Workshop Report 2019

WORLD METEOROLOGICAL ORGANIZATION

ICIMOD

FOR MOUNTAINS AND PEOPLE

Regional workshop on Communicating Flood Early Warning for Last Mile Connectivity

2–4 October 2018 | Kathmandu, Nepal

About ICIMOD

The International Centre for Integrated Mountain Development (ICIMOD) is a regional knowledge development and learning centre serving the eight regional member countries of the Hindu Kush Himalaya (HKH) – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – based in Kathmandu, Nepal. Globalization and climate change have an increasing influence on the stability of fragile mountain ecosystems and the livelihoods of mountain people. ICIMOD aims to assist mountain people to understand these changes, adapt to them, and make the most of new opportunities, while addressing upstream and downstream issues. ICIMOD supports regional transboundary programmes through partnerships with regional partner institutions, facilitates the exchange of experiences, and serves as a regional knowledge hub. We strengthen networking among regional and global centres of excellence. Overall, we are working to develop economically and environmentally-sound mountain ecosystems to improve the living standards of mountain populations and to sustain vital ecosystem services for the billions of people living downstream – now and in the future.

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Workshop Report 2019/2

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Contents

Acronyms and Abbreviations

AWS	Automatic Weather Station
BCAS	Bangladesh Centre for Advanced Studies
BMD	Bangladesh Meteorological Department
BWDB	Bangladesh Water Development Board
CBDRM	Community Based Disaster Risk Management
CBFEWS	Community Based Flood Early Warning System
CDMC	community Disaster Management Committees
CDO	Central District Office
CHy	Commission for Hydrology
CPP	Cyclone Preparedness Programme
CSO	Civil society organizations
DDM	Department of Disaster Management
DDMA	District Disaster Management Authorities
DDRC	District Disaster Relief Committee
DEOC	Dzongkhag/District Emergency Operation Center
DHM	Department of Hydrology and Meteorology
DHMS	Department of Hydro-Meteorological Service
DMA	Disaster Management Authorities
DMC	Disaster Management Committees
DMIC	Disaster Management Information Centre
DRR	Disaster Risk Reduction
DRRM	Disaster Risk Reduction Management
DRRMA	Disaster Risk Reduction Management Authority
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
EWS	Early Warning System
FEWS	Flood Early Warning System
FFC	Federal Flood Commission
FFD	Flood Forecasting Division
FFWC	Flood Forecasting and Warning Centre
FFWS	Flood Forecasting and Warning System
FYPs	Five-Year Plans
GDMC	Gewog Disaster Management Committee
GDP	Gross domestic product
GLOF	Glacier Lake Outburst Flood
GLOFAS	Global Flood Awareness System
GOB	Government of Bangladesh
GOI	Government of India
HBV	Hydrologiska Byråns Vattenbalansavdelning model
HEC-RAS	Hydrologic Engineering Center's - River Analysis System
HEC-HMS	Hydrologic Engineering Center's - Hydrologic Modeling System

HF	High Frequency
HKH	Hindu Kush Himalaya
HYCOS	Hydrological Cycle Observation System
ICIMOD	International Centre for Integrated Mountain Development
IFAS	Integrated Flood Analysis System
IFRC	International Federation of Red Cross
IHMS	Integrated Hydrological Modelling System
IMD	India Meteorological Division
INGO	International Non-Government Organization
IVR	Interactive Voice Response
MoEA	Ministry of Economic Affairs
MoHA	Ministry of Home Affairs
MoU	Memorandum of Understanding
NABIC	Nansen-Bangladesh International Centre for Coastal, Ocean and Climate Studies
NCHM	National Centre of Hydrology and Meteorology
NDMA	National Disaster Management Authority
NeOC	National Emergency Operations Centre
NGO	Non-Governmental Organization
NOAA	National Oceanic and Atmospheric Administration
NWP	Numerical Weather Prediction
OXFAM	Oxford Committee for Famine Relief
PCIW	Pakistan Commissioner for Indus Waters
PDMA	Provincial Disaster Management Authorities
PMD	Pakistan Meteorological Department
PTA	Pakistan Telecommunications Authority
RFIS	Regional Flood Information System
RIMES	Regional Integrated Multi-Hazard Early Warning System
RMCs	Regional Member Countries
SAR	Search and Rescue
SMS	Short Message Service
SOD	Standing orders on Disasters
SOP	Standard Operating Procedures
TMA	Town Municipal Administration
UCs	Union Councils
UDMC's	Union Disaster Management Committees
UN	United Nations
UNDP	United Nations Development Programme
VHF	Very High Frequency
WAPDA	Water and Power Development Authority
WECS	Water and Energy Commission Secretariat
WMO	World Meteorological Organization
WRFM	Weather Research and Forecasting Model

Executive Summary

A three-day regional workshop on 'Communicating flood early warning for last mile connectivity' was held in Kathmandu, Nepal from 2-4 October 2018. The main objective of the workshop was to learn about 'early warning communication' from the experiences of key stakeholders. A total of 30 representatives from hydromet agencies, disaster management authorities, and organizations working in disaster risk reduction in Bangladesh, Bhutan, Nepal and Pakistan and the World Meteorological Organization (WMO) participated in the workshop.

The workshop was organized by the International Centre for Integrated Mountain Development (ICIMOD) and WMO in the frame of the HYCOS-User Phase project (2017-2019) under ICIMOD's Hi-RISK initiative.

All of the aforementioned entities are involved directly or indirectly in one or more components of flood early warning systems to save lives, livelihoods, and property of flood vulnerable communities – especially of women, children, the elderly, the differently abled, and the poor. Thus they had lots to share with one another.

Participants discussed gaps in communicating early warning in their countries, solutions for addressing the gaps in gender-responsive and socially inclusive ways, and opportunities for collaboration.

Country-wise presentations were made by representatives from hydromet agencies, disaster management authorities, and DRR practitioners, followed by interactive discussions on key strengths, weaknesses, and gaps associated with flood early warning communication for last mile connectivity.

Country-wise group discussions were held to identify potential solutions to the key gaps and weaknesses already identified for each country at different levels under three domains – technical, institutional/governance, and socio-cultural.

Relevant participants shared the key initial findings of the strategic assessment of flood early warning communication conducted in Nepal through participatory approaches such as key informant interviews, focus group discussions, and desktop research.

A WMO presentation made a persuasive case for end-to-end flood early warning systems (E2E FEWS) for forecasting, in which all pieces must be in place and working harmoniously. Hydromet agencies, especially their flood forecast and warning divisions, were called on to leverage the South Asia Flash Flood Guidance System's potential to generate and issue timely and accurate flash flood warnings and to move toward impact-based forecasting.

The workshop participants agreed in principle to contribute to case studies on good practices on flood early warning communication in Bangladesh, Bhutan, Nepal, and Pakistan. They also agreed on the methodology and framework for developing these case studies for regional sharing as well as for replication and upscaling of documented good practices across the Hindu Kush Himalayan region.

1. Background

Across the Hindu Kush Himalaya, people are vulnerable to various types of disasters, which threatens sustainable development and aggravates poverty in the region. Climate change and variability are likely to increase the intensity and frequency of flood events which are often transboundary in nature and have major human, environmental, and economic consequences. As evident from previous disasters, lack of proper institutional mechanisms for dissemination of flood early warning, lack of early warning information that is relevant to the community, limited understanding of flood early warning system from social and cultural perspectives, limited capacity of various agencies have resulted in significant loss of life, infrastructure and livelihoods. For example, the 2013 Uttarakhand flood in India killed more than 5,000 people. Moreover, women, girls and marginalized groups experience floods and weather-related hazards differently and more acutely than men.

Early warning systems play a critical role in minimizing the adverse impacts of floods by saving lives and assets, reducing displacement, and strengthening the resilience of vulnerable communities. However, the science, technology and governance behind early warning systems have spread unevenly across regions, countries and communities. Many developing countries have not adequately benefited from advances in early warning systems. An effective early warning system involves several actors across administrative scales, both vertical and horizontal, as well as the communities, which are not homogeneous entities. This implies that flexibility is needed in the design and implementation of the system, particularly in effecting appropriate actions to save lives and protect infrastructure and livelihoods. In order to maximize effectiveness, it is necessary to understand the implications of flood early warning in relation to these actors' capacities. It is also important to consider in the design the extent of coordination among them and to ensure that policy, legislations, regulations and protocols are in place as these provide the necessary mandates and help guide their actions. Together these shape the flood early warning system into an effective communications and response-inducing tool.

History has shown that there are significant gaps in these systems, especially in reaching the "last mile" – the most vulnerable and exposed populations – with timely, understandable and actionable warning information. While the generation of flood forecasts and early warning is a complex process, it is equally important to ensure that these are communicated to the communities through a proper mechanism in a timely and understandable manner for early action.

To address the need for enhanced regional collaboration on flood risk reduction, ICIMOD established a Regional Flood Information System (RFIS), in partnership with four of its regional member countries (Bangladesh, Bhutan, Nepal and Pakistan) and through engagement with India and China as observers and with the World Meteorological Organization as a technical partner. Building on the achievements of HKH HYCOS, the User Phase seeks to enhance the end user interface. It focuses on enhancing community response to warning information through improved understanding of institutional mechanisms for communicating and disseminating early warning from the national to the local level. It also stresses capacity building and awareness raising among end users themselves so they are better prepared to take timely action to reduce losses, contributing to their increased resilience. Enhancing access to early warning and response capacity of communities will also contribute to the 7th target of the Sendai Disaster Risk Reduction Framework, which aims to "substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030". As part of this initiative a regional workshop was held by ICIMOD from 2-4 October in Kathmandu in collaboration with WMO.

2. Objectives

The regional workshop brought together various stakeholders engaged in implementing flood early warning systems from the HKH region to fulfill the following objectives:

- share their experiences and identify good practices on effective flood early warning communication, with a focus on women, girls, children, the differently abled, the poor, and marginalized groups;
- share advances and best practices of monitoring and forecasting flood early warning;
- enhance regional collaboration to improve preparedness and response to flood early warning;
- share and discuss the preliminary findings of the strategic assessment of flood early warning conducted in Nepal.

A total of 30 representatives from hydromet agencies, disaster management authorities, and organizations working in disaster risk reduction in Bangladesh, Bhutan, Nepal and Pakistan and the World Meteorological Organization (WMO) participated in the regional workshop.

The first day of the regional workshop included an opening session and three technical sessions on generation of early warning for disaster risk reduction, perspectives on communicating early warning from disaster management authorities and from implementation agencies. There were PowerPoint presentations and plenary discussions. On the second day country-wise group work on strengths, weakness and gaps on communicating flood early warnings and on key weaknesses and potential solutions on communicating flood early warnings were held with presentations and discussions in the plenary.

3. Proceedings of the Workshop

3.1 Opening Session

Day 1: 2 October 2018

Chair: Arun Bhakta Shrestha, Programme Manager, River Basins and Cryosphere, ICIMOD

The three-day workshop commenced with Basanta Shrestha from the International Centre for Integrated Mountain Development (ICIMOD) welcoming the participants.

Basanta Shrestha, Director, Strategic Cooperation, ICIMOD

Basanta Shrestha welcomed the representatives of various organizations to the workshop. They included Graham Murphy, Deputy Chief of Mission, Australian Embassy to Nepal; Paul Pilon, Chief Hydrological Forecasting and Water Resources Division of WMO; and representatives from hydromet agencies, disaster management authorities, and entities working on water induced disaster risk reduction in Bhutan, Bangladesh, Nepal and Pakistan. He said that the HKH is a disaster hotspot. Floods, landslides, and earthquakes are a painful reminder of devastations wrought on people's lives, livelihoods and environments. The 2010 Pakistan floods, 2008 Koshi floods, and 2013 Uttarakhand floods were major floods that affected the lives of millions. He highlighted that:

- Focusing on the technological approach to water-induced DRR from a regional perspective is important.
- ICIMOD is strategically placed to address last mile connectivity through different approaches such as partnership with implementation partners, regional knowledge platform for sharing insights, and regional cooperation on DRR and early warning system, application of space and ground-based technologies with the exchange of data through different protocols and capacity development of its regional member countries to avert or minimize water-induced disasters.
- Deployment of FEWS has decreased the number of casualties from floods. However, there are gaps in disseminating and communicating flood early warning to cross the last mile to reach the flood vulnerable communities, especially in the hills and mountains. This platform is also important for learning about best practices on FEWS.

Graham Murphy, Deputy Head of Mission, Australian Embassy, Nepal

Graham Murphy noted that South Asia is very disaster prone and affected by various types of natural hazards, particularly floods. Many lives are lost annually due to floods, affecting the most vulnerable, mainly women, children and the elderly.

The Sustainable Development Investment Portfolio (SDIP) seeks to build adaptive capacity and resilience of women and men, foster regional cooperation, and bring about policy reforms targeted at the most vulnerable in the HKH. Under the SDIP Portfolio, the Australian government's Department of Foreign Affairs and Trade (DFAT) is pleased to support ICIMOD to address these challenges of managing risks and reducing physical vulnerabilities in transboundary river basins of the Hindu Kush Himalaya, mainly in the Indus, Ganges and Brahmaputra. He noted that lack of timely early warning to the most vulnerable is a gap that needs to be addressed urgently. He expressed happiness at seeing representatives from Bangladesh, Bhutan, Nepal, Pakistan and the WMO office in Switzerland gathered to share their learning and strengthen collaboration over the next three days.

Paul Pilon, Chief, Hydrological Forecasting and Water Resources Division, World Meteorological Organization

Paul Pilon noted that water disasters are among the top risks for humanity, comprising 40% of disasters, and are exacerbated by climate change and variability. He said that average annual losses due to disasters are estimated at USD 300 billion. He also highlighted the positive aspects of floods.

He said the challenge is to reduce exposure to disaster risks, and make timely warning available to those who need it the most. He called on the participants to delve into the science and technologies of flood forecasting and expressed hope that the regional workshop would result in:

- Agreement on steps to be taken to communicate early warnings
- Articulation of good practices to be followed by hydro-met agencies
- Suggestions for making early warnings understandable and actionable.

Mandira Singh Shrestha, Programme Coordinator, Hi-RISK initiative, ICIMOD

Mandira Shrestha highlighted that 40% of disaster events in the HKH are flood related and called attention to the Pakistan 2010 floods and Uttarakhand 2013 floods. She reminded the participants that the August 2017 floods in South Asia affected 40 million in the region and killed 160 people across Nepal, prompting the National Planning Commission in Nepal to state that "communication is the weakest link" in the deployment of flood early warning systems in the event of floods. She outlined the expected outcomes of the workshop:

- To discuss gaps in communicating early warning to the most vulnerable;
- To identify solutions to address these gaps;
- To seek feedback on the strategic assessment on 'early warning communication' conducted in Nepal; and
- To discuss documentation of good practices on 'early warning communication' as currently practiced in selected countries in the HKH.

Arun Bhakta Shrestha, Regional Programme Manager for River Basins and Cryosphere programme, ICIMOD

Arun Bhakta Shrestha said that there is evidence that floods are likely to increase in frequency and intensity in the future. He remarked that the workshop should discuss how to cross the "last mile" to connect with those most vulnerable to floods, including how floods impact men and women differentially and what approaches can better address these gendered differences.

3.2 Technical Session 1: Generation of Early Warning for Disaster Risk Reduction

This session was focused on the overview of processing and generation of flood early warnings by the hydromet agencies, examples of warning products, means of communicating warnings, target audiences, and existing gaps.

3.2.1 Present status of flood forecasting and early warning services in Bangladesh

Afrifuzzaman Bhuiyan, Executive Engineer, Bangladesh Water Development Board (BWDB)

Bangladesh is a lower riparian country situated in the Brahmaputra, Ganges, and Meghna basins, with a high population density (1100-plus people per sq. km). Eighty percent of the country is flood plains. Fifty-seven transboundary rivers flow into Bangladesh. Riverine and flash floods are major concerns during the monsoon season, as they cause extensive human suffering and loss of crops. However, the number of casualties is going down over the years, due to improvements in flood forecasting and warning services. ICIMOD helped install seven automatic (water level and rainfall) stations in Bangladesh and they transmit data in near real time. Rainfall and flood forecasting is done mostly for 29 major rivers in Bangladesh through an assortment of water level and rainfall stations, some of which are automatic. Flood warning is issued through various tools such as SMS, integrated voice recognition (IVR) using mobiles, email, social media, and landline when the water level exceeds the warning/danger level. BWDB has developed a flood mobile app to communicate different kinds of information services such as the bulletin, FAQ, inundation maps, and flood warning but the app needs to be popularized to encourage its use. One area where Bangladesh needs to work on is in making available location-specific flood information, as it is in great demand. Most importantly, flood forecasting and warning messages need to be transmitted from the central to local level within the shortest possible time, for which community radios and other media need to be engaged.

Discussion points

- Bangladesh has 5-6 mobile service providers. Mobile networks are very good. Anyone can open a flood forecasting website and browse. Ninety percent of the country's population are mobile users, including the majority of rural populations.
- The Joint River Commission between India and Bangladesh is governed by the Farakka Treaty. The commission discusses what data and information the two countries can share with each other. Currently Bangladesh has been receiving rainfall and water level data from India; it can access water level forecast information from the commission's website.
- A flood mobile app was launched in April 2018. Not everybody in rural areas is familiar with this app. Its use, confined to urban areas, is slowly spreading to rural areas too.
- Some NGOs are piloting forecast-based financing schemes, using BWDB's products. Five-day deterministic forecasts are issued to avoid infrastructure damage (through regulating BWDB's embankments, sluice gates and canals), and 10-day forecasts to prevent loss of crops. The longer the lead time, the greater the uncertainty.

- Feedback on any discrepancies in the communication protocol is sought from district administrators/ commissioners and members of local communities through landline and mobiles.
- The World Bank is funding a mega project to strengthen hydromet services, building on the past work of the HYCOS project. ICIMOD's work has inspired Bangladesh to install radar sensors in 300 stations. The challenge is to maintain and sustain these stations.

3.2.2 Generation of early warnings for disaster risk reduction in Bhutan

Sangay Tenzin, Engineer, National Centre for Hydrology and Meteorology, Bhutan

NCHM (successor to DHMS) was founded in 2016 as an autonomous agency of the Royal Government, and is governed by a board. It oversees 62 automatic weather stations; and 59 automatic water level stations on channels, of which about 30 are unrated, but a plan is afoot to rate them gradually as it takes time to do a field survey. It issues 72-hour weather forecasts, which become additional inputs for hydrological forecasting. Early warning systems with two levels – alert level for early warning and alarm level for evacuation – are in place for GLOFs and rainstorms flood. A GLOF EWS website and 18 sirens are placed in 2011 to warn downstream communities in the path of potential GLOF in Punakha-Wangdue Valley using irridium satellite as the primary communication system. This GLOF EWS was replicated to GLOF hazard potential valleys of the Chamkhar Chhu River and Mangde Chhu River Basin with Support from JICA in 2012-13. In these basins, EWS as commercial satellite-based communication is not sustainable; therefore, HF radio and Meteosat, a geostationary satellite operated by European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), is used as a communication system. HF communication systems are also used for activation of warning sirens and to broadcast audio warnings of pre-recorded or live broadcast through warning sirens.

With financial support from the World Bank, the Regional Integrated Multi-Hazard Early Warning System (RIMES) based in Bangkok is piloting a decision support system for visualization and dissemination of hydrological and flood warning services. Awareness raising, including mock drills and sensitization, is needed to raise the understanding about flood forecasting and warning services. Communication protocols need to be set including expected responses from stakeholders during flood events and emergencies. Early warning systems are part of the national hydromet network, as data emanating from them end up in the national database. Hydropower companies contribute some money for the maintenance of GLOF EW systems. False alarms can dilute faith in early warning systems but it is better to have a false alarm than have no alarm when there is a flood. After floods, it is a good idea to revisit threshold levels in stations.

Discussion points

- All hydropower companies are publicly owned and mandated to contribute annually to EMP as part of their DPRs. That amount comes to NCHM, a portion of which can be spent on the maintenance of hydromet systems, including early warning systems.
- There is a dearth of real-time stations for generating climate data in northern Bhutan. People have to visit the manual stations in person to collect recorded data.
- NCHM has two gaps: 1) lack of a centralized database system that can store data from multiple sources for flood forecasting; 2) lack of IT capacity, thus making sub-daily forecasting a challenge.

3.2.3 Generation of early warning for disaster risk reduction in Nepal

Binod Parajuli and Sunil Pokharel, Department of Hydrology and Meteorology, Nepal

Rainfall variability is an important characteristic of Nepal's climate. Precipitation can exceed 500 mm in 24 hours in places like Pokhara, causing flash floods. Extreme precipitations are concentrated in lesser hill ranges such as the Siwalik and south of the Siwalik and even more so towards the east than the west. Precipitations of 60 mm per hour are thresholds for landslides and floods. Nepal is in the process of strengthening its network of stations, of which about 50-60 water level stations have telemetry. Modelling started only in 2014 as that requires real-time data. There has been a reduction in flood casualties, and landslides have caused more casualties than floods in recent decades.

Flood early warning systems started in the 1990s, with watchtowers initiated by Practical Action. Then manual gauge stations in the 2000s helped increase the lead-time. Real telemetry began only after 2010. Once data started being transmitted at 5-15 minute intervals, the lead-time increased significantly. Currently there are about 175 hydrological (water level) stations in the country, where discharge is measured three times a year to update the rating curve.

The probabilistic mechanistic model used with 5-hour lead-time is more accurate. Flood forecasts with WRF 9 km resolution are issued, after correcting for bias. Flood inundation maps are based on HEC models. Mike 11 hydrological and NAM hydrodynamic models are used for regional flood outlooks and flood modelling. Other forecast products used for supporting flood advisories are: GLOFAS, the South Asian flash flood guidance system, ICIMOD's regional flood outlook, and hydro-viewer. There is SoP for flood forecasting and warning services. Flood bulletin is issued twice a day during the monsoon.

Means of warning dissemination are hotline 1155, social media, and email. Currently there are eight polygons (designated areas) that receive early warning mass SMS provided by Nepal Telecom and NCell. There are now plans to increase to 42 polygons in eight river basins to reduce the number of casualties due to floods and landslides. There are still many challenges such as lack of human resources, especially technical expertise, lack of coordination among stakeholders, lack of hydromet monitoring in remote (mountain) areas, lack of clarity in treaties with India regarding data sharing, and lack of mechanism for data sharing between China and Nepal – to warn of potential floods, say in the Bhote Koshi. The way forward may be to revise communication protocol as per Nepal's new government structure, move to risk-based warning and impact based forecasting, and develop decision support systems for various applications.

Discussion points

Information communication is a two-way process. In the case of GLOF, in remote areas, early warning systems may be out of operation. As media has presence in most parts of the country, they play an important role in communicating early warning.

3.3 Technical Session 2: Disaster Management Authorities

3.3.1 Disaster management: Bangladesh perspective

Md Abu Syed, Fellow, Bangladesh Centre for Advanced Studies, Bangladesh

Annually, about 3.48 million people are affected by disasters in Bangladesh. The cyclone preparedness programme has 60,000 volunteers to conduct evacuations in the event of a cyclone and storm surges in reducing casualties. These volunteers are provided with refresher training. Bangladesh's National Disaster Management Council, chaired by the prime minister, advises and guides national agencies on disaster management. The Government of Bangladesh (GOB) has established an early warning communication system for reaching the most vulnerable community through different channels; even if one communication channel fails, the rest serve the purpose. The legal framework for disaster management has standing orders on disaster (SoD), with detailed steps to take in the event of different categories of cyclones (category 1, category 2, etc.).

Main responsibilities of Cyclone Preparedness Programme (CPP) are:

- Disseminate cyclone warning signals issued by the Bangladesh Meteorological Department (BMD) to the community people.
- Assist people in taking shelter.
- Rescue distressed people affected by a cyclone.
- Provide first aid to the people injured by a cyclone.
- Assist in relief and rehabilitation operations.
- Assist in the implementation of the Bangladesh Red Crescent Society (BDRCS) Disaster Preparedness Plan.
- Assist in participatory community capacity build-up activities.
- Assist in the co-ordination of disaster management and development activities

However, despite a lot of rhetoric about improved flood early warning, something similar to CPP couldn't be established yet for flood. BMD is generating weather forecasts (with 1 km resolution). Structural risk mitigating interventions being undertaken are construction of embankments, polders, bridges, culvers and 'killas' – elevated shelters for livestock and people –in flood plains and coastal areas. Mock drills for fire, floods, and earthquakes are conducted nationwide and flood depth type determines the kind of flood early warning to be issued. Integration of citizen science (monitoring and crowdsourcing of water level data) for early warning generation and dissemination is the way forward.

Discussion points

- The Prime Minister's Office makes available funds including resources such as rice, wheat and blankets both nationally and regionally in case of emergencies. District administrations also have some funds for emergencies.
- Forecasts and early warning information are provided to farmers through a mobile app and SMS.

- Citizen science can help increase the accuracy of flood forecasts and early warning.
- A World Bank-funded national data centre is being set up. It will house national digital IDs, passports, and all early warning systems. Inputs provided by individuals will be incorporated in the models, and coastal weather information will be provided to coastal fishing and riverine fishing communities.
- Relevant government sectoral departments have to estimate and report human and economic losses due to disasters as per the country's Disaster Management Act and Plan. These departments also have their own contingency plans with budget allocations in the event of disasters.

3.3.2 Disaster management system on flood hazard management in Bhutan

Yang Dorji, Chief Programme Officer, Department of Disaster Management, Bhutan

The Disaster Management Act of 2017 governs the National DM Authority, which has eight desks, each with its own roles and responsibilities. Bhutan has a total of 25 potential dangerous glacial lakes out of 2,794 glacial lakes. The last GLOF event occurred in Lemthang on 28 June 2015. In the event of a GLOF, NCHM sirens are automatically activated; it also conducts rapid damage assessments. GLOF EWS has proven to be very effective. GLOF risk mitigation measures such as lowering the lake water level, installing EWS in Punakha and Chamkhar valleys, and conducting awareness raising and mock drills are giving the most vulnerable some respite.

Floods are seasonal, and flash floods are common due to steep terrain and poor drainage systems in the country, however, no flood hazard zonation maps are available for major rivers. Over 70% of settlements are located in drainage systems, underscoring their vulnerability.

Discussion points

- The local community's access to flood early warning information is quite limited.
- One lesson learnt from flood-affected industrial areas is that a one-off training is not enough, so the frequency and quality of mock drills and awareness raising should be increased, as there is still confusion among people as to where to go, which route to take in the event of a flood.
- Dzongkhag Disaster Management Committee, a civil society authority under the Ministry of Homes, is comprises representatives from NGOs. The Bhutan Chamber of Commerce and other entities are empowered to conduct mock drills, to which people from media and private sector are invited. All private individuals must come out with their own contingency plans.

3.3.3 Disaster coordination structure in Nepal

Daya Ram Shrestha, Information Officer, Ministry of Home Affairs, Nepal

The warning information is first communicated by DHM to the National Emergency Operation Centre (NEOC) under Ministry of Home Affairs (MoHA). The information is then verified within 15 minutes and then communicated down to the local level through the District Emergency Operation Centre.

Under Nepal's new government structure, the formation of Provincial Emergency Operation Centre is envisaged. The Police Headquarters receives a flood bulletin from MoHA and communicates it to police forces at the local level for necessary action.

MoHA recently came out with the DRR Policy and Strategic Action Plan 2018. It also circulated an instruction to the local government to form Local Emergency Operation Centre for local level disaster management.

3.3.4 Flood Forecasting and Early Warning System in Pakistan

Mohammad Zafar Iqbal, Director, National Disaster Management Authority, Pakistan

Pakistan is very flood prone. Economic losses due to flood were estimated at USD 18.89 billion in the last decade – with about 4,799 deaths and 4 million households affected. Pakistan Meteorological Department (PMD) is responsible for gathering rainfall, water level and river discharge data and is mandated to issue early warning.

Flood Forecasting Department (FFD) of PMD issues flood forecasts. Flood early warning is issued via telephone, email, fax, PMD website, print, digital, and broadcast media. The National Disaster Management Authority (NDMA) is the lead agency at the federal level for policy implementation.

Discussion points

- Pakistan has good policies regarding flood disasters but implementation is weak. It is the first country to pioneer the 'UN cluster system'.
- As no individual can make decisions in isolation, technology driven data analysis and decision systems are important.

3.4 Technical Session 3: Perspectives from Implementing Agencies

3.4.1 Good practices in communicating flood early warnings to the end users in Bhutan

Chhimi Dorji, National Consultant, Bhutan

Bhutan has come up with water security index that looks at five different dimensions of water-induced disaster. One dimension is resilience, with three sub-dimensions and 25 indicators. In KD5C of disaster and climate resilience there is provision of flood/GLOF early warning systems, which is the major responsibility of DHMS, MOEA. In Bhutan, most public infrastructure is in the flood plains, which increases vulnerability during extreme weather events, including floods.

One-day weather forecast is issued through various media; however, there is no system of sharing information directly with the public. Information shared by agencies is too generic whereas TV and newspapers bring the news of the flood only the next day.

There is lack of land space for installing more hydro-met stations. Some budget is allocated by hydropower companies for the maintenance of existing hydromet stations.

Discussion points

- There are some differences in dimensions of rural and urban resilience. However, there is no need to create separate structures and reporting mechanisms to deal with different types of resilience.
- A lot of construction work and encroachment is going on in the flood plains and river banks, but efforts to remove these structures to reduce their exposures to risks have not been successful. Development activities are relatively new, so there is a tendency to approve construction work in flood prone areas.

- Community needs to be aware of information provided by NCHM. Flood hazard zone maps are updated by certain offices, so there is a need to incorporate these in five-year, annual and individual plans.
- The water security index for Bhutan in 2017 was 3.08 out of 5. This could be used as a tool for monitoring and implementation of programs in the water sector.

3.4.2 Communicating flood warnings to end users and stakeholders in Nepal

Gehendra Gurung, Head of Programme – DRR and Climate Change, Practical Action, Nepal

NGOs are playing a crucial role in making government generated data and information available to flood vulnerable communities. Through the first responders (e.g., community disaster management committees and related task forces), information trickles down to the household/community level. Mass SMS, telephone, siren, hand mike, door to door visit, local FM radio and website, etc. are the communication channels used when the river level crosses the warning and danger levels. Information is again circulated once the flood level recedes to normal level. Communities now understand flood risk at different levels – normal, warning and danger levels. Flood information communication charts – who communicates to whom – are updated before the monsoon every year. Response capacity is enhanced through mock drills and training, including provision of information on how to swim, where to go, which route to take in the event of a flood. Local authorities also need to know what early warnings mean and the existing early warning communication protocol.

Open street map tool is used to digitize hand-drawn community maps.

Lack of standardization of SOP on flood early warning communication, shifting towards disaster preparedness from response-centric focus, sustainability of systems, multi-hazard early warning to address lightning, landslides, floods and forest fires, and use of advanced technologies to address increased uncertainty are some of the existing challenges.

Coverage area in terms of geography and hazards, lead and lag time, collaboration at regional and even transboundary scale needs to be increased.

Discussion points

- Indigenous knowledge/local knowledge needs to be factored in during the risk assessment phase.
- The disaster information portal is owned by the government but open to accepting information from any source. Local government needs to take stronger ownership of the FEWS and its disaster management role.
- Sustainability of hydro-met stations, including early warning systems, is the main challenge. Once the project leaves, mock drills, awareness raising and maintenance of systems come to an abrupt halt. This is where the local government needs to be brought in.

- It will be good if local governments (municipalities) can allocate money for the maintenance of early warning systems, including remuneration for the local managers, e.g. caretakers.
- Providing verified location-specific information directly to the community is the way to go but that needs more work.
- Flood events need to be anticipated by undertaking disaster preparedness measures as currently people respond and react only when flood comes. Based on the Sendai Framework, early warning information is meant to be used for rebuilding/recovery; however, such is not the practice in Nepal.

3.4.3 Design test and demonstrate disaster management information system down to household level in Bangladesh

Md Abu Syed, Fellow – Bangladesh Centre for Advanced Studies, Bangladesh

Community members respond differently to flood early warning depending on their risk perceptions and exposures – those living closer to the flood prone river might react more quickly than those living farther up. Therefore local reference systems should be established and kept at public places, the level at which you are compelled to evacuate. Based on the reference and locals' perception, several mock drills and simulations can be conducted. Flag signal system is used in Bangladesh for cyclone warnings.

In Bangladesh, multiple communication channels are in place for communicating flood early warning information to vulnerable communities, so when one channel fails another works.

To reach the last mile more effectively, SMS needs to be circulated in the local language, and several Union Disaster Management committees, citizen science, micro finance institutions (e.g., Grameen bank) should be linked to EWS networks.

Discussion points

- Due to improved flood early warning dissemination and response, Bangladesh has achieved zero casualties. In addition, due to a long flood history in the country, people are better attuned to flood risks and how to address them.
- Yellow flags are used to signal to the community the extent of the increase in water level at that point in time. 1 flag means water level has risen by 9 inches, two flags means it has risen by 1 hand-length.
- The main challenge is to reach the local community. River flood forecasting is for more than 100 million people – so the NGOs such as Practical Action, BRAC, and Care Bangladesh have a role to play in terms of addressing last mile connectivity. These NGOs work with local committees to help community members interpret flag symbols and colour codes, etc. through organizing trainings, mock drills, and simulations.

3.4.4 Communicating flood early warning for last mile in Pakistan

Saeed Hafeez, Programme Development Officer, Lead Pakistan

In Pakistan, floods of all types affect about 715,000 individuals annually. The last major flood occurred in 2010, with an estimated economic damage of USD 10 billion. PMD, national and provincial disaster management authorities are responsible authorities. PMD is directly responsible for validation and dissemination of information down to union councils and communities. Lead Pakistan has also led capacity building of government staff, produced and disseminated knowledge products.

Flood early warning information is disseminated through TV/radio stations. Local early warning messages are circulated through tehsil, town and union council members. In addition, community awareness programs are conducted to raise awareness. Roles of different groups (the elderly, indigenous people) are integrated to reach the last mile.

The warning messages are too linear and there is a need to increase the coverage and secure consistent power. There is also a need to increase community awareness to ensure greater cooperation.

There is a need to assess flood warning and communication systems and develop integrative FEWS. Mock drills and awareness needs to be conducted.

Discussion points

- Pakistan piloted standardized SMS messages as they are cost effective. Some 56 million SMSs have been disseminated. However, it is hard to assess what percentage of the intended recipients actually opened, understood and acted on the text messages. People receive the early warning texts on their mobiles only if they are inside the designated area (or polygon). Moving forward, more augmented approaches or low cost approaches are recommended. IVR is not feasible.
- Encroachment is rife in urban areas, in canals and river bunds, many of which are prone to floods as they are fed by hill torrents. Many people will not leave their homes in urban areas or market places until it is too late. To effect behavioural change, participatory community awareness and training of trainers are needed. The government has to control encroachments in flood-prone areas or relocate those whose settlements are at risk to reduce their exposures.
- Community risk mapping follows from community risk assessments, which help in devising community level disaster preparedness and response plan.

3.5 Group Session I: Discussion on Strengths, Weaknesses and Gaps in Communicating Flood Early Warning

The participants were divided into four country groups to discuss the following three questions for 50 minutes:

- What are the strengths in the early warning chain?
- Where are the weaknesses in the early warning chain?
- What do you see as the key gaps in communicating early warning?

They considered the whole communication chain, comprising hydro-met agencies, disaster management authorities, and civil society organizations, and research institutes.

Bangladesh

Description	Strengths	Weaknesses	Gaps
Hydromet services			
Generation of early warning • Flood forecasting models; • Global models	• Flood forecast model • Well calibrated and validated up to district level	• Model outputs required to be downscaled and validated to sub-district and local level; • Early warning generated in major river points; medium and small rivers are absent	• People or regions far from forecasting points do not have access to early warning.
Products and packaging of early warning for dissemination • Flood bulletin; • Advisories	• Both flood bulletins & advisories; • Nationwide flood situation at a glance	• Bulletins/advisories cannot clearly describe the vulnerability of the local/ specific areas or char land areas.	• Identifying the specific sub-districts/unions/locality
Means of communication, language and frequency	• Media, email, fax, IVR, mobile voice call; use of both Bangla & English	• No automated system till now	• Vulnerable communities have to wait for information through UDMC or IVR
Transborder early warning	• Existing nationwide dissemination system	• Insufficient lead time	• No cross-border exchange of information • People living near the border and administration cannot get enough time to minimize crop loss and human suffering.

Description	Strengths	Weaknesses	Gaps
Disaster management authority			
Dissemination of early warning *Who are the recipients*	• Ministry, zonal offices, DDM, DMC, UDMC	• No direct mechanism to convey warning to people; UDMC weak; DMIC does not work properly	• Not enough lead or response time for vulnerable people or community
Coordination between various agencies and end users	• Coordination exists but not satisfactory	• NGO communication	• Information from central level is not available to end users in a timely/ required manner. • EW information/messages are not customized to local contexts and languages.
Means of communication, language and frequency • SMS, Phone, Media, website; • How many times and in which format?	• SMS, phone, IVR, media, website	• Database of phone/text receivers are not updated regularly, • Flow of message/ information also needs to be regular and consistent, • Lack of publicity of IVR/ phone/text services	• Database of phone/ text receivers need to be updated regularly. • Regular and consistent flow of messages/info • Lack of publicity of IVR/ phone/text services
Civil society, research organizations			
Awareness of communities and capacity building	• Large no. of NGOs and civil society work with govt. • Govt. and civil society work hand in hand.	• Ad-hoc • Lack of coordination and sometimes irrational roles/ tasks taken up by NGOs/ civil society; • Consistent collaboration among DDM/FFEW and NGOs/CS absent	• Lack of coordination and sometimes irrational roles/ tasks taken by NGOs/CS
Coordination between various agencies and end users	• There is still room for improvement in terms of coordination	• Lack of coordination between NGOs and government body	• Lack of coordination between NGOs and the government body
Materials for enhancing awareness	• Awareness program	• Budget constraints	
Means of communication, language and frequency	• Local languages • Daily meeting	• Translate information into audience-appropriate languages	• Information not available to end users on time
Addressing gender and differentiated vulnerabilities	• No significant example	• Vulnerabilities increase for women, children and elderly people	• Vulnerabilities increasing for women, children and elderly people
Mechanisms for feedback?	• Strong feedback at village level meetings	• All vulnerabilities not clearly identified by NGOs/civil society	

Bhutan

Description	Strengths	Weaknesses	Gaps
Hydromet services			
Generation of early warning: • Flood forecasting models • Global models	• Good number of hydrological models at disposal; • National WRF and NWP has improved a lot up to 3 days; • Good flood detection in some basins; • Telemetric observation stations augmented	• Quality of observed hydromet data; • Missing observed meteorological data; • Long time series WRF data availability of NCHM; • HR capacity; • Model setup for only a few river basins; • Centralized database management issues	• Hindcast of NCHM WRF for at least 6 years; • Model setup in another basin by NCHM; • Data quality control scheme; • Integration of other hydrological model outputs into DSS; • Ensemble forecast using different rainfall forecast inputs: RIMES WRF, NCHM WRF
Products and packaging of early warning for dissemination • Flood bulletins; • Advisories	• Good flood detection in some basins; • Telemetric observation stations; • Information on flood status thrice a day; • 3-day flood forecast issued; early warning issued when flood detected.	• Flood bulletins and advisories issued while flood is forecasted/ detected to DDM and stakeholders only; • No direct communication to end users except with sirens and PA systems	• Flood bulletin too technical (gives only hazard information and no impact information); • Accuracy of forecast is good only up to 24 hours.
Means of communication, language and frequency	• Alarm/siren triggered automatically when flood detected; • Social media accessible to most communities.	• False alarm; • Problem in SMS (no polygon information from telecom)	• No flood advisory/bulletin/ apps; • Problem with SMS; • Weather forecast not updated in national media as per NCHM.
Mechanism of feedback?			No feedback system at all.
Trans-border early warning	• Govt of India program issuing info to North India; • Long-term relation.	Only issuing information…but not receiving any feedback.	No information from North India
Disaster management authority			
Dissemination of early warning; Who are the recipients?	NEOC, DDMC, DDMOs/ TDMOs, GDMCs	Not able to go down to the grassroots level	Roll-out programs not done
Coordination between various agencies and end users	• Inter-ministerial taskforce formed; • DMCP's: 16 districts and 2 Thromdes made; • Simulation exercise between UN agencies and other stakeholders	• Not able to coordinate at the local level; • Coordination mechanism not tried and tested; • Coordination between/with NDMA members not tested	• No taskforce at the local level; • Simulation exercises of DMCP's are done only at 4/16; • No DMCP's in 4 districts and 2 Thromdes; • Not all NDMA members present
Means of communication, language and frequency; SMS, phone, media, website	• DDM, NDMA secretariats taken seriously; • Small communities with good connection; • Draft SOP on flood	• Warnings are not site or time-specific; No experience of implementing the SOP for flood	• Information specific to time and place not available; • Flood SOP not endorsed

Description	Strengths	Weaknesses	Gaps
Other disaster management issues	Act and rules are in place	• Not enough technical people with adequate capacity; • No dedicated DDMOs/TDMOs	• GIS skills, technical skills; • Dual role
Trans-border early warning	Not an issue at the moment		
Civil society, research organizations			
Awareness of communities and capacity building	• Mock drill experience; • CBDRM training	People do not take simulations seriously.	• People who have not experienced disasters are not motivated enough to be prepared.
Coordination between various agencies and end users	NGOs are in the field	No NGO working on EWS or related aspects as of now	• NGOs lack capacity. • Government agencies implement all activities.
Materials for enhancing awareness	• Multi hazard booklets; • Guidelines on do's and don'ts; • Audio visual	Not everyone understands the communication materials.	Not in local dialect
Addressing gender and differentiated vulnerabilities	Vulnerability assessments done		
Mechanisms for feedback?	Weather and flood information is available at the centre.	Weather and flood forecasts are not used for decision making purposes.	Lack of service centre/website/ protocols for sharing information with the public

Nepal

Description	Strengths	Weaknesses	Gaps
Hydromet services			
Generation of early warning and flood forecasting models			
Flood Forecasting Models	• Confidence and accuracy; • Understandable; • Linked with DMA	• Difficult for non-technical people to understand; • Uncertainty in rainfall forecast; • Limited trained human resources • Inadequate ICT	• National and basin level rainfall forecasts for flood forecasting
Global models	• Increased lead-time for early action; • Free of cost; • Node can be added at any place	• Less accuracy; • Dependency on others	
Products and packaging of early warning for dissemination			
Flood bulletin	• Strong lifesaving message; • Means of preparedness	• Limited to certain groups (email users only)	
Advisories	• Easy to self-plan, very helpful in harvesting and planting crops		

Description	Strengths	Weaknesses	Gaps
Means of communication, language and frequency	• Followers of social media (Facebook and Twitter) reaching out to larger groups	• Only in Nepali language- local language • Not accessible or limited to end users	• Local language
Mechanism of feedback?	• Toll-free number and social media for feedback	• Limited social media users	
Transboundary early warning	• Community-community linkage social cohesion	• No data sharing between Tibet (China) and Nepal • No institutional/ governmental linkages	• No policy on transboundary EWS
Disaster management authority			
Dissemination of early warning, who are the recipients?	• Extend institutional structures up to community level (TFs and CDMCs); • Local governments in place	• Area coverage is limited (project based only); • Limited awareness; limited capacity of local governments and end users	• Sustainability
Coordination between various agencies and end users	• Coordination and collaboration among all stakeholders	• Limited project-based area coverage	• Community underrepresented in district level mechanism
Means of communication, language and frequency: SMS, phone, media, website	• Social media (Facebook and Twitter) – reaching out to larger groups; • Toll free #, website with visual displays, twice a day in monsoon as and when required; • Maps, texts and graphs	• Limited to certain groups (email users only); • Limited internet service: solar power backup	
Civil society, research organizations			
Community awareness and capacity building	• Community level structures (TFs and CDMCs); • Training on CBFEWS	• Limited or project based; • No clear policy on roles of the local government	Continuity
Coordination among various agencies and end users	• Strong mechanism all the way up to community level; • Increase in number of supporting agencies	• Lack of effective coordination among stakeholders	• Institutional relations lacking
Means of communication; language and frequency	• HF radio set; • Community level TFs	• Limited to DEOC (around 56-573 local agency)	• Project-based operators
Addressing gender and differentiated vulnerabilities	• Gender focal points		

Pakistan

Description	Strengths	Weaknesses/Gaps
Hydromet services		
Generation of early warning • Flood Forecasting Models; • Global models	• Based on scientific evidence; • Hydrological modelling, including FEWS & IFAS.	• Does not have disaggregation at sub-district level
Products and packaging of early warning for dissemination: • Flood bulletins; • Advisories	• Daily updates issued to all concerned federal /provincial authorities and also posted on PMD website; • Regular radio/TV broadcasts	• Information does not always reach the sub-district/Union Council level
Means of communication, language and frequency	• Daily frequency of bulletins; 2. Use of telephone, fax, email; • Use of website & social media in understandable languages.	• Should also be in local languages; • Web connectivity & power failures can pose communication problems
Mechanism of feedback?	• Regular meetings between stakeholders.	• Need for a public feedback mechanism.
Trans border early warning	• Data sharing agreement with India for eastern river monitoring	• No timely information sharing; • Complex communication protocols
Disaster management authority		
Dissemination of early warning; Who are the recipients?	• Recipients include federal/provincial government line departments, DMAs and civil society; • Daily updates provided.	• Feedback mechanism needs to be set up.
Coordination between various agencies and end users	• Federal & provincial level coordination is strong. • Coordination with UN Resident Coordinator and other UN agencies is strong. 3. UN OCHA-NDMA quarterly meetings for coordination	• Local/sub-district coordination SOPs need to be improved.
Means of communication, language and frequency; • SMS, phone, media, website; • How many times and in which format?	• All media tools, including social media, used for dissemination of information on a regular basis; • Regular updating of information on the website	• SMS messages are being sent in Roman Urdu. This should be in Urdu script and other local languages/scripts.
Mechanism of feedback?	• NDMA organizes an annual monsoon contingency conference for all relevant stakeholders. (Output: monsoon contingency plan)	• Timely follow-up actions by the local line department are lacking. [Do not adhere to the set timelines in some cases.]
Transboundary early warning	• PMD has the capability to gather rainfall data in catchment areas of the eastern rivers.	• Water discharge data from the Indus Commission of India are received with delays. • Coordination mechanism needs improvement

Description	Strengths	Weaknesses/Gaps
Civil society, research organizations		
Awareness of communities and capacity building	• Use of easy-to-understand communication materials; • Local language trainings	• Increase frequency of trainings and scale up lessons; • Many INGOs/NGOs target easy-to-access communities, so remote/far-flung areas are neglected. • Targeting of vulnerable groups can be improved; • Different regions have different socio-cultural constraints. • Lack of interest among local administrations/communities
Coordination between various agencies and end users		• Coordination can be improved through keeping better track of trainings. • Duplication of actions
Materials for enhancing awareness	• Easy-to-understand materials in English & national languages used; • Pictorial materials are used in trainings	• Training materials should be in all major regional languages.
Means of communication, language and frequency	• Use of audio-visual equipment, including multi-media; • Use of flip charts and group exercise results	• Frequency of local trainings can be increased; • Insufficiently trained human resources; • Budget constraints.
Addressing gender and differentiated vulnerabilities	• Trainings ensure gender representation; • Guidelines are gender-sensitive and cater to the needs of vulnerable groups.	• Low participation level of some vulnerable groups, specifically the elderly and persons with disabilities.
Mechanisms for feedback?	• Regular feedback received from the trainees	

3.6 Group Session II: Discussion on Key Weaknesses and Potential Solutions on Communicating Flood Early Warning

The group work followed up on the earlier group discussion to identify potential solutions to improve early warning communication for last mile connectivity. Country-wise solutions for technical, institutional/governance and socio-cultural domains presented at the end of the discussion are summarized in the Table below.

Country	Technical	Institutional/governance	Socio-cultural
Bangladesh	• Downscale and validate national model outputs to district and sub-district level; • Develop regional (sub-national) basin wise-nested models integrated to national ones; • High resolution digital elevation model (DEM) needs to be incorporated into the national and regional nested models. • Automated system integration among BMD, FFWC and DMIC; • Automatic dissemination mechanism to automatically disseminate early warning (via email, phone, text, IVR) to defined audiences	• National government will work with basin sharing countries (government and inter-government institutions) for transboundary data and information sharing with reasonable lead time; • DMIC has to be institutionalized and integrated with FFWC and BMD forecast systems (National data centre may act as the hub.) • Institutional modalities to update the list of NGOs, institutions and individuals before flood season, disseminate EW materials, and ensure two-way communication and feedback.	• EW messages customized to local contexts and in local languages should be made available through various media. • Develop/disseminate gender differentiated materials/ messages; • Coordination among government and non-government institutions in respective regions/basins to avoid duplication. Existence of redundant dissemination networks a must to ensure that if one communication channel doesn't work, the other does; • Develop two-way communication and feedback modalities

Country	Technical	Institutional/governance	Socio-cultural
Bhutan	• Impact-based forecast and warnings; • Extend newspaper/TV/ radio weather forecasts and warnings by up to 3 days in various dialects; • Use social media (WeChat/Facebook) for communication; • Upgrade NCHM/DDM website with warnings and forecasts	• Local block/gewog officers should be made aware and responsible as per Acts and Rules, IWP/APAs; • MOU with service providers for concessions; • Directly communicate with the local block/Gewog offices; • Develop a strategy and plan for the communication system with adequate budget allocation; • Regular monitoring and evaluation (feedback) of the system by a designated authority	• Disseminate information about the availability of forecasts and its impacts/benefits in local dialects. • Network of volunteers and community based information sharing; • Involve women, children, the elderly and special needs people in discussions and awareness raising activities.
Nepal	• Nation wise multi-hazard risk assessment mapping (basin and sub-basin); • Atomization of hydrometrological stations (i.e., stand-alone); • Expand the telecom network and its services to all places; • Inclusive technology (visible, sound and symbols/ signage) for dissemination of information; • Alternative means/ of communication (VHF, radio wave based, satellite based); • Use of social media and mobile apps; • Capacity building up to local level	• Formulate FEW guidelines in line with the existing Act, Policy, and Strategic Action Plan; • Integrated approaches of all institutions at all levels for nationwide multi-hazard risk assessment mapping (basin and sub-basin); • Local government ownership of existing monitoring stations and establishment of new ones; • Vertical collaboration between institutional setups and EWS system i.e., from NEOC to LEOC; • Proper communication channels (vertical and horizontal); • Institutionalize task forces (early warning system, search & rescue, first aid.) in the local governments	• Integrate indigenous, social-cultural knowledge in risk assessment mapping; • Diverse messages reaching diversified target audiences: language, social norms and values; • Integrate social and cultural norms in stations establishment and capacity strengthening of most vulnerable; • Gender sensitive response actions (to address risk taking behaviours) **Economic solutions** • One door system guided; • Attract local government's budget and allocate budget from all government levels
Pakistan	• Hydrological modelling, hazard mapping & risk assessments up to Union Council/Tehsil level should be ensured; • Upgrade existing forecasting equipment including weather radars/stations; • Install more telemetry data collection units to ensure round-the-clock real-time coverage of river flow data; • Establishment of modern weather forecasting equipment for dissemination of early warning twice daily; • Alternate back-up support to overcome power outages or system malfunction	• Revisit and simplify the complex communication protocol signed with neighbouring countries for sharing water discharge data; • Feedback mechanism from district government and civil society stakeholders needs to be streamlined and strengthened; • Harmonized data collection protocols & mechanism (to aid disaggregation in reporting); • Improve local/sub-district coordination SOPs including communication protocol; • Vigorous human resource development through coordinated trainings by master trainers at grassroots level to avoid duplication and overlapping	• Incorporate traditional wisdom and local knowledge into early warning & response; • Translate text messages into regional/local languages; • Scale up community-based capacity building sessions on EWS; • Training materials, techniques and trainers must be in line with religious, cultural and social norms of the targeted communities; • Community participation in preparation of activities before the onset of a flood/flash flood

3.7 WMO's CHy National Assessment of End to End EWS Capability for Flood Forecasting: Moving to Best Practices in Communicating Flood Early Warning

Paul Pilon, World Meteorological Organization

Paul Pilon said that disseminating early warning strategically is important so actions can be taken. Numerical weather prediction, QPE (quantitative precipitation estimates), real time and historical data and data analysis and assimilation are important for modelling and flood forecasting. The FEWS has to be looked at from end to end, starting from real-time data collection, modelling and forecasting, warning preparation, early warning dissemination, and decision support system to preparedness and response. Every piece of the E2E FEWS value chain must work. The countries in the region should make use of the South Asia Flash Flood Guidance System (SAsiaFFGS) to develop their capability to generate and issue flash flood forecasts and warnings, and also move toward impact based flood forecasting, focusing on where and when the inundation is going to occur.

Discussion points

- CHy has developed assessment guidelines in consultation with hydromet services. Assessments are done by national entities (DHM, in the case of Nepal). WMO is open to helping its member countries that want to undertake an assessment.
- Multi-hazard warning system could cover floods, landslides, and droughts. Each country does its own reporting for the Sendai Framework.
- The CHy Manual on Flood Risk Mapping will go a long way towards improving the understanding of flood hazards, vulnerabilities to flooding, and resulting risks. It is most beneficial if the hazard, vulnerability and risk assessment is linked to the flood forecasting system, targeting vulnerable communities – e.g., which houses, buildings or infrastructure including streets in a particular area are going to be inundated.
- Many countries have more than one database for hydrological, meteorological and climatological data. Some databases are proprietary for which license fees have to be paid. Countries – especially least developed countries – could explore options to have community-based databases that are free.

3.8 Findings of Strategic Assessments of EWS in Nepal

Mandira Singh Shrestha, ICIMOD

Mandira Shrestha shared key findings of the strategic assessments conducted in Nepal on early warning communication. These assessments were based on key informant interviews (KII) with relevant stakeholders (DHM, MoHA, OXFAM, UNDP, Lutheran World Relief, Mercy Corps, Practial Action, municipality mayor, Chief District Officer, ward chairperson, etc.) and focus group discussion in the Ratu watershed in Manara Sisuwa Municipality in Mahottari district. Key issues identified include the transboundary nature of some floods, lack of coordination and institutionalization, lack of integration of flood risk information in EWS, lack of awareness and ownership, and lack of socio-culturally appropriate response.

The assessment found gaps in warning communication to the vulnerable due to

- Damage to mobile networks
- Lack of early warning in tributaries
- No linkage of CBFEWS to the national system.
- No easy access to flood bulletins and advisories
- Lack of human resources and technical expertise
- Gaps in warning dissemination from the district to vulnerable community at the local level and vice-versa

Some of the findings related to the socio-cultural domain are:

- Capacity to communicate and understand early warning is weak at various levels.
- Women are involved in first aid only, not in early warning communication and search and rescue.
- Early warnings are more accessible to men than to women due to gendered differences in terms of social barriers, mobility, education, and social networks.
- There is a lack of information products (hazard maps, paintings, signboards, etc.) that address the needs of women, the marginalized and the illiterate.

Some recommendations were:

- Integrate flood forecasting and warning in DRM activities such as risk communication, awareness raising and disaster preparedness.
- Disseminate timely early warning in an understandable format – e.g., local FM radio broadcasting in local languages can help the community to respond immediately.
- Institutionalize CBFEWS in DRR through local government bodies such as the municipality under DHM's supervision and CDMCs.
- Conduct awareness raising, build response capacity and a feedback mechanism at the local level.
- Prioritize communication protocol for EWS and early action for communities in the planning process.
- Circulate flood information to DHM and the local government; help develop and expand the polygons by adopting lessons from the past and other models.

Discussion points

- The process of institutionalizing the community-based early warning system could be initiated with UNDP's input. The station in Ratu is not in the national network although it has given Sarpallo a 1-2 hour lead-time and Bihar a 7-8 hour lead-time. Ownership by DHM and the local government can help in making the effort sustainable. Ultimately, the data would come to DHM and to the polygon-based dynamic SMS system. Institutionalization of CDMCs is mentioned in the Act – but the question is how the local government will take it. The way forward could be to tie up the Ratu EWS with local government's programs and budget.
- It is recommended that the findings of the strategic assessment of FEWS in Nepal are shared with the community, DHM and other stakeholders to seek their feedback and guidance on implementing communication protocols for early warning and early action.
- The 2019 plan for HYCOS User Phase under HI-RISK initiative considers continuing this strategic assessment in Nepal, institutionalization of EWS, conducting study on behavioural response to early warning of first responders and the vulnerable community.

Takeaways from the discussion

- Flood early warning communication does not address socio-cultural aspects, especially those related to gender. Focus should not be limited to early warning only; preparedness and early actions are just as important.
- In the case of Pakistan, there is a need to revisit SoP guidelines, and review EWS and response capability if further improvements are to be made.
- Documentation of good practices in EWS, including case studies, can improve our communication system. More countries such as Afghanistan, Myanmar, and India should be invited to regional events in the future, as observers.
- The role of private sector is key to sustainability – e.g., in Bhutan, with regards to hydropower companies. Standardization of training packages for building the capacity of local communities is key, so they are all taught in the same way as per hazard/disaster type. Integration of socio-cultural/gender part should be considered during while setting up institutions and planning.
- The end point should not be response, but rather recovery and building flood resiliency.
- South Asian countries are lagging behind in EWS implementation. One way to guarantee implementation is to link water-induced disaster management plan or DRR to government's five-year plan and local government's annual plan.
- The challenge is to extend EWS from major rivers to flash flood prone tributaries and flashy and ephemeral rivers.
- Solutions are within our region – one of the major problems is lack of budget and lack of human resources. Engineers are working on social aspects for which they are not trained – doing FGD/mock drills. NGOs and social workers need to do that. Engineers can focus on modelling and so on.
- Governance is important. If governance is gotten right, every other thing will take care of itself.
- Different donors give priority to different models and platforms – need a national strategy (say we need this model, not that model). Bangladesh will have 300 stations. What will happen to those stations once the donor leaves? No modelling in small basins – flash flood guidance system can be used there, using satellite based precipitation estimation and soil moisture and QP forecast. There is a need to forecast at a much higher resolution – improve communication products. There should not be many false alarms otherwise there will be a loss of credibility. Move to impact-based flood forecasting.

3.9 Development of a Framework and Methodology on Good Practices in Communicating Early Warning in the HKH Region

3.9.1 Documenting current practices on 'early warning communication'

ICIMOD's country partners and participating entities agreed in principle to document good practices in terms of EW communication, for which an outline and timeline were collectively drawn up, as follows.

Executive Summary

1. Country background reflecting DRR/DRM and EW in relation to floods
2. Legislative environment of EWS
   - Acts, policies and strategies related to EW
   - Strengths, weaknesses and gaps
3. Institutional structure/arrangements
   - Key stakeholders at national, provincial and local levels
     - Government institutions at all levels
     - Others (NGO/INGO, civil society, UN/inter-government agencies, academia, research organizations, development partners)
     - List of ongoing projects and those in the pipeline
   - Strengths, weaknesses and gaps
4. Operational aspects of EWS (Value chain – overview of infrastructure in place through the four pillar lens – risk knowledge, monitoring and warning, communication and dissemination, and response and recovery)
   - Guidelines, manuals, tools, SOPs for EW
   - Flood early warning generation
     - Data collection, processing, and validation
     - Flood forecasting products (risk/impact based if available) and dissemination (advisories, warning, bulletins)
   - Hazard, risk and vulnerability assessment (maps) at national, provincial, district and local levels [including community risk assessment??]
   - Action plans
   - Strengths, weaknesses and gaps
5. Observations and conclusions
6. Recommendations and way forward (short term, medium term and long term)

Length of the paper – 20-25 pages with references

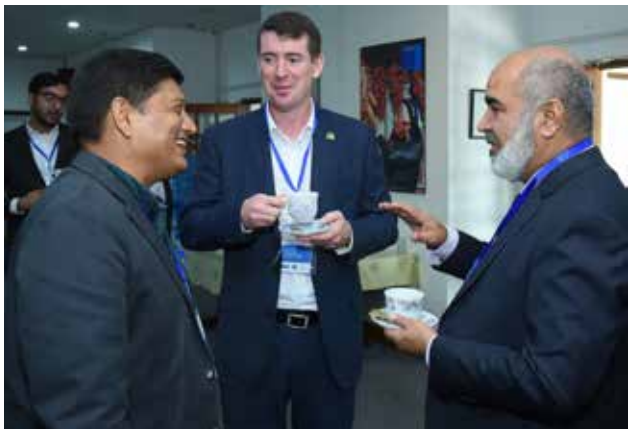
3.9.2 Case Study methodology

The participants suggested considering the following questions while examining the technical, institutional and socio-cultural aspects of flood early warning communication with reference to the study area and context. Paul Pilon also suggested referring to the assessment guideline developed by the Commission on Hydrology for ideas, going forward.

Technical	Institutional [Governance]	Socio-cultural
• What kind of flood advisory is generated? • Are GESI-specific warnings generated? • What are the means of communicating early warning? • What types of communication products (e.g., GIS maps, flood outlook, inundation maps, etc.) are used by your institution to communicate flood early warning to district level stakeholders? • What are some of the limitations (give examples)? What are the technical challenges? • Tools for communication	• Which institutions are involved in communicating early warning? • Are their roles and responsibilities clearly defined in government policies and legislation at all levels? • Available human resources? • What kind of coordination exists between the agencies? • Is there a seamless transfer of information? • How do you receive flood alerts or early warnings from relevant agencies? • Is there a verification process (process for monitoring flood forecast and alerts) and how long does it take before issuance of the warning? • Means and medium of disseminating flood early warning to various relevant institutional stakeholders • Communication bottlenecks	• Are there regular community awareness and preparedness programs? • What language is used for these awareness programs? • What materials are available for raising awareness? • Physical and social vulnerabilities • Whether Gender Equality and Social Inclusion (GESI) is incorporated in the programs

4. Closing Session

The participants expressed their gratitude to ICIMOD for organizing the regional workshop and for being able to share their experiences in communicating flood early warning. They said they were keen to contribute to documenting good practices on communicating flood early warning. On behalf of the WMO, Paul Pilon expressed his satisfaction at the successful completion of the regional workshop and said he looked forward to continued engagement with the partners and ICIMOD. Mandira Singh Shrestha thanked the WMO and the participants for their contribution and the ICIMOD team, particularly the Regional Programme Manager Arun Bhakta Shrestha and the ICIMOD senior management, for their continued support and cooperation, and the Australian government for their generous support.



Annex I: Programme

DAY 1: Tuesday, 2 October 2018

Time	Topic	Speaker/Facilitator/Session Objective(s)
09:00	**Registration**	• *Govinda Shrestha*
Opening Session		
Chair: *Arun Bhakta Shrestha, Programme Manager, River Basin and Cryosphere Programme, ICIMOD*		
09:30-09:35	Welcome Address	• *Basanta Shrestha*, Director Strategic Cooperation, ICIMOD
09:35-09:40	Opening Address	• *Graham Murphy*, Deputy Head of Mission, Australian Embassy
09:40-09:45	Opening Address	• *Paul Pilon*, Chief, Hydrological Forecasting and Water Resources Division, WMO
09:45-09:55	Objectives and expected outcomes of meeting	• *Mandira Singh Shrestha*, ICIMOD
09:55-10:05	Remarks by the Chair	
10:05-10:20	Introduction of Participants	• *Participants*
10:20-10:45	*Group Photograph, Tea break*	
Session 1: Generation of early warning for disaster risk reduction		
10:45-12:30	Overview of processing and generation of flood early warnings, examples of warning products, means of communicating warnings, target audiences and existing gaps	• *Arifuzzaman Bhuiyan*, FFWS, Bangladesh • *Sangay Tenzin*, NCHM, Bhutan • *Binod Parajuli*, DHM, Nepal • Presentation by PMD, Pakistan 15-minute presentations followed by 10-minute discussion
12:30-13:30	*Lunch Break*	
Session 2: Communicating/Disseminating early warning to stakeholders for disaster risk reduction		
13:30-15:30	Institutional arrangements for communicating flood early warning, methods and means of communication and strategies for communicating with vulnerable populations and existing gaps Promoting communication of flood early warnings at local level, means of communication and target audiences, finding synergies with flood early warnings issued by hydromet agencies and existing gaps Bangladesh Bhutan Nepal Pakistan	Disaster management authorities from Bangladesh, Bhutan, Nepal and Pakistan • *Yang Dorji*, DDM, Bhutan • *Daya Ram Shrestha*, NEOC, Nepal • *Muhammad Zafar Iqbal*, NDMA, Pakistan • *Md. Abu Syed*, BCAS, Bangladesh • *Chhimi Dorji*, Bhutan • *Gehendra Gurung*, Practical Action • *Saad Hafeez*, LEAD, Pakistan • NGOs/INGOs authors of case studies, that have established FEWS and institutions that are implementing flood early warning systems; 10-minute presentation by NGO/research organization from each country
15:30-15:45	*Tea Break*	
15:45-17:00	Facilitated group discussion on identifying the strengths and weaknesses of communicating flood risk Report back from the groups	Guided questions - What are we doing well and where are the biggest gaps? Looking through governance structures 5 minutes for each group
18:30-20:30	*Dinner hosted by ICIMOD*	

DAY 2: Wednesday, 3 October 2018

Session 3: International good practices on communicating flood early warning

09:00-09:30	Key messages from Day 1	
09:30-10:30	WMO's CHy National assessment of end to end early warning system in flood forecasting: moving to best practices in communicating flood early warnings	*Paul Pilon*
	Discussion of application of the CHy national assessment process in the HKH	*Participants*
10:30-13:00	Facilitated discussion on key weaknesses and potential solutions on communicating flood early warning	Shortlist of key weaknesses and potential solutions Facilitated by *Vijay Khadgi*, *Min Gurung*, *Soumyadeep Banerjee* and *Pradeep*
	Map out details of the potential solutions on effectively communicating flood warnings to avert flood disasters	Break out groups and reporting Facilitated by *Min Gurung*, *Soumyadeep Banerjee*, *Vijay Khadgi* and *Pradeep*
13:00-14:00	*Lunch break*	
14:00-14:30	Synthesis of group work	Discussion

Session 4: Strategic assessment of communicating flood EWS in Nepal – and national assessment of early warning

	Strategic assessment of communicating flood early warning in Nepal	*Mandira*
	Discussion and feedback	
15:30-15:45	*Tea Break*	
15:45-16:30	Synthesis and way forward	

Day 3: Thursday, 4 October 2018

Session 5: Development of a framework and methodology on good practices in communicating early warning systems in the HKH region

09:00-09:30	Context for the framework and methodology	*Mandira* and *Paul*
09:30-10:30	Feedback on framework and methodology and proposal for adapting these to country context	Countries
10:30-12:00	Develop an outline for documenting current practices in communicating flood early warnings by country	All participants
12:00-13:00	Way forward	

Annex II: List of Participants

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