Stories of success

BUILDING RESILIENCE TO HIGH-IMPACT HYDRO-METEOROLOGICAL EVENTS THROUGH STRENGTHENING MULTI-HAZARD EARLY WARNING SYSTEMS IN SMALL ISLAND DEVELOPING STATES AND SOUTH EAST ASIA

Canada CREWS Project
Stories of success

BUILDING RESILIENCE TO HIGH-IMPACT HYDRO-METEOROLOGICAL EVENTS THROUGH STRENGTHENING MULTI-HAZARD EARLY WARNING SYSTEMS IN SMALL ISLAND DEVELOPING STATES AND SOUTH EAST ASIA

Canada CREWS Project
FOREWORD

Every year, disasters related to weather, water and climate extremes, such as tropical cyclones, severe storms, floods, heatwaves and drought, lead to loss of life and socioeconomic impacts around the world. The extent of these losses is disproportionately higher in regions where there is a lack of understanding of the severity and risks associated with these hazards, and a lack of preparedness to predict and respond. Many studies have indicated that Small Island Developing States (SIDS) and countries in Southeast Asia (SeA) are more likely to experience increased exposure to these extreme events due to climate change and developmental challenges.

As authoritative providers of weather, water and climate services, National Meteorological and Hydrological Services (NMHSs) play a central role in protecting lives and livelihoods. They contribute to national resilience by providing timely and accurate forecasts, advisories, and warnings of hydrometeorological hazards, and historical hydrometeorological data and information. WMO facilitates increased application of meteorological, hydrological and climatological knowledge to support decision-making processes, ensuring that products and services are developed based on the specific needs and requirements of decision makers and communities.

In 2016, Environment and Climate Change Canada (ECCC) allocated CAD 10 million to the project “building resilience to high-impact hydrometeorological events through Strengthening Multi-Hazard Early Warning Systems in Small Island Development States (SIDS) and Southeast Asia” (Canada CREWS). The grant represented Canada’s institutional support to the Climate Risk and Early Warning Systems (CREWS) Initiative. The CREWS Initiative is a mechanism that funds Least Developed Countries (LDC) and SIDS for risk informed early warning services, implemented by three partners and based on clear operational procedures.

Canada CREWS aimed to protect lives and property through strengthening weather, climate, and water-related impact-based decision support services in SIDS and SeA. This was achieved through sponsoring WMO flagship activities in the project regions, the Caribbean, Pacific, and SeA, to benefit stakeholders from all socioeconomic sectors and communities.

This document comprises stories of success from the Canada CREWS project with WMO and its partners. The stories highlight activities undertaken at the regional, national and local level that have led to stronger resilience against hydrometeorological disasters. The stories demonstrate strengthened governance and institutional frameworks, improved product development for impact-based forecasts and risk informed warnings, and enhanced service delivery from producers to users of early warning services.
ACKNOWLEDGEMENTS

The building resilience to high-impact hydrometeorological events through strengthening multi-hazard early warning systems in Small Island Development States (SIDS) and Southeast Asia project was made possible with financial contribution from ECCC under the framework of the CREWS Initiative, and through collaboration with various partners including the Asian Disaster Preparedness Centre (ADPC), la Asociación Cooperadora de la Facultad de Ingenieria y Ciencias Hidricas (ACoFICH), Association of Southeast Asian Nations (ASEAN), Brigham Young University (BYU), Caribbean Disaster Emergency Management Agency (CDEMA), Caribbean Institute for Meteorology & Hydrology (CIMH), Caribbean Meteorological Organization (CMO), Hydrological Research Centre (HRC), Institute for Atmospheric Pollution Research National Research Council (CNR-IIA), Instituto Nacional de Recursos Hidráulicos/National Institute of Water Resources (INDRHI), Instituto de Meteorología de la República de Cuba (INSMET), Meteorological Service of New Zealand, National Environment Agency (NEA) Singapore, Regional Integrated Multi-Hazard Early Warning system for Africa and Asia (RIMES), The Pacific Community (SPC), Secretariat of the Pacific Regional Environment Programme (SPREP), Servicio Meteorológico Nacional (SMN) Argentina, the UK Met Office (Met Office), and the United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP).

CONTRIBUTORS

Lead Author: Vanessa Mazarese
Other contributors (in alphabetical order):
Arlene Laing, Caribbean Meteorological Organization (CMO)
Dinh Thai Hung, Viet Nam Meteorological and Hydrological Administration (VNMHA)
Du Duc Tien, Viet Nam Meteorological and Hydrological Administration (VNMHA)
Herve Damlamian, Pacific Community (SPC)
Israel Acosta, National Institute of Water Resources (INDRHI) Dominican Republic
Jean-Noel Degrace, MétéoFrance
Kathy-Ann Caesar, Caribbean Institute for Meteorology and Hydrology (CIMH)
Lam Hoang, Viet Nam Meteorological and Hydrological Administration (VNMHA)
Maria Cecilia A. Monteverde, Philippine Atmospheric, Geophysical &Astronomical Services Administration (PAGASA)
Nikotema Iona, Tuvalu Meteorological Service (TMS)
Rossy Mitiepo, Niue Meteorological Service
Salesa Nihmei, Pacific Regional Environment Programme (SPREP)
Viliame Vereivalu, Fiji Meteorological Service (FMS)
CONTENT

FOREWORD ................................................................. 2
ACKNOWLEDGEMENTS ...................................................... 3
CONTRIBUTORS ............................................................ 3

STORIES OF SUCCESS:
01 Strengthening capacities for hydrometeorological forecasting in the Dominican Republic ................................................................. 5
02 Strengthening governance mechanisms through effective strategic planning ............ 6
03 Forecasting severe weather and extreme events in the Caribbean .......................... 7
04 Providing community based early warnings to Niue ........................................... 8
05 Reducing vulnerability of Pacific communities to coastal inundation .................... 9
06 Collaboration between Fiji Meteorological Service and national stakeholders for an effective Flash Flood Guidance System ............................................. 10
07 Viet Nam as a regional centre for meteorological & hydrological forecasting and warning ................................................................. 11
08 Philippines perspective on effective severe weather warnings in the country .......... 12
09 Supporting countries in Southeast Asia to provide forecasts and warnings for flash floods and landslides ......................................................... 13
10 Understanding current Multi Hazard Early Warning Systems (MHEWS) capacities in Southeast Asia ........................................................... 14

REMARKS ........................................................................... 15
In the Caribbean region, floods and flash floods account for a significant number of lost lives and property damage. In the Dominican Republic these hydrometeorological hazards, usually resulting from tropical storms, affect millions of people every year. As floods and flash floods can occur suddenly and unexpectedly, there has been an urgent need for the country to prioritize efforts that aim to improve early warning capabilities, in line with the Sendai Framework 2015–2030.

While WMO and other entities have provided support in improving early warning systems capabilities, the country was still lacking an operational hydrological system for riverine floods. “This was due to minimal budget, lack of governmental support, insufficient collaboration amongst hydrometeorological services, and limited qualified personnel” said Israel Acosta, Department Head – National Hydrologic Service – National Institute of Water Resources, Dominican Republic.

To address this, in collaboration with:
- National Institute of Water Resources INDRHI,
- National Meteorological Service ONAMET (La Oficina Nacional de Meteorología),
- Cuban Meteorological Institute INSMET (Instituto de Meteorología de la República de Cuba),
- Brigham Young University (BYU), Utah, United States,
- Italian National Research Council’s Institute of Atmospheric Pollution Research CNR-IIA (Consiglio Nazionale delle Ricerche – Istituto sull’Inquinamento Atmosferico),
- Regional Training Centre Argentina,

WMO developed a fully operational Integrated Riverine Flood Forecasting (IRFF) system.

The system considered the improvement of existing flood forecasting products and implemented impact-based flood forecasting in Yaque del Norte and Haina pilot basins. The IRFF uses data and products from existing systems such as the Severe Weather Forecasting Programme (SWFP), Flash Flood Guidance System (FFGS), Coastal Inundation Forecasting Initiative (CIFI), Immediate numerical prediction system (SISPI) and the National Streamflow forecasting (GeoGLOWS).

Not only have the tools and models available to INDRHI and ONAMET been strengthened through the integration of the IRFF system, but so have the technical capacities of its staff. Virtual trainings on Numerical Weather Prediction (NWP), operational hydrology and flood management were conducted to improve understanding, interpretation and operation of the new system. Furthermore, local in-person workshops were organized to involve stakeholders from disaster risk management agencies.

While the IRFF system has proven a useful hydrometeorological tool for INDRHI and its staff, its implementation has also brought forth additional benefits to the country. Cooperation and support amongst not only flood management entities, but all organizations linked to hydrometeorology have strengthened; INDRHI is able to provide warnings to local civil protection agencies, allowing for improved response and contingency plans in the face of extreme events due to flooding; and under the “Operational Protocol of Emergencies”, ONAMET has increased its technical capacities to produce and provide INDRHI with numerical forecasts of local precipitation.

In describing the importance of inter-institutional collaboration for complex issues, Mr Acosta explained, “In every stage of a multi-disciplinary project involving different agencies, there is, and always will be, an improved understanding and vision around a situation or problem.”

The implementation of the IRFF system has provided INDRHI with the fully operational hydrological system for riverine floods it was lacking. This has paved the way for potential scaling-up in other basins in the country.
Over the years, National Meteorological and Hydrological Services (NMHSs) in the Caribbean region have continued to advance in their capacity to forecast and deliver early warnings and other climate services. With this came a need for a legal mandate for the delivery of existing, and development of new services, as well as more overall organizational structure of the NMHSs.

This has been delivered through a Model Meteorological Bill and Policy, and National Strategic Plan and Framework for Weather, Water and Climate Services (NFCS) and Action Plans developed for eight Caribbean Meteorological Organization (CMO) Members: Anguilla, Antigua and Barbuda, Dominica, Grenada, Guyana, Jamaica, Saint Kitts and Nevis, and Saint Vincent and the Grenadines.

CMO Director Dr Arlene Laing stated, “Given the importance and multi-faceted nature and functions of an NMHS, and its extensive range of stakeholders, it is essential that its operations be underpinned and guided by comprehensive legislation. This legislation (Meteorological Bill and Policy) should clearly define the roles, responsibilities, and extent of the NMHSs authority and provide a solid basis for defending the NMHS, and, by extension the Government, from litigation.”

An NFCS is an institutional mechanism put in place to coordinate, facilitate and strengthen collaboration among national institutions to improve the co-production, tailoring, delivery and use of science-based climate predictions and services over a period of five years. Its complementary Action Plan builds on the decisions and recommendations of the national consultation workshop.

The successful development, endorsement, and implementation of these two components culminates several months of consultation with the NMHSs of the CMO members and their stakeholders, organized by an external consultant and the project’s national focal points. The national consultation on the Strategic Plans and National Frameworks included the WMO subregional office in Costa Rica and the Caribbean Institute for Meteorology and Hydrology (CIMH) – the technical organ of CMO and a WMO Regional Climate Centre. While the Model Meteorological Bill and Policy is the fruit of a collaborative effort between WMO, CMO, the Organization of Eastern Caribbean States and the Caribbean Community (CARICOM).

National focal point for Grenada, Ms Cecil Mitchell, noted that the Strategic Plan “is a dynamic tool which will spur greater operational efficiency, support capacity-building, strengthen the linkages with stakeholders; thus, improving our service delivery.”

These endorsements are foundational to strengthen the hydrometeorological services of Members in the region. Furthermore, they will provide governments with guidance on the essential requirements for NMHSs to operate and give WMO and other development partners a better understanding of priority needs in the countries.
Small Island Developing States (SIDS) and Least Developed Countries (LDCs) in the Caribbean have a long history of being adversely affected by natural disasters, many of which are hydrometeorological in nature. For over 40 years, the region has been privy to a successful and effective operational plan, developed through the WMO Hurricane Committee’s Tropical Cyclone Programme. The plan highlights processes and procedures to be used for forecasting and warning services related to tropical cyclones. Disaster preparedness efforts in the region also focus strongly on this type of natural phenomena.

While they may not have the greatest socioeconomic impact, many other related severe weather events occur – and have been increasing in frequency – in the region. This includes heavy rainfall from convective storms, thunderstorms, strong winds, flash floods, and ocean waves and swell. Unfortunately, for the greater part of these past 40 years, NMHSs and other regional entities in the Caribbean did not have the infrastructure or capacity to adequately monitor and forecasts these events. This was seen, for example, with floods that devastated Saint Lucia in 2013, and Dominica in 2015, resulting in dozens of deaths.

While the increased frequency of these extreme events cannot be controlled, the way they are monitored and forecasted, and the subsequent warnings that are disseminated could be improved. In 2016, as requested by the region, WMO initiated the Severe Weather Forecasting Demonstration Project (SWFDP) which, in 2019, became the Severe Weather Forecasting Programme (SWFP) – Eastern Caribbean. The goal of the programme was to increase collaboration amongst NMHSs and other stakeholders to strengthen regional capacity to forecast hazardous severe weather events not related to tropical cyclones.

The programme was developed in collaboration with the Regional Forecast Support Facility (RFSF) in Martinique, CMO and CIMH, with contributions from the global NWP centres including MétéoFrance, European Centre for Medium-Range Weather Forecasts (ECMWF), Environment and Climate Change Canada (ECCC), and US National Weather Service (NWS) (Regional Specialized Meteorological Centre (RSMC) Miami) with a view of providing support to 16 Member States and Territories. Four main objectives were identified:

1. Raise the operational capacity of NMHSs in the region to produce effective severe weather alerts and warnings for the people in their countries;
2. Strengthen the role of the various regional centres in their services to countries in the region including RFSF Martinique and RSMC Miami;
3. Improve the efficiency of interaction of participating NMHSs with Disaster Risk Management (DRM) agencies;
4. Improve engagement of NMHSs with users and other relevant stakeholders to introduce and strengthen impact-based forecasts and risk-based warning services to improve Disaster Risk Reduction (DRR) activities and for improved decision-making by users and communities.

In 2020, an extranet hosted by RFSF Martinique was co-produced, and the SWFP implemented across all Member NMHSs, granting them access to the high-value NWP and severe weather forecast guidance products. Several SWFP workshops were conducted to train operational forecasters on how to access and make best use of the available NWP and satellite-based products and regional severe weather guidance to issue forecast and alerts for hazardous weather in their respective SIDS.

Dr Arlene Laing, Director, CMO said, “A main outcome we have seen through the programme so far is the capacity development of forecasters in the region. From a technical standpoint, forecasters have been trained on severe weather in the region and how to better predict it, and overall remote collaboration has been put in place, through using the extranet to develop forecasts.”

The Severe Weather Forecast Programme for the Eastern Caribbean will further its development beyond the life of this project as the extranet will continue to be maintained at RFSF Martinique. Additional funding has been provided by the CREWS Initiative to carry out further trainings and capacity-building activities and the development of a severe weather operational plan for the region.
The Pacific region is home to several island States that face complex issues regarding climate change and variability, and extreme events. These island States are home to many rural communities who are often situated near ocean shores, making them more susceptible to these issues which are ever-increasing in frequency. During the onset of hydrometeorological hazards, it is important that warnings not only reach these rural communities but that they are adequate for interpretation. However, while it does vary by country, literacy levels of the people living in these communities are generally lower, and substantially so in Least Developed Countries (LDCs).

In Niue, an island state with just over 1,600 inhabitants, situated north-east of New Zealand, many community groups are challenged by weather and climate-related terminology. The Niue Meteorological Service delivers climate information daily through a variety of traditional and social media platforms, however, the need for basic climate awareness and understanding among these community groups still exists.

To strengthen climate science awareness and knowledge and allow communities to better adapt to climate change and plan their daily activities, the Niue Meteorological Service looked to the Island’s youth to bring about change. The Community Based Early Warning Systems (CBEWS) activity enlisted the Niue Girls and Boys Brigades to collaborate on a one year, four-sided (spiritual, physical, social, and educational) programme.

Rossy Mitiepo, Director of the Niue Meteorological Service stated, “The knowledge on weather and climate information instilled within the children and youth at a young age is maintained and sustained over a long period of time. Weather changes daily and climate over a long period of time, and it is important that these terms are well understood.”

Through the course of the programme, the Brigades participated in training workshops on weather, climate, and climate change, learned how to link traditional knowledge to climate knowledge, and did more hands-on activities like creating shirts with slogans on them, and early warning billboards. The billboards highlighted the key topics that are needed to build the foundation of understanding weather, climate, climate change, and disaster terminology. The youth were then able to share new information with their elders while receiving reciprocated knowledge.

The success of this programme can be attributed to the collaboration amongst the community, and the proactive approach taken by the Niue Meteorological Service.

Salesa Nihmei, Meteorology and Climatology Adviser at SPREP explained, “when working with a community, we identify what their priority hazards are, what is most important to them in terms of hazards. We then separate them into gender and age groups, and find that they normally come with different priority hazards. We bring this information to the met services, and ensure that each community member receives the necessary information, and then work with these members to ensure they understand what they are receiving. From there, we work with them to identify solutions.”

The Niue Meteorological Service staff played a big role in ensuring all activities were completed, and there is now a strengthened relationship between them, Nie Elakesia Niue (main Church) and the Brigades.

As the project comes to an end, the Climate Traditional Knowledge monitoring activity will continue, along with the Niue Girls and Boys Brigade climate groups. The support that was provided will assist the groups to sustain their activities for present and future generations. The Niue CBEWS Project has proved profitable for all parties, allowing community members to apply their new knowledge to better plan their daily activities.
As low-lying, reef-fronted islands, Kiribati and Tuvalu are bound by nature to be affected by coastal flooding. Until recently, the countries relied solely on global tide forecasts and wave information to support their coastal inundation early warning systems. However, due to the complex nature of inundation events, deep ocean and offshore wave information is not enough to make informed decisions on these warnings. The lack of access to tools that would generally be used to forecast coastal inundation for countries in the Pacific, further exacerbated this issue.

In collaboration with the Secretariat of the Pacific Community (SPC), a tailored forecasting system was developed to provide timely, accurate and actionable coastal inundation information and more, to all inhabited islands that make up Kiribati and Tuvalu. While these systems are typically very computationally demanding, a special system was designed to fully function on a standard computer. This provides more autonomy and ownership to the countries’ NMHSs as they are able to run and operate it from their offices.

The newly developed system for these islands pulls data and information from two pre-existing initiatives in the region – the WMO Coastal Inundation Forecasting Demonstration Project in Fiji (CIFDP-Fiji), funded by the Korea Meteorological Administration (KMA) and the United Nations Development Programme (UNDP) Tuvalu Coastal Adaptation Project (TCAP), funded by the Global Climate Fund (GCF).

In partnership with the Tuvalu Government, the TCAP project provided state of the art, high-resolution topography and bathymetry lidar data, which shows the shape of the bottom of the sea and land and is imperative not only to provide accurate inundation information, but also for risk assessment and long-term planning. With this information and based on the work done through CIFDP-Fiji, an innovative system was developed to forecast inundation seven days in advance. This forecast system was designed to be tailored to the geomorphology of Pacific island countries, accounting for coastal processes that trigger inundation, for example, in reef-fronted islands, and tailored to the resources available in national and regional met services. Further, wave buoys were purchased and deployed in both countries to provide real-time wave information to forecasters who use this information to validate or assess the accuracy of the forecast coming in on the system.

Herve Damlamian, Team Leader, Ocean Prediction and Monitoring, SPC said, “The project has been made successful thanks to stakeholder engagement that we’ve had with the directors of the met services of Kiribati and Tuvalu, especially in Kiribati where we’ve done a lot of rescoping of the project to ensure that the deliverables would be really tailored to the needs and requirements of our stakeholders.”

The information this system provides will not only be useful for the met services for inundation forecasting, but for a wide range of ocean stakeholders in both countries, such as fishermen, who will use it to increase navigational safety of inter-island shipping. It will also allow the National Disaster Management Office to faster alert communities, ensuring the information reaches those who need it the most.
Spread across more than 3,000,000 square kilometres and made up of over 300 separate islands in the South Pacific Ocean is the Small Island Developing State of Fiji. Fiji’s landscape includes volcanic mountains up to 1,300 metres high, river systems, plateaux, lowlands, coastal plains, and coral shores. These characteristics make the country prone to severe flash flooding, which has increased in severity and frequency in recent years due to climate variability and change.

Flash floods occur within a few hours of heavy rain with little or no warning and are the most common and deadly type of flood experienced by Pacific Island States. These floods have significant socioeconomic impacts on Fiji’s infrastructure and agricultural sector, affecting lives and livelihoods.

Until recent years, the country did not have the appropriate infrastructure in place to forecast and monitor flash floods. Flood alerts and warnings were issued solely based on information provided from forecasting stations installed in major rivers.

In 2019, through the Canada CREWS project, a national subproject titled, “the Flash Flood Guidance System for Fiji” (FijiFFGS) was developed. FijiFFGS has provided the Fiji Meteorological Service’s (FMS) trained forecasters with the capacity to generate and issue flash flood forecasts and warnings up to 36 hours in advance. The system also incorporates inputs from high-resolution NWP model products, a result of the implementation of the SWFP in the country. These NWP products help forecasters better compute flash flood risks and threats.

The successful implementation and usefulness of the system can, in part be attributed to the important collaboration amongst various national stakeholders. FMS worked with the National Disaster Management Office (NDMO) and others to receive additional data that resulted in the development of a more advanced system. Demographics, vulnerability maps, evacuation facilities, infrastructure, educational and health facilities were all added into the MapServer interface, where the FFGS is displayed. With these inclusions, forecasters and disaster managers are able to better identify the possible impacts of flash floods.

Viliame Vereivalu, Principal Scientific Officer at FMS said, “We engaged stakeholders in our initial planning meeting, and then in the second, third, and so on, just for them to understand what FMS is trying to achieve through this project. So, requesting this data from the stakeholders was not a problem at all, they were willing to help – for the sake of the country.”

With FijiFFGS in place, the nation’s nearly 900,000 people now have access to an effective early warning system that will support their preparation and response to severe flash floods.

In 2020, during the tropical cyclones Sarai, Tino and Harold, FMS used FijiFFGS products to issue several flash floods and heavy rainfall alerts and warnings in advance, while the NDMO disseminated 13 public advisories, advising the general public to be on alert and take precautionary measures from heavy rainfall, flash flooding and its secondary hazard – landslides.

Further, in order to reach a wider audience, the NDMO is now issuing public advisories on heavy rainfall and flash flood alerts and warnings in three languages – English, Hindi and iTaukei.

With the frequency and severity of flash floods only expected to increase, the development and implementation of systems like FFGS are more crucial than ever to protect communities, safeguard economies and save countless lives.
Over the past 30 years, 90% of all disasters in Southeast Asia have been hydrometeorological in nature. Viet Nam, in particular, experiences 19 different types of meteorological and hydrological disasters every year, including strong winds, heavy rain, damaging waves, landslides, flood inundation, flash floods and typhoons. In 2020, the country experienced 15 typhoons, including Typhoon Molave, which made landfall in October, and over 100 landslides and flash floods caused by heavy rainfall. These disasters resulted in a combined 350 lives lost and US$ 1.7 billion in economic damages.

National Meteorological and Hydrological Services (NMHSs) in the region are facing increasing pressure from their governments and the general public who rely on them to forecast and provide adequate warnings ahead of these disasters. The pressure is underpinned by an increase in socioeconomic activity in coastal, mountain and urban areas.

Due to a lack of capacity, NMHSs in Southeast Asia turned to Regional Specialized Meteorological Centres (RSMCs) in developed countries such as China and Japan to receive bulletins which provided more advanced warning and forecast information. However, the distance between the countries resulted in limited support and insufficient information on very specific phenomena which occur only in Southeast Asia.

In 2011, the WMO Regional Forecast Support Centre (RFSC) for Southeast Asia in Hanoi, Viet Nam was created, and with the support of ECCC, it has further developed. The Centre acts as a hub for five countries: Cambodia, Lao People's Democratic Republic, the Philippines, Thailand and Viet Nam. RFSC Hanoi collects real-time observation, radar and forecasting data from these countries in order to provide high-quality, region-specific bulletins for early warnings.

Dr Din Thai Hung, Vice Director General, Institute of Natural Resources and Environment Training, (Ministry of Natural Resources and Environment (MONRE)) , Viet Nam said, “The Centre helps to build experience through workshops, short- and long-term trainings, and other capacity-building activities. It also connects forecasters in each country to exchange experiences on how to apply new technology and products to help improve our forecasting and warning capabilities. For each type of hydrometeorological phenomena, we create a bulletin. Finally, we learn from each other how to work with other organizations related to natural disaster prevention, such as ministries of agriculture and transportation.”

Further to its regular mandate, two WMO flagship programmes and projects which strengthen multi-hazard early warnings have been integrated into the region through RFSC Hanoi: the Severe Weather Forecasting Project for Southeast Asia (SWFP-SeA) and the Southeast Asia Flash Flood Guidance System (SeAFFGS).

Through SWFP-SeA, short- and medium-range warnings for strong wind and heavy rainfall are collected, and guidance is provided by the RFSC. The SeAFFGS allows for better prediction and adequate warnings of flash floods which can occur suddenly and unexpectedly.

Furthermore, RFSC Hanoi has been supported to ensure that the forecasts and warnings generated through these programmes are impact-based. This helps to inform the general public not only of what the weather will be, but also what it will do. In order to achieve this, RFCS Hanoi works directly with stakeholders from other national agencies, such as National Disaster Management Offices to better understand how to implement impact-based forecasts and warnings.

Forecasters in each country have partaken in various trainings to be able to effectively use each of these systems and feed information back into the RFSC, and the collaboration between them is what makes the systems most effective.

With the capacity-building support provided throughout the project, RFSC Hanoi will remain long beyond the life of the project and will continue to advance its technology and capabilities to provide multi-hazard early warnings to protect life and property in Southeast Asia.
The Philippines Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) serves as the country’s National Meteorological and Hydrological Service (NMHS). Like its neighbouring countries in Southeast Asia, the Philippines is frequently faced with hydrometeorological disasters that impact the lives, livelihoods and property of its residents. Typhoons are the primary extreme weather event that devastates the nation and they bring on other severe weather such as heavy precipitation, strong winds and high waves, imposing negative socioeconomic impacts on the developing country.

PAGASA joined the WMO Severe Weather Forecasting Demonstration Programme (SWFDP) in 2012, at which point, the usefulness of its existing Numerical Weather Prediction (NWP) capabilities was tested to understand how NWP outputs could be used in severe weather forecasting. During this time, the NMHS was heavily dependent on the skills and experience of its forecasters to mainly make use of the available deterministic NWP models to forecast severe weather. When compared to an Ensemble Prediction System (EPS), deterministic models are not capable of predicting uncertainty in future conditions.

In 2016, through the Canada CREWS project, the SWFDP-SeA (subproject for Southeast Asia) entered its demonstration phase. At this point, EPS were made available through global and regional centres, including RFSC in Hanoi, Viet Nam through SWFDP’s ‘cascading forecasting process’. NMHSs in the region, including PAGASA, received training on how to best use EPS products to estimate uncertainty in forecasts and issue probabilistic forecasts of severe weather several days in advance of hazardous events, to aid decision-making by disaster managers and other stakeholders.

Maria Cecilia Monteverde, Chief of the Research and Development and Training Division at PAGASA said, “The introduction of the EPS and the capacity development of the NMHSs through the SWFP-SeA project has allowed forecasters to build more confidence when issuing severe weather warnings with the aid of high-resolution and state of the art numerical models.”

Since this introduction, a yearly two-week workshop has been organized by WMO to enhance the technical capacity of NMHS staff. The workshops bring together forecasters and researchers to develop their skills in interpreting global and regional models for various weather and high-impact weather events, for application in operational forecasting. Further, it also improves engagement between NMHSs and stakeholders including disaster management and civil protection authorities, local governments and media to introduce impact-based forecast and warning services.

The SWFP-SeA has also allowed for more cooperation and collaboration amongst forecasters from NMHSs and WMO designated regional centres. The programme’s five target countries: Cambodia, Lao People’s Democratic Republic, the Philippines, Thailand and Viet Nam hold regular meetings to share individual experience and learnings for improved implementation and continued success. Furthermore, the RFSC in Hanoi, Viet Nam periodically provides additional forecast trainings to PAGASA staff, and maintains the SWFP web interface, which is imperative for continued application by users.

The web interface will continue to be operational beyond the life of the project and now, the Philippines has a forward-looking plan to bring accurate, high-level severe weather forecasts all the way down to local communities. While more advanced forecast products are available at the national level, PAGASA seeks to provide support to local forecasting centres in the operational use of NWP models. This will be done through a study conducted on severe weather events, and the use of model-generated indices for local thunderstorm forecasting. Ultimately, this will ensure early and accurate severe weather warnings for all, reducing loss of life and damage to property in the Philippines.
Flash floods account for approximately 85% of annual flooding cases, exceeding any other flood-related event like riverine and coastal flooding. They also have the highest mortality rate, causing more than 5,000 deaths worldwide per year. As the global population increases, especially in urban areas, and societies continue to encroach upon floodplains, the need for flash flood early warning systems becomes more paramount.

Flash floods are caused by intense rainfall from slow moving thunderstorms and tropical cyclones, rainfall over hills and mountains, the condition of the soil and surrounding environment, and sudden release of impounded water from natural dams. They occur within a few hours of heavy rain with little or no warning and have the power to change the course of rivers, bury houses in mud, and sweep away or destroy whatever is in their path.

In Southeast Asia, flash floods frequently and significantly impact lives and livelihoods, and often result in another severe hazard – landslides. Between 1990 and 2021 it is estimated that flash floods and landslides, triggered by tropical storms have resulted in 4,012 deaths and US$ 3.4 billion in damages.

To respond to the urgent need to strengthen the capacity of National Meteorological and Hydrological Services (NMHSs) to issue timely and accurate flash flood warnings, the Southeast Asia Flash Flood Guidance System (SeAFFGS) was developed.

SeAFFGS was developed by the Hydrologic Research Centre (HRC) and is implemented by WMO, while the National Oceanic and Atmospheric Administration (NOAA) provides satellite data to the system. It is part of a global FFGS, which currently provides early warnings to three billion people – 40% of the world’s population – across more than 60 countries.

The system, which covers Cambodia, Lao People’s Democratic Republic (PDR), Thailand and Viet Nam, has one of the largest amounts of quality-controlled input data. It receives data from 20 weather radars, more than 1,500 automatic weather stations, various high-resolution NWP models, high-resolution satellite data, and is the first FFGS with nowcast information, which will greatly improve the value and efficiency of warnings. For the timely prediction of flash flood events, the value of high-resolution and high-quality quantitative precipitation estimation and corresponding forecasts is extremely important.

Moreover, the SeAFFGS MapServer interface provides forecasters with the ability to overlay FFGS products with Geographic Information System (GIS) data, including demographic data, vulnerability maps, evacuation facilities, infrastructure, and educational and health facilities. By providing hydrometeorological and disaster management agencies with information about the vulnerabilities of infrastructure, NMHSs can help minimize the adverse impacts of weather-related disasters and reduce fatalities, damages and losses.

Since the beginning of the project, more than 100 regional hydrologists, meteorologists and disaster managers have been trained on the use of FFGS and how to issue effective flash flood warnings and alerts.

From early 2022, the SeAFFGS will be operated by the Viet Nam Meteorological and Hydrological Administration (VNMHA), which acts as the FFGS regional centre, and will provide flash flood guidance, threat and risk products (up to 36 hours in advance) and heavy rainfall forecasts, data and training for regional forecasters and disaster managers.

Scientists expect the frequency and severity of flash floods and landslides will increase due primarily to climate change, population growth and land-use changes. Development and implementation of FFGS and landslide modules are, therefore, more crucial than ever to protect communities, safeguard economies and save countless lives. Together, FFGS partners, participating countries and regions will continue to mitigate the impacts of flash floods and landslides by enhancing early warning capabilities.
A clear understanding of the capacities, gaps and needs of National Meteorological and Hydrological Services (NMHSs) for producing, delivering and acting on MHEWS is critical in order for them to receive necessary tailored support. Since 2010, this information has been generally limited in countries in Southeast Asia (SeA).

To ensure that efforts being made in SeA under the Canada CREWS project were relevant to countries’ needs, an initiative was undertaken, with the aim of assessing MHEWS capabilities in Cambodia, Lao People’s Democratic Republic, the Philippines, Thailand and Viet Nam. The initiative was spearheaded by a Member-led intergovernmental institution – RIMES – Regional Integrated Multi-Hazard Early Warning system for Africa and Asia.

The baseline assessments provided comprehensive insights into each country’s climate and disaster risk profile, policy, legal and institutional frameworks, NMHSs governance, risk knowledge and forecasting capabilities, available early warning systems, and ongoing programmes and projects. Further, it identified MHEWS gaps using the widely recognized MHEWS checklist, to help inform contents and approaches of future capacity development initiatives and projects.

Carlyne Yu, Climate Risk Management Specialist at RIMES and lead of the initiative outlined the three-step process taken to complete these assessments, “First, we did a desk study, gathering any documentation that was readily available online, this helped us identify gaps and information we needed to follow up on. The second step was to conduct national multi-stakeholder workshops to present and verify our findings. At this stage, we also conducted a number of interviews with key stakeholders from various sectors like agriculture, health, and disaster management, as well as with NMHSs to ensure we filled all of the desk study gaps. Finally, we presented the findings at a regional workshop that brought together NMHS and disaster management representatives from all five countries.”

The aforementioned workshop took place in Bangkok, Thailand, in February 2020, and was jointly hosted by WMO, the United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP), and the Food and Agriculture Organization (FAO). The workshop allowed for stakeholders from different sectors involved in early warnings to interact and learn from each other, and results of the baseline assessments led to a consensus reached by participants on the need for a more coordinated Southeast Asia-wide framework for hydrometeorological disaster risk reduction and capacity development of NMHSs.

The workshop further built a common understanding of Forecast-based Financing (FbF) and Early Warning Early Action (EWEA). These approaches enable access to humanitarian funding for early action based on in-depth forecast information and risk analysis.

The MHEWS assessments have already proven necessary and useful for donors and implementing partners to have a full understanding of NMHS capabilities, which will allow them to scale up technical and financial support in the region. This can be seen through the CREWS Initiative, which approved a follow-up project in Cambodia and the Lao People’s Democratic Republic.
REMARKS

“Supporting CREWS from its inception underscores Canada’s recognition that Early Warning Systems are proven to reduce the loss of life and economic hardship caused by hydro-meteorological hazards. The Canada CREWS SIDS and Southeast Asia project was developed, together with WMO, as a multi-year, multi region plan to address hydro-meteorological hazards in Southeast Asia, the Caribbean and the Pacific as these areas tend to be disproportionately impacted by high-impact weather such as tropical cyclones, droughts and floods.”

— Jen Collette
Director General, Meteorological Services of Canada
Environment and Climate Change Canada / Government of Canada

“There is a growing body of evidence that LDCs and SIDS in Southeast Asia, Pacific and Caribbean are amongst the most exposed to the impacts of climate change and will continue to be for the foreseeable future. Building the capacity to monitor, predict and issue warnings so that people can take lifesaving action is the main objective of the CREWS Initiative. We are grateful, not only for the leadership demonstrated by Environment and Climate Change Canada but also for the guidance and oversight of the operations. Building end-to-end early warning systems is not an easy task and it requires continuous learning, exploring of new and innovative technologies, ownership from the countries concerned, supported by long term engagement and partnerships.”

— John Harding, Head, CREWS Secretariat

“The WMO programmes implemented through the Canada CREWS project support the National Meteorological and Hydrological Services of these countries by strengthening their ability to accurately forecast and disseminate warnings for hydro-meteorological hazards such as tropical cyclones, flash floods, riverine floods, coastal floods and drought. This work is critical, as understanding, preparing, and responding to these hazards is important to protect national growth and development while ensuring that any threat to people’s lives and livelihoods is averted.”

— Filipe Lúcio, Director, Member Services Department, WMO
For more information, please contact:

**World Meteorological Organization**
7 bis, avenue de la Paix – P.O. Box 2300 – CH 1211 Geneva 2 – Switzerland

**Strategic Communications Office**
Tel.: +41 (0) 22 730 83 14
Fax: +41 (0) 22 730 80 27
Email: communications@wmo.int

public.wmo.int