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Stocktaking – Climate Risk and Early Warning Systems – Caribbean Region

The stocktaking on climate risk and early warning systems for the Caribbean Region was requested by the CREWS Steering Committee to facilitate and guide future investment decisions for the region. The request was made at the Steering Committee’s 2nd Meeting (CREWS/SC.2/workdoc.7), 9 November 2016, in Marrakech, Morocco.

Specifically, the CREWS Secretariat was invited “to consult with the World Meteorological Organization (WMO), the World Bank/Global Facility for Disaster Reduction and Recovery (GFDRR) and the United Nations Office for Disaster Risk Reduction (UNISDR), as well as relevant regional organizations such as the Caribbean Disaster Emergency management Agency (CDEMA), the Association of Caribbean States (ACS) and the Caribbean Institute for Meteorology and Hydrology (CIMH), to carry out a rapid mapping of capacity, gaps, needs and ongoing initiatives on early warnings in order to identify potential projects in the Caribbean to be presented at the 3rd meeting of the Steering Committee as part of the CREWS Investment Plan”.

The Stocktaking is part of the activities identified in the CREWS Investment Plan 2016-2020 to support countries and regional organizations to develop more systematic climate risk and early warning system metrics, to: (i) assist countries measure their access to climate information and early warning systems; (ii) guide their own, and others, investments in countries; and (iii) measure the effectiveness of such investments.

The stocktaking benefited from existing regional reviews of climate risk and early warning systems in the Caribbean. These are included in Table 1.

TABLE 1 - Recent reviews and studies of climate risk and early warning systems in the Caribbean¹		
Date / Author	Title	Content
2011 (CDEMA, JICA)	<i>Recommendations from the Caribbean Disaster Management (CADM) Project phase 1 &2</i>	<ul style="list-style-type: none"> - Gaps in national EWS programmes and an outline of key actions necessary to address these. - Focus on flood hazards. - Countries covered are Belize, Dominica, Grenada, Guyana and Saint Lucia.
2012 (WMO)	<i>Strengthening of Risk Assessment and Multi-hazard Early Warning Systems for Meteorological, Hydrological and Climate Hazards in the Caribbean</i>	<ul style="list-style-type: none"> - An assessment of the capacities, gaps and needs of NMHSs to support risk assessment and multi-hazard early warning systems in the Caribbean. - Sources for meteorological and climate products and services for early warning systems - A selection of regional projects in the Caribbean relevant to the assessment. - Recommendations for capacity building of NMHSs.
2015 (WMO)	<i>Survey on Impacts of Achieved Results by National</i>	<ul style="list-style-type: none"> - Measured performance against the established baselines and targets set in the WMO Monitoring and Evaluation System.

¹ Complete list of references at the end of the report.

	<i>Meteorological and Hydrological Services</i>	- NMHSs response covering the Caribbean region: Antigua and Barbuda; Bahamas; Belize; British Caribbean Territories; Curaçao and Sint Maarten; Dominica; Dominican Republic; France; Netherlands; Trinidad and Tobago; United Kingdom of Great Britain and Northern Ireland; United States of America.
2016 (CDEMA, IFRC and UNDP)	<i>Early Warning Systems in the Caribbean: A Desk Review</i>	- An overview of the evolution of early warning systems in the Caribbean. - A mapping of regional institutions. - Case studies and examples of early warning programmes in the region.
2016 (CDEMA, UNISDR, UNDP, IFRC)	<i>Caribbean EWS workshop report</i>	- Recommendations and findings to enhance EWS in the Caribbean. - Case studies.
2016 (UNISDR, CDEMA)	<i>Updates on Disaster Risk Reduction Priorities for the Caribbean</i>	- A self-identification of main national priorities for managing disaster risk by Anguilla, Barbados, Cuba, Dominica, Grenada, Guyana, Haiti, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago, Turks and Caicos Islands, Virgin Islands.
2017 (GIZ)	<i>Climate change realities in Small Island Developing States in the Caribbean - A study commissioned by the Global Programme on Risk Assessment and Management for Adaptation to Climate Change</i>	- Focuses on the Caribbean region with a special emphasis on Grenada. - Includes information on status of loss and damage to climate change in the Caribbean. - Includes information on adaptation and risk management initiatives by regional and international actors. - Case studies.
2017 (WMO)	<i>Regional Subproject Implementation Plan for Severe Weather Forecasting Demonstration Project (SWFDP) - Eastern Caribbean</i>	- Focus on the Eastern Caribbean. - Provides information on status of operational and service delivery capacities of National Meteorological Centers (NMCs). - Provides needs towards implementation of Severe Weather Forecasting Demonstration Project (SWFDP) in the Eastern Caribbean including responsibilities of contributing global Numerical Weather Predictions (NWP) and satellite information centres, regional centres and NMCs.

The countries covered by this stocktaking are 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 referred to as the Caribbean states/territories).

Stakeholders consulted²: Association of Caribbean States (ACS), Caribbean Disaster Emergency Management Agency (CDEMA), Caribbean Community Climate Change Centre (CCCCC) and Caribbean Institute for Meteorology and Hydrology (CIMH), International Federation of Red Cross and Red Crescent Societies (IFRC), International Telecommunication Union (ITU), United Nations Development Programme (UNDP), United Nations Office for Disaster Risk Reduction (UNISDR), World Bank Global Facility for Disaster Reduction and Recovery (GFDRR), World Meteorological Organization (WMO).

² The findings of the Stocktaking do not necessarily reflect the official positions or opinions of the institutions consulted, the CREWS Members, the CREWS Observers and the CREWS Implementing Partners.

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1. Summary

1. All states/territories in the Caribbean region rely on climate information and early warning systems as a component of their disaster risk management strategies and more broadly as a contribution to their resilience to climate change and efforts towards sustainable development.
2. In 2016, early warning systems were identified as a priority in a self-assessment by Caribbean states/territories of their strategies to manage disaster risk and extreme events³.
3. Nine out of the sixteen countries⁴ in the region that have Intended Nationally Determined Contributions (INDCs) and Nationally Determined Contributions (NDCs) refer specifically to early warning systems. A further six of those documents identify the need to address the risk of extreme climate events as a national climate change adaptation priority.
4. The needs regarding early warning systems to effectively protect lives and properties, in light of socio-economic patterns in Caribbean states/territories and changing climate projections, exceed the resources currently available in the region.

³ UNISDR, CDEMA, 2016, supported by the European Commission.

⁴ Antigua & Barbuda Bahamas, Barbados, Belize, Cayman Islands, Cuba, Dominica, Dominican Republic, Grenada, Guyana, Haiti, Jamaica, Saint Kitts & Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago.

5. States/territories in the Caribbean and regional institutions have experience and expertise in relation to many aspects of multi-hazard early warning systems⁵ with cooperation ongoing between countries and technical organisations in the region and globally.
6. Regional reviews of the status of early warning system and existing regional initiatives and programmes provide a basis to identify and guide funding priorities. Opportunities exist to build on cooperation between the Caribbean Disaster Emergency Management Agency (CDEMA), the Caribbean Community Climate Change Centre (CCCCC) and Caribbean Institute for Meteorology and Hydrology (CIMH).
7. Climate and risk information and assessments are readily available in Caribbean states/territories. The type and the format of information collected are not always adapted to guide early warning systems. This includes data required to allow the identification of risk thresholds for associated alert levels as well as consideration of at-risk populations to target early warnings.
8. Observing and monitoring systems for hurricanes is sufficient across the regions, while other types of events, including so called secondary hazards, require additional investment, in particular forecasts for flash floods, storm surge, tsunamis and drought, as well as certain public health and technological threats.
9. National Meteorological and Hydrological Services' capacity in the region, is varied with regard to both weather and climate services, with a small number of countries requiring long term engagement and support.
10. The capacity to communicate and disseminate early warning and risk information, both with regard to the channels (established authoritative and official voices) and the methods (standard alerting protocols that allow to reach the general public through media, mobile platforms and social networks) is varied. Opportunities exist to upscale all countries to the Common Alerting protocol (CAP) standard.
11. In line with good practices on early warning systems and climate information in the region, and internationally, efforts by states/territories require sustained and institutionalized cooperation between relevant national institutions, including national weather services, national disaster management institutions, planning and financing ministries and institutions working on climate change.

2. Methodology

12. The Stocktaking draws on existing regional reviews and ongoing projects on early warning systems and climate services in the Caribbean.

⁵ The hurricane early warning system in Cuba, and the adaptation of the French "Vigilance" system in the French Antilles and French Guiana provide examples of good practices that can be replicated in other countries, within and beyond the Caribbean region.

13. The scope of the stocktaking is the capacities, gaps and needs of states/territories and regional institutions in the Caribbean to generate and communicate early warnings and climate information to protect lives, livelihoods and assets.
14. Information was collected based on a set of criteria that are aligned with current practices in measuring effectiveness and access to multi-hazard early warning systems and climate information (see Table 2 – Criteria to look at gaps and needs related to early warning in the Caribbean Region).
15. A desktop review of INDCs and NDCs for the region was carried out.
16. The findings contained in the Stocktaking - including the information on ongoing or recently finalized projects and programmes of relevance - are mainly drawn from existing studies. Gaps were addressed through further regional and national stakeholder consultations.

2.1 Stakeholder Analysis

17. In 2012, WMO carried out an assessment of capacities, gaps and needs of National Meteorological and Hydrological Services capacities in the Caribbean. The assessment looked at meteorological products and service development, monitoring and observation networks, operational forecasting, data management and exchanges, IT and telecommunication and operational relationships with other agencies.
18. In 2016, a Caribbean Early warning System workshop took place and provided regional findings and recommendations. These draw on a report commissioned by IFRC and UNDP, that provided an overview of regional institutions roles and activities. The report provides a stakeholder analysis of regional institutions on their support and ongoing cooperation on early warning including Association of Caribbean States (ACS), the Caribbean Community (CARICOM), The Organisation of Eastern Caribbean States (OECS), the Caribbean Disaster Emergency Management Agency (CDEMA), the Caribbean Community Climate Change Centre (CCCCC) and Caribbean Institute for Meteorology and Hydrology (CIMH), the Caribbean Development Bank (CDB), the Caribbean Catastrophe Risk Insurance Facility (CCRIF), and the Caribbean Center for Climate and Environmental Simulation at CIMH.
19. In 2015, a questionnaire based survey by WMO targeting National Meteorological and Hydrological Services (NMHSs) in the region (WMO Region IV) provided a self-assessment of NMHSs performance against established baselines and targets set in the WMO Monitoring and Evaluation System.
20. The University of West Indies (UWI) is assisting with assessing research needs in the Caribbean related to climate services for the Global Framework for Climate Services (GFCS).

TABLE 2 – Climate Risk and Early Warning Systems Metrics Used for the Stocktaking**A. Country's exposure to climate risk**

- Recorded and projected average annual loss to disaster (projected cost of disasters for the country's economy per year and per natural hazard type).
- Recorded and projected casualty loss risk (risk of life loss per hazard probability of occurrence and intensity).
- Exposure to climate change, recorded occurrence and frequency of extreme events, climate variables and their projected changes.

B. Access to and efficiency of national and local early warning systems

- The design of the system is based on a documented understanding of hazards, and the exposure and vulnerability of people and property to the hazard.
 - o Is standardized and updated information available on potential hazards, their return periods, as well as the people and property exposed and vulnerable to these?
 - o Is the hazard and risk information provided in an accessible format to guide the design of the systems?
 - o Are target groups regularly identified along with their specific information needs?
- Appropriately resourced, scientifically-based operational capacity exist that provide monitoring services, forecasts from short-term weather to climate time frames and warnings for all hazards.
 - o Do relevant hazards have monitoring, forecasting and warning systems with sufficient lead-time and reliability?
 - o Are reliable seasonal forecasts available?
 - o Does the forecasting system include predefined, localized thresholds and impacts for warning issuance?
 - o Are warning authorities clearly identified and operational 24/7?
- Communication and dissemination systems are in place and are used to convey accurate, timely warnings to all those who may be at risk from a hazard event, including relevant authorities and enterprises.
 - o Are there Common Alerting Protocols, or similar, in place for warning dissemination?
 - o Does the dissemination mechanism reach/cover all of the at risk exposed/population?
- All those who receive the warnings understand them and are equipped with the knowledge and capacities to effectively respond to reduce human and material losses and injury.
 - o Are there standard operational procedures for early warnings in existing preparedness and response plans and strategies?
 - o Do national and local strategies for disaster risk management and contingency plans outline the roles and responsibilities, including for agencies at the technical levels for warning dissemination to act on warnings?
 - o Is their sufficient cooperation between NMHS, DRM and other administrative bodies (e.g. districts) dealing with disasters?

C. Identification of early warning systems as a priority in the country's Nationally Determined Contributions (INDCs and NDCs), national disaster risk management strategies and national development and poverty reduction strategies**D. Potential for leveraging additional resources and aligning existing programmes in the region and country**

- Alignment and coherence with ongoing or planned national and regional programmes and projects related to the climate information and early warning systems.
- Potential to leverage investments from other mechanisms such as the Green Climate Fund (GCF), the Global Environment Fund (GEF), World Bank and Regional Development Banks' development assistance portfolios and bilateral partners assistance.

3. Main Findings

21. Multiple studies⁶ highlight the impact of disasters and climate variability on Caribbean countries' economies, the well-being of their populations and their environment. The main economic sectors of Caribbean states/territories are tourism, transport, agriculture and finance⁷. All are vulnerable to natural and climate-related hazards.
22. Risk in the region is related to the following hazards: flash floods, thunderstorms and lightning, storm surges, coastal flooding, droughts, landslides or mudslides, strong winds, river flooding, tsunamis and earthquakes.
23. Caribbean states/territories share many of the characteristics of other small island states around the world. These include low availability of resources, high debt, small but rapidly growing population, remoteness and excessive dependency on imports.
24. The Intergovernmental Panel on Climate Change⁸ reports that the vulnerability to natural hazards is further compounded by the effects of climate change and the cyclic events of climate variability such as the El Niño (Southern Oscillation) and La Niña phenomena. Caribbean states/territories are identified amongst the most vulnerable to the impact of climate change⁹.
25. The social and economic exposure to disasters and climate change in the Caribbean varies from one state/territory to another due primarily to the level of development of each state/territory. Direct links exist in the Caribbean between poverty, extreme poverty and the vulnerability to disasters and climate change due in part to the low access to information, alerts and knowledge of pre-identified actions to be taken upon receiving alerts¹⁰.

3.1 Early Warning Component 1: Risk-Informed System Design

26. Most Caribbean countries/territories have access to hazard analyses covering most types of relevant hazards. Studies on hazard return frequency are also available in many states/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. Wind hazard maps have been developed by using hurricane hazard models, historic records, and existing wind maps. The Caribbean Drought and Precipitation Monitoring Network provides Standardized Precipitation Index (SPI) maps as a means of drought and excessive seasonal rainfall monitoring.

⁶- Potential Economic Impacts of Climate Change in the Caribbean Community. LCR Sustainable Development Working Paper No. 32 World Bank, Toba N (2009)

- LAC Small Island Development States, Inter-American Development Bank (IDB, 2014)

- Climate change realities in Small Island Developing States in the Caribbean (GIZ, 2017)

⁷ With the exception of Trinidad and Tobago, where the oil industry represents close to 30 per cent of the gross domestic product (GDP)

⁸ IPCC Fifth Assessment Reports (RA5, 2014)

⁹ IPCC Fifth Assessment Reports (RA5, 2014)

¹⁰ UNISDR Global Assessment Report, 2011

27. Hazard and risk information is not always presented in a format to guide early warning systems, such as the identification of risk thresholds for associated alert levels as well as consideration for at-risk populations to target early warnings.
28. Capacity building on disaster loss databases has been carried out in Grenada, Saint Lucia, Saint Kitts and Nevis, St. Vincent and the Grenadines, Dominica and Antigua and Barbuda in 2014. Disaster loss databases were established for these six countries in 2014.
29. Not all countries in the region have georeferenced risk analysis information covering relevant hazards with identified at risk populations, critical infrastructure and user needs analysis for climate services. Fewer states/territories are able to quantify residual risks associated with projected climate change.
30. The Climate Studies Group Mona (CSGM) and CCCCC have played a role in downscaling global climate change models and creating frameworks and actions plans necessary to combat the effects of climate change. These efforts have resulted in better drought, rainfall and sea-level rise predictions.
31. There is a need in the Caribbean to leverage opportunities to exchange risk data and information across different hazards, including climate variability and change, and also across different hazard risks such as storm surges and tsunamis.
32. Jamaica, is identified as a country with good practices in risk assessment. It has undertaken downscaled hazard analysis and mapping for several rivers and coastal hazards (for example, storm surge for Kingston and Montego Bay). The Water Resources Authority (WRA) has produced flood hazard maps and established a number of flood early warning systems in watersheds.
33. Cuba and the French West Indies have completed high-resolution risk assessment for the entire islands to the level of streets or ground parcels.
34. For the French West Indies, a methodology for hazard analysis has been developed to identify different danger thresholds that serve as the basic criteria for watches and warnings.
35. Most states/territories express the need 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. Currently hazard maps are often found in different institution, in formats and scales that are not necessarily compatible. Maps in some cases are outdated. Specific gaps and needs across the states/territories include:
- Lack of involvement of NMSs in the national risk assessment process.
 - Stakeholders' needs with regard to hazard analysis are not sufficiently well known.
 - Vulnerability assessments that consider social, physical, environmental, economic and political factors of vulnerability
 - High-resolution topography and coastal bathymetry is lacking in some states/territories.

- Good practices, expertise and regional resources for modelling, training and hazard product development.
- There is a need to improve access to, and usability and understanding of, risk assessment data products to achieve better weather, climate and warning services (identification of danger thresholds to serve as basic criteria for watches and warnings).

3.2 Early Warning Component 2: Monitoring, Forecasting and Warning

36. Not all states/territories have National Meteorological Services (NMS), for example, Antigua and Barbuda NMS provides services to Anguilla, the British Virgin Islands, Montserrat and Saint Kitts and Nevis. Barbados NMS provides forecast and warnings to Dominica and Saint Vincent. Meteo-France through the Direction interregional Antilles-Guyane (DIRAG) based in Martinique is responsible for meteorological activities and operations throughout the French islands and French Guiana. 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).
37. There are four islands (Cuba, the Dominican Republic, Guadeloupe and Martinique) with National Hydrological Services (NHSs) that include risk management in their mandate. In most other Caribbean states/territories, the water resources authorities are responsible for some hydrological aspects, including expertise and data networks. In Barbados, CIMH is the official institution for hydrology. It also provides hydrological support, through regional advisors, to all its members.
38. The Caribbean Radar Project (EU, CMO, Météo-France, 2003 www.cmo.org.tt/radar.html) led to improvements in hazard monitoring across the region. Some Caribbean countries/territories have access to the long-range lightning detection system of the United Kingdom Met Office and to information on Websites such as the World Wide Lightning Location Network (wwlln.net).
39. All the Caribbean states/territories with NMHSs have their own observation networks. Some have a limited number of real-time Automated Weather Stations (for example, as of 2012, one in Saint Vincent, two in Barbados, two in Antigua and Barbuda, and two in Dominica) while others have a larger number (for example, as of 2012, 40 in Martinique and over 80 in Cuba).
40. Some Caribbean states/territories (for example, Jamaica, Martinique, Saint Lucia) have implemented special observation networks coupled with an automated system for flash flood alerts. 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).
41. Specific needs identified in a number of states/territories include:
- Increase the spatial coverage of observation sites in most Caribbean countries/territories.
 - Improve the telecommunications process to ensure that all data from automated weather stations are transmitted in real time throughout the region.

- Develop the capacity to provide impact-based forecasts and warning services in NMHSs, working in formal collaboration with entities that possess impact data related to Hydrometeorological hazards.
- Develop sustainability plans for all the national observing networks, including maintenance, spare parts, calibration, continuity and optimization. As well as additional resources and training for maintenance of observation sites and networks (for example, for staffing, staff training, funding and provision of spare parts).
- Modernize and expand the observation network (equipment and software, automation, improvement in telecommunication systems);
- The need for improved climatological observation networks to support slow-onset hazards such as drought and heat waves, and for work on climate change downscaling.
- Need for capacity to convert drought forecasts to information and to effectively communicate that information to stakeholders;
- Increase awareness of the availability of the forecasting products and support provided by CIMH and the capacity of the downstream users to effectively integrate drought information into decision making

42. The level of forecasting infrastructure (for example, workstations and access to networks) varies from country to country¹¹. Gaps and needs include:

- Increasing access and accuracy of weather forecasting and severe weather guidance system with downscaling capacities.
- Automation and integration of available monitoring systems to increase access, in real time, to a greater variety of information from numerical models and satellites, with more functionalities.
- Improving downscaling capacities from national threats to potential local impacts, including marine hazards forecasts.
- Strengthening capacities for downscaling regional-scale monthly or seasonal forecast information to national needs.
- Increasing numbers of qualified forecasters are required in many Caribbean states/territories

43. In some Caribbean states/territories, the NMHS 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 NMHSs. 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).

44. Regarding climate services, according to the 2015 survey by WMO, most countries access some form of monthly and longer climate predictions (empirical/dynamical) while the capacity to provide specialized climate products to meet the needs of major climate-sensitive sectors

¹¹ WMO 2012 survey provides a list of websites where National Meteorological Services (NMS) in the Caribbean obtain image products from global and regional product centers.

including seasonal climate outlooks remains highly varied between states/territories across the region.

45. According to the same survey, a certain number of countries do not provide basic climate products for climate diagnostics and analysis or for hazard and extreme value analysis.

3.3 Early Warning Component 3: Communication and Dissemination

[ITU - provide penetration levels for mobile phones/internet/radio/others]

46. A number of states/territories refer to communications, especially the dissemination of information to the general public and the media as a recurrent challenge, including the need to enhance services via mobile platforms and social networks.

47. 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).

48. Territories of the French West Indies use a complete automatic dissemination platform that is directly linked to the production system. In the Caribbean, the Common Alerting Protocol (CAP) - enabled SmartAlert freeware from Finnish Meteorological Institute is installed in Antigua and Barbuda, Cuba and Jamaica.

49. There are four interlinked CAP Servers in Anguilla, Aruba, Montserrat, and Sint Maarten. CAP is being implemented with freeware in Trinidad and Tobago, and in Dominica. CAP is also operational in Puerto Rico and the U.S. Virgin Islands, as part of IPAWS.

50. There is a need to strengthen the mechanisms for continual improvement processes for warning communications through clear and timely feedback procedures, including systematic post-event evaluations, and exercises involving all Disaster Risk Management (DRM) stakeholders and NMHSs.

51. Some states/territories, such as Saint Vincent and the Grenadines and Haiti would benefit from an island wide alert system through television, radio and SMS text messages. In Haiti, the reliability of the telecommunication system of the emergency services is an issue and access to internet is limited in parts of the countries.

3.4 Early Warning Component 4: Ability to Respond

52. 85% of CDEMA participating states include early warning measures in their contingency planning¹².

53. Current national strategies do not sufficiently allow the naming of alerting and warning authorities and the establishment of the associated protocols.

54. Training mechanisms and educational materials that target specific sectors and vulnerable populations are required in most states/territories for example, for women, children, isolated families, the elderly, tourists) on subjects such as meteorological hazards and their impacts.

¹² CDEMA, 2010

55. In many countries/territories, regional institutions such as CDEMA as well as national Red Cross societies supported by IFRC, play a role in public awareness, risk culture and preparedness, particularly at the local level. Education targeted at the general population was highlighted as a gap in the Caribbean, on all hazards (hurricanes having the best coverage by education material).

56. Jamaica has a good example of the integration of disabled persons into EWS with the Portmore Early Warning System (EWS) for the Disabled Project in 2013. The Alert and Warning System is routed through a web based application hosted by a local radio station. Application of the system involves routing hurricane related information (hurricane preparedness, warnings and evacuation notices) to handheld devices distributed to blind/visually impaired and deaf/hearing-impaired users. Blind/visually impaired persons are alerted by a distinct sound made by the device for incoming messages that are read audibly to the user. The deaf and/or hearing-impaired are able to detect notifications by a flashing light. Incoming messages are displayed on the screen.

4. Relevant Programs and Projects on Climate Risk and Early Warning Systems

57. Annex 1 presents a list of ongoing or recently finalized projects and programmes identified for early warning and climate information in the region. The information is compiled to promote alignment and harmonization between programmes, projects and different funding flows.

58. The Stocktaking was not able to provide an overall estimate of the amount of resources currently invested on early warning systems in the region, either by states/territories or through multi-lateral and bilateral aid. The *2016 Desk Review of Early Warning Systems in the Caribbean* (CDEMA, UNDP, IFRC) identified investment levels, by 7 key donors in the region on early warning systems, during the period 2005-2015, to total US\$ 57 million (2005-2010, US\$ 39 million and 2011-2015, US\$ 18 million). These figures probably underestimate the overall levels of investment.

5. Recommendations

59. Data and information on climate risk and early warning systems in the Caribbean presented in this Stocktaking, allow for the validation and prioritization of potential country funding proposal by the CREWS Implementing Partners to the Steering Committee (i.e. to ensure proposals are aligned with priority gaps and needs, present the potential for leveraging additional resources and are coherent with existing programmes in the region).

60. The stocktaking points to the need for a comprehensive, structured approach at the local, national, regional and international levels to strengthen early warning systems in the Caribbean. Such an approach must contribute to donor harmonisation, and address all four components of effective, integrated, risk-based, people-centred, multi-hazard early warning systems: (1) disaster risk knowledge; (2) detection, monitoring, analysis and forecasting of the hazards and possible consequences; (3) dissemination and communication and (4) preparedness at all levels to respond to the warnings. It also needs to contribute programmatically to the disaster risk reduction pillar of the Global Framework for Climate Services (GFCS).

61. Country investment and programmes on early warning systems in the region will need to incentivize states/territories to apply recognized programming principles and good practices regarding early warning systems. Such as, to ensure sustained capacity in national institutions to ensure timely and accurate warnings that are risk based, multi-hazard, communicated through official sources in a manner that reach the most vulnerable people using standard alerting protocols along with associated information on likelihood and impact.
62. Opportunities exists to strengthen regional cooperation around support to states/territories for comprehensive early warning systems and climate information. Such an approach would need to carry forward existing regional findings and recommendation; align existing services lines, regionally and globally, to address each states/territories' needs; and support the application of metrics by state/territory in the region that will allow for an ongoing evaluation of their system, comparison, transfer of knowledge and ease of reporting on progress¹³.

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¹³ Early warning metrics, would assist states/territories report against regional and international agreements, such as the Sustainable Development Goals (SDGs), the Paris Climate Change Agreements and the Sendai Framework for Disaster Risk Reduction, and, in particular, the indicators under Target G of the Sendai Framework. Target G calls on countries to “*substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030*”

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ANNEX 1 Ongoing or recently finalized projects and programmes of relevance

1. Hazard, Vulnerability and Exposure Analyses and Mapping and Climate Change Resilience Programmes			
Name	Description	Coverage	Funding source
Caribbean Risk Information Program (WB)	The Caribbean Risk Information Program, closed on June 30, 2016. The project developed the Caribbean Handbook on Risk Information Management which guides the generation and application of landslides and flood hazard and risk information to inform planning and infrastructure projects. The project also developed landslide susceptibility and flood hazard maps for all participating countries. See www.charim.net	involving Belize, Grenada, Dominica, St. Lucia and St. Vincent and the Grenadines,	EU-ACP
ERC project/ Dewetra Platform CDEMA and CIMA Foundation	The project leading to the delivery of the Dewetra Platform has the goal of strengthening civil protection mechanisms by capacity development for EWS, information dissemination, and institutional coordination for disaster management and response	in CARICOM Member States	Italy
Mapping Wind Hazards in Caribbean Islands (PAHO/WHO)	PAHO/WHO, together with Applied Research Associates, a North American institute, and participants from different Caribbean countries, have created maps that show wind hazards The project simulates 100,000 years of Atlantic storms using hurricane hazard models, historic records, and existing wind maps and will help in the design and construction of new health facilities.	For Caribbean islands and along the Caribbean coasts of Central and South America.	tbd
Regional Disaster Risk Management for Sustainable Tourism in the Caribbean	tbd	tbd	tbd
DIPECHO Caribbean Programme –	Targets disaster risk management stakeholders and community level operatives.	tbd	DIPECHO

Strengthening the Resilience and Coping Capacity through Integrated Early Warning Systems (IFRC/UNDP)			
BRCCC	tbd	tbd	USAID
UKHO, Cefas & NOC Commonwealth Marine Economies Program	In May 2016, the United Kingdom Hydrographic Office (UKHO) initiated a “Proposal of Seabed Mapping for Improved Charting and Environmental Management” for St. Vincent and the Grenadines and Grenada; further sub-projects are: - Seabed Mapping SVG and GRD - Regional evaluation of the impacts of climate change in the Caribbean - Installation of a radar technology tide gauge in Saint Lucia to monitor impacts of climate change (http://www.cmeprogramme.org/ ; https://www.gov.uk/guidance/commonwealth-marine-economies-programme).	Grenada, Saint Vincent and the Grenadines, and Saint Lucia as well as regional	UK (Foreign and Commonwealth Office)
Vision 2030 – Measurable Reduction of Risk WB executed	The principal objectives of the proposed project is to (a) support the Government of Saint Lucia to understand disaster risk for transport infrastructure as well as the related liabilities the government is holding, (b) enable the government to use this information for the development of a comprehensive DRM strategy and (c) monitor risk levels over time. https://www.gfdrr.org/acp-eu/saint-lucia---measurable-reduction-of-disaster-risk-specific-to-public-infrastructure	Saint Lucia	EU_ACP
CaribSave Climate Change Risk Atlas (CCCRA) CCCCC executed	CCCRA was conducted from 2009 – 2011. The CCCRA successfully used evidence-based, inter-sectoral approaches to examine climate change risks, vulnerabilities and adaptive capacities; and develop pragmatic response strategies to reduce vulnerability and enhance resilience in 15 countries across the Caribbean. Main outputs include: - Full Climate Change Risk Profiles for all participating countries - Climate Change Risk Profile Summary Documents and Snapshots for all participating countries	Anguilla, Antigua & Barbuda, The Bahamas, Barbados, Belize, Dominica, The Dominican Republic, Grenada, Jamaica, Nevis, Saint Lucia, St. Kitts, St. Vincent & the Grenadines, Suriname and the Turks & Caicos Islands	UKAID & AusAid
Programme for building	The project aims at establishing a sustainable Regional Climate Centre (RCC)	Regional	U.S. Agency for

<p>regional climate capacity in the Caribbean</p>	<p>for the Caribbean housed at the Caribbean Institute for Meteorology and Hydrology (CIMH). By developing and distributing climate and weather products and services, the RCC will support adaptation to climate variability and change and enhance disaster risk reduction capacities in the Region.</p>		<p>International Development/The Office of U.S. Foreign Disaster Assistance (USAID/OFDA)</p>
<p>Reduce Risks to Human and Natural Assets Resulting from Climate Change (RRACC) Project</p>	<p>http://www.gwp.org/globalassets/global/gwp-c-files/iwrm-initiatives_oecs_rracc.pdf</p>	<p>tbd</p>	<p>USAID</p>
<p>Caribbean Disaster Risk Financing Programs WB executed</p>	<p>The projects aim at supporting Caribbean countries in understanding fiscal risk from disasters: Quantification and analysis of fiscal risk from disasters to provide a concrete understanding of the exposure to disaster risk and its liability to finance direct and indirect costs associated with disasters. Earthquake and hurricane country disaster risk profiles were created for all participating countries.</p>	<p>Belize, Grenada, Saint Lucia, Jamaica and Haiti</p>	<p>EU-ACP</p>
<p>Caribbean Risk Atlas 2008-2013 UWI executed</p>	<p>Objective was to produce an on-line Atlas of Disaster Risk for the Caribbean, and detailed risk maps for several Caribbean territories to inform decision-making.</p>	<p>Antigua and Barbuda, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago with hazard & risk assessments carried out in Jamaica, Grenada and Barbados</p>	

2. Forecasting, Prediction and Warning Capacity for Natural Hazards and Climate Variability

Name	Description	Coverage	Funding source
Regional Weather Radar Warning System	tbd	tbd	funded by the EU
Carib-HYCOS	Assist NMHSs in the modernizations and strengthening of their activities related to water resources and data for the issuance of more accurate short, medium and long term forecasts.	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 Euros 3.5 million
Real Time Flood Forecasting	CIMH	Barbados, Guyana, Jamaica	tbd
Climate Change Adaptation Program (CCAP)	Promote the use of climate data and information for the use in decision-making; support innovative adaptation approaches which demonstrate proof of concept necessary to secure additional financing; and foster climate financing to support scale up and replication of sustainable adaptation initiatives	Antigua and Barbuda, Commonwealth of Dominica, Barbados, Grenada, Guyana, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago	USAID Implemented by CCCCC with support from CIMH
Strengthening Operational Weather, Water and Climate Services for Saint Lucia: Roadmap	Analyze the user needs vs. capacities of service providers and services currently provided; determine gaps; and develop a roadmap to strengthen hydromet services	Saint Lucia	WPP
Disaster Vulnerability	Separate projects with small hydromet components as well as hazard & risk assessment	Saint Lucia, Dominica and Grenada	Climate Investment Funds (PPCR) & WB

Reduction Projects	activities		
The Continuously Operating Caribbean GPS Observational Network (COCONet)	COCONet aims at developing a large-scale geodetic and atmospheric infrastructure in the Caribbean that will form the backbone for a broad range of geoscience and atmospheric investigations and enable research on process-oriented science questions with direct relevance to geohazards (http://coconet.unavco.org/)	Regional	National Science Foundation (NSF)
FEWS - JICA	http://www.cdema.org/cdmconference/presentations/2015/YNishimura_JICA_StrentheningCommunityResilience.pdf	tbd	tbd
SWFDP-Eastern Caribbean	The Severe Weather Forecasting Demonstration Project (SWFDP) in the Eastern Caribbean aims to improve forecasting and delivery of warning services for severe weather in Island States and Territories in Eastern Caribbean including in Members of Caribbean Met. Organization (CMO)	Sub-regional	The project has been kick-started with seed funding from Canada for GFCS. The development of an implementation plan is in progress. However, additional resources would be required to initiate the project activities.
3. Access to Information and Communication Technologies (ICTs) and Availability of Standard Protocols for Alert Communications			
Name	Description	Coverage	Funding source
Community Alert Project Executed by UNDP	Demonstrate Common Alerting Protocol (CAP as a process to improve community warning CDEMA, FRC, UNDP, NDOS	6 pilot communities in Grenada, Dominica, St. Vincent and the Grenadines	European Commission Humanitarian Aid and Civil Protection DIPECHO program

<p>e-GEOS Implementation of an Information Centre in the Caribbean island of Saint Lucia</p>	<p>The project aims to support the Saint Lucia Government with an Information Center that provides advanced capabilities for multi-faceted hydro-meteorological risk management, sea pollution and forest resources control. Services include: Natural disaster forecast and early warning; flood mapping; etc.</p>	<p>Saint Lucia</p>	<p>Italy</p>
<p>C-READ - Caribbean Regional Environmental and Atmospheric Data Executed by CCCCC</p>		<p>tbd</p>	<p>tbd</p>
<p>Fisheries Early Warning and Emergency Response</p>	<p>Reduce the risks to fishers associated with climate change and variability by developing ... early warning and emergency response ... for fishers in the Caribbean, including training. Focuses on ICT</p>	<p>(1) Dominica (2) Grenada (3) Saint Lucia (4) St Vincent and the Grenadines</p>	<p>IDB</p>