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CDEMA CARIBBEAN DISASTER EMERGENCY MANAGEMENT AGENCY *Resilient States · Safer Lives*

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STRENGTHENING EARLY WARNING SYSTEMS IN THE CARIBBEAN

SAINT LUCIA

HAZARD, VULNERABILITY, AND RISK STUDY FOR FLOODS

PRIOR KNOWLEDGE AND IDENTIFICATION OF RISK

MONITORING AND WARNING SYSTEMS

DISSEMINATION AND COMMUNICATION

RESPONSE CAPACITY

STRENGTHENING EARLY WARNING SYSTEMS IN THE CARIBBEAN SAINT LUCIA

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This document covers humanitarian aid activities implemented through the project *Strengthening the integration of early warning systems for more effective disaster risk reduction, through knowledge and tools transfer*. The project is led by the United Nations Development Program (UNDP) in collaboration and coordination with the Caribbean Disaster Emergency Management Agency (CDEMA) and the International Federation of Red Cross and Red Crescent Societies (IFRC). Financial assistance was provided by the European Civil Protection and Humanitarian Aid Operations (ECHO).

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ACRONYMS

ADCIRC » Advanced Circulation Model
CAP » Common Alerting Protocol
CDEMA » Caribbean Disaster Emergency Management Agency
CDM » Comprehensive Disaster Management
CEWS » Community Early Warning Systems
DEM » Digital Elevation Model
DIPECHO » Disaster Preparedness Program of the European Civil Protection and Humanitarian Aid Operations
DRR » Disaster Risk Reduction
ECHO » European Civil Protection and Humanitarian Aid Operations
EU » European Union
EWS » Early Warning System
FEMA » Federal Emergency Management Agency (USA)
GIS » Government Information System
GIS » Geographic Information System
HIP » Humanitarian Implementation Plan
HVR » Hazard, Vulnerability, and Risk
IFRC » International Federation of Red Cross and Red Crescent Societies
IN-MHEWS » International Network for Multi-Hazard Early Warning Systems
NEMO » National Emergency Management Organization
NMS » National Meteorological Services
NOAA » National Oceanic and Atmospheric Association (USA)
SSC » South-South Cooperation
SVG » Saint Vincent and the Grenadines
SWAN » Simulating Waves Nearshore
UNDP » United National Development Program
USGS » US Geological Survey
WRMA » Weather Risk Management Association

1. INTRODUCTION

The Caribbean region is highly prone to natural hazards such as hurricanes, floods, volcanic and seismic activities, droughts and forest fires. The increasing impact of global climate change and the risk posed by a range of natural, environmental and technological hazards are among the Caribbean's most critical development problems. The past decades have been marked by an intensification of the impact of disasters, such as destruction of livelihoods and communities, as well as a setback in development gains.

Due to the high levels of vulnerability, there is a broad recognition of the need to strengthen capacity for preparedness, response, and recovery, and integrate risk reduction measures into development paths to create safe, resilient and sustainable communities and States in the Caribbean. As one component to reducing risk, the Caribbean Comprehensive Disaster Management (CDM) Strategy 2014 – 2024 prioritizes integrated, improved and expanded community early warning systems.[1] This focus is reinforced by the Sendai Framework for Action which calls for enhanced disaster preparedness.[2] Likewise, UNDP's Strategic Plan 2018 – 2021 aims to strengthen resilience to crisis and shocks and support countries with assessments, planning tools and mechanism so that gender-sensitive and risk-informed prevention and preparedness solutions are available to limit the impact of natural hazards.[3] Reducing risk and building resilience is a theme that cuts across the Sustainable Development Goals.

As identified in the ECHO Humanitarian Implementation Plan (HIP) 2017, preparation and response capacities in the Caribbean have improved. However, the need for further action to address preparedness capacities, reinforce Early Warning Systems (EWS) and foster exchanges between countries and linkages with regional institutions is crucial. The HIP specifically highlighted that "collaboration between countries on Early Warning Systems to exchange on good practices should be

1. Priority Area 4, Outcome 3, Regional CDM Strategy 2014 – 2024 https://www.cdema.org/cdm
2. Priority Area 4, Sendai Framework for Disaster Risk Reduction 2015 – 2030. https://www.unisdr.org/we/coordinate/sendai-framework
3. Outcome 3, Signature Solution 6, UNDP Strategic Plan 2018 – 2021 https://strategicplan.undp.org/

fostered" and stressed that the "compilation of DRR tools and processes endorsed at national and regional level, led by national systems in coordination with the CDEMA, EU Delegations and other development actors" are priority areas for action.

Thus, Antigua and Barbuda, Dominica, Dominican Republic, Saint Lucia and Saint Vincent and the Grenadines (SVG) set out to improve their Early Warning Systems (EWS) through an 18-month project financed by European Civil Protection and Humanitarian Aid Operations (ECHO). The *"Strengthen Integrated Early Warning Systems for more effective disaster risk reduction in the Caribbean through knowledge and tool transfer"* project sought to strengthen EWS components and close priority gaps at a national level, contributing to the integration of national and community EWS, and addressing sustainability and national ownership of EWS.

The country level actions were supported by UNDP, International Federation of the Red Cross and Red Crescent Societies (IFRC), and the Caribbean Disaster Emergency Management Agency (CDEMA), who embraced a partnership approach and helped reinforce the efforts to realize a more integrated EWS and enhance disaster risk reduction at the regional, national and community level.

The project also aimed to increase access to tools and knowledge of EWS at a regional, national and regional level, through development of, improvement to, and translation of models, methodologies and toolkits to distinct contexts. Emphasis was put on knowledge transfer and exchange, allowing actors to leverage the expertise that exists in the Caribbean to reduce disaster risk and foster stronger linkages between countries exposed to the similar risks.

This case study details the South-South Cooperation (SSC) process and activities between Dominica and Cuba. Based on the EWS Checklist analysis and the Gap Report, Dominica identified risk analysis for floods as a specific gap that could benefit from Cuban expertise. Cuba offered to adapt and share the Hazard, Risk and Vulnerability (HRV) study methodology; Cuban institutions and specialists prepared packages and trainings and accompanied Dominican institutions in implementing a pilot project that addressed identified deficiencies in the early warning system. This document provides a systematization of the results, lessons, processes and tools used in the process of transferring knowledge and capacity between Dominica and Cuba.

This document is intended to be read together with, and complemented by, the *Strengthening* Early Warning Systems in the Caribbean and Strengthening Early Warning Systems in the Caribbean: South-South Cooperation documents.

2. CONTEXT

Saint Lucia, by virtue of its geographic location, physical formation andfragile ecosystems is at risk from several natural, technological and human-induced hazards. These hazards have the potential to cause loss of lives, severe damage to infrastructure and other economic assets, as well as cause adverse effects on livelihoods. Some of the natural hazards include hurricanes, flooding, landslides, tsunamis, droughts, and seismic and volcanic activity. Tropical storms and hurricanes are also frequently accompanied by storm surges, floods and landslides, which give rise to soil, beach and/or coastal erosion.

Interventions at the national level towards measurably reducing vulnerability to natural hazards and the adverse impacts of climate change in Saint Lucia have involved significant infrastructure and mitigation works, and strengthening emergency preparedness and early warning systems, as well as training and capacity development for community-based disaster management organizations, shelter managers and the staff of the National Meteorological Services (NMS). The National Emergency Management Organization (NEMO) continues to develop and revise national emergency management plans for specific hazards and sectorial/agency multi-hazard plans. These advancements contribute to the state of readiness of the country.

While there has been notable progress, there is still a need to further strengthen EWS particularly for hurricanes, floods, tsunamis, and volcanic events. Improvements are also required in data collection - particularly for hydrological and meteorological monitoring networks at both national and regional scales.

3. DEMAND & OFFER

3.1 The Demand

Initial Identification of Needs: In the case of Saint Lucia, a SSC initiative had not been initially planned within the framework of the project. When the first contact with Cuba was made during the "Regional Exchange of Experiences for Disaster Risk Reduction" event held in Juan Dolio, Dominican Republic during the first week of April of 2018, Saint Lucia was preparing itself for the launch of the MHEWS Checklist and had therefore not identified the full scope of its gaps and priorities. Nevertheless, Saint Lucia had already identified the management of flooding risk as a key priority, given its disaster history. Hearing about Cuba's good practices, Saint Lucia expressed interest in collaborating with Cuba. The Director of NEMO Saint Lucia met with the Cuban delegation, CDEMA, and UNDP during the event to request technical assistance. Thus, in Saint Lucia's case, a precise need was determined from the get-go, unlike other countries that received a series of options and Solutions Packages. An agreement was reached whereby Cuba would prepare a single Solution Package for Hazard, Vulnerability and Risk (HVR) Studies, while Saint Lucia continued its gap analysis process. Saint Lucia agreed to send the gap findings to Cuba so that the proposed solutions could be more tailored to their needs.

Solutions Package: The Cuban SSC Expert Committee prepared a single Solution Package for Saint Lucia focused on the HVR Studies, with emphasis on flooding from intense rains and a note that more information on the EWS institutional system would influence its applicability. The Cuban Civil Defence delivered the Solution Package to Velda Joseph, Director of NEMO Saint Lucia, during the 10th International Congress on Disasters held in Cuba in July of 2018.

SSC Priority Action Proposal: The Solutions Package was reviewed by NEMO Saint Lucia and CDEMA; follow-up discussions were held with the Cuban Ministry of the Environment and Civil Defence to seek clarification on the proposal. Saint Lucia then prepared the Priority Action Proposal, which adjusted for the resources available, the country context, the findings of the MHEWS Gap Report, and the nature of the transfer needed. The final proposal focused on HVR Studies and aligned its actions under the Comprehensive Disaster Management (CDM) *Priority Action 1* (Strengthening of the Enabling Environment) and *Priority Action 2* (Capacity Building for Conducting Hazard, Vulnerability and Risk Studies), as well as the priority actions of the MHEWS Roadmap. $ USD 30,410 was budgeted for the proposal: $ USD 18,808 from the ECHO-funded project, $ USD 10,000 from CDEMA, and $ USD 1,602 of NEMO Saint Lucia's funds. The proposal further highlighted the following gaps:

a) There are no national standards for the systematic collection, sharing, and assessment of risk information and data related to hazards, exposure, vulnerabilities and capacities readily available to assist with DRR activities;

b) There has not been an assessment of how the impact of activities of people or groups increases or compounds risk;

c) Assessment of exposure, vulnerabilities, capacities, and risks and documentation of such does not exist for critical infrastructure/services, therefore, implementation of risk management solutions to increase resilience of critical infrastructure is lacking;

d) There is a general absence of risk management plans at the local level.

Identification of Leading Recipient Organization: Given NEMO's role and the multi-disciplinary nature of HVR Studies, NEMO was identified as the coordinating recipient institution, in line with the responsibilities assigned for this priority action. No external or additional human resources were included to support the implementation.

Implementing Partner: The implementing partner supporting Saint Lucia was CDEMA. Its role was two-fold, to facilitate all exchanges between Cuba and Saint Lucia, and to ensure that tools, training, and methods used by the offering country were properly adapted to the context, time available, and language of the recipient country. UNDP provided additional support.

Selecting a Community: The coastal community of Dennery located on the eastern side of Saint Lucia was identified as the pilot community based on two criteria:

- It is an area historically affected by extreme flooding events, including coastal inundations, which had caused severe devastation and significant losses to individuals and households. Over the years, the community had called for practical solutions to address such issues, as well as the district's vulnerability to natural hazards in general;

- The community had piloted its Common Alerting Protocol (CAP) compliant multi-hazard EWS in 2017, and the initiative was looking to enhance and build upon this previous work.

Virtual Coordination Session: A video conference was held between NEMO, Cuba, CDEMA and UNDP in October 2019, during which it was decided to focus the HVR on two types of hazard: a) floods from intense rains, and b) coastal floods. This would require an adaptation of the material and design of the training, as each has a separate methodology under the Cuban HVR Studies guidelines. A list of required information was shared by Cuba for both types of hazards, so that NEMO could compile and send them to the Cuban team in preparation of the training. A list of recommended technical profiles of trainees was also shared.

Establishing a Multi-disciplinary Team: A multidisciplinary group was formed with 21 experts from several national institutions, including NEMO, Ministry of Planning, NMS, Department of Education, Department of Infrastructure, Fire Services, Department of Housing, Department of Gender Relations, and Ministry of Equity. CDEMA and UNDP accompanied the training group.

3.2 The Offer – Hazard, Vulnerability and Risk Study (HVR) for Floods

Coastal floods are influenced by the submarine slope and the configuration of the coast and occur as a result of waves and surges generated by meteorological conditions such as cold fronts, winds, and hurricanes. Analysis of coastal flooding draws on historical data, is based on return period, and considers impact direction, for any range of event intensity. The HRV Study for Coastal Flooding incorporates these variables into a numeric model; vulnerability calculations take into account damage to infrastructure. This coastal flooding methodology was combined with the HVR Study for Intense Rain.

HVR Study for Coastal Flooding

PRODUCTS IT GENERATES:

- Standardized procedures for collecting and organizing information and developing HVR research to ensure a homogeneous level of measurement and analysis in all territories, from national to local levels.
- Risk analysis of coastal floods for different return periods.
- Hazard maps of coastal floods in Geographic Information System (GIS)
- Maps of exposed elements and vulnerabilities according to the key indicators, using GIS and field data.
- Risk analysis for municipalities and comparison with others within the country, and their GIS mapping
- Technical report including the results and cartographic output for each unit of analysis.

SCOPE OF THE STUDY:

- For coastal floods, the study is at the municipality level. The working scale is 1:25 000 or higher for detailed case studies.

PRE-REQUISITES:

- GIS
- Sufficient available data, such as inland cartography, data on wind, extreme wave and extreme weather conditions, etc.
- Digital Elevation Model (DEM) at scale 1:25 000 or higher in digital format

SUMMARY OF THE METHODOLOGY:

Coastal Flooding Hazard

- ***Numerical surge modelling:*** Is based on variables related to processes of surge and storm tides, including size, travel speed, maximum wind speed, radius of maximum winds and central pressure, bathymetry, topography and coast configuration, buildings and facilities on the coast, and vegetation, among others.
- The spatial characteristic of the ocean bottom is the most important factor in surge wave amplification.
- ***Numerical wave modelling:*** Includes variables related to the processes of energy generation and dissipation, wind generation, nonlinear interactions, diffraction, dissipation by white capping and by wave breaking due bottom influence.
- Uses numerical prediction modelling systems, such as SWAN (Simulating Waves Nearshore) and ADCIRC (Advanced Circulation Model), combined with GIS.

Vulnerability

- **Structural vulnerability:** Analyses the resistive capacity of buildings to the destructive forces of different floods and waves. This includes the construction type, technical condition and height of buildings, the soil type, the influence of slope and height where the building is located, and housing location with respect to the coast to consider the effect of waves and the fast flow of water, among other variables.
- **Non-structural vulnerability:** Assesses the effects that the vital networks of the territory under study may suffer, such as roads, pipelines, communication, power generation system, transmission towers and electricity grids (including underground grids, in case of flooding), as well as the status of the drainage system and sewerage networks.
- **Functional Vulnerability:** Studies the influence of structural and non-structural vulnerability on the stability or interruption of production and services, for each type of event. The analysis of this vulnerability determines the status of preparedness and response, from the availability of emergency power generator sets, preparedness of the health-care system to cope with disaster, shelter capacity for evacuees and certification of facilities, access to remote areas, reserve of basic supplies (water, food, fuel, medicines) and others.
- **Social vulnerability**: Assesses the extent to which social factors can increase vulnerability, such as the total exposed population, population density or impact on the population, risk perception and preparedness, presence of solid waste on the streets, and preparedness of management authorities.
- **Ecological Vulnerability:** Assesses fragile ecosystems, ecologically sensitive areas, and protected areas that may be affected.
- **Economic Vulnerability:** Assesses Industrial zones, crop areas and animals in flood areas, the implementation level of vulnerability reduction measures, and response costs.

Risk

- Determines the risk of occurrence for flooding, by calculating total vulnerability to a hazard combined with the likelihood of occurrence of a hazard. It allows for the determination of three levels of risk: low, medium, and high risk, which allows for planning and decision-making tailored to zones under each risk level.
- Assesses the overall risk based on the hazard value of a potentially harmful event occurring with particular intensity, the total vulnerability, and the cost of exposed assets. It allows for the determination of three levels of risk: low, medium and high risk, contributing to planning and decision-making tailored to zones under each risk level.

HVR-Floods from Intense Rains

PRODUCTS IT GENERATES:

- Standardized procedures for collecting and organizing information and developing HVR research to ensure homogeneous measurements and analysis in all territories.
- Risk of floods from intense rains calculations for different return periods
- Flood hazard from intense rains maps; exposed elements, vulnerability and risk maps, using Geographic Information Systems (GIS)

SCOPE OF THE STUDY

- Analysis and evaluation of hydrographic basins; results are expressed at provincial, municipal and community levels; the working scale is 1:25 000 or higher

PRE-REQUISITES

- System for Automated Geoscientific Analyses (SAGA); Geographic Information System (GIS)
- Sufficient data available regarding historical flooding, rainfall, drainage, geomorphology, soil, land use, infrastructure, and municipality limits (See the complete list of data needed for a full HVR Flood Study in the Toolbox)
- An accurate digital elevation model (MDE) with a spatial resolution of 10 m or less pixels

SUMMARY OF THE METHODOLOGY

Flood Hazards

- Characterizes the site that is susceptible to flooding by generating a hazard scenario map
- Determines when the flooding event will take place by calculating its return period
- Estimates the intensity of the event by combining the severity with the degree of susceptibility to hazard and rain intensity that can cause it.
- Maps the fluvial topographic zone and shows the different levels that the potentially flooded areas could reach.

Vulnerability

- Structural vulnerability: Evaluates the resistive capacity of buildings to the destructive forces of floods. It is based on the damage factor, that certain types of construction can suffer according to their technical constructive state, and the exposure factor, related to their proximity to the riverbed.
- Non-structural vulnerability: Assesses the effects that the vital networks of the territory under study may suffer.
- Social vulnerability: Measures the tendency of social factors, such as population density and vulnerability perception, to influence potential damage of losses.
- Ecological Vulnerability: Assesses fragile ecosystems, protected areas, and ecologically sensitive areas that may be affected.
- Economic Vulnerability: Assesses the value of production in the flood areas, against the implementation of disaster risk reduction measures and costs associated with response.

Risk

- Determines the risk of occurrence for flooding, by calculating total vulnerability to a hazard combined with the likelihood of occurrence of a hazard. It allows for the determination of three levels of risk: low, medium, and high risk, which allows for planning and decision-making tailored to zones under each risk level.

4. ADAPTATION

Given the request from Saint Lucia to look at two different hazards, each with its own methodology, a combined training was offered to Saint Lucia; a training approach that covered all material, but varied in the calculation methods as per hazard, was devised. It was decided that the participants would need to be divided into three groups to transfer the content adequately.

For the recipient country, this implied the need for more space and resources for simultaneous interpretation, as English-speaking instructors were not available at the time of the training.

From the offering country's perspective, this implied the need to translate all the material and adapt them to the context, in particular the perception surveys.

Some challenges were faced in terms of obtaining the information needed: not all information was available prior to the training. Saint Lucia's bathymetric data, including topography, shape and design of the eastern region of the country, was not available. Alternative data was obtained from the US Geological Survey (USGS), the National Hurricane Centre in Miami, and the National Oceanic and Atmospheric Association (NOAA).

5. TRANSFER

From November 19th to 28th, a team of four Cuban specialists from the Risk Evaluation Group of the Ministry of Science, Technology and the Environment conducted an eight-day training on HVR for intense rains and coastal flooding in Saint Lucia and carried out a pilot study of the community of Dennery.

The training was divided into three parallel groups. One group was trained in calculating flood hazards from intense rainfall; a second group was trained in calculating coastal flooding hazards, and how to generate hazard maps for both; the third group was trained in calculating vulnerabilities: structural, non-structural, functional, social, environmental and economic, as well as how to carry out community risk perception surveys. A field expedition to the community took place to gather data, validate the hazard maps, and apply the perception survey with community members. The groups processed the data and prepared a draft report. A numerical simulation of Hurricane Tomas (2010) was conducted as a training exercise.

TOOLBOX

- Cuba Methodologies for Determining Disaster Risks at Local Level: HVR for Flood from Intense Rains (pag.11-32)
- Cuba Methodologies for Determining Disaster Risks at Local Level: HVR for Flood from Intense Rains (pag.35-51)
- Drafting Procedures for HVR Study Reports
- List of Data needed for HVR Rain Flood Study
- List of Data needed for HVR Coastal Flooding Study
- SWAN User Manual
- Introduction Guide to Sea Level Flooding Risk, Flooding from Intense Rains
- Saint Lucia HVR Flood Study for Dennery: Report

The simulation used a combination of numerical prediction systems. The first, ADCIRC (Advanced Circulation Model), is an open-sourced model certified by the US Federal Emergency Management Agency (FEMA), and used for simulating storm surge, tides, and coastal circulation. The second is SWAN (Simulating Waves Nearshore), an open source developed by Delft University of Technology, the US Office of Naval Research and the Dutch Ministry of Water Management and used for computing random, short-crested wind-generated waves in coastal regions and inland waters. The third model used is LISFLOOD-FP, a two-dimensional hydrodynamic model specifically designed to simulate floodplain inundation in a computationally efficient manner over complex topography.

By combining these three models, the extreme values of the sea levels for the simulated hurricane in a period of 38 hours were obtained; the flooding of coastal floodplains was mapped at a 30-meter pixel resolution, and a coastal flood hazard map was produced.

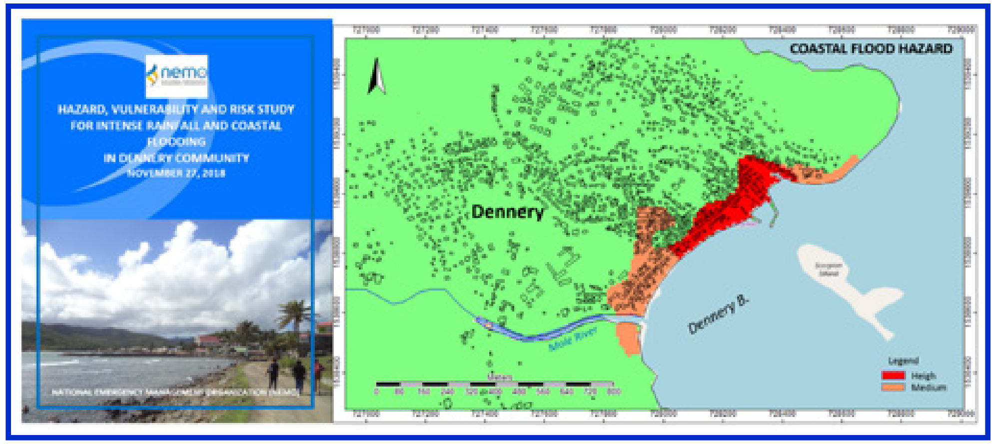
The other group used the HVR Floods from Intense Rains methodology to generate a rain flood hazard map, with geomorphological variables, topography wetness index, and accumulation of flow, among others. The third group calculated three types of vulnerability - structural, non-structural, and social.

The maps and calculations were then validated in the field. Perception of risk was surveyed in the community. The flooding risk perception was predominantly at the medium range (61%). A lack of community and household awareness regarding evacuation plans was observed. This observation should be incorporated into the development of the community disaster risk management plan and inform training interventions.

Finally, hazard and vulnerability data were combined to calculate and generate the overall risk maps. The final report included a series of recommendations to strengthen and address disaster risk reduction in the community.

6. RESULTS

- A Hazard, Vulnerability and Risk Study for Intense Rains and Coastal Flooding in Dennery Community completed with readily usable maps for decision-makers and the community, including:
  - Flood from Intense Rains Hazard Map
  - Coastal Flooding Hazard Map
  - Exposure factor, damaged factor, population exposure, and non-structural vulnerability index and curves charted
  - Flood from Intense Rains Risk Map
  - Coastal Flooding Risk Map
- A multidisciplinary group of 21 specialists trained in HVR Flood Studies
- A series of practical lessons and recommendations for Dennery and for Saint Lucia to increase its capacity to conduct HVR studies



7. SUSTAINABILITY

- ***Additional Training:*** The sustainability of this initiative would benefit significantly on more training opportunities to solidify the knowledge acquired, as the content was extensive and the time short. A second round of training could prepare the country to replicate the study to other areas of the island.

- ***Potential Partial Replication:*** The Weather Risk Management Association (WRMA) is currently analysing if it can replicate the hydrological modelling component in communities or watersheds in the western region of the country if the necessary information is obtained.

- ***A High-Level Commitment:*** The strongest indication of the continuation of this effort comes in the form of the commitment document *'Sustaining the Multi-Hazard Early Warning System Strengthening Process in Saint Lucia'* that the Prime Minister signed on February 1st of 2019, whereby the country committed to improve, sustain, and replicate the tools adapted through as part of the EWS Roadmap process and south-south cooperation with Cuba., namely the HVR for Intense Rains and Coastal Flooding and the Risk Perception Survey.

8. LESSONS AND RECOMMENDATIONS

LESSONS LEARNED	RECOMMENDATIONS
Carrying out a SSC initiative with Cuba represented good exposure for NEMO, strengthening its ties with a broad range of stakeholders and positioning NEMO as a provider of institutional capacity development.	*Institutionalizing HVR:* Consider institutionalizing and delegating an institutional body for the coordination of HVR studies in Saint Lucia, as a periodic exercise for the island. Discuss the institutional capacities and architecture within the EWS, guided by additional technical assistance from Cuba.
To be able to generate adequate hazard maps, the Digital Elevation Model (DEM) available in the country needs to have a minimum of resolution. Saint Lucia's DEM (30 meters mesh points) was too broadly scaled and didn't allow for the generation of the actual geography of the Dennery coastline. Additionally, the coordinates system Saint Lucia uses is the British West Indies BWI 1955, while Cuba uses the WGS 84, posing a compatibility problem. In terms of other type of data, it would have been important to consider the technical state of the infrastructures and houses under fluvial flood threat zone, so structural vulnerability could be evaluated more accurately.	*Address Data Generation Gaps:* Generate accurate and comprehensive data through the following: **a)** Invest in the production of bathymetric charts to calculate sea level rise; **b)** Obtain GPS location points of the water level gauge and layer it with the flood maps to allow for future and more precise analysis; **c)** Carry out a topographic survey to determine the flow of water in the Dennery basin; **d)** Generate a more accurate DEM, ideally with mesh points at 6 meters apart.
The training was designed to allow trainees to put the knowledge into practice and – even with data limitations – generate a series of recommendations to strengthen EWS in the community.	*Short-term Recommended Actions for Dennery:* Strengthen EWS through the following short-term actions: **a)** Place signage in the flood prone zone to deter further construction of homes or businesses; **b)** Enforce existing building codes and update where necessary; **c)** Revise and improve the drainage system, with a focus on preventing litter, so that the water can be channelled into an area that would not increase the observed contribution to water accumulation. *Policy Recommendations:* Strengthen EWS policies through the following: **a)** Take flood maps into account during physical urban planning for future developments; b) Legally designate and enforce flood prone areas; **c)** Consider a comprehensive plan to prevent and mitigate flooding for the entire island, including the restoration of mangroves, relocation or elevation of buildings most at risk from high tides and heavy storm surges, reforestation, improving or building new and effective drainage systems, and restoring the natural water ways; **d)** Look at legislation on mandatory evacuation; update and disseminate community evacuation and recovery plans.

LESSONS LEARNED	RECOMMENDATIONS
The adaptation and combination of HVR methodologies for two different hazards proved possible by designing parallel sessions per hazard and calculating the specific vulnerabilities for each, in a third session. Nevertheless, for a more solid transfer, a longer training would be required, with more time to involve the community in the feedback of results and the preparation of the final study.	*One-Hazard Focus:* Focus on one hazard at a time unless the time available for the training is significantly longer. *Expand Modelling Sessions:* Given the complexity and detail that goes into modelling, allocate more time for training participants in the step-by-step process to generate the outputs, as well as creating or sharing a more detailed and visual guide for coastal flooding numerical modelling. Allocate more time to practicing the modelling, so that participants can demonstrate confidence and success doing it. *Study Guides:* Include study guides for each training session, with stated learning objectives and reading lists for each session. Share this information beforehand so participants can prepare.
The perception survey was considered a highly valuable tool; the length and the style could have been adapted to ensure enthusiasm of the participating community members.	*Revision and Adaptation:* Share all training materials in a timely manner, including the questionnaires and presentations, to allow for revision and adaptation to the local context. Translate all materials in advance.
Accommodation in or close to the studied community maximizes the trainers' time. Ensuring the engagement and participation of the community in HVR studies is a key pillar of their success. For any larger scale-replication, a social communication strategy geared towards the community would be required. From the perspective of the transfer and adaptation, success depends significantly on constant and fluid coordination between the offering and recipient countries. It requires multiple scheduled work sessions to prepare a detailed work plan, jointly revise and adapt the training material prior to any visit, and coordination of all logistical details in a timely manner.	*Selection of the community:* Finalize selection of a community (that meets the criteria) early in the timeline to facilitate sufficient preparation of the community and any materials required. *Preparatory Data:* Share all preliminary data with the trainers with enough time to allow them to analyse the information for the selection of the pilot community and the preparation of the detailed training agenda. *Additional Sessions:* Hold at least three virtual work sessions between the offering country and the recipient country, to detail the following elements: • A planning session: Jointly develop and revise a detailed work plan, determining all transfer methods and the results of each (e.g. fact-finding missions, trainings, technical assistance, etc.), key milestones, indicators and monitoring responsibilities, reporting and documenting responsibilities, detailed schedule, and budget. • An adaptation session: Hold a session to jointly revise the training agenda and all the learning material, to ensure that each session has a study guide and organized bibliography, that sessions and content are adapted to the time available, that the training has been adapted according to available data, and all materials are translated, as necessary. • A logistical session: Discuss in detail all logistical and organizational needs related to travel, translation, community visits during field visits, meeting rooms and supporting material.

LESSONS LEARNED	RECOMMENDATIONS
The trainees who worked in the hazard group using GIS and generating maps were well selected; their previous knowledge of GIS facilitated their learning. More attention is needed in defining pre-requisite knowledge for the groups working on vulnerabilities, particularly if prior knowledge of software is required. This would improve the nomination of staff for the trainings.	*Trainee Profiles & Pre-Requisites:* Specify criteria for staff nomination, in terms of profile or software skills.
Some additional lessons during the transfer of HVR are related to the early access to the training material, the language barrier with Spanish-speaking trainers, and the lack of clarity as to who was responsible for a report of activities and results of the transfer.	*Sharing of Data:* Use 'shared online folders' directly between the offering and recipient country to ensure large amounts of data can be shared quickly and that participants can have access to them as early as possible. The regional coordinator can upload the necessary information to the shared folders. Agreeing on a system for organizing the folder (i.e. by session) is also helpful. *Post-Training Communication:* Set up a mechanism to keep in contact with the Cuban team for a period afterwards, for additional questions. *Language:* Conduct trainings with English-speaking trainers whenever possible. If that is not the case, the offering country should identify the exact number of translators that will be required according to the working groups well before hand, so preparations can be made in a timely manner.

9. CONCLUSION

Together with Antigua and Barbuda, Dominican Republic, Dominica, and SVG, Saint Lucia has advanced in policy making for early warning systems, through analysis of gaps and planning a roadmap forward. This process has reinforced countries' understanding and identification of the strengths and gaps in their early warning systems, the standards for people-centred multi-hazard systems, and promoted commitment to addressing potential risks and threats with prioritized actions plans.

These efforts were supported by Cuban technical assistance, leveraging tested tools and methods, and promoting engagement between countries sharing similar context and exposure to hazards. In Saint Lucia, the training and application of the Cuban Hazard, Risk, and Vulnerability study methodology for intense rains and coastal flooding aimed to strengthen EWS Pillar One - Identification of Risk. This experience provides solid lessons and recommendations for planning and implementing future knowledge transfers in Saint Lucia or other islands. It also lays the foundation for applying the model to other communities on the island or to other hazards, providing authorities and decision-makers with the risk analysis necessary to provide effective and integrated early warning to the communities.

This systematization aims to make a fruitful contribution to the region's knowledge on early warning systems and to global knowledge on South-South Cooperation practices.