CREWS PROJECT FINAL REPORT

1. Project title	CREWS Caribbean - Strengthening Hydro-Meteorological and Early Warning Services	**2. Project reference** CREWS/CProj/04/Regional Caribbean
3. Implementing Partners	World Bank (Lead) World Meteorological Organization (WMO) United Nations Office for Disaster Risk Reduction (UNDRR)	**4. Operational Partners involved in the project** • Caribbean Disaster Emergency Management Agency (CDEMA) • Caribbean Meteorological Organization (CMO) • Caribbean Institute for Meteorology and Hydrology (CIMH) • National NMHSs and NDRMOs
5. Project Timeframe	June 2018 – June 2023 (original timeframe June 2018-June 2021)	
6. Actual Project Duration/Timeframe (if no-cost extensions were approved)	November 2018 – June 2023 The project launch was in November 2018 • A 1st no cost extension was approved in June 2021 to extend the project until December 2022 • Additional funding was provided to one of the implementing partners (UNDRR) in January 2022 • A 2nd no cost extension was approved in November 2022 to extend the project until June 2023	
7. SC approved Project Budget (in USD)	6,500,000[1]	
8. Reporting focal point	Anna Maria Bogdanova – ambogdanova@worldbank.org Other IP focal points: Jair Torres- jair.torres@un.org Stephanie Gallasch – SGallasch@wmo.int	

[1] Including additional funding in the amount of US$1,000,000 allocated to UNDRR in 2022

9. Report Certified Accurate by (with signature):	Niels Holm-Nielsen
10. Project overview	**Please include synergies, leveraging, key project deliverables and total funding in bullet points. (max 250 words)** **Objectives:** To strengthen and streamline regional and national systems and capacity related to weather forecasting, hydrological services, multi-hazard impact-based warnings and service delivery for enhanced decision-making. **Key Deliverables:** (i) Regional roadmap to strengthen and streamline early warning and hydromet services; (ii) Institutional strengthening and streamlining of early warning and hydromet services; (iii) Piloting high priority national activities on end-to-end EWS including impact-based forecasting. **Leveraging:** This project is complemented with US$ 1.5 million from the CREWS aligned contribution from Environment and Climate Change Canada to WMO through the project "Building Resilience to High-Impact Hydrometeorological Events through Strengthening Multi-Hazard Early Warning Systems in Small Island Developing States and Southeast Asia". The project further leverages CREWS investments in Haiti under the CREWS Haiti project (USD 1,5 Million). The project had three components, with the first component led by WB and implemented with the support of GFDRR, WMO, UNDRR, and regional and national partners to develop a regional roadmap for enhanced decision-making and action planning related to weather forecasting, water and climate services, and multi-hazard impact-based warnings. The second component, led by WMO, focused on institutional strengthening and streamlining of early warning and hydromet services at the regional and national level, while the third component, led by WB, together with the UNDRR, piloted high priority activities proposed by the strategy, including impact-based forecasting.

11. Summary of outcomes	**What project outcomes were achieved? What were not realized? Describe any unexpected outcomes.** The CREWS Caribbean project was launched in 2018 to strengthen and streamline regional and national systems and capacity related to weather forecasting, hydrological services, multi-hazard impact-based warnings and service delivery for enhanced decision-making. The project faced challenges during implementation, including complicated coordination and delays due to the COVID-19 pandemic, which required adjustments in scope, timeline, and delivery methods. The outcomes achieved under the Strengthening Hydro-Meteorological and Early Warning Services in the Caribbean (CREWS Caribbean) project are both at the regional, national levels and community levels. To support regional capacity, the project had a strong focus on collaboration with regional agencies – CDEMA, CIMH, CMO HQ. <u>Summary of Outcomes: Project Components 1 and 3 (WB-Led)</u> Under project component 1 and 3, the outcomes were achieved largely at the regional level through the development of a regional MHEWS roadmap, and four pilot priority activities tested at the regional and national levels to support national meteorological, hydrological and DRM agencies towards implementing a robust, cascading, national-regional impact-based MHEWS. The development of a *regional roadmap* for strengthening and streamlining Multi-Hazard Early Warning Systems (MHEWS) in the Caribbean region began with a Situation Analysis to identify foundational strengths, weaknesses, opportunities, and emerging threats. The situation analysis aimed to identify specific transformative initiatives to strengthen early warning services and ensure alignment with existing MHEWS processes and strategies, such as the Regional Comprehensive Disaster Management (CDM) Strategy. The process involved consultations with regional and national stakeholders, including a two-day workshop, parallel consultations, and one-on-one interviews, and resulted in a draft regional roadmap. The MHEWS roadmap focuses on achieving people-centered and self-sustaining regional impact-based MHEWS that ensure participation from gender groups, community leaders, vulnerable groups, and the private sector. It is centered around 10 strategic initiatives that, when implemented together, can help transform national and regional delivery of the MHEWS required for the Caribbean to thrive. The strategic initiatives include supporting the transition to impact-based forecasting and warning services, developing a high-resolution grid of observed and predicted rainfall, and establishing a regional multi-hazard operational plan. The regional roadmap provides a clear summary

	of the rationale, objective, approach, main tasks, and actors for each strategic initiative, which can be used as a guide to inform harmonized development of national roadmaps and to take implementation of the strategic initiatives forward. The successful implementation and sustainability of the roadmap significantly relies on the capabilities and commitment of national agencies, complemented by the support provided by regional agencies. Establishing a robust coordination framework and ensuring interoperability are crucial for advancing the development of the MHEWS in the region. While the project itself did not include tools for direct monitoring or implementation support, future sustainability has been considered as one of the key elements during the development of the roadmap. The roadmap offers a common framework, emphasizing the optimization and promoting coherence in national expenditures. It serves as a guide for donor investments, aiming to align activities with national and regional priorities to prevent fragmentation and inefficiencies. The strategic initiatives within the roadmap propose approaches that leverage existing regional-level capacities and initiatives in the region, fortifying the foundations at the national level and facilitating the transition from an EWS for hydrometeorological hazards to a more impactful MHEWS. The resurgence of the REWS consortium and the subsequent CREWS 2.0 project led by WMO and UNDRR, are also expected to contribute to sustainability of the implementation of the roadmap as part of the alignment with the regional commitment to the EW4ALL initiative. The project has supported the institutional and operational capacity of the regional partners – CDEMA, CMO HQ and CIMH. An example of collaboration with CDEMA was the development of EWS Checklists for Barbados, Guyana and Trinidad and Tobago that supported the development of the Multi Hazard Early Warning Systems (MHEWS) gap reports and roadmaps in three Caribbean countries using an internationally recommended approach. The activity aimed to assess the status of EWS in these countries, develop a gap analysis, and create national MHEWS roadmaps fed into the development and implementation of the regional multi-hazard early warning systems roadmap under CREWS Caribbean. The information used for the gap analysis in the three countries, resulting in the formulation of national EWS roadmaps complemented and supported the information gathered in the situation analysis preceding the development of the regional roadmap. At the request of the CMO HQ, the project also supported the assessment of radar capacity in the region. The evaluation of the status and available gaps in the existing Doppler radar network in the Caribbean region resulted in the development of an action plan for strengthening the regional network to ensure its sustainable operation, at

	least for the hurricane season. The study concluded that Caribbean radars working together can increase confidence in precipitation measurements, enable increased lead time for flash flood and severe alerts and warnings, etc. The study helped define funding needs for the radar upgrades and capacity development programs for operating and maintenance. The program of radar modernization is led by the CMO HQ. Four priority activities were selected for the implementation based on the strategic initiatives outlined in the regional roadmap and several selection criteria and endorsed by the project steering committee in July 2020. *PA 1. The support to transition to impact-based forecasting (IBF) and warning services*. The initiative included the development of the IBF implementation plan to build capacity in multi-hazard impact-based forecasting in the Caribbean region in a uniform and structured manner. The implementation plan aimed to support the establishment of people-centered impact-based forecast and warning services that operate routinely to provide actionable information on the impact of hazards, in a form that the public, disaster managers, and other sectors understand and can take action to protect lives, livelihoods, and property. The IBF implementation plan was accompanied by seven technical webinars for stakeholders from the region, which aimed to develop a uniform and even understanding of the principal concepts related to producing, disseminating, and communicating impact-based forecasts and early warning services. The webinars helped countries to develop a thorough understanding of the user community's needs for impact information, identify critical partners in the IBF process, enhance dissemination and communication strategies, and improve preparedness and response capabilities at all levels to the warnings received. The webinars were developed in partnership with the Weather and Climate Ready Nations program and counted with the participation of national and regional stakeholders of nine Caribbean countries (Barbados, Belize, Cayman Islands, Dominique, Jamaica; Saint Vincent, St Kitts & Nevis, Saint Lucia and Surinam). *PA2. Development of prototype of a regional multi-sensor precipitation grid* to increase regional capacity for forecasting and using MHEWS. The current spatial and temporal resolution of rainfall data in the Caribbean region is insufficient to meet expanding needs for disaster risk and emergency management, water resource management, agriculture, and so on. The initiative aimed to develop an operational prototype of a Multi-sensor Precipitation Grid (MSPG) combining rainfall data, satellite-derived rainfall data, and radar data, a high-resolution grid of estimated rainfall for the next 24 hours that could be linked to a forecast rainfall grid for input to flood and flash flood early warning systems. The MSPG was implemented in Barbados, Saint Lucia, Martinique, and St. Vincent and the Grenadines, and the main data sources for the MSPG were automated rainfall stations, the Dual Polarization Surface Rainfall Intensity product, and the Self-Calibrating Multivariate Precipitation Retrieval product from the

	Geostationary Operational Environmental Satellites of NOAA. Capacity development activities aimed at improving the monitoring capability and fostering the use of the MSPG product were implemented, including training courses for national and regional organizations. *PA3. Integrated approach to floods* priority activity aimed to help develop an end-to-end (E2E) flood-integrated operational early warning system (EWS) in Jamaica and Saint Lucia. Most national hydrological services in the Caribbean region have inadequate real-time observation networks and neither the hydrologic forecasting systems nor the trained hydrologists to predict the occurrence of flash floods, riverine flooding, or mudslides. The initiative developed two strategy documents on flood management integration for Jamaica and Saint Lucia, outlining a strategy following incremental steps toward achieving the vision of integrated flood forecasting. The documents describe a strategy for developing an E2E flood-integrated operational EWS in both countries that produces timely flood warnings efficiently communicated to help emergency managers and other decision-makers take effective anticipatory actions to save lives and prevent or reduce flood impacts. The core agencies in Jamaica and Saint Lucia provided the information to define the baseline, or the country's flood forecasting and E2E EWS status, and initial findings and analysis indicate that while some components are in place, many still need to be developed. The documents propose activities that both Jamaica and Saint Lucia can choose and prioritize in a systematic and well-planned strategy and offer guidance on how to develop these into operational plans. The strategies were presented by the national stakeholder in the CREWS Caribbean wrap up event held in Kingston, Jamaica, with the participation of more than 30 national and regional stakeholders. *PA4. Technical study for the development of the Regional Emergency Alert System* was aimed to support implementation of an effective, people-centered regional impact-based emergency alert communication and dissemination system that prompts appropriate action by everyone. The technical study contained an in-depth analysis of the existing regional alert capacity of the region, the principles that are currently being used, benchmarking it versus best international practices, and providing recommendations on the most sustainable ways to strengthen the regional capacity with a special focus on wireless alerting to mobile phone users. The project team conducted interviews with relevant regional stakeholders and a detailed desk review of available documentation to gather information and develop an understanding of the current regional context and capabilities of emergency alerts and early warning systems, challenges, opportunities, and requirements for supporting the establishment, operationalization, and sustainability of a Regional Early Warning System, and information from previous studies/assessments to develop Emergency Alert or similar systems. The study conclusions and recommendations

	were presented to the regional and national partners and later were reviewed by the EW4ALL pillar 3 working group and is used by the group to elaborate recommendations for the global initiative. In addition to the activities implemented by the World Bank in the framework of this component, UNDRR complement this component by: 1) **Measuring MHEWS effectiveness.** In line with the CREWS Global Project for Measuring MHEWS effectiveness, the Caribbean Regional Workshop on Measuring Effectiveness of Early Warning Systems through Sendai Framework Target (g) and Custom Indicators, was held in Port of Spain, Trinidad and Tobago, 10-11 May 2022. It gathered 65 representatives of: National Disaster Management Offices; Regional and National Meteorological and Hydrological Services; and National Offices of Statistics of 22 Caribbean countries and overseas territories. Countries have now a set of custom indicators that they can adapt and adopt for measuring progress in their implementation of their MHEWS. Similarly, a dialogue between the NDMOs, MET office and office of statistics has started leading to more collaborative efforts on disaster risk management among these organizations. 2) **Risk and EWS' Perception Dialogues**. In coordination with the Tobago Emergency Management Agency, ODPM, St. Lucia's NEMO, St. Vincent and the Grenadines NEMO, ODPEM Jamaica, IFRC and their national societies in Tobago (T&T), Castries (SLU), Bequia (SVG) and Port Antonio (JAM), four two-days Risk and EWS' Perception Dialogue were organized. The purpose of the activity was to increase the understanding of risk and early warning systems perceptions of local and national institutions and local communities so as to facilitate increased engagement and use of MHEWS by stakeholders and practitioners. By engaging local communities in perception dialogues, the needs and views of community representatives were better understood by the authorities, and the outcomes of this dialogues will be later integrated in local and national strategies and policies for MHEWS, ensuring a people-centered approach of MHEWS. 3) **Mapping of existing national and regional capacities for MHEWS**. A mapping of existing national and regional capacities for MHEWS has been developed. This mapping is being now integrated in the Situational Analysis prepared for selected (13) CDEMA Participant States. The first preliminary version was presented at the last Regional Early Warning Systems Consortium's (REWSC) meeting. This mapping allows to identify gaps and potential synergies among different cluster hazards EWS; REWSC members have contributed extensively to their elaboration enhancing their cooperation. 4) **Strengthening regional mechanisms for MHEWS.** A REWSC member's meeting was held from 1-2 September 2022. In the framework of this meeting the Strategic Roadmap for Advancing MHEWS in the Caribbean 2020-2030, the mapping of existing capacities of MHEWS in the region, and actions for ensuring

	synergies among REWSC's members programmes and activities, were discussed. Regional mechanisms aiming to strengthen cooperation among different cluster hazards EWS promoters and providers is being enhanced at the regional level. The final goal is to ensure a multi-hazard approach for EWS in the region. 5) **Regional consultation for improving MHEWS governance in the Caribbean region**. The regional consultation was held from 6-7 October 2022. In the framework of this meeting the Strategic Roadmap for Advancing MHEWS in the Caribbean 2020-2030; the mapping of existing capacities of MHEWS in the region; the National Strategic Plans and Frameworks for Weather, Water and Climate Services; and actions for improving MHEWS governance in the Caribbean region, were discussed. The outcomes of this consultations will be summarized on a regional report stating recommendations for improving MHEWS governance in the region. it is expected that policy mechanisms, such as the National Roadmaps for MHEWS and MHEWS national policies, will be strengthen, this in order to ensure sustainability of EWS while providing clear roles and mandates for the different stakeholders involved. 6) **Regional Consultation among Chambers of Industry and Commerce, Regional and National Disaster Risk Management Offices, and Meteorological Agencies in the Caribbean region**. A regional consultation on Integrating Private Sector on Multi-Hazard Early Warning Systems' Governance and Actions was held in Saint George's, Grenada - November 21-23, 2022. This consultation is the first regional dialogue between public and private sector representatives on the issue of MHEWS. A regional plan of action was agreed and it would be implemented by the representatives of this consortium, aiming to integrate private sector capacities and views in MHEWS, while ensuring that better services could be provided to them notably on issues related to MHEWS and DRM (such as Business Continuity Plans). In addition to this, public sector actors engaged to support the development of the CARICHAM center of excellence for business resilience. 7) **Virtual Center of Excellence – CARICHAM**. With the support of this project a Virtual Center of Excellence was created (VCE). The VCE aims to support business resilience in the Caribbean region with a particular focus on SMEs. Specific resources for MHEWS are available for SMEs. Summary of Outcomes: Project Component 2 (WMO-led) Under component No. 2 – *Institutional Strengthening and streamlining of early warning and hydromet services* – activities and initiatives have focused on strengthening and operationalizing a cascading forecasting system that feeds into comprehensive and coordinated early warning systems in the region. Activities have been conducted on regional, national and community levels and were tailored to beneficiary needs, requirements, and challenges. All activities implemented align with the Regional Strategic Roadmap developed under project component 1, other

project activities carried out by the other IPs and in line with the overall project objectives. The outline below only shows a summary of major outputs.

Major outputs (aligned with proposed project activities as outlined in the project concept note) are the following:

(a) Institutional strengthening at regional and national level to support a clear definition of roles and responsibilities, as well as coordination to enhance the cascading forecasting system

- **Meteorological legislation, national strategic plans (NSPs), frameworks for weather, water and climate services (FWWCS) strengthen national NMHSs**
  Meteorological legislation and policy, NSPs as well as FWWCs are crucial to strengthening the hydro-meteorological services Caribbean countries. Legislation provides an appropriate legal mandate to national NMHSs with well-defined roles, responsibilities, and adequate resources to support their national economies, better predict high-impact hydro-meteorological events and correlated hazards and deliver user-oriented services. Under the leadership of the CMO, a model meteorological legislation and policy for the Caribbean was developed and endorsed by CMO Member States in June 2022. This model was adapted to and endorsed by eight countries/OTs: Anguilla, Antigua and Barbuda, Barbados, Belize, Grenada, Jamaica, St Kitts and Nevis, Saint Lucia, and St Vincent and the Grenadines.
  Further, ten NSPs including FWWCS and detailed action plans for a period of five years have been developed and accepted in Anguilla, Antigua and Barbuda, Cayman Islands, Dominica, Grenada, Guyana, Jamaica, Turks and Caicos Islands, St Kitts and Nevis and St Vincent and the Grenadines. The NSPs, some of which are already being incorporated in national development plans, provide guidance for the development of NMHSs. They also serve national governments and development partners with a transparent understanding of priority needs for weather, water, climate, and related environmental fields. All deliverables were developed through a series of national consultations with key stakeholders.
  Deliverables/additional information: Google Drive Folder

- **(Model) Standing Operating Procedures (SOPs) between NMHSs and NDRMOs improve collaboration and alignment on regional and national level**
  A comprehensive literature review and stakeholder consultations, under the leadership of CDEMA, led to the development of model SOPs between NMHSs and NDRMOs. These model SOPs were tested via tabletop exercises and are ready to be adapted on a national level. In May 2023, during a consultative workshop with

representatives from four pilot states - Antigua and Barbuda, Bahamas, Barbados and Trinidad and Tobago - opportunities, challenges, and next steps for the national adaptation of these model SOPs were discussed and initiated.
Deliverables/additional information: Google Drive Folder

(b) Strengthening of meteorological and hydrological observation, data management and weather, climate and flood forecasting;

- **Opportunities and gaps identified through review of marine and ocean service delivery in the Caribbean**
  A review of current activities related to marine and ocean services delivery has provided a baseline on the current state of ocean service provision, highlighting identified opportunities, gaps and recommendations. This baseline will inform future activities in the region – for example under the CREWS Caribbean 2.0 project currently under development (September 2023). The development of phase II of the WMO Marine Service Course was also supported through the project.
  Deliverables/additional information: Google Drive Folder

- **Regional Marine Forecast Support Centre (RMFSC) at CIMH supported and capacity strengthened**
  Improving marine governance processes in the Caribbean to sustainably manage the region's marine resources and ecosystems requires human and technological capacity, as well as a range of data at varying spatio-temporal scales. Against this background, the CIMH which is leading the RMFSC, received support through the project to strengthen its' capacity with regards to ocean circulation modeling (salinity, ocean currents and temperature) and wave forecasting (surface currents, tides and surge). In its function as RMFSC, the CIMH will then train NHMSs in the region..

- **End-user needs and requirements with regards to marine service provision identified and NMHSs marine forecasting capacity strengthened in Trinidad and Tobago and Grenada**
  Two workshops held in November 2022 and May 2023 with participants from NMHSs and key-target sector end-users from fisheries, tourism, academic, oil-and-gas sectors identified user needs with regards to marine service provision. The workshops functioned as platform for exchange, increased mutual understanding and paved the way for more intensive collaboration. Action plans to integrate user requirements in the service portfolio of the NMHSs were developed. Further, capacity was strengthened in related NMHSs of Grenada and Trinidad and Tobago in specified high-need areas as requested by the respective NHMSs – for example

	with regards to rip currents, astronomical tides, or the role and provision of support from NOAAs in the region. *Deliverables/additional information: Google Drive Folder* • **Database for non-tropical cyclone severe weather cases in the Caribbean developed** Under the leadership of CMO, a prototype database of Caribbean severe weather cases, which are not produced by tropical cyclones was finalized in June 2023. The database improves regional forecasting capability through enabling forecasters to recognize environmental conditions and characteristics of various types of severe weather and their impacts. A graphical user interface was further developed to enable queries through various methods, e.g., by phenomena, by date, by season or attributes. *Deliverables/additional information*: *Google Drive Folder* • **Integrated river flood forecasting system (IRFF) successfully implemented in the Dominican Republic (financed through ECCC CREWS project closed in 2022) and next steps initiated** After the IRFF was successfully implemented, a baseline review was conducted to guide and inform the development of a strategic/operating institutional plan at national level. This plan shall address persisting deficiencies in infrastructure and data management, accessibility of real-time hydrological data, capacity building (mainly in the field of hydrology), knowledge transfer between various institutions and processes/systems that deliver information to support decision-making on hydrometeorological warning. *Deliverables/additional information*: *Google Drive Folder* (c) Implementation of WMO cascading initiatives such as the Severe Weather Forecasting Demonstration Project, Global Flash Flood Guidance System, Caribbean Climate Outlook Forum, and Caribbean Early Warning Information Systems Across Climate Time Scales Consortium Meetings. • **Regional workshops and meetings brought together relevant stakeholders, fostered cross-regional collaboration, strengthened capacity and knowledge transfer** The Caribbean Climate Outlook Forums (CARICOFs) and Early Warning Information Systems Across Climate Time Scales Consortium Meetings (EWISACTS) between 2019 and 2022 were supported through the CREWS Caribbean project. The “Climate Change in the Caribbean” workshop, held in November 2019, encouraged the application of climate sciences and longer-term climate change considerations across the region. Two “Elucidating the Role of Clouds-Circulation Coupling in Climate” (EUREC4A) workshops under the Caribbean

	Severe Weather Forecasting Initiative (SWFP) were held in December 2019 and February 2023. The first workshop prepared the EUREC4A- Atlantic Trade wind Ocean-Atmosphere Mesoscale Interaction Campaign/Ocean Atmosphere component tests which addresses the Northwest Tropical Atlantic Ocean-atmosphere interactions and their relation to the regional Oceanic Barrier Layer, air-sea interactions, and atmospheric shallow-convection. Through the workshop, forecasters enhanced their capacity to monitor and forecast local weather with the use of state-of-the-art, high-resolution weather forecasting models; especially related to dry-season conditions. The second workshop developed draft sections for a scientific paper on the EUREC4A field study, the synoptic influences on severe weather and the transportation of dust and other aerosols. *Deliverables/additional in*formation: *Google Drive Folder* • **Capacity with regards to forecasting and management of hurricanes and tropical cyclones strengthened; newly developed online module provides additional 24/7 learning opportunity for forecasters** Through CREWS Caribbean, experts from the region partook in the WMO organized "Hurricane Committees" in 2019, 2022 and 2023 as well as in "Tropical Cyclone Forecasting Workshops" in 2019 and 2022. A newly developed learning module accessible on WMO Moodle on "Caribbean Early Warnings Using the Potential Tropical Cyclone (PTC) Advisory" improves capacity with regards to the timeliness of impact-based warnings associated with developing tropical cyclones in the Caribbean. *Deliverables/additional information: Google Drive Folder,* (d) Improve utilization of Doppler radar information and other remote sense data for "now-casting" of extreme meteorological and hydrological events. Multi-Sensor Precipitation Grid developed by WB under project Component III. *(e) Introduction of Multi-Hazard Early Warning Systems, risk assessments and Impact-Based Forecasting;* • **A new weather application for smartphones creates easy access to weather information and warnings to the Jamaican population** The Meteorological Service of Jamaica (MSJ) launched an easy-to-use weather app for smartphones. It provides hour-by-hour forecasts for all locations on the island for the next five days (under development: 5-day MHEWS forecast & marine forecast). The Jamaica Weather app, which is free to download for apple and

	android systems further shows any weather warnings that are in force. The initiative strongly improved the ways MSJ communicates with its users, especially those who are most vulnerable to extreme weather impacts. The app-development was based on the principle of co-design, which involved bringing together producers, users and communicators of weather information to jointly design more accurate, easy to understand and useful weather information products. This activity included the procurement of a workstation, training of MSJ staff through the Finnish Meteorological Institute, outreach activities conducted/coordinated by Resurgence, the Caribbean Climate Innovation Center and Food for the Poor as well as an update of the MSJ website (under finalization). The initiative was co-funded between the Inter-American Development Bank (IDB) and the CREWS Caribbean initiative. *Deliverables/additional information: Google Drive Folder* • **Implementation of the Common Alerting Protocol (CAP) supported through training workshops in Belize and Turks and Caicos Islands** Workshops held in Belize and Turks and Caicos in May 2023 provided a platform for key stakeholders, such as representatives of NMHSs, NDRMOs, police, media and telecommunications involved in the production and dissemination of warnings to get together to advance the implementation of CAP in their respective countries. As outcomes of the workshops, national arrangements for the preparation and dissemination of CAP alerts and warnings were defined and competence in the application of CAP in hydrometeorological early warning systems, processes and procedures was increased. This will lead to increase of efficiency and effectiveness in early warning communications, especially with regards to most at risk population. *Deliverables/additional information*: *Google Drive Folder* *(f) Awareness raising with multiple actors on early warning as integrated element of disaster risk management and (g) Awareness raising and capacity building for priority sector users through joint training with service provides* • **Early response and action capability with regards to flood hazards strengthened in vulnerable communities of Antigua and Barbuda and Trinidad and Tobago** Aligned with the above mentioned PA3, community-based flood management activities were implemented in the two countries under the Associated Programme on Flood Management. This was implemented in joint collaboration with community leaders, local NMHSs, NDRMOs, the Trinidad and Tobago Red Cross society and other key authorities. In Antigua and Barbuda, a flood awareness and management workshop along

	with a first aid-training strengthened relevant capacities of more than 20 leaders from flood prone communities of - St. Mary's North, St. Mary's South, St. John's Rural West and St. John's City East. Flood level house markings, the procurement of loudspeakers and mapping of vulnerable houses increased the preparedness of these communities. A media training helped to increase understandability of weather information for 8 media representatives and a regional training workshop on gender mainstreaming in end-to-end early warning system for flood forecasting and integrated flood risk management discussed opportunities, challenges and obstacles related to integrating most at risk groups in flood management. In Trinidad and Tobago, a flood management and awareness workshop strengthened relevant knowledge of community leaders and served as a platform to engage as well as assess available resources and established processes for flood management in the community of Sangre Grande. Over 15 Flood Level house markings installed by the community members further increased awareness and preparedness amongst the whole community. Based on these activities, a draft manual on "Community Based Flood Management in the Caribbean" was developed which will function as a "living repository". *Deliverables/additional information: Google Drive Folder* • **Awareness videos inform Caribbean population about usability and expected behavior with regards to ocean buoys and costal inundation in three local languages** All videos are accessible on YouTube: ○ English: Ocean Buoy Awareness - Caribbean (English) - YouTube ○ Creole: Ocean Buoy Awareness - Caribbean - (Creole) - YouTube ○ Spanish: Ocean Buoy Awareness - Caribbean (Spanish) - YouTube ○ English: Coastal Inundation Awareness - Caribbean – Hilly terrain (English) - YouTube ○ English: Coastal Inundation Awareness – Caribbean – Low-lying landscape (English) - YouTube ○ Creole: Coastal Inundation Awareness - Caribbean – Hilly terrain (Creole) - YouTube ○ Creole: Coastal Inundation Awareness – Caribbean – Low-lying landscape (Creole) - YouTube ○ Spanish: Coastal Inundation Awareness - Caribbean – Hilly terrain (Spanish) - YouTube ○ Spanish: Coastal Inundation Awareness – Caribbean – Low-lying landscape (Spanish) - YouTube • **Improving living repository of open-source global and national risk data to improve risk literacy and strengthen national risk data ecosystems.** A first mapping of sources of information for gathering available, accessible, up-to-date, and recurrent data that could be tailored for integrating impact information in early

	warning systems was developed for Guyana and Trinidad and Tobago. A discussion with national entities producing this data is planned to establish a sharing data mechanism aiming to create living repositories of open-source national risk data at the national offices for disaster risk management in both countries. Additionally, a National workshop on Impact-based Forecasting databases was held in Trinidad and Tobago. As a platform to centralize and make hazard and climate risk information available, the development of a mirror of the Risk Information Exchange (RiX) platform in the country has been launched. Discussions with Guyana have been initiated, and it is expected that the launch of the RiX platform for Guyana would start at the beginning 2023. Impact: multisectoral dialogues have been started around risk data aggregation. All sectors in the selected countries are now identifying the information they currently produce as input data for describing exposure or vulnerabilities. With this information NDMOs and scientific public institutions, such as the MET offices, will have a better set of information that could be tailored for transitioning from traditional EWS to those with impact information (IBF). RiX country pages developed in the framework of this project can be found in the following link. Additionally, the Bank carried out the radar study based on the request of the CMO HQ in Belize, Barbados, Trinidad and Guyana. The results were highly satisfactory and provided additional technical information to the CMO HQ that forms the basis of radar modernization strategy in countries. At this stage, in line with the CREWS/GCF Scaling Up framework, a project proposal is being developed to ensure the radar modernization strategy. The project has achieved its objective of helping partners continually improve national and regional hydrometeorological and early warning capacity and service delivery to advance preparedness and reduce multi-hazard risks. The project's outcomes will be helpful to all those involved in the planning of the future activities in the region, including regional and national agencies as well as development partners.
12.	

13. Lessons Learned

Kindly note important lessons learned from the project, including what were the factors that hindered or enabled successful project implementation and contributions to each of the CREWS value propositions (200 to 250 words).

1. Successful implementation of the roadmap and advancing the transition to MHEWS are contingent on the region taking ownership and securing resources, as the strategic initiatives will require collaboration and resourcing at international, regional, and national levels. While the roadmap serves as a strategic document to guide regional actions for implementing a robust, cascading, impact-based MHEWS, regional organizations and member state agencies will need to provide direction, leadership, and commitment which will require sustained adequate resourcing.
2. Further harmonization of activities aimed at strengthening the regional Multi-Hazard Early Warning Systems (MHEWS) is needed, and synchronization of regional and international cooperation is essential for societies to improve timely access to high-quality, actionable information.
3. Connecting the capacities and capabilities of regional institutions with the national services is critical for the sustainability of results. The Caribbean is a region with strong regional institutions. Regional ownership of the roadmap as the commitment to improving MHEWS on a regional is vital, as regional organizations will need to provide direction, leadership, and commitment for their member state agencies since the implementation will be largely at a national level and will require strong national and local operational coordination and interoperability to be sustained and remain relevant.

4. The policy and regulatory environment will need to advance in concert with technical progress, with all participating states implementing CDEMA's Model National MHEWS Policy. Supporting a regionally harmonized approach is essential for interagency data-sharing, developing the applications and modeling that are crucial for IBF transition, and facilitating the expansion of private sector collaboration along the whole EWS value chain.
5. Data policy development is challenging, yet crucial for impact-based MHEWS delivery. Although there is considerable capacity in the region, there are also significant challenges. Chief among these is the ability and willingness to share data, and the lack of understanding of the consequences of withholding data—on weather, water, climate and geophysical hazards, exposure, and vulnerability—needed to produce risk-based warnings for communities and sectors. Such constraints adversely affect key institutions' ability to understand causal hazard processes and develop robust methodologies for delivering continually improving impact-based services.
6. Countries should prioritize capacity building and retention to ensure the sustainability of impact-based MHEWS implementation and ongoing change management. Knowledge and skills training are required at all levels to apply available tools and techniques to ensure the relevant institutions can manage change effectively to ensure the sustainability of introducing new techniques or technologies. A systematic approach to preparing and implementing a tailored capacity development plan should allow for identifying capacity gaps.
7. Involving private sector actors as contributors and beneficiaries will strengthen demand for sustaining impact-based MHEWS. A new service driven business model needs to be explored and developed. Larger regional-level enterprises can also shoulder some of the

responsibility for ongoing maintenance and improvement to ensure needs-responsive EWS, while engaging micro-, small- and medium-sized enterprises (MSMEs) in national processes will help services reach the last mile and strengthen inclusion by enabling business owners to define their needs and help build the impact-based MHEWS.

8. The transformative gender and inclusion methodology is integral to MHEWS delivery. As well as ensuring an ongoing examination of who is most at risk, who has access to the information needed to generate early warnings, how and to whom warnings are issued, and the adequacy of anticipatory actions triggered by alerts, this will help ensure vulnerable groups participate in and contribute to disaster risk reduction, preparedness, response, and recovery.
9. The academic sector is an important vehicle for growth in the hydromet and other hazard domains. Applying scientific advances to strengthening early warning systems and building new technologies to address community, national, regional and global challenges is crucial for bringing about some of the changes.

14. Stakeholders

a. List all individuals or groups that either contributed to, have been engaged and have benefited from the funded project/activity.

Stakeholder	Role/Contribution
Association of Caribbean States	Substantial contributor to the development of a report mapping the existing capacities of CDEMA Participating States
Bruce Muller (Mr.)	Substantial contribution to the Marine Service Course
Caribbean Climate Innovation Center (CCIC)	Substantial contributor in the development of weather app in Jamaica
Caribbean Disaster Emergency Management Agency (CDEMA)	Regional partner, substantial contributor to all major products, and chair of REWSC
Caribbean Institute for Meteorology and Hydrology (CIMH)	Regional partner, leader for a priority activity, substantial contributor to all major products
Caribbean Meteorological Organization (Headquarters)(CMO)	Regional partner, leader for several priority activities, substantial contributor to all major products

CARICHAM, Caribbean Chambers of Commerce	Regional partner supported the development of the regional consultation on Integrating Private Sector on Multi-Hazard Early Warning Systems' Governance and Actions. Similarly, they host the Virtual Center of Excellence where MHEWS resources are available for SMEs.
Caribbean Telecommunications Union	Substantial contributor to PA4
Carol Subrath Ali (Ms.)	Substantial contributor to Marine workshops in Grenada and Trinidad and Tobago
Civil Defence Commission of Guyana	Substantial contributor to the development of the living repository of open-source global, regional, and national risk information
Eliot Cristian (Mr.)	Substantial contributor to CAP implementation workshops Belize and Turks and Caicos Islands
Evan Thompson (Mr.)	President of WMO RA IV – substantial contributor to major products, peer reviewer of roadmap, substantial contributor in the development of weather app in Jamaica
International Federation of Red Cross and Red Crescent Societies	Substantial contributor to the implementation of risk and MHEWS´ perceptions dialogues with national and local authorities and local communities in Trinidad and Tobago, Saint Lucia, Jamaica and Saint Vincent and the Grenadines
Fidel Perez (Mr.)	Substantial contributor to baseline assessment Dominican Republic
Finnish Institute for Meteorology (FMI)	Substantial contributor in the development of weather app in Jamaica
Grenada Airports Authority (GAA)	Substantial contributor to Marine Services workshop
Jacinto Leonardo Artigas Montilla (Mr.)	Substantial contributor to baseline assessment Dominican Republic
Jean Noel Degrace (Mr.)	Substantial contributor to marine workshop in Grenada
John Parker (Mr.)	Leading the review of Marine Service provision in the Caribbean
Lon Goldstein (Mr.)	Substantial contributor to Learning Module Development – Tropical Cyclone Forecasting
Matthew Kelsch (Mr.)	Substantial contributor to Learning Module Development – Tropical Cyclone Forecasting
Meteorological Service of Jamaica (MSJ)	Substantial contributor to PA3, substantial contributor in the development of weather app in Jamaica Water Resources Authority, Jamaica – substantial contributor to PA3

National Emergency Management Office of Saint Vincent and the Grenadines	Supported the implementation of risk and MHEWS´ perceptions dialogues with national and local authorities and local communities in Bequia island
National Meteorological Service of Belize	Substantial contributor to CAP Implementation (workshop)
National Oceanic and Atmospheric Administration (NOAA)	Contributor to marine workshop in Grenada and Trinidad and Tobago
National Office of Disaster Services (NODS)	Substantial contributor to community based flood management activities in Antigua and Barbuda
Office of Disaster Preparedness and Emergency Management of Jamaica	Supported the implementation of risk and MHEWS´ perceptions dialogues with national and local authorities and local communities in the Parish of San Antonio
Office of Disaster Preparedness and Management of Trinidad and Tobago	Supported the implementation of risk and MHEWS´ perceptions dialogues with national and local authorities and local communities in Tobago Island. Similarly, they were a substantial contributor to the development of the living repository of open-source global, regional, and national risk information
Resurgence	Substantial contributor in the development of weather app in Jamaica
RoofTop	Video Development
Regional Early Warning Systems Consortium	Substantial contributor to the development of the MHEWS Capacities mapping in the Caribbean region.
Saint Lucia Meteorological Service	Substantial contributor to PA3
Saint Lucia National Emergency Management Organization	Supported the implementation of risk and MHEWS´ perceptions dialogues with national and local authorities and local communities in Saint Lucia
Tobago Emergency Management Agency	Supported the implementation of risk and MHEWS´ perceptions dialogues with national and local authorities and local communities in Tobago Island
Trinidad and Tobago Water Resources Agency	Substantial contributor to community-based flood management activities in Trinidad and Tobago

Trinidad and Tobago Red Cross Society	Substantial contributor to community-based flood management activities in Trinidad and Tobago, including risk and MHEWS´ perceptions dialogues with national and local authorities and local communities in Tobago Island
Turks and Caicos Airports Authority	Substantial contributor to CAP Implementation (workshop)
University of West Indies	Substantial contributor to the risk and MHEWS´ perceptions dialogues with national and local authorities and local communities
UK Met Office (UKMET)	Substantial contributor to EUR4CA Workshops & Climate Change in the Caribbean Workshops
Vieri Tarchiani (Mr.)	Consultant baseline assessment Dominican Republic
Water Resources Management Agency of Saint Lucia	Substantial contributor to PA3
Willian Burbano (Mr.)	Substantial contributor to RIX Development

b. What were the roles of the individuals or groups listed in a and what were their concrete contributions?

See a)

15. Visibility products

a. Insert or copy any links to press releases, videos or communication items and/or social media links

Over the course of the project, many visibility products have been created by the project team and/or partners. Please find below a selection of the most important products

Project Component	Category	Link
General	Project Information General	• https://www.gfdrr.org/en/crews-caribbean • Coordinating Early Warnings for All - Americas and the Caribbean | World Meteorological Organization (wmo.int)

	• Enabling sustainability for Early Warning Systems in the Caribbean | World Meteorological Organization (wmo.int) • https://www.preventionweb.net/news/caribbean-leads-way-towards-early-warnings-all • UN-backed project boosts early warning services in the Caribbean | UN News • Regional cooperation strengthens disaster risk reduction efforts in the Caribbean • Disaster prevention in the Caribbean: a buoy for the future
Governance	• The Caribbean consolidates its partnership for advancing multi hazard early warning systems in the region • Mapping MHEWS capacities of CDEMA Participating States (Interactive Map) (Report) • Disaster risk reduction in the Caribbean: Situational analysis • Virtual Center of Excellence to support business resilience for Caribbean SMEs. (MHEWS) • Prime Minister calls for more timely hazard warnings and business continuity • A human-centred understanding of disaster risk • NEMO, UNDRR, IFRC to hold 'early warning systems' workshop in Bequia • Lessons from SVG's disaster response integrated into UN framework • Tobago participation in a risk perception dialogue • Caribbean Regional Workshop on Measuring Effectiveness of Early Warning Systems through Sendai Framework Target (g) and Custom Indicators • UWI, UNDRR Launches Survey to Study Knowledge & Perception of Risk & Early Warning Systems in The Caribbean • Gov't committed to improving disaster early warning systems • Remarks by the Resident Coordinator at the Improving Multi-Hazard Early Warning Systems' Governance Consultation with National Disaster Risk Management Offices in the Caribbean • Legislation to be introduced to develop Early Warning Systems

Component 1	Strategic Roadmap	• https://www.preventionweb.net/publication/strategic-roadmap-advancing-multi-hazard-impact-based-early-warning-systems-and • Mapping MHEWS capacities of CDEMA Participating States (Interactive Map) (Report) • Disaster risk reduction in the Caribbean: Situational analysis • Virtual Center of Excellence to support business resilience for Caribbean SMEs. (MHEWS)
Component 2	Weather App Development - Jamaica	• Met Service Launches BReTCAT- March 28, 2022 – Jamaica Information Service (jis.gov.jm) • JIS News-23.03.2022 - YouTube • Project To Enhance Weather Communication In Jamaica – Jamaica Information Service (jis.gov.jm) • Met Service Launches BReTCAT- March 28, 2022 – Jamaica Information Service (jis.gov.jm) • https://drive.google.com/file/d/115W8J4opuolQetKPTHB0dZa9uLFsqkRC/view?usp=sharing (COP27 Side Event Segment featuring BReTCAT) • Jamaica Weather on the App Store (apple.com)
	Community Based Flood Management - Trinidad and Tobago; Antigua and Barbuda	• NODS reinforces flood management measures with two-day workshop | Antigua Observer Newspaper • Gender mainstreaming workshop strengthens flood preparedness response across CDEMA states | Antigua Observer Newspaper • Implementation of Community-based Approaches to Flood Management | World Meteorological Organization (wmo.int)
	Marine Workshops - Grenada; Trinidad and Tobago	• November 17th, 2022 | World Meteorological Organization concludes two day training - YouTube • CREWS Caribbean Project Delivers on Marine Services and Flood Management | World Meteorological Organization (wmo.int) • (20+) Facebook Live | Facebook • TTMS improving Marine Services in T&T - Trinidad Guardian

Component 3		• TTMS improving Marine Services in T&T - CNC3 • https://newsday.co.tt/2023/05/19/tobagonians-learn-about-weather-warnings
	Meteorological Legislation; National Strategic Plans	• Press release CMO • Press release WMO
	Workshops on Implementation of the Common Alert Protocol - Belize; Turks and Caicos	• TCI developing its own national meteorological services (suntci.com) • Early warning communication training for emergency workers (tcweeklynews.com) • National Meteorological Service of Belize hosts workshop on Common Alerting Protocol (CAP) (breakingbelizenews.com)
	Living repositories of open-source national risk information (RIX Mirror)	• Risk Information Exchange • https://www.undrr.org/news/trinidad-and-tobago-adopts-undrrs-new-risk-information-exchange • https://www.preventionweb.net/news/trinidad-and-tobago-benefit-disaster-risk-information-platform • https://sdgs.un.org/sites/default/files/2022-07/UNDRR_Inputs_2022_SG_Report_on_Caribbean_Sea.pdf • https://trinidadandtobago.un.org/en/190799-trinidad-and-tobago-gears-increase-resilience-disasters
		• httpwoos://www.youtube.com/watch?v=J7eS4wfUsng&feature=youtu.be

16. Supporting documents

a. List and annex to the report any documents providing details on project activities such as review reports, reports of training sessions, technical assessment reports, online solutions and tools, manuals, summaries of high-level discussions etc.

- A Situation Analysis of the Caribbean Multi Hazard End to End Early Warning Systems
- Final Multi-Hazard Early Warning Systems Report for Barbados
- Final Multi-Hazard Early Warning Systems Report for Guyana
- Final Multi-Hazard Early Warning Systems for Trinidad and Tobago
- Caribbean Meteorological Organization Weather Radar Review
- A Strategic Roadmap for Advancing Multi-hazard Impact-based Early Warning Systems and Services in the Caribbean.
- Implementation Plan for Building Capacity in Multi-hazard Impact based Forecasting and Warning Services in the Caribbean region
- Development of a Multi-sensor Precipitation Grid under the Climate Risk and Early Warning Systems (CREWS) Caribbean Initiative
- Strategy for developing an end-to-end (E2E) flood-integrated operational early warning system (EWS) in Jamaica.
- Concept of an Integrated Flood Forecast and Warning System for St. Lucia.
- Strengthening Regional Emergency Alert Capacity of the Caribbean Region.
- National Strategic Plans & Legislation (in google folder)
- All deliverables are available here: *Google Drive Folder*