministries and funds are channelled through them. Close relations are maintained by NODS with CDEMA. The institution has strengthened its coordination mechanisms and preparedness for the hurricane season period, but at the same time emphasized its institutional weakness, citing not only the deficit of equipment and resources, but also the cost involved in subcontracting to private enterprises. Antigua and Barbuda has a National Disaster Plan in place which defines roles and responsibilities in case of a disaster, preparedness measures, warning arrangements and response operations.

Meteorological and hydrological services and capacities

The Antigua and Barbuda NMS is based at the international airport. The service maintains an observation network with two AWSs in Antigua and one in Barbuda. There is no hydrological institution on the islands, mostly because there are no rivers. In addition to providing services to the Antigua and Barbuda Government, the NMS has the mandate to support Anguilla, the British Virgin Islands, Montserrat, and Saint Kitts and Nevis, none of which have their own NMS.

Other stakeholders

A number of NGOs are affiliated with NODS, including the Red Cross, the Saint John Ambulance Brigade, the Salvation Army and a number of service clubs and church organizations. The Red Cross is arguably the most involved, its activities focus mainly on community-level support. A number of public institutions have also been involved in the past, including the Antigua Public Utilities Authority, which is responsible

for telecommunications, energy and water. Past projects have typically been funded by USAID and USAID OFDA, by Japan and by the EC (ECHO).

Cooperation with the region

Antigua and Barbuda is part of ACS, CARICOM, OECS, CDEMA, CMO–CIMH and the CDB. It is also a member of the Eastern Caribbean Currency Union (ECCU), which is supervised by the Eastern Caribbean Central Bank. The country has close relations with Venezuela and is part of ALBA, through which it received US\$ 50 million in 2009.

Aruba



Aruba belongs to the Dutch OCTs and has been an autonomous territory of the Netherlands since 1 January 1986. It is located in the Lesser Antilles, just north of the Venezuelan coast.

Size: 180 square kilometres;

Population: 107 138;

GDP per capita (PPP): US\$ 24 436 (2009 estimation);

GDP per sector: Agriculture: 0.4 per cent; industry: 33.3 per cent; services: 66.3 per cent.

Economy and finances

Tourism is one of the main pillars of the Aruba economy and the main source of employment for the population. Another important sector is offshore banking. Aruba receives some development assistance from the Netherlands each year, but this is gradually being reduced with the objective of making Aruba economically independent. Assistance usually takes the form of direct material or technical support. Aruba enjoys one of the highest standards of living in the Caribbean region and a low unemployment rate. The island's main trading partners are the United States, the Netherlands and the (former) Netherlands Antilles.

Vulnerability to natural hazards

Aruba is not at high risk of tropical cyclones. Nevertheless, the island was heavily affected by hurricanes *Hazel* (1954), *Janet* (1956), *Lenny* (1999) and *Ivan* (2004), of which the last caused severe damage to infrastructure and the tourism sector. Other major hazards are earthquakes, droughts, floods, storm surges, tsunamis, fires, as well as oil spills or possible accidents in the oil refinery.

Institutional arrangements for DRM

Aruba is relatively self-sustained and has limited capacity to help other islands in the region. The island has a Crisis Management Office, which reports directly to the Prime Minister. Coordination is carried out through this office, which has a clear mandate but only four permanent staff. Key partners with the Crisis Management Office are the Fire Department, and the police and health services. All have contingency plans for hurricanes, and aerial and marine incidents. Every other year the organizations involved carry out a full-scale drill for a possible aeroplane accident to test the operational procedures and protocols.

Meteorological and hydrological services and capacities

The NMS of the country is the Meteorological Department of Aruba (DMA), which is considered by ICAO to be a well-equipped aeronautical meteorological office. As with many NMSs on small island states it has a limited number of forecasters and meteorologists. The DMA is actively involved in recruiting new employees to fill its staffing requirements. Currently, the services that cannot be provided by the DMA are being bought from the NMS of Curaçao and Sint Maarten. All local forecasts and warnings are being issued by the DMA itself. Aruba does not have a hydrological service.

Other stakeholders

Aruba has a Royal Dutch Marines base on its territory, which has limited resources and capacity for disaster response. The Aruba Red Cross Society has about 100 volunteers and limited equipment and supplies and provides support to the government health and social affairs agencies during emergency situations. These stakeholders maintain a good relationship with the Crisis Management Office, but they develop their own activities and dynamics.

Cooperation with the region

Aruba is an associate member of ACS. It is involved in R3I, together with all the other Dutch OCTs. Exchange with other islands in the Caribbean is focused mainly on the former Netherlands Antilles.

The Bahamas



The Bahamas is a country composed of approximately 700 islands and cays, located to the north of Cuba.

Size: 13 939 square kilometres;

Population: 307 552;

GDP per capita (PPP): US\$ 29 700 (2009 estimation);

GDP per sector: Agriculture: 1.2 per cent; industry: 14.7 per cent; services: 84.1 per cent.

Economy and finances

The Bahamas is one of the wealthiest Caribbean countries/territories. Its economy is heavily dependent on tourism and offshore banking. Tourism, together with tourism-driven construction and manufacturing, accounts for approximately 60 per cent of GDP and directly or indirectly employs half of the archipelago's labour force. The financial sector is currently smaller than it has been in

the past due to the enactment of new and more strict financial regulations in 2000, which caused many international businesses to relocate elsewhere. Manufacturing and agriculture combined contribute approximately one tenth of GDP and show little growth, despite government incentives aimed at those sectors.

Vulnerability to natural hazards

The Bahamas is exposed to hurricanes, tropical storms, non-tropical processes, floods, coastal erosion, rising sea levels and sea infiltrations, drought and pollution. Major hurricanes that have affected the Bahamas include *Andrew* (1992), *Floyd* (1999), *Michelle* (2001), *Frances* (2004), *Jeanne* (2005) and *Irene* (2011). Both *Frances* and *Irene* had a devastating impact on the archipelago.

Institutional arrangements for DRM

The organization responsible for DRM is the country's NEMA. It groups 39 organizations, including the Royal Bahamas Police Force, the Royal Bahamas Defence Force, the Ministry of Health, the Department of Meteorology, the Department of Environmental Health, the Ministry of Tourism, the Ministry of Social Services and Community Development, the Ministry of Transport and Aviation, the Ministry of Foreign Affairs, Bahamas Customs, HM Prison, Bahamas Electricity Corporation, the Water and Sewerage Corporation, Bahamas Telecommunication Corporation, the Public Hospitals Authority, the Airport Authority, the Port Authority, Bahamas Red Cross, the Salvation Army and the Department of Local Government. They have regular monthly meetings to coordinate actions in case of disaster response, preparedness and coordination before the hurricane season. Reporting directly to the Office of the Prime Minister, the NEMA mandate is defined in the 2006 Disaster Preparedness and Response Act.

Meteorological and hydrological services and capacities

The Bahamas NMS is located in Nassau. It is responsible for all of the 40 inhabited islands of the Bahamas, and also provides forecasts and warnings to the Turks and Caicos Islands.

Other stakeholders

The Bahamas Red Cross Society collaborates closely with NEMA. In emergency situations this office provides care in the form of volunteers, supplies and shelter management. The office also permanently engages in actions aimed at public awareness of disaster management, working with communities to

organize training activities, community risk maps, development plans, and the like. The Bahamas Red Cross has also been involved in a number of projects funded by DIPECHO in the last few years. The health sector in the Bahamas also maintains close liaison with NEMA, though they have limited resources. Initiatives have also been supported by USAID, focusing on contingency planning and coastal zone management, among others.

Cooperation with the region

At a regional level with respect to DRM issues, the Bahamas benefits from a close cooperation with Jamaica, the Turks and Caicos Islands, the Cayman Islands, Belize and Barbados. The Bahamas is an associate member of ACS and an active member of CARICOM and CDEMA, via which it is participating in the CDM Regional Strategy.

Barbados



Barbados is an island State located in the Lesser Antilles.

Size: 431 square kilometres;

Population: 284 589 (2010 estimation);

GDP per capita (PPP): US\$ 17 700 (2009 estimation);

GDP per sector: Agriculture: 6 per cent; industry: 16 per cent; services: 78 per cent.

Economy and finances

In recent years the economy has diversified into light industry and tourism with about 75 per cent of GDP and 80 per cent of exports being attributed to services. Offshore finance and information services are important foreign exchange earners. The ratio of public debt to GDP rose to over 100 per cent in 2009, largely because a sharp slowdown in tourism and financial services led to a wide budget deficit.

Vulnerability to natural hazards

Barbados has had limited experience of disasters in the last 25 years. From 1980 to 2007, there were only seven events (mostly tropical storms), killing a total of one person. On average, less than 300 persons are affected by disasters each year. In spite of the relatively benign experience, Barbados remains potentially exposed and vulnerable to severe earthquakes, tsunamis and tropical cyclones, as well as damaging waves and coastal inundations. With the highest point being 337 metres, the island is mostly flat and not exposed to torrents, although a possible risk exists from urban inundation and landslides.

Institutional arrangements for DRM

The Barbados DEM is responsible for the development and implementation of the Emergency Management Programme. It has the responsibility for coordinating emergency management activities. The DEM came into being on 1 April 2007 by the statutory legislation of the Emergency Management Act 2006. It replaces the Central Emergency Relief Organization Secretariat, which dated back to the 1940s when an organization for hurricane relief was formed under the authority and direction of the Governor. At that time, the main emphasis was on relief. The DEM is implementing a national Comprehensive Disaster Management programme which embodies the concept of all hazards, natural and man-made, at all phases of the disaster continuum: prevention and mitigation, preparedness, response and recovery, as well as integration of all aspects of DRR. It has six professional posts and serves as secretariat and coordinator of the National Emergency Management System, which is constituted of key government ministries and departments, representatives from the private sector, NGOs, community-based organizations and international and regional emergency management organizations.

Meteorological and hydrological services and capacities

Barbados has its own NMS located near the airport. It maintains an observation network with two AWSs. The NMS also provides support to Saint Vincent and the Grenadines, and Dominica, both of which have their own NMSs but do not have the capacity for forecasting. Barbados also hosts CIMH, which is directly responsible for hydrology in Barbados.

Other stakeholders

Barbados is an important regional centre because it accommodates a large number of institutions and agencies that work at the regional level, among which CDEMA, the CARICOM Disaster Relief Unit (CDRU), Regional Security Systems (RSS), the Regional Response Mechanism (RRM) and a large number of donor

regional offices, including those of the EC, United Kingdom DFID, CIDA, UNDP, UNICEF, the Pan-American Health Organization (PAHO), the Inter-American Development Bank and CDB. A number of other organizations are active in national DRM, especially the Barbados Red Cross Society, the Saint John Ambulance Brigade and the Salvation Army.

Cooperation with the region

Barbados is a member of ACS, CARICOM, OECS, CDEMA, CMO-CIMH and CDB.

Belize



Belize is an independent State in Central America, along the west coast of the Caribbean Sea.

Size: 22 966 square kilometres;

Population: 307 899 (2010 estimation);

GDP per capita (PPP): US\$ 8 300 (2009 estimation);

GDP per sector: Agriculture: 29 per cent; industry: 17 per cent; services: 54 per cent.

Economy and finances

Tourism is the number one foreign exchange earner, followed by exports of agricultural goods, such as marine products, citrus fruit, sugar from sugar cane, bananas and garments. Oil discoveries made in 2006 have also contributed to economic growth. Exploration efforts continue and production has increased further in 2009. In

2007, the government restructured nearly all of its public external commercial debt, which helped reduce interest payments and relieve some of the country's liquidity concerns. A sizeable trade deficit and foreign debt continue to be a significant concern.

Vulnerability to natural hazards

Belize lies in the hurricane belt. In recent years, the country has been affected by hurricanes *Mitch* (1998), *Keith* (2000), *Iris* (2001), *Dean* (2007) and *Richard* (2010), and tropical storms *Arthur* (2008), *Alex* (2010), *Karl* (2010), *Matthew* (2010) and *Harvey* (2011). Belize is also subject to earthquakes, the last of which occurred in 2009 but caused only limited damage. Other potential hazards include urban and river flooding.

Institutional arrangements for DRM

The responsible government agency for disaster management is now Belize NEMO. The organization was created in 2000 and has the sole authority for disaster management issues. Officially placed under the Office of the Prime Minister, NEMO is now part of the Ministry of National Emergency and Transport. The organization has 21 permanent employees and operates at the national as well as at district and village levels, and carries out a number of technical activities, such as hazard mapping, mitigation land-use management, building codes for construction, and others.

Meteorological and hydrological services and capacities

Coordination between the Belize NEMO and NMS is close. Meteorological data are made directly available to NEMO. The NMS is also the responsible agency for hydrology and water resources management, and has its own hydrological unit.

Other stakeholders

Belize hosts CCCCC. In the field of disaster management, CCCCC is planning a regional project for the integration and expansion of monitoring of the Caribbean Sea level together with EWS (Caribbean Integrated Monitoring System – CIMS). The Japanese development agency, JICA, is funding an AWS project along the Guatemalan border. Other donors in the country include OAS, CDB, IDB and UNDP.

Cooperation with the region

Belize is a member of ACS, OAS, CARICOM, CDEMA, CMO-CIMH and CDB. It has close bilateral ties to a number of countries/territories in the Caribbean region, including Jamaica, Cuba, Trinidad and Tobago, and Barbados.

The British Virgin Islands



The British Virgin Islands (BVI) is a British OCT consisting of the main islands of Tortola (capital city), Virgin Gorda, Anegada and Jost Van Dyke, along with over fifty other smaller islands and cays. The island group is located east of Puerto Rico.

Size: 166 square kilometres;

Population: 29 537 (2010 estimation);

GDP per capita (PPP): US\$ 30 282 (2010 estimation);

GDP per sector: Goods 6.5 per cent; services 94.5 per cent (2010 estimation);

Tourism GDP of total GDP: 30.3 per cent (2010 estimation);

Financial services GDP of total GDP: 17.5 per cent (2010 estimation).

Economy and finances

Having the twelfth highest GDP per capita in the world, BVI boasts one of the most stable and prosperous economies in the Caribbean. The country is highly dependent on tourism and financial services, which, when combined, represent approximately 50 per cent of the national income. Nearly 1 million tourists visit the islands each year, mostly from the United States.

Vulnerability to natural hazards

The main natural hazards that have been identified for BVI are hurricanes and related weather systems, including flooding, wind damage and coastal flooding. The islands are also at risk from the effects of earthquakes, including severe ground shaking, tsunami-generated flooding and landslides, and from oil-related accidents. However, there have been few disasters in recent years, and these have resulted in only minor local damage and no casualties. A study carried out by the BVI DDM concluded that the level of multi-risk hazard is moderate to very low.

Institutional arrangements for DRM

The responsible agency is the DDM, which has a permanent staff of 12 and, as in all British OCTs, reports to the Governor's Office. The agency has established a comprehensive National Disaster Plan, with legislation in place based on CDEMA model legislation. Emergency services, government departments as well as public utility companies, are all involved in DRM processes. The National Disaster Plan, however, does not appear to be updated frequently. The DDM also carries out specific activities to impose earthquake-resistant construction.

Meteorological and hydrological services and capacities

There is no independent meteorological or hydrological department in BVI.

Other stakeholders

As for other British OCTs, in the case of a disaster BVI can rely on the United Kingdom Rapid Response Team, as well as on support from the United States base in Puerto Rico. The United Kingdom DFID is closely involved in DRM, and a number of NGOs are also part of the official DRM structure, the most important of which include the BVI Red Cross Society and a number of service clubs and church organizations.

Cooperation with the region

Because BVI is mostly self-sufficient, cooperation with the rest of the Caribbean is for the most part relatively limited. However, BVI is an associate member of CARICOM and OECS, as well as a member of CDEMA, CMO–CIMH and CDB. It is currently involved in R3I, and in the Comprehensive Disaster Management Harmonized Implementation Programme. Funding for this programme comes from CIDA and DFID and is under joint CDEMA/OECS coordination.

The Cayman Islands



The Cayman Islands is a British OCT situated in the western Caribbean, just south of Cuba.

Size: 264 square kilometres;

Population: 60 456;

GDP per capita (PPP): US\$ 43 800 (2004 estimation);

GDP per sector: Agriculture: 1.4 per cent; industry: 3.2 per cent; services: 95.4 per cent.

Economy and finances

The economy is mostly based on offshore banking and luxury tourism. Tourism alone accounts for approximately 70 per cent of GDP and 75 per cent of foreign currency earnings.

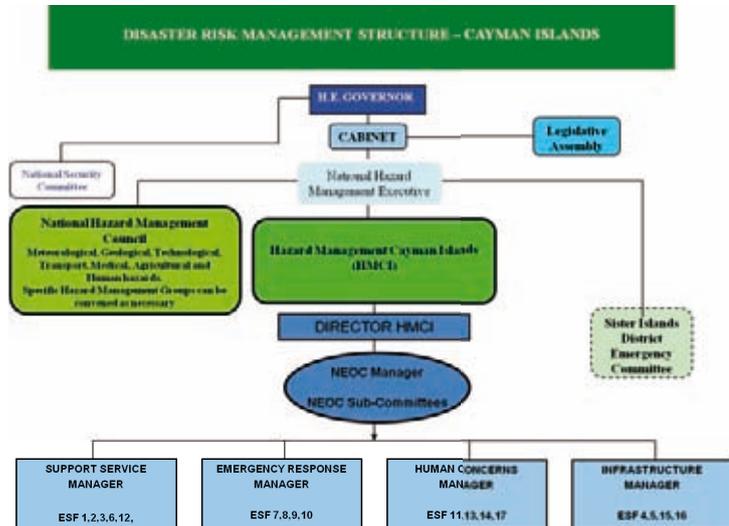
About 90 per cent of the territory's food and consumer goods must be imported. The Cayman Islands enjoys one of the highest standards of living in the world.

Vulnerability to natural hazards

The islands are at risk of hurricanes, tropical storms and earthquakes. In 2008, the territory was severely affected by Hurricane *Paloma*, which damaged several houses and some tourist resorts, and in 2004, Hurricane *Ivan* directly affected the Cayman Islands and caused two casualties as well as considerable damage to buildings and infrastructure. Other recent hurricanes that hit the islands were *Dean* (2007), *Michelle* (2001), *Gilbert* (1988) and *Katrina* (1981). In December 2004, an earthquake of 6.7 on the Richter scale occurred, though without causing significant damage.

Institutional arrangements for DRM

The HMCI is the responsible agency for coordination between the relevant DRM agencies (see Figure). This agency is responsible for the National Emergency Operations Center (NEOC) which is located at the fire station in George Town. The NEOC is activated to direct and coordinate the response to national threats. The National Hazard Management plans for threats, such as hurricanes and earthquakes, are also the responsibility of HMCI. Many disaster reduction and preparedness activities and actions have been developed in recent years, including a regular revision and development of legislation related to risk reduction, modernization of the construction code, and evaluation of existing buildings. The National Hurricane Plan is reviewed and updated regularly.



Meteorological and hydrological services and capacities

The Cayman Islands is the only British OCT that has its own Meteorological Office. This has the overall responsibility for hazard monitoring and forecasting, and maintains two human observation sites as well as 12 AWSs. There is a good national EWS in place that is operated by the NMS.

Other stakeholders

In the Cayman Islands, NGOs, private companies and government agencies are not legally mandated but are required under the National Disaster Plan to undertake public functions in the event of disastrous events. However, HMCI has an MOU with NGOs, private and public companies such as the Cayman Islands Red Cross, the police, construction companies, and the like, to provide specific services during a disaster. The EU has a history of funding projects and recovery efforts on the Cayman Islands.

Cooperation with the region

The Cayman Islands OCT is an associate member of CARICOM and a member of CMO–CIMH and CDB. Though it is not part of CDEMA, it has offered training services in WebEOC, a data management system, to other countries in the region. The territory is also part of R3I and is involved in CCRIF, the Regional Disaster Risk Management for Sustainable Tourism in the Caribbean, and the Regional Weather Radar Warning System funded by the EU.

Cuba



Cuba is the largest country in the Caribbean, situated 145 kilometres south of Florida.

Size: 109 886 square kilometres;

Population: 11 451 652 (2010 estimation);

GDP per capita (PPP): US\$ 9 700 (2009 estimation);

GDP per sector: Agriculture: 4.3 per cent; industry: 21.6 per cent; services: 74 per cent.

Economy and finances

The Government of Cuba has recently initiated a number of reforms to reduce government spending, increase economic efficiency and stimulate private-sector initiatives. The country remains affected by the United States economic embargo and has limited access to consumer goods.

Vulnerability to natural hazards

Cuba has a high exposure to natural and technological hazards. In the last ten years, the country has been affected by 20 cyclonic events, 14 of them reaching the hurricane level, of which seven caused severe damage. Droughts, forest fires and marine pollution are all cited as major concerns. Earthquakes, although these have not been severe in recent history, are high on the priority list of the authorities for at least part of the country. Cuba boasts a high level of community preparedness, which has proven effective in sharply reducing the mortality rate caused by natural hazards.

Institutional arrangements for DRM

The Cuba National Civil Defense, since its creation in 1962, is the agency responsible for DRM. It is a powerful body closely linked to and supported by the highest authorities. It exercises considerable and direct authority on all private and state resources. Its scope of authority is broad and includes the implementation of long-term DRR measures. All external assistance projects in DRR are coordinated by the National Civil Defense. Cuba has a strong policy of self-reliance and maintains important stocks of material and resources at national and local level for immediate response to disasters. It decentralized, for example, the electricity network to reduce its vulnerability. Disaster preparedness is an integral part of the educational curriculum (from primary school to postgraduate education). Cuba is also one of the few countries with an academic two-year programme leading to a master's degree in disaster management.

Meteorological and hydrological services and capacities

The main office of the NMS is on the same site as the Hydrological Institution, located nearby to the DRM agency. Overall staff amount to 1 200, distributed over the country. Each province has its own forecasting office with capacities including radar and regional Websites.

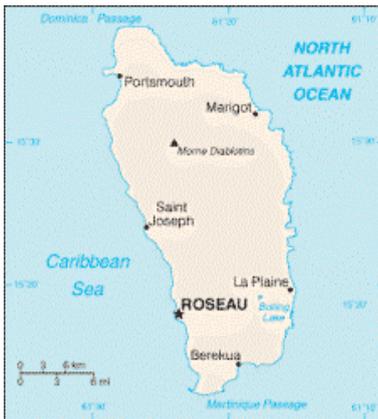
Other stakeholders

The Cuba Red Cross is involved in community education prior to the disaster and in welfare assistance as and when requested by the National Civil Defence. Cuba has partnerships with UNICEF and WHO through its Latin American Center for Disaster Medicine (CLAMED). In Cuba, the Medical Brigades trained by CLAMED are an important actor in disaster response and operate nationally as well as internationally.

Cooperation with the region

Cuba is only a member of one regional organization, this being ACS. In part due to the country's economic isolation, there is only limited bilateral coordination on prevention and preparedness with other countries or territories in the region. Cuba regularly organizes an international congress on DRM on its territory and the country is very active in providing disaster response to neighbouring countries, primarily in the form of medical support. At the same time, Cuba benefits from a number of international projects supported by various United Nations agencies present on the island (UNDP, UNICEF, Food and Agricultural Organization of the United Nations (FAO), and others).

Dominica



Dominica is an island State in the Lesser Antilles.

Size: 754 square kilometres;

Population: 72 660 (2010 estimation);

GDP per capita (PPP): US\$ 10 200 (2009 estimation);

GDP per sector: Agriculture: 17.7 per cent; industry: 32.8 per cent; services: 49.5 per cent.

Economy and finances

Principal economic activities are fishing, forestry, tourism (hiking, cruise ships) and financial services. In 2003, the Government of Dominica began a comprehensive restructuring of the economy, including elimination of price controls, privatization of the state banana company and tax increases, to address the economic and financial crisis and to meet

International Monetary Fund (IMF) requirements.

Vulnerability to natural hazards

Dominica is at risk from a number of natural hazards, including tropical cyclones, flash floods, coastal flooding, river flooding, landslides and droughts. Recent major disasters include Hurricane *Dean* (2007), which caused damage equivalent to 20 per cent of the country's GDP.

Institutional arrangements for DRM

The ODM is the government institution responsible for coordination of the Disaster Action Plan. The plan is reviewed every three years. The ODM reports to the Prime Minister's Office and has a staff of five people. The overall policy guiding emergency management is the 2006 Emergency Planning and Disaster Management Act, outlining the different stakeholders as well as their respective responsibilities in case a disaster occurs. The act also clearly describes the role and responsibilities of the NMS.

Meteorological and hydrological services and capacities

Dominica has an NMS, although this does not have any forecasting capacity, and depends on Barbados NMS for its forecasts and warnings. An office with observation capacity is located at each of the island's two airports. The main office is located at the international airport.

Other stakeholders

In addition to different ministries and national and local service providers, the Dominica Red Cross Society plays an important role in DRM. It has in the past received project funding from ECHO, USAID OFDA and CIDA. Most of the Red Cross projects are focused on the community level. The USAID OFDA office in Dominica, which also coordinates actions for Antigua and Barbuda, and Saint Vincent and the Grenadines, has been working on a long-term agricultural strategy that incorporates development and mitigation aspects. The ODM also receives technical assistance from JICA, with priorities indicated as being flood mitigation and warning systems. In the past, the World Bank has also been involved with assistance to projects.

Cooperation with the region

Dominica participates in ACS, CARICOM, OECS, CMO-CIMH, CDB and CDEMA, the latter being especially responsible for the coordination and funding of a large number of projects in the country.

The Dominican Republic



The Dominican Republic is the second largest Caribbean nation (after Cuba). It occupies the eastern part of the island of Hispaniola. Size: 48 442 square kilometres;
 Population: 9 650 054 (2010 estimation);
 GDP per capita (PPP): US\$ 8 300 (2009 estimation);
 GDP per sector: Agriculture: 11.7 per cent; industry: 21.6 per cent; services: 66.6 per cent.

Economy and finances

The Dominican Republic is the second largest economy in the Caribbean and is classified as an upper-middle-income developing country. In recent years, the country's service sector has overtaken agriculture as the economy's largest employer, due to growth in tourism and free-trade zones. The economy is largely dependent on the United States, which is the destination for nearly 60 per cent of exports. Remittances from the United States amount to approximately one tenth of GDP, equivalent to almost half of exports and three quarters of tourism receipts.

Vulnerability to natural hazards

The Dominican Republic is at a high risk of earthquakes, floods, damaging waves, storm surges and technological accidents. Recurrent tropical cyclones often bring very heavy rains, the damage from which amounts to 2–5 per cent of GDP every year. Most affected areas are along the northern coast and in the downstream catchments of the Yaque del Norte and Yuna rivers.

Institutional arrangements for DRM

The National Civil Defense is the responsible agency. It has some 200 permanent employees, out of which 36 are heads of provincial departments. Volunteer numbers amount to approximately 4 000. Permanence of staff is very good, and some of the volunteers remain engaged for 10–15 years. The Director of the National Civil Defence is also chair of the National Emergency Commission. The 2002 Law on Risk Management defines the role and tasks of the agency as well as the responsibilities of the different actors it encompasses. The law also describes the role of the NMHS.

Meteorological and hydrological services and capacities

The Dominican Republic has an NMS and an NHS. A hydrological advisor is also employed by the former. The NMS is ISO-certified for QMS. Both services are overseen by the General Directorate of Civil Aviation.

Other stakeholders

The Dominican Republic hosts a large number of international agencies, and many different donors are active in the country. The EU is funding a number of post-hurricane recovery programmes, the largest of which (a Partners in Population Development (PPD) project) is being executed by UNDP. The World Bank and IDB are also present, the first with the Disaster Recovery Program (US\$ 80 million) and a further programme for post-Hurricane *Noel* reconstruction (US\$ 5.5 million). A project financed by IDB at a level of US\$ 110 million is targeted at post-Hurricane *Jeanne* reconstruction. Another important donor in the Dominican Republic is the Spanish agency AECID. The National Civil Defense, NMS and NHS cooperate with a number of NGOs, including the Dominican Republic Red Cross Society.

Cooperation with the region

The Dominican Republic is part of ACS and OAS. As its neighbour, the country has a history of active support of Haiti.

French Guiana



French Guiana is a French overseas department situated on the north part of the South American continent. It has borders with two nations, Brazil to the east (following the Oyapok River) and south, and Suriname to the west (following the Maroni River).

Size: 83 534 square kilometres;

Population: 229 000 (2009 estimation), giving a very low population density of less than three inhabitants per square kilometre, almost half of which live in the urban area of Cayenne, the capital;

Nominal GDP: €3.2 billion (2008 estimation);

GDP per capita (PPP): €14 204 (2008 estimation).

Economy and finances

French Guiana is heavily dependent on mainland France for subsidies, trade, and goods. The main industries are fishing (accounting for three quarters of foreign exports), gold mining and timber. In addition, the Guiana Space Centre at Kourou accounts for 25 per cent of the country's GDP and employs about 1 700 people.

Vulnerability to natural hazards

French Guiana is not exposed to tropical cyclones. The main potential hazards are heavy rain and thunderstorms (from heavy storms or in conjunction with the proximity of the ITCZ) that may lead to slow-onset flooding and wide landslides.

Institutional arrangements for DRM

Civil protection in French Guiana is under the responsibility of the official representative (*Préfet*) of the French Government through SIDPC Guyane. The *Préfet* is also head of the defence and security zone which deals with disasters through the Etat-major interministériel de zone Guyane (EMIZG). Responsibilities for risk reduction, preparedness and response are widely distributed within the government at the appropriate level of management. French Guiana depends primarily on support from France in case of a major disaster. In such cases, EMIZG is the focal point.

Meteorological and hydrological services and capacities

The official institution responsible for meteorological activities and operations throughout the French West Indies and French Guiana is DIRAG. This institution is based in Martinique and has an operational base and forecasting centre in French Guiana located at the main airport (Rochambeau). Hydrology, DRR and related information is the responsibility of DEAL Guyane.

The French West Indies



The French West Indies is a grouping of French overseas departments and territorial communities, composed of Martinique, Guadeloupe, Saint Martin and Saint Barthélemy.

Size (square kilometres): 1 128 (Martinique); 1 628 (Guadeloupe); 53.2 (Saint Martin); 21 (Saint Barthélemy);
Population: 397 730 (Martinique); 405 500 (Guadeloupe); 35 925 (Saint Martin); 7 448 (Saint Barthélemy);

GDP per capita (PPP): €19 607 (2008 estimation) (Martinique); US\$ 21 780 (2006 estimation) (Guadeloupe); US\$ 20 600 (2007 estimation) (Saint Martin); US\$ 37 000 (2007 estimation) (Saint Barthélemy);

GDP per sector: Agriculture: 15 per cent; industry: 17 per cent; services: 68 per cent.

Economy and finances

The economy is principally oriented toward the tourism industry, with most tourists arriving from France. Most manufactured goods need to be imported, though agriculture remains a relatively large sector, especially in Guadeloupe and Martinique. Main goods are tropical produce such as sugar cane and bananas, which are mainly for export.

Vulnerability to natural hazards

The main natural hazards are cyclones, floods, landslides, earthquakes, tsunamis and volcanic eruptions. Marine pollution is a concern addressed through joint planning and exercises among the islands, especially where fuel storages may form a potential threat. Recent disasters include the hurricanes *Hugo* (1989), *Luis* and *Marylin* (1995), *Jose* (1999), *Lenny* (1999), *Dean* (2007) and *Omar* (2008), all of which had an impact on one or more of the islands. Flash floods are common on Martinique and Guadeloupe, as are earthquakes.

Institutional arrangements for DRM

The French West Indies are part of the French West Indies Defence Zone under the command of the Préfet de zone de défense et de sécurité (that is, the official representative of the French Government) based in Martinique. Though Saint Martin and Saint Barthélemy have become autonomous communities and have gained some autonomy in DRM, they are still under the responsibility of the French Préfet. Their status also means that emergency assistance from France has to be requested, and that the islands themselves are financially responsible. Responsibilities for DRR, preparedness and response are widely distributed within the government. All the islands depend primarily on support from France in case of a major disaster.

Meteorological and hydrological services and capacities

The Direction interrégionale Antilles-Guyane (DIRAG) of Météo-France is the official institution responsible for meteorological activities and operations throughout the French islands and French Guiana. The institution is based in Martinique and has operational bases and forecasting centres throughout the territory. The meteorological service of Guadeloupe also supports the DRM agency in Saint Martin. Hydrology, DRR and related information is the responsibility of DEAL, which has offices in Martinique and Guadeloupe.

Cooperation with the region

The French West Indies have associate membership of ACS and, at least in the case of Guadeloupe, observer status in a number of CARIFORUM commissions. The islands have a degree of external involvement through the management of the Interreg IV process. Martinique and Guadeloupe have the largest response capacity and have in the past been very active with emergency interventions, in particular in Haiti and Grenada, following Hurricane *Ivan*, and in Haiti after the 2010 earthquake.

Grenada



Grenada is an independent country situated in the Lesser Antilles.
 Size: 344 square kilometres;
 Population: 90 739 (2010 estimation);
 GDP per capita (PPP): US\$ 10 300 (2009 estimation);
 GDP per sector: Agriculture: 5.4 per cent; industry: 18 per cent; services: 76.6 per cent.

Economy and finances

Strong performances in construction and manufacturing, together with the development of tourism and an offshore financial industry, have in recent years been the driving force behind growth in national output. The country's main source of foreign exchange is tourism. The public debt to GDP ratio is nearly 110 per cent, mostly due to the recent high costs of post-hurricane reconstruction.

Vulnerability to natural hazards

A variety of natural hazards effect Grenada, including tropical cyclones and related events, floods, droughts, fires and landslides. Grenada was directly hit by Hurricane *Ivan* in 2004 (causing US\$ 1 billion in damage and 44 deaths) and in the following year by Hurricane *Emily*.

Institutional arrangements for DRM

The NaDMA is the responsible government institution, reporting directly to the Prime Minister's Office. The institution has 12 staff, though not all are professionals. Its functions and structure are defined through the National Disaster Plan and the Emergency Powers Act. There is no legislation governing NaDMA, and the country does not currently have a hazard mitigation plan. The islands are divided into 17 districts that each have a responsible District Disaster Committee.

Meteorological and hydrological services and capacities

The NMHS is an integral part of the National Emergency Advisory Council and provides warnings for floods, droughts and other weather-related events. Advisories and warnings are disseminated by NMHS to NaDMA and the media via telephone, fax and live broadcasting. Relevant agencies are then informed by NaDMA. The NMHS and EWS is financed primarily by the Grenada Airport Authority. The NMHS has also received support from CMO and the World Bank for the development of the country's observation and communication network. The country receives support from Trinidad in terms of regional coordination for tropical cyclones. Grenada is not a member of WMO.

Other stakeholders

The NaDMA and Grenada Red Cross Society work closely together, the latter receiving project funding from different donors, including CIDA, ECHO and USAID OFDA. All projects are aimed at the community level. Other donors active in Grenada include the Japan Social Development Fund and the World Bank. The UNDP is also involved in projects, at least one of which is being implemented by the Agency for Rural Transformation, a Grenadian NGO working on disaster preparedness. Technical assistance was provided by PAHO to Grenada for the drafting of a National Health Sector Disaster Management Plan in 2006.

Cooperation with the region

Grenada is a member of ACS, OAS, CARICOM, OECS, CDEMA, CMO-CIMH and CDB. It has a close relation with CDEMA, which has been involved in numerous projects in the country.

Guyana



Guyana is an independent country bordering Venezuela, Brazil and Suriname.

Size: 214 969 square kilometres;

Population: 752 940 (2010 estimation);

GDP per capita (PPP): US\$ 6 500 (2009 estimation);

GDP per sector: Agriculture: 25 per cent; industry: 24 per cent; services: 51 per cent.

Economy and finances

The Guyanese economy is largely dependent upon the export of six commodities – sugar, gold, bauxite, shrimp, timber and rice – which together represent nearly 60 per cent of the country's GDP. The country's entrance into the CARICOM Single Market and Economy in

January 2006 has broadened the country's export market, primarily in the raw materials sector. Ninety per cent of the population and about 80 per cent of GDP are concentrated in the country's coastal area.

Vulnerability to natural hazards

Guyana is not exposed to hurricanes and tropical cyclones, though floods as a consequence of heavy storms and coastal inundation do occur, mostly in the country's densely populated, low-lying coastal region. Other hazards include salt intrusion and drought, urban and forest fires, oil spills and industrial hazards, and seismic or tsunami hazards. The last earthquake, with an epicentre 190 kilometres offshore from Georgetown, occurred in November 2008 and caused only limited damage.

Institutional arrangements for DRM

The CDC, established in 1985, is the responsible agency. It currently falls under the responsibilities of the Office of the President and employs about 15 permanent staff. In case of an emergency, CDC relies on the direct involvement of the country's military forces. The agency has developed a number of priorities, including the improvement of the national EWS, consultation at the central and community level, reinforcement of the existing legal framework and internal organization, provision of personnel training and of technical staff, coordination with external bodies for disaster prevention and relief operations, and the like.

Meteorological and hydrological services and capacities

There is a single NMHS that is responsible for monitoring, forecasting and warning for the CDC, while other technical agencies are in charge of dissemination and communication, preparedness and response, and knowledge transfer. There is no MHEWS and there are no criteria-based SOPs for warnings.

Other stakeholders

The PAHO is an active DRM supporter in Guyana, in close cooperation with the Ministry of Health. A number of projects are being coordinated by UNDP in cooperation with CDC, including a study on EWSs executed by the Guyana Lands and Surveys Commission. Donors include CIDA, UNDP, CDEMA, USAID, USAID OFDA, United States Southern Command, JICA and IDB.

Cooperation with the region

Guyana hosts the secretariat of CARICOM and is also a member of ACS, OAS, CDEMA, CMO-CIMH and CDB.

Haiti



Haiti is an independent country situated on the island of Hispaniola, to the west of the Dominican Republic.

Size: 27 750 kilometres;

Population: 9 035 536;

GDP per capita (PPP): US\$ 1 300 (2009 estimation);

GDP per sector: Agriculture: 28 per cent; industry: 20 per cent; services: 52 per cent.

Economy and finances

Haiti is the poorest country in the region, with 80 per cent of the population living under the poverty line. Two thirds of all Haitians depend on the agricultural sector, mainly small-scale subsistence farming, and remain vulnerable to damage from frequent natural disasters, exacerbated by the country's widespread deforestation. The government relies on formal international economic assistance for fiscal sustainability.

Vulnerability to natural hazards

Owing to its geographical position in an area prone to tropical cyclones, its high agricultural dependency, and the level of deforestation and general erosion, Haiti is very vulnerable to damage caused by meteorological, hydrological and climate-related hazards. This vulnerability is further exacerbated by poverty in the country, a continuous state of complex emergency and overall environmental degradation. The hazards that have the highest impact in terms of loss of life, number of people affected and economic losses are floods, hurricanes or tropical storms, landslides or mudslides, earthquakes and droughts. Among the most significant recent events is the combined impact from tropical storms *Fay* and *Gustav* (2008) and hurricanes *Hanna* and *Ike* (2008), which together caused the deaths of 793 people, the destruction of 112 000 homes, and damage to agriculture and road infrastructure to the extent of 15 per cent of GDP.

Institutional arrangements for DRM

Following Hurricane *Georges* in 1998, Haiti developed a National Disaster and Risk Management Plan which established the DRM agency, the Permanent Secretariat for Risks and Disasters Management (SPGRD). The agency brings together a network of participating institutions with functions and responsibilities in risk management. The NMS is an important part of this network, and its Director acts as one of the focal points of the SPGRD. The Secretariat was further strengthened after Hurricane *Jeanne* and the 2008 hurricane season.

Meteorological and hydrological services and capacities

The NMS is located at the Port-au-Prince airport. With 22 personnel, the institute is relatively well staffed compared to other islands in the region. The service's infrastructure was severely damaged by the earthquake of January 2010. Reliability of the telecommunications system is reported to be an issue, and access to the Internet is limited. The NMS does not have real-time observation capacity or the essential raw data and information needed for the production of early warnings for meteorological, hydrological and climate-related hazards, forecasts and other operational products and services.

Other stakeholders

A long list of government institutions, international organizations and NGO's are active in Haiti, and many of them take part in DRR activities. The Finnish Development Agency has in the past donated two AWSs,

and the EU has funded a project with the National Geospatial Information Centre, under which 10 automatic meteorological stations were about to be delivered to the NMS just before the 2010 earthquake. The United Nations is present first and foremost through the United Nations Stabilization Mission in Haiti (MINUSTAH), which has considerable capacity for emergency response. As a result of the 2010 earthquake, the overall force levels of MINUSTAH to support the immediate recovery, reconstruction and stability efforts in the country were increased.

Cooperation with the region

Haiti is a member of ACS, OAS, CARICOM, CDEMA and CDB.

Jamaica



Jamaica is an island nation located to the south of Cuba.
 Size: 10 991 square kilometres;
 Population: 2 825 928;
 GDP per capita (PPP): US\$ 8 400 (2009 estimation);
 GDP per sector: Agriculture: 6 per cent; industry: 30.1 per cent;
 services: 63.9 per cent.

Economy and finances

The country derives most of its foreign exchange from tourism, remittances, and bauxite/aluminium. Remittances account for nearly 20 per cent of GDP, but have declined 15 per cent since the onset of the global recession. Revenues from tourism account for 20 per cent of GDP. Public debt amounts to more than 120 per cent of GDP, and is one of the highest in the world.

Vulnerability to natural hazards

Hurricanes and tropical storms constitute the most immediate and recurrent threat, including related hazards such as flooding and landslides. The island also experiences periodic drought, such as in 2000, when crop and livestock losses amounted to US\$ 125 million. Jamaica is also notable for its seismic activity, with major historical earthquakes in 1958 and 1993. Landslides related to earthquakes have in the past resulted in deaths and damaged transportation infrastructure. In spite of this high vulnerability, major negative impacts are limited, thanks to the relatively advanced level of preparedness and response capacity.

Institutional arrangements for DRM

The responsible government institution is ODPEM. It is headed by a management board directly appointed by the Prime Minister, which in turn appoints the agency's Director General. The agency consists of five divisions: the Corporate Services Division, the Information and Training Division, the Mitigation, Planning and Research Division, the Preparedness and Emergency Operations Division, the Projects Implementation, Development and Monitoring Division. The actions of ODPEM are in compliance with the Jamaica National Disaster Plan of Action, which is a detailed reference document to cope with the effects of natural and/or man-made disasters. This plan also defines the responsibilities for coordination of emergency situations. The Comprehensive Disaster Management Strategy drafted by CDEMA has been adopted by ODPEM. The legislative and policy framework consists of the 1993 Disaster Preparedness and Emergency Management Act, and the 2001 Hazard Mitigation Policy.

Meteorological and hydrological services and capacities

The NMHS is part of the DRM structure through the National Emergency Organization, which combines the different organizations and agencies involved. The NMS forecasts weather and also issues bulletins and news broadcasts twice daily. The Water Resources Authority collects hydrological data and is responsible for DRM issues that concern risks related to droughts or flooding. The Water Resources Authority supports ODPEM by providing systems for monitoring, archiving and disseminating data on key hazards. All major hazards have EWSs in place. They are funded directly by the Government of Jamaica and through bilateral assistance from international donors.

Other stakeholders

Service providers and NGOs (including the Jamaica Red Cross Society) collaborate with ODPEM through the National Emergency Organization. Other important actors are the Disaster Preparedness Centre, the

Jamaica Military Service and the Flood Preparedness Resource Centre. Active donors in the country include the EU, USAID, CIDA, IDB, UNDP and the World Bank. In particular, UNDP is involved in a large number of projects in Jamaica, for example in its support for the development of local vulnerability and risk assessments.

Cooperation with the region

Jamaica takes part in ACS, OAS, CARICOM, CDEMA, CMO-CIMH and CDB. The island is mostly self-sufficient and possesses significant DRM capacity and resources that could also be useful for other islands in the region. Jamaica played an important logistical role in the international relief operation following the 2010 earthquake in Haiti.

Montserrat



Montserrat is a British OCT located in the Lesser Antilles.

Size: 102 square kilometres;

Population: 5 097;

GDP per capita (PPP): US\$ 3 400 (2002 estimation);

GDP per sector: Agriculture: 1.2 per cent; industry: 23.1 per cent; services: 75.7 per cent.

Economy and finances

Montserrat has one of the lowest GDP per capita in the region. The island's economy was severely affected by Hurricane *Hugo* (1989) and by the eruption of the Soufriere Hills Volcano (1995 and 1997), which entirely destroyed the island's capital. As a result, economic activities have been reduced to the selling and shipping of aggregate for construction. Life on Montserrat depends on external assistance and imports of goods for sale on the island. The United Kingdom has launched a three-year aid programme of US\$ 122.8 million to help reconstruct the economy. Half of the island is expected to remain uninhabitable for another decade.

Vulnerability to natural hazards

Montserrat is a unique case in the Caribbean because its largest natural hazard continues to be volcanic activity. Other major hazards are seismic activity, hurricanes, tropical storms, landslides (in the uninhabited zone) and inland localized flooding. The eruption of the Soufriere Hills Volcano of June 1997 killed 19 people, and caused the capital to be evacuated and ultimately abandoned. The entire southern half of the island was devastated and designated as an exclusion zone. About two thirds of the population of 11 000 was forced to relocate to the northern half of the island, to other eastern Caribbean nations, the United Kingdom or the United States. The collapse of the lava dome on 12 July 2003 was the largest event in the entire eruption. It produced major pyroclastic flows that entered the sea, a pyroclastic surge that covered the north-eastern flank of the volcano, a tsunami that reached Guadeloupe and a series of large explosions.

Institutional arrangements of DRM

The government agency responsible for DRM is DMCA, which is part of the Governor's Office and plays a coordination role when a natural hazard occurs. The staff of DMCA amounts to eight people and additional volunteers. The agency has developed and implemented three different plans: the National Disaster Plan, the Hurricanes Plan and the Volcano Plan. These plans are evaluated each year to adjust them to the current situation. The legal framework consists of the Disaster Preparedness and Response Act. The DRM framework is based on the CDEMA model and adjusted to the specific needs of Montserrat.

Meteorological and hydrological services and capacities

There is no real meteorological office. Meteorological services are provided by the airport authorities, and by Antigua NMHS. The airport has the authority to issue warnings on all meteorological hazards including flash floods, strong winds, thunderstorms, tropical cyclones, storm surges, coastal flooding, heat waves, marine hazards, and hydrometeorological hazards to aviation. The Montserrat Volcano Observatory issues warnings on seismic and volcanic hazards.

Other stakeholders

Expert technical and financial assistance is provided by DFID, the EU and CARICOM; local Red Cross Societies are active partners of DMCA.

Cooperation with the region

Montserrat is a member of CARICOM, OECS, CDEMA, CMO-CIMH and CDB.

The Netherlands Antilles



The Netherlands Antilles was a Dutch OCT consisting of five islands: two situated just off the Venezuelan coast, Curaçao and Bonaire, and three forming part of the Leeward Islands, Saba, Sint Eustatius and Sint Maarten. The Netherlands Antilles was dissolved on 10 October 2010. Curaçao and Sint Maarten gained more autonomy within the Kingdom of the Netherlands and became a political entity similar to Aruba. Bonaire, Saba, and Sint Eustatius became part of the Netherlands. This recent change in political status is expected to affect the DRM structure on the islands.

Size: 800 square kilometres;
 Population: 227 049 (2010 estimation);
 GDP per capita (PPP): US\$ 16 000 (2004 estimation);
 GDP per sector: Agriculture: 1 per cent; industry: 15 per cent; services: 84 per cent.

Economy and finances

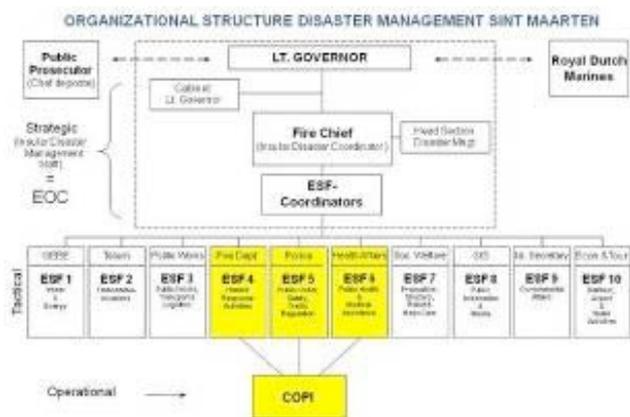
Curaçao is the largest and most populated island of the former Netherlands Antilles, and therefore also has the most extensive economic infrastructure. As on all the islands, tourism is one of the main economic activities. Curaçao also has a large petroleum refinery, which is owned by the Venezuelan State Oil Company, and, together with Bonaire and Sint Eustatius, serves as a major oil transportation hub. The islands also function as an offshore financial centre. The Netherlands Antilles received economic support from the Netherlands.

Vulnerability to natural hazards

All the islands are at risk from hurricanes and tropical storms, floods and tsunamis, and droughts. By their location, however, Sint Maarten, Saba and Sint Eustatius are considerably more exposed to tropical cyclones than the other islands. Earthquakes and indirect volcanic activity are considered to be of secondary importance. Curaçao, Sint Eustatius and Bonaire are also at risk from oil spills. Past disasters include hurricanes *Omar* (2008), *Felix* (2007), *Lenny* (1999), *Georges* (1998), *Marilyn* (1995) and *Luis* (1995).

Institutional arrangements for DRM

All the islands have a similar DRM structure (see Figure). The Lieutenant Governor is currently in charge of DRM for the entire territory, while the local fire department chief acts as Island Disaster Coordinator. A model Island Ordinance on Disaster Management is in place in the different islands and contains rules and regulations about preparations for and management of disasters, and responsibilities of the island territories. The ordinance also details the tasks of the Executive Office (working mostly on preparedness) and of the Lieutenant Governor, who is in supreme command of disaster operations. As of 10 October 2010, the corresponding Prime Minister is in supreme command of disaster operations for Curaçao and Sint Maarten. The DRM structure consists of an operational level, a tactical level (emergency support functions) and a strategic level (coordinated by the Emergency Coordination Centre). The Disaster Coordinator is charged with operational coordination of disaster management preparation. A Disaster Board that includes representatives from the nine Emergency Support Functions (ESFs) advises the Prime Minister/Lieutenant Governor. The nine ESFs prepare and coordinate plans and procedures, and manage the training and practices within their particular fields.



Meteorological and hydrological services and capacities

The MDC is mandated by law to provide warnings for tropical cyclones, severe weather or geophysical phenomena. It also plays an advisory role in the local disaster management organizations on the different islands. Sint Maarten alone possesses a siren warning system, which, in addition to radio and other media, can be activated in case of a hazard. The other islands use e-mail, the Internet, radio and other media. In addition, there are plans to provide warning by SMS. The only island that has produced hazard-risk maps is Sint Maarten.

Other stakeholders

The Red Cross is a full part of the Disaster Board that advises the Lieutenant Governor. Curaçao has a United States Southern Command operations base on its island and holds one of the main naval installations for the Royal Navy of the Netherlands in the Caribbean Sea. Both bases have considerable resources. The Royal Dutch Marines can be deployed in case of disaster through a request of the Lieutenant Governor. The Government of the Netherlands is an active stakeholder and provides direct support through courses and technical training.

Cooperation with the region

The Netherlands Antilles was an associate member of ACS. Interaction of the Dutch islands with the anglophone Caribbean is mostly formal. While DRM activities are generally self-financed with Dutch support, financing in the past has been limited. The islands are part of R3I.

Saint Kitts and Nevis



Saint Kitts and Nevis is a federal two-island nation in the Lesser Antilles.

Size: 168 square kilometres;

Population: 40 131 (2010 estimation);

GDP per capita (PPP): US\$ 14 700 (2009 estimation);

GDP per sector: Agriculture: 3.5 per cent; industry: 25.8 per cent; services: 70.7 per cent.

Economy and finance

The country's principal economic activities are agriculture, tourism and light manufacturing. The government has been working to diversify the economy and develop the tourist industry as well as the financial sector, but it is constrained by a high public debt burden equivalent to roughly 185 per cent of GDP, largely attributable to public enterprise losses.

Vulnerability to natural hazards

Saint Kitts and Nevis is exposed to tropical cyclones and related hazards, as well as to heavy rain and damaging waves. The last hurricane to strike Saint Kitts was *Georges* in 1998.

Institutional arrangements for DRM

The responsible agency is Saint Kitts and Nevis NEMA, which is a department within the Ministry of National Security. The staff is composed of seven members in Saint Kitts and four in Nevis. Operations conducted by NEMA are part of the government annual budget. The agency has developed a National Disaster Plan, but this has not been updated since 1999. Work is currently being done on a new plan with the support of CDEMA, and will reflect the priorities and needs outlined in the CDEMA model, namely to provide information, to provide a minimum level of assistance if it is needed, and to provide resources and assistance if requirements are major. Due to the limited staff capacity, Saint Kitts and Nevis NEMA does not formulate or implement projects for risk reduction (prevention and mitigation). This responsibility lies with the Government Projects Division in the Ministry of National Security.

Meteorological and hydrological services and capacities

There is a weather-observation station situated at the airport in Saint Kitts and another at the airport in Nevis. Weather observation commenced in Saint Kitts on 19 March 1971 and in Nevis on 1 April 1999. The office hours coincide with the airport's standard operational hours of 6 a.m.–9 p.m. daily. The Antigua NMS is charged with the responsibility of providing daily forecasts and the relevant tropical cyclone watches and warnings for Saint Kitts and Nevis. It is not a member of WMO.

Other stakeholders

The Saint Kitts and Nevis Red Cross Society and NEMA work closely together to coordinate actions funded by donors, for example in a project funded by USAID OFDA and the American Red Cross on DRM education in schools. The focus of IFRC projects is mainly on capacity building at the community level, creating disaster committees in districts, and the like. The agencies CDEMA and USAID OFDA are frequently involved with technical assistance to projects. The Ministry of Health, Social and Community Development maintains a close relation with PAHO. Both address directly all issues related to disasters. The health DRR projects aim to create capacities to reduce the vulnerability of the population and increase the sector's preparedness. Projects are funded through PAHO.

Cooperation with the region

Saint Kitts and Nevis is a member of ACS, OAS, CARICOM, OECS, CDEMA, CMO–CIMH and CDB. Annual meetings are held with Saint Lucia, Saint Vincent and the Grenadines, Grenada, Dominica, Antigua and Barbuda, Montserrat, Anguilla and the British Virgin Islands to exchange experiences in good practices and analyze DRR issues, as part of the OECS framework.

Saint Lucia



Saint Lucia is an island nation located in the Lesser Antilles.

Size: 616 square kilometres;

Population: 173 765;

GDP per capita (PPP): US\$ 10 900 (2009 estimation);

GDP per sector: Agriculture: 5 per cent; industry: 15 per cent; services: 80 per cent

Economy and finances

The principal economic activities of Saint Lucia are agriculture (mostly the production of bananas), tourism and light manufacturing industries. The country has been able to attract foreign business and investment, especially in its offshore banking and tourism industries, with a surge in foreign direct investment in 2006, attributed to the construction of several tourism projects. Although crops such as bananas, mangos and avocados continue to be grown for export, tourism provides the main source of income and is the island's biggest employer. Tourism is the main source of foreign exchange, although tourism sector revenues declined with the global economic downturn as United States and European travel dropped in 2009.

Vulnerability to natural hazards

Saint Lucia shares much of the hazards of the rest of the islands of the Lesser Antilles, namely hurricanes and tropical cyclones, river and coastal flooding, landslides, droughts, earthquakes and tsunamis.

Institutional arrangements for DRM

The government institution in charge of DRM is the country's NEMO. It forms a part of the Office of the Prime Minister, and is composed of a staff of five, of which three are professionals. The organization developed a Saint Lucia National Emergency Plan that was approved in 2007. For this it worked closely with the World Bank and OECS. The organization is currently drafting a five-year institutional plan with the technical assistance of CDEMA. The relevant legislative framework is made up of the 2006 Disaster Management Act and the 1995 Emergency Powers (Disasters) Act. The Disaster Management Act provides for an MHEWS. The structure of Saint Lucia NEMO is divided up into District Disaster Committees, a National Emergency Management Advisory Committee and a Secretariat.

Meteorological and hydrological services and capacities

The Saint Lucia NMS has three offices, of which two are at the country's airports and the third, main office is located in a government building in the capital. The forecasting office is at the international airport. The Director takes part in NEMO committees and is responsible for activities pertaining to meteorological hazards, droughts and tsunamis. The primary role of the country's NMS within the DRM structure is to give advice and provide information. An EWS is in place and dissemination takes place via radio, e-mail and SMS. In case of disaster, the monitoring agency is responsible for contacting NEMO directly. Hydrology is under the responsibility of the Water Resources Management Agency, which works in close collaboration with Saint Lucia NMS.

Other stakeholders

The Saint Lucia Red Cross Society works closely with NEMO, and has a legal mandate that defines its role in DRM. Funds for national projects and initiatives are received through IFRC. Funding is provided mainly through ECHO and USAID OFDA. The Government of Saint Lucia is also financing a number of IFRC programmes and projects directly.

Cooperation with the region

Saint Lucia is a member of ACS, OAS, CARICOM, OECS, CDEMA, CMO-CIMH and CDB.

Saint Vincent and the Grenadines



Saint Vincent and the Grenadines is a nation located in the Lesser Antilles, composed of the main island of Saint Vincent and the northern two thirds of a grouping of smaller islands (the Grenadines).

Size: 389 square kilometres;

Population: 104 574 (2010 estimation);

GDP per capita (PPP): US\$ 10 200 (2009 estimation);

GDP per sector: Agriculture: 10 per cent; industry: 26 per cent; services: 64 per cent.

Economy and finances

The country's economic activities are agriculture (mostly bananas and other exotic fruits), light manufacturing industries and tourism. The government's ability to invest in social programmes and respond to external shocks is constrained by its high debt burden. Approximately 25 per cent of current revenues are directed towards debt servicing. Nevertheless, the current administration is investing in infrastructure projects to boost the tourism sector, including a new international airport that is expected to be completed in 2011.

Vulnerability to natural hazards

Saint Vincent and the Grenadines is vulnerable to flash floods, strong winds, thunderstorms and lightning, tropical cyclones, storm surges, coastal flooding, hydrological hazards to aviation and tsunamis.

Institutional arrangements for DRM

The responsible agency, NEMO, is part of the National Security Department of the Prime Minister's Office and employs 11 personnel, of whom three are professionals. The organization has developed a Disaster Management Plan for 2010–2012 that addresses all related topics on institutional objectives and action lines that fall under DRM. The plan was formulated and developed with technical assistance from CDEMA. Funding for operational aspects is channelled directly through the national budget. Currently, the focus is on addressing recurring hazards such as forest fires, water shortages, and the like. The organization also provides support to education projects aimed at training teachers in risk prevention.

Meteorological and hydrological services and capacities

The Meteorological Office of Saint Vincent and the Grenadines receives forecasting information from Barbados NMS. The primary role of the Meteorological Office is to give advice and provide information. There is one qualified forecaster and Saint Vincent and the Grenadines is not a member of WMO.

Other stakeholders

The NEMO cooperates closely with the Saint Vincent and Grenadines Red Cross Society, which focuses on community-level preparedness and awareness, especially in relation to landslides and fires.

Cooperation with the region

Saint Vincent and the Grenadines is part of ACS, OAS, CARICOM, OECS, CDEMA, ALBA, CMO-CIMH and CDB.

Suriname



Suriname is a country in South America bordering Guyana, Brazil and French Guiana. Suriname is located 5 degrees north of the Equator.

Size: 163 821 square kilometres;

Population: 481 267 (2009 estimation);

GDP per capita (PPP): US\$ 8 642 (2009 estimation);

GDP per sector: Agriculture: 11 per cent; industry: 24 per cent; services: 65 per cent.

Economy and finances

The country's economy is mostly dependent on the export of aluminium oxide, which accounts for 70 per cent of export earnings. Other export products include gold, crude oil, lumber, bananas and rice. The relationship of Suriname with the Netherlands remains important to the economy. The Netherlands gives annual financial assistance to programmes and projects to the extent of US\$ 30 million–US\$ 40 million.

Vulnerability to natural hazards

Being located just north of the Equator, Suriname is not subject to hurricanes and tropical cyclones. Potential hazards include floods (severe events occurred in 2006 and 2008), heavy rains and winds, epidemics, and man-made disasters of which oil and chemical spills pose the most significant risk. Floods are usually a consequence of heavy storms and are concentrated in coastal lands during the rainy seasons. Salt intrusion is also reported in the coastal areas, although to a lesser extent than Guyana. There is a low level of risk for seismic hazards.

Institutional arrangements of DRM

The NCCR is the responsible government agency. The agency is in the process of developing a comprehensive contingency plan for existing hazards, and is cooperating with other institutions and international organizations to implement a first hydrological early warning network, composed of five semi-automatic stations. The agency employs 10–12 people on a permanent basis.

Meteorological and hydrological services and capacities

The NMS employs approximately 100 permanent staff, most of whom are field observers. The overall observation network is composed of 45 stations, of which only five are AWSs with satellite transmission. The NMS does not dispose of a satellite receiver, so data are sent to NOAA and then retrieved by Internet. Hydrology is managed by the Ministry of Public Works Directorate of Civil Engineering Works, Hydraulic Research Division. No exchange of data seems to take place between this agency and the NMS, except in emergencies. No meteorological radars are actually installed in Suriname. The NMS does not currently make any significant contribution to disaster preparedness.

Other stakeholders

A number of international organizations and agencies are present in Suriname. The EC is funding a project, entitled Humanitarian Aid for People Affected by Floods in Suriname, through ECHO, and is also funding additional humanitarian operations under DIPECHO VI, with the cooperation of the Suriname Red Cross Society. The United Nations Office for the Coordination of Humanitarian Affairs, the Dutch Minister of Development Cooperation and the Bureau for Crisis Prevention and Recovery supported Suriname following the 2006 and 2008 floods. Other donors include IDB and CIDA.

Cooperation with the region

Cooperation with the Caribbean community is relatively limited. Suriname mostly relies on the Netherlands and the United States as its key partners. Suriname is, however, part of ACS, OAS, CARICOM and CDEMA.

Trinidad and Tobago



Trinidad and Tobago is a republic in the southern Caribbean, just off the Venezuelan coast.

Size: 5 131 square kilometres;

Population: 1 229 953 (2010 estimation);

GDP per capita (PPP): US\$ 21 300 (2009 estimation);

GDP per sector: Agriculture: 0.5 per cent; industry: 59.2 per cent; services: 40.3 per cent.

Economy and finances

Economic growth has mainly been fuelled by investments in liquified natural gas, petrochemicals, and steel. Additional petrochemical, aluminium and plastics projects are in various stages of planning. Trinidad and

Tobago is the leading Caribbean producer of oil and gas, and its economy is largely dependent upon these resources, but it also supplies manufactured goods, notably food products and beverages, as well as cement to the Caribbean region. Oil and gas account for about 40 per cent of GDP and 80 per cent of exports, but only 5 per cent of employment. The country is also a regional financial centre, and tourism is a growing sector, although it is not as important domestically as it is in many other Caribbean countries/territories. The economy benefits from a growing trade surplus.

Vulnerability to natural hazards

Due to its location, the country is less at risk from natural hazards than many of the other Caribbean islands. Trinidad and Tobago is vulnerable especially to earthquakes, flash floods and landslides. Industrial hazards and a risk of oil spills due to the large oil industry on the islands are perceived as considerable risks. The risk of seismic activity was illustrated in 2005 by an earthquake just west of the capital, though there was no major damage. Tobago is slightly more vulnerable to meteorological hazards than Trinidad.

Institutional arrangements for DRM

The responsible agencies are ODPM and the Tobago Emergency Management Agency, both of which report to the Ministry of National Security. For humanitarian relations, however, ODPM liaises with the Ministry of Health. The mandate of this organization is to "implement pro-active measures to mitigate the impact of all hazards that threaten the people of Trinidad and Tobago and provide effective response and recovery in the aftermath of a disaster. This will be achieved in collaboration with our local, regional and international partners." The agency has a full-time staff of 50 and receives its budget (approximately US\$ 5 million per year) from the central government.

Meteorological and hydrological services and capacities

The NMS of Trinidad and Tobago has approximately 60 employees. In Trinidad, it is divided over two sites near to the airport. The main administrative office accommodates the climate and rawinsonde sections, while the other office is responsible for observation and forecasting. The meteorological station in Tobago also has qualified observers. Trinidad and Tobago has the responsibility for warning coordination with Grenada and its dependencies with regard to tropical cyclones. The country also hosts the offices of CMO. The task of this organization is to coordinate the activities of the different meteorological organizations for the 16 CARICOM countries (RA IV of WMO).

Other stakeholders

A number of other organizations have regional offices in Trinidad and Tobago. The IFRC has an office in Port of Spain that is responsible for the coordination of activities between its offices in 13 Caribbean

countries. The IFRC is particularly active, and coordinates the ECHO-funded Caribbean Disaster Management Strategic Framework (CDMF) 2009–2014, for a global amount of US\$ 2 million, as well as minor projects for rebuilding livelihoods on different islands after major hurricanes. The UNDP is an active stakeholder, for example through the coordination of an EU/IDB-funded project for the implementation of a National Emergency Operation Centre on the island. The country also hosts the headquarters of ACS, which has DRM from natural hazards as one of its priorities.

Cooperation with the region

Trinidad and Tobago is a member of ACS, OAS, CARICOM, CDEMA, CMO–CIMH and CDB. Cooperation with the region is strong, particularly with the Dutch and British OCTs. The islands host a number of international and inter-Caribbean conferences each year. At the same time, the hazards affecting the country are slightly different than those menacing many of the other islands, and this is reflected by the country's differing priorities.

The Turks and Caicos Islands



The Turks and Caicos Islands is a British OCT situated north of the island of Hispaniola.

Size: 430 square kilometres;

Population: 22 942 (2010 estimation);

GDP per capita (PPP): US\$ 11 500 (2002 estimation);

GDP per sector: N/A.

Economy and finances

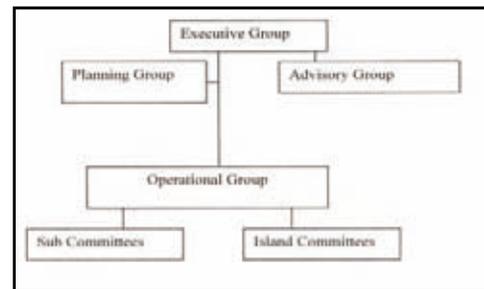
The economy of the Turks and Caicos Islands is based on tourism, offshore financial services and fishing. Most capital goods and food for domestic consumption are imported. The United States is the leading source of tourists, accounting for about three quarters of arrivals per year. Major sources of government revenue also include fees from offshore financial activities and customs receipts.

Vulnerability to natural hazards

The islands are exposed to various hazards and risks including tropical cyclones and related events (especially storm surge and damaging waves), floods and oil spills. The islands were affected by Hurricane *Donna* (1960) and Hurricane *Kate* (1985), Tropical Storm *Erin* (1995), Hurricane *Frances* (2004) and in 2008 by Tropical Storm *Hanna*, which caused several deaths and severe damage to the country's infrastructure.

Institutional arrangements for DRM

The DDME is the responsible government agency. Its main office is located in Grand Turk and it employs seven people. The DDME has developed a National Disaster Plan that is updated annually (see Figure for an outline of the main organization). Its priority actions include the retrofitting of houses and buildings, the development of a modern communications system and public information and education. For disaster recovery, a Recovery Task Force chaired by the Ministry of Finance has been established, as well as a Disaster Recovery Board that is chaired directly by the Governor. The DDME also established a Disaster Information Management Group, though it has currently no operative mechanism. The agency has been working to implement the CDEMA-drafted CDM strategy. The overarching legislative framework is set out in the Emergency Powers Ordinance and the Hurricane Relief Ordinance.



Meteorological and hydrological services and capacities

The Turks and Caicos Islands does not have an NMHS. Meteorological information is provided by the Bahamas NMS, which is mandated under a WMO agreement to provide the Turks and Caicos Islands DDME with hazard warning information. There is no EWS in place, and there is no public Website for forecasts and warning information.

Other stakeholders

The islands receive direct support from DFID. The UNDP and EC are present with, amongst others, R3I, and CIDA is another significant donor.

Cooperation with the region

The Turks and Caicos Islands is an associate member of ACS and CARICOM, and a member of CDEMA, CMO–CIMH and CDB. It is part of R3I and participates in CCRIF. Other current cooperation projects include the Regional Disaster Risk Management for Sustainable Tourism in the Caribbean (funded by IDB/CTO), Strengthening of the Search and Rescue Capability of the Caribbean Disaster Emergency Management Agency (funded by UNDP), and Social Policy, Monitoring and Evaluation for Children’s Rights (funded by UNICEF). There is also a project for water security at the regional level which involves Jamaica and Trinidad.

APPENDIX 3 – REFERENCES AND OTHER SUPPORTING DOCUMENTS

References not included in the tables of primary and secondary sources in Appendix 1, Tables 6–10

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- Enhancing Resilience to Reduce Vulnerability in the Caribbean, UNDP CIMH, <http://www.bb.undp.org/index.php?page=enhancing-resilience-to-reduce-vulnerability>.
- Fiftieth Session of the Caribbean Meteorological Council, George Town, Grand Cayman, Cayman Islands, 22–23 November 2010.

APPENDIX 4 – LIST OF ACRONYMS

ACP	African, Caribbean and Pacific Group of States
ACS	Association of Caribbean States
AECID	Agencia Española de Cooperación Internacional para el Desarrollo (Spain)
AgMP	Agricultural Meteorological Programme (WMO)
ALBA	Alternativa Bolivariana para las Américas
AMDAR	Aircraft Meteorological Data Relay
AMP	Applications of Meteorology Programme (WMO)
AREP	Atmospheric Research and Environment Programme (WMO)
AWS	automatic weather station
BCT	British Caribbean Territories
BVI	British Virgin Islands
CADM	Caribbean Disaster Management Project
CAFFG	Central American Flash Flood Guidance System
CAP	Common Alert Protocol (ITU)
CARDI	Caribbean Agriculture Research and Development Institute
Carib-HYCOS	Caribbean regional component of WHYCOS
CARICOM	Caribbean Community
CARIFORUM	Caribbean Forum (sub-group of ACP)
CARIWIN	Caribbean Water Initiative
CB	citizen band
CCCCC	Caribbean Community Climate Change Centre
CCRIF	Caribbean Catastrophe Risk Insurance Facility
CDB	Caribbean Development Bank
CDC	Civil Defence Commission (Guyana)
CDEMA	Caribbean Disaster Emergency Management Agency
CDERA	Caribbean Disaster Emergency Response Agency
CDM	Comprehensive Disaster Management (CDEMA)
CDMF	Caribbean Disaster Management Strategic Framework
CDPMN	Caribbean Drought and Precipitation Monitoring Network
CDRU	CARICOM Disaster Relief Unit
CEHI	Caribbean Environment Health Institute
CGMS	Coordination Group for Meteorological Satellites
CHAMP	Caribbean Hazard Mitigation Capacity Building Programme
CIDA	Canadian International Development Agency
CIMH	Caribbean Institute for Meteorology and Hydrology (CMO)
CMO	Caribbean Meteorological Organization
CNM	Centre national de météorologie (Haiti)
COE	Centro de Operaciones de Emergencias (Dominican Republic)
COMET	Cooperative Programme for Operational Meteorology, Education and Training
CRMI	Caribbean Risk Management Initiative
CTU	Caribbean Telecommunications Union
CTWC	Caribbean Tsunami Warning Centre (ICG/CARIBE EWS)
DDME	Department for Disaster Management and Emergency (Turks and Caicos Islands)
DEAL	Direction de l'environnement, de l'aménagement et du logement (France)
DEM	Department of Emergency Management (Barbados)
DFID	Department for International Development (United Kingdom)
DIPECHO	Humanitarian Aid Department (ECHO) Disaster Preparedness Programme (EC)
DIRAG	Direction interrégionale Antilles-Guyane (Météo-France)
DMA	Meteorological Department of Aruba
DMCA	Disaster Management Coordination Agency (Montserrat)
DMO	Disaster Management Organization (Aruba)

DOWASCO	Dominica Water and Sewerage Company Limited (Dominica)
DPC	Direction de la Protection civile (Haiti)
DRM	disaster risk management
DRR	disaster risk reduction
ECCU	Eastern Caribbean Currency Union
ECHO	Humanitarian Aid Department (EC)
ECLAC	Economic Commission for Latin America and the Caribbean
ECMWF	European Centre for Medium-Range Weather Forecasts
EMWIN	Emergency Managers Weather Information Network
EMZA	Etat-major de zone Antilles
EMIZG	Etat-major interministériel de zone Guyane
ENSO	El Niño Southern Oscillation
ERRVC	Enhancing Resilience to Reduce Vulnerability in the Caribbean
ETRP	Education and Training Programme (WMO)
EU	European Union
EWS	early warning system
FAO	Food and Agriculture Organization of the United Nations
FFGS	Flash Flood Guidance System
FMI	Finnish Meteorological Institute
FR OR	French outermost regions
FTP	File Transfer Protocol
GCOS	Global Climate Observing System
GDP	gross domestic product
GDPFS	Global Data-processing and Forecasting System
GEF	Global Environment Facility Project (World Bank)
GFS	Global Forecast System
GIS	Geographic Information System
GOES	Geostationary Satellite Server (NOAA)
GOOS	Global Ocean Observing System
GPC	Global Producing Centre
GTS	Global Telecommunication System
GTS-WIS	GTS-WMO Information System
HAZMAT	hazardous materials
HFA	Hyogo Framework for Action
HMCI	Hazard Management Cayman Islands
HOP	Hurricane Operational Plan (WMO RA IV Hurricane Committee)
HWRP	Hydrology and Water Resources Programme (WMO)
IAOS	Integrated Atmosphere Observing System
ICAO	International Civil Aviation Organization
ICG/CARIBE EWS	Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions
ICSU	International Council for Science
ICT	Information and Communication Technologies
IDB	Inter-American Development Bank
IDRC	International Development Research Centre (Canada)
IFRC	International Federation of Red Cross and Red Crescent Societies
INSMET	Instituto de Meteorologia (Cuba)
IOC	Intergovernmental Oceanographic Commission (UNESCO)
IPCC	Intergovernmental Panel on Climate Change
IRD	Institut de recherche pour le développement (France)
ISCS/WAFS	International Satellite Communication System/World Area Forecast System
ISO	International Organization for Standardization
IT	information technology
ITCZ	inter-tropical convergence zone
ITU	International Telecommunications Union
JICA	Japanese International Cooperation Agency
LIDAR	light detecting and ranging

MCI	mass casualty incidents
MDC	Meteorological Department of Curaçao
MEOW	maximum envelope of water
MHEWS	Multi-hazard Early Warning System
MINUSTAH	United Nations Stabilization Mission in Haiti
MM5	Mesoscale Model 5
MMOP	Marine Meteorology and Oceanography Programme (WMO)
MOU	memorandum of understanding
NaDMA	National Disaster Management Agency (Grenada)
NCCR	National Coordination Centre for Disaster Relief (Suriname)
NEMA	National Emergency Management Agency (Bahamas)
NEMO	National Emergency Management Organization (Saint Lucia)
NESDIS	National Environmental, Satellite, Data and Information Service (NOAA)
NGO	non-governmental organization
NHS	National Hydrological Service
NL OCT	Dutch overseas countries and territories
NMC	National Meteorological Centre
NMHS	National Meteorological and Hydrological Service
NMS	National Meteorological Service
NOAA	National Oceanographic and Atmospheric Administration (United States)
NOAA–NWS	National Oceanographic and Atmospheric Administration National Weather Service
NODS	National Office of Disaster Services (Antigua and Barbuda)
NWP	numerical weather prediction
OAS	Organization of American States
OCT	overseas countries and territories
OCT R3I	Caribbean Overseas Countries and Territories Regional Risk Reduction Initiative
ODM	Office of Disaster Management (Dominica)
ODPM	Office of Disaster Preparedness and Management (Trinidad and Tobago)
ODPEM	Office of Disaster Preparedness and Emergency Management (Jamaica)
OECS	Organization of Eastern Caribbean States
OR	outermost region
PAHO	Pan-American Health Organization
PPD	Partners in Population Development (EU)
PPP	purchasing power parity
PTWC	Pacific Tsunami Warning Center (NOAA–NWS)
PWSP	Public Weather Services Programme (WMO)
QMS	Quality Management System
R3I	Regional Risk Reduction Initiative (OCT R3I)
RA	Regional Association (WMO)
RCC	Regional Climate Centre (WMO)
RCOF	Regional Climate Outlook Forums (WMO)
RFFP	Real-time Flood Forecasting Project (CIMH)
RIC	Regional Instrument Centre
RMTN	Regional Meteorological Telecommunication Network
RRR	Rolling Requirements Review (WMO)
RSMC	Regional Specialized Meteorological Centre (WMO)
RTC	Regional Training Centre (WMO)
RTH	Regional Telecommunication Hub
SAT	Space Programme (WMO)
SHOCS	Strengthening Hydrometeorological Operations and Services in the Caribbean SIDS
SIAC	Statistics in Applied Climatology Programme
SIDPC	Service interministériel de défense et de protection civile (France)
SIDS	Small Island Developing States
SOP	standard operating procedure
SPI	Standardized Precipitation Index
TAC	Technical Advisory Committee (CDEMA)

TCOP	Technical Cooperation Programme (WMO)
TCP	Tropical Cyclone Programme (WMO)
TWFP	Tsunami Warning Focal Points (ICG/CARIBE EWS)
UCAR	University Corporation for Atmospheric Research
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
UNITAR	United Nations Institute for Training and Research
US/RA IV–WIGOS	United States/RA IV–WIGOS Demonstration Project
USAID	United States Agency for International Development
USAID OFDA	United States Agency for International Development Office of Foreign Disaster Assistance
UWI	University of the West Indies
VCP	Voluntary Cooperation Programme (WMO)
VLab	Virtual Laboratory for Training and Education in Satellite Meteorology (WMO–CGMS)
WCASP	World Climate Data and Monitoring Programme (WMO)
WCP	World Climate Programme (WMO)
WCDMP	World Climate Data and Monitoring Programme (WMO)
WCRP	World Climate Research Programme
WHYCOS	World Hydrological Cycle Observation System
WIGOS	WMO Integrated Global Observing System
WIS	WMO Information System
WMC	World Meteorological Centre
WMO	World Meteorological Organization
WRF	Weather Research and Forecasting Model
WWS	watch warning system
WWW	World Weather Watch (WMO)

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