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## *Urbanisation and Disaster Risks in the Himalaya*

### **Enhancing Forecast-Based Disaster Response in Nepal**

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## ENHANCING FORECAST-BASED DISASTER RESPONSE IN NEPAL

Dinanath Bhandari<sup>1</sup>, Binod Prasad Parajuli<sup>2</sup> and Puja Shakya<sup>2</sup>

### Abstract

Implementation of humanitarian actions in advance of a disaster event is a new approach to enhance overall effectiveness of disaster responses. Early actions following forecasts and early warnings can significantly reduce disaster losses and the cost of disaster recovery. Evidence from pilot projects reveal potential to integrate forecast-based humanitarian actions into disaster preparedness planning. Building on advanced technologies, it has been possible to predict disaster risk of many meteorological and hydrological hazards like heavy rainfall, storm surges, flood, drought and cyclones. Nepal has developed community-centered, end to end flood early warning systems, which have utilised different global and regional weather forecasting models. The models have the capability to provide weather and flood scenarios three days in advance. In this study, we carefully examine current practices and approaches to explore opportunities to use weather forecasts, flood alerts and warning to inform forecast-based humanitarian actions. Furthermore, we analysed existing policy provisions and legal mandates in Nepal to assess the availability of enabling environment needed for adopting forecast-based humanitarian actions. We also present our learning from piloting this approach to disaster preparedness planning in 19 selected districts of Nepal. Our findings suggest that adequate legal provisions and appropriate institutional mechanisms are essential to ensure effective implementation of forecast-based early actions. It is important and urgent to depart from traditional post-event relief approach to a risk-informed preventive decision-making. Technological limitations and operational gaps between agencies are major barriers to proactive actions. The challenges can be overcome through sufficient legal provisions, technical guidelines and protocols to clarify roles, responsibilities and accountabilities of the authorities.

**Keywords:** forecast-based preparedness, early warning, humanitarian actions, disaster risk reduction, financing

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## INTRODUCTION

Traditional disaster risk reduction strategies are driven by post-disaster actions and there used to be less focus on utilising available information to reduce the potential risks (Coughlan de Perez et al., 2015). Nepal is not different; Nepal's first-ever disaster management Act namely the Natural Calamity Relief Act 2039 (1982 AD) had provisions for the rescue, relief and rehabilitation of disaster victims. Following the provisions of the Act, the institutional efforts focused on rescue and relief after a disaster event would strike. New Disaster Risk Reduction and Management Act 2074 (2017 AD) has included provisions to make a shift in approach considering key components of disaster risk reduction and management cycle. However, the focus is still more on post-event activities and the new Act lacks sufficient mandatory provisions and accountabilities of federal, provincial and local government authorities to disaster risk reduction and effective preparedness. Nevertheless, improved access to advanced technologies in weather forecasting, hazard monitoring and wireless communication have improved disaster management capacities to a great extent. Evidence-based policy advocacy drawing on the lessons from other countries and demonstration of successful examples in the country could help shift the focus and help incorporate innovative approaches and measures to disaster risk reduction and resilience in Nepal.

Forecast-based early action (FbA) is an approach that involves a range of disaster

responses such as the evacuation of areas that are potential to be affected, the arrangement of temporary shelter for displaced populations, food and other emergency support to the communities at risk and possible hazard mitigation measures following a trigger of a hazard and prior shock or acute impacts of hazard. These early actions aim at preventing deaths and reduced losses and damages from the forecasted hazard. Adopting from Pichon (2019), we consider definition of the FbA as 'actions triggered using climate or other forecasts prior to a shock or before acute impacts are felt, to reduce the impact on vulnerable people and their livelihoods, improve the effectiveness of emergency preparedness, response and recovery efforts and reduce the humanitarian burden'. The terms anticipatory humanitarian actions, early actions and forecast based actions are often used interchangeably in disaster risk management. Forecast-based financing (FbF) is the funding given to carry out the forecast-based early actions. The term also denotes the mechanism and approaches of forecast-based financing. The forecast-based funding and forecast-based financing are used interchangeably in literature. Generally, the FbAs are linked to pre-agreed funding, disbursed after a trigger (Wilkinson et al., 2018). The pre-agreed funding is made under the forecast-based financing.

Advanced computer technologies have improved weather and flood forecasting and early warning systems. These have enabled disaster managers to go for early response actions in the community prior

to a disastrous event (IFRC, 2008a; WMO, 2015; Met Office, 2018). This has opened up a new window of opportunity for taking early actions to prevent casualties, reduce disaster losses and better prepare to cope with the impacts of potential hazard. The concept of Forecast-based Financing (FbF) emerged out of these innovative practices on disaster preparedness and response by using outputs of early warning system, and providing cash to the vulnerable communities such that the recipients can arrange things of their priority requirements. Experiences from the pilot projects (IFRC, 2009a; Coughlan de Perez et al., 2015; GRC, IFRC and WFP, 2015; UNDRR, 2019) show that the FbF is cost-effective for disaster response and further benefit the vulnerable communities by making economic and non-economic recovery possible in the aftermath of a disaster. For example, the cash disbursed in advance of a hazard hitting an area is also supportive to quickly reinstate local markets and community livelihoods by recovering local economic activities after a disaster.

In this paper, we discuss the emerging approaches of disaster preparedness and response amidst advancing early warning systems, looking into the potential of forecast-based financing to anticipatory humanitarian actions also known as early actions. We have explored international practices on the FbA and FbF considering their replicability (IFRC, 2009a; IFRC, 2009b; Coughlan de Perez et al., 2015). Drawing from our professional experience, we also include the challenges in adopting the approach in Nepal.

## **METHODOLOGICAL APPROACH**

We adopted an integrative approach in the study. The paper builds on (1) review of currently available literature on the concepts and practices of the FbA and the FbF in different countries and (2) experience from our work in the development of step-by-step operating procedures and actions to disaster response following rainfall and flood forecasts. Furthermore, our findings and analyses also build on our professional work experience on community-centered flood early warning systems in Nepal and other countries.

The secondary information was collected and analysed from a range of published documents including articles, case study reports, project evaluation reports and practitioners' as well as academicians' insights. We reviewed practices and learning of pilot programmes on forecast-based financing and forecast-based early action practices of different countries in Africa, South America and Asia. These learnings were synthesised from independent post-event studies and programme evaluation studies.

The paper has benefitted largely from our work on development of Standard Operating Procedures (SOP) for forecast based disaster response actions and integration of the SOPs into District Disaster Preparedness and Response Plan (DPRP) in 19 flood prone districts: (1) Jhapa, (2) Morang, (3) Sunsari, (4) Saptari, (5) Siraha, (6) Udayapur, (7) Dhanusha, (8) Mahottari, (9) Sarlahi, (10) Rautahat, (11)

Makawanpur, (12) Chitawan, (13) Nawalparasi, (14) Dang, (15) Banke, (16) Surkhet, (17) Bardiya, (18) Kailali and (19) Kanchanpur of Nepal as shown in Figure 1.

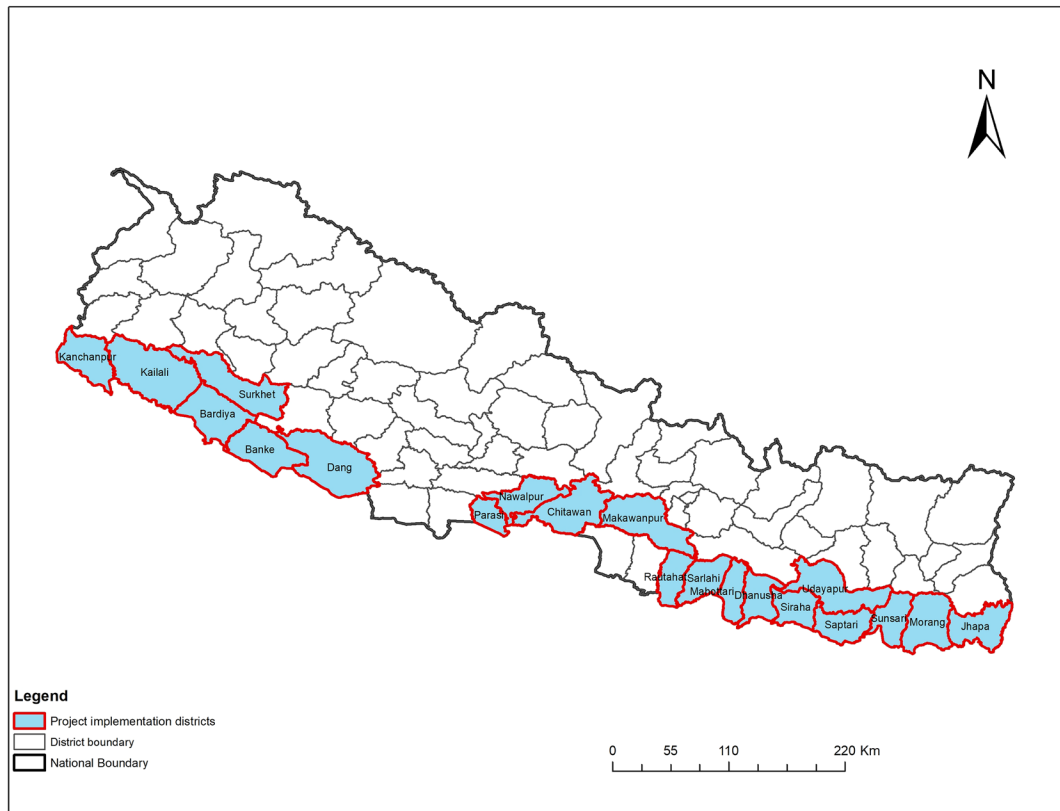


Figure 1. Districts for forecast-based early action integration into disaster preparedness plans in Nepal

## FINDINGS AND DISCUSSION

The forecast-based early actions largely depend on the availability of funding. This funding mechanism is the forecast-based financing (FbF). The FbF can have different modalities such as conditional grant, social security allowance credits, contingency funding with flexibility to use as per the local needs and provision of stocking materials to provide communities based on the forecasts prior to the disaster

event. The available time span for the early actions, which is between a forecast of trigger and actual event, depends on the nature of hazard. Therefore, the funding mechanism should be flexible enough to address uncertainty lying in the forecasts and differences between predicted and actual shocks and impacts of a hazard. Disaster management authorities need to consider available forecasts and capacity to respond to the early warning messages as part of overall disaster response

capacity of communities and available humanitarian assistance with respect to nature, scale and impacts of the hazards. In this section, we discuss about integrating the forecast-based early actions in disaster preparedness and response planning based on the findings from international practices and piloting in Nepal.

### **The evolving context of innovating approaches in disaster risk reduction and management**

Disaster management has been evolving through learning to cope with the disastrous situations, testing innovations and institutionalisation of successful practices, advanced technologies and improved approaches. As the multi-disciplinary science and art, the disaster risk reduction and management has integrated learnings from various socio-economic development projects and indigenous practices. In this sub-section, we discuss evolving context of forecast-based early actions and forecast-based financing approaches based on our findings.

#### **a. Building on local practices and modern science and technology**

In scientific literature and humanitarian business, the FbF is new approach and is emerging through pilot projects on disaster management. Preparedness to anticipatory seasonal adversities is however a traditional practice in many communities. In Nepal, seasonal migration from high altitude to low altitude area during winter is a traditional coping strategy

to avoid impacts of severe cold in high mountains. Some livelihood practices such as storage of fuelwood for rainy season can be attributed to anticipatory preparedness. The anticipation of weather phenomena is built on long-time experiences of the locality and the knowledge or idea is passed on to the younger generations from their parents or elders. So, these practices depended on ethno-meteorological and intuitive knowledge, skills and experience, and continue until superseded by scientific information such as meteorological forecast or forgotten due to dwindling significance of traditional knowledge and practices.

The priorities to forecast weather change with the changes in livelihood practices as the different livelihood strategies are differently exposed and sensitive to hazards. Forecasts are more important in the human-ecosystem interface or nature-based agricultural practices to know about disease outbreaks, weather conditions including extreme events and likewise hazards. The timely availability of reliable forecasts helps farmers to alter the schedule to plant, fertiliser application and harvesting.

Modern forecast-based disaster preparedness, including anticipatory humanitarian actions builds on combination of modern technologies and traditional indigenous livelihood practices of target communities and learning from traditional post-disaster rescue and response approaches (Jjemba et al., 2018; Pichon, 2019; IFRC, 2019). Therefore, in devising operating procedures and activities to forecast-based early actions,

we tried to build on the traditional local practices and help the community and humanitarian responders to take response actions following early warning messages from the authorities well before the hazard would hit the area (WFP and PAC, 2019).

Anticipatory preparedness and forecast-based response actions are still in their infancy in many countries (IFRC, 2019; UNDRR, 2019). However, programs piloted in different countries of Africa, South America and South Asia provide replicable and scalable examples for policy uptake and practical adoption (IFRC, 2009a; IFRC, 2009b; Stephens et al., 2015). Furthermore, there has been significant technological progress in forecasting of weather, weather-related hazards and their potential impacts. The forecasting technologies are utilised through systematic processes following guidelines, international standards and protocols (WMO, 2015; NWS, 2013; Met Office, 2018), which enable weather forecasters to provide impact-based forecasts (IBF). Such forecasts help disaster managers to take anticipatory disaster risk reduction and response actions against particular hazard events. With these abilities, many National Weather Service (NWS) agencies have been able to provide weather information services to various actors in systematic manner (NOAA, 2018).

In many countries, there is a gap between available and required capacity for disaster preparedness and response due to limited access to the advanced technologies and weather and hazard forecast (UNDRR, 2019; WMO, 2020). It is crucial to enhance access of countries and communities,

particularly least developed countries to seasonal forecasts, weather forecasts and hazard forecasts (WMO, 2020). It is also important to enhance capacity of the countries and communities for taking early actions by responding to the available forecast information (UNDRR, 2019). Role of flexible financing like FbF is utmost important to enhance these capacities.

World Meteorological Organisation (WMO) has introduced Global Framework for Climate Services (GFCS)<sup>3</sup> in collaboration with regional and National Weather Service (NWS) Agencies, who are also implementing the framework. The GFCS provides guidelines and examples to standardise weather forecasting and communication of the impact-based forecast information for disaster risk reduction (WMO, 2014). The impact-based weather forecasting is a shift in weather and disaster risk forecast from 'what it is' (about weather situation) to 'what it can do' to support anticipatory actions to disaster risk reduction.

The FbF approach evolved from early warning-based disaster preparedness and responses in Africa, South America and Asia (Braman, 2009; Hellmuth et al., 2011). Because the disaster preparedness and response require financial and technical resources, the FbF is an innovative pre-event disaster financing to anticipatory disaster response, including humanitarian actions. It builds on the successful practices from early warning triggering early action to disaster risk reduction (IFRC, 2009a).

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<sup>3</sup> For details, <https://gfcs.wmo.int/> (last visited on 18 July 2020).

Disaster preparedness and response agenda attracts financial investment, political sensitivity, governance and jurisdiction mandates, institutional structures, funding mechanisms and several associated practical issues. Apart from technical capability to predict hazards, their scales and potential consequences in terms of human, property and livelihoods losses, the underlying political and practical issues influence decision making in financing early actions.

Therefore, the agenda must navigate through several technical and procedural pathways to access impact-based forecasts and early warning, preparedness to anticipatory disaster consequences, and application of early actions following forecasts and warnings (WMO, 2015). These pathways are complex and require resources and legal mandates, and therefore, the progress is very slow to generate decision support information. However, there are sufficient practical measures available now (Wilkinson et al., 2018; WMO, 2020) to institutionalise the approach through legal and regulatory frameworks, institutional structures and financing mechanisms.

#### **b. Policy and institutional landscape**

Hyogo Framework for Action (HFA) 2005-2015 (UN/ISDR, 2007) introduced early warning as one of the priority actions that prompted governments and disaster management actors to further enhance research and development on hazard forecasting and enhance preparedness and early response. Since then, there have been national efforts through various

policy, institutional and practical efforts for effective preparedness and response to disaster events building on multi-hazard early warning systems at different scale.

Current global Disaster Risk Reduction (DRR) policy landscape is shaped in Sendai Framework for Disaster Risk Reduction (SFDRR) 2015-2030 (UNDRR, 2015). National strategies and plans are mostly harmonised with the SFDRR. For example, Nepal is implementing Disaster Risk Reduction National Strategic Action Plan 2018-2030 (MoHA, 2018), which is in line with the SFDRR. The SFDRR is the outcome of review of research, practices, scientific and political dialogues during the Hyogo Framework for Action to Disaster Risk Reduction period (2005-2015). The SFDRR has recognised understanding risk to the natural hazard as a vital component in building resilience to disasters.

Forecast information is key to predict potential hazard impact and its disaster risk to enhance preparedness for effective response. Priority 4 of the SFDRR highlights that the forecasting is important step in end-to-end early warning enabling disaster managers and vulnerable people to take preventive, risk reduction and response measures prior to the hazard striking an area, community and the sectors of concern.

Similarly, the target E of the Sendai Framework has highlighted institutional structures, plans and implementation mechanisms and enabling institutional environment for the adoption of innovative approaches like forecast-based early actions. Several countries have



established such institutional structures and implementing plans for disaster risk reduction and management (UNDRR, 2019).

### **c. Evolving mechanisms for forecast-based financing**

There are different funding mechanisms to disaster risk reduction. These mechanisms are context specific, often built in existing budgetary systems and delivery mechanisms. Kellett et al. (2014) highlighted that the DRR financing “is in all cases an evolution in each country context, and is based very specifically on the state of development of the system of law and governance.” They also highlighted different ways of DRR financing in three blocks as:

- (1) part of a Disaster Risk Reduction and Management (DRRM) budget,
- (2) a separate budget line or special fund in the annual budgets and
- (3) integrated into development planning and management (ibid).

Similarly, other studies suggested that the fund for the FbAs can be channelled through existing social protection safety nets, stand-alone FbA fund, insurance or contingency financing mechanisms (Costella et al., 2017; Wilkinson et al., 2018) depending on the country’s governance and fund transfer mechanism.

Generally, majority of funding is available to post-disaster short-term response while less funding is available for preparedness and contingency planning despite of the evidences showing that

pre-event investments are more efficient than post-event funding. Of the total funding to the disaster sector from 1991 to 2010, only about 12% of funding was invested in reducing disaster risk before it would happen; the rest was spent on emergency response, reconstruction and rehabilitation (Kellett and Caravani, 2013).

In Nepal, there are policy provisions and mechanisms to funding disaster rescue and relief. Federal government has Prime Minister Disaster Relief Fund, which is utilised for rescue and relief after a disaster event. Similarly, province and local governments have established disaster management fund. Government has mandate to allocate contingency fund in its annual budget and invest on disaster preparedness and response. However, none of the federal, provincial and local governments have funded the forecast-based actions citing that there is lack of clear regulatory mechanism to fund forecast-based-financing and existing legal provisions only allow spending the fund for post-event response and recovery.

Existing social protection allowance mechanisms have covered children, elderly, people with disabilities and ethnic minorities. These mechanisms could be utilised to provide fund to families at risk of disasters and carry out pre-event activities following a forecast as trigger. However, these are yet not operationalised through policies and institutional mechanisms to properly support disaster preparedness and response plan implementation.

## **Lessons from practices**

According to Costella et al. (2017), piloting of forecast-based financing was initiated at a local level in 2008. Since then, there have been a number of success stories in different countries demonstrating benefit of pre-disaster event financing to prevent disaster losses, enable to cope with the event successfully and reduce post-event response support needs significantly (ibid). Different projects were piloted in developing countries and vulnerable communities to promote early response actions based on the forecasts. These included funding and material supply to the communities at risk in advance of a disaster (Braman, 2009; Hellmuth et al., 2011; Coughlan de Perez et al., 2015).

In 2015, German Red Cross (GRC), International Federation of Red Cross and Red Crescent Societies (IFRC) and World Food Programme (WFP) jointly released a pressnote, 'Releasing Disaster Funds Before Crisis Would Transform Humanitarian Response' citing their experience from pilot projects to highlight the benefits of acting on weather forecasts and providing funds to vulnerable communities before the crisis (GRC, IFRC and WFP, 2015).

The FbF approaches have been applied through different mechanisms in disaster management programmes building on early warning as trigger of fund flow or other response actions to single or multiple hazards (Wilkinson et al., 2018). There are lessons from successes or failure from different practices in South Asia, Africa and South America. These lessons are captured by independent research and

programme evaluation (IFRC, 2008b; IFRC, 2009a; Hellmuth et al., 2011; Tozier de la Poterie. et al., 2018; Raun, 2018).

There are evidences from across the world that investment on better preparedness pays back to saving lives and preventing loss and damage of properties to a great extent. In 2014, cyclone Hudhud hit India and Nepal. There was zero casualty of fishermen in India as all fishermen came back home well before cyclone landfall following early warning and instructions from authorities (NDMA, 2015). Unfortunately, at least 59 people were killed, other 40 estimated were missing and 175 injured in Nepal in the same cyclone (MoHA, 2015). These casualties and injuries were due to heavy blizzards and avalanches in different trekking routes as trekkers did not take any preventive measures even after Nepal had received alert about potential effect of the cyclone.

Ghosh et al. (2013) described that low death toll (23 people were killed) of Cyclone Phailin (11-12 October 2013) in India was because of the evacuation of as many as 800,000 people in advance of Phailin's landfall. Ghosh et al. (2013) believed that the evacuation was possible due to timely weather predictions using state of the art climate models such as the Weather Research and Forecasting model.

Different studies have recommended to improve hazard forecasting to increase the visibility of benefit of investment in early action and reduce the cost of acting in vain as all forecasts cannot come true due to uncertainty in weather phenomena (Wilkinson et al., 2018; Coughlan de Perez

et al., 2015; Jjemba et al., 2018). Post event analyses suggest that a number of agencies have to work in mutual collaboration following a systematic procedure and ensure effective disaster response (NDMA, 2015; Norton et al., 2020). While piloting the forecast-based early action approach in Nepal, authorities and stakeholders showed strong concern about the reliability of the forecasts and how to justify expenses of early actions if the forecast did not come true. The concern was raised in all stakeholder interaction workshops during the piloting of the approach in disaster preparedness and response planning. It is important to sensitise authorities about the no regret or low regret early-actions against anticipatory disaster consequences in the context of climate change and growing uncertainty of climatic extreme events and their consequences.

### **Integrating forecast-based humanitarian actions into disaster preparedness and response in Nepal**

In Nepal, forecast-based actions to flood preparedness and response were piloted in 19 districts (now 20 as Nawalparasi district has been divided into 2 districts) as shown in figure 1. These activities undertaken between 2016 and 2018 engaged National Emergency Operation Centre (NEOC) and Department of Hydrology and Meteorology (DHM) (WFP and PAC, 2019). The project supported each District Disaster Management Committee (DDMC) in the districts to prepare Standard Operating Procedures (SOP) as annex to

the district disaster preparedness and response plan, which is updated before summer monsoon every year. All these 19 districts are in Tarai plains and prone to flood. Since the flood is priority hazard in all the districts, the operating procedures considered flood as only case to devise the forecast-based actions. The SOPs were prepared and integrated into the district disaster preparedness and response planning through seven steps as shown in Figure 2.

Nepal's disaster preparedness has adopted participatory approach ensuring inputs from multiple stakeholders in different stages of planning (MoHA, 2019). Building on that approach, we devised and implemented an iterative process to integrate forecast-based anticipatory actions to disaster risk reduction and response as shown in figure 2 below and mentioned in the points thereafter.

1. The first step involved review of profile of hazards and disaster risk of the unit (here district) for which the disaster response plans are being prepared. Generally, profiles are available as stand-alone document or are embedded into the existing plan and provides basis to understand preparedness and response requirements. In our case, the disaster risk information was available in the previous years' Disaster Preparedness and Response Plan (DPRP) of each district. We updated them through literature review, event analysis and consultation workshop involving the actors of the DPRP. In all cases, this is vital to understand existing as well

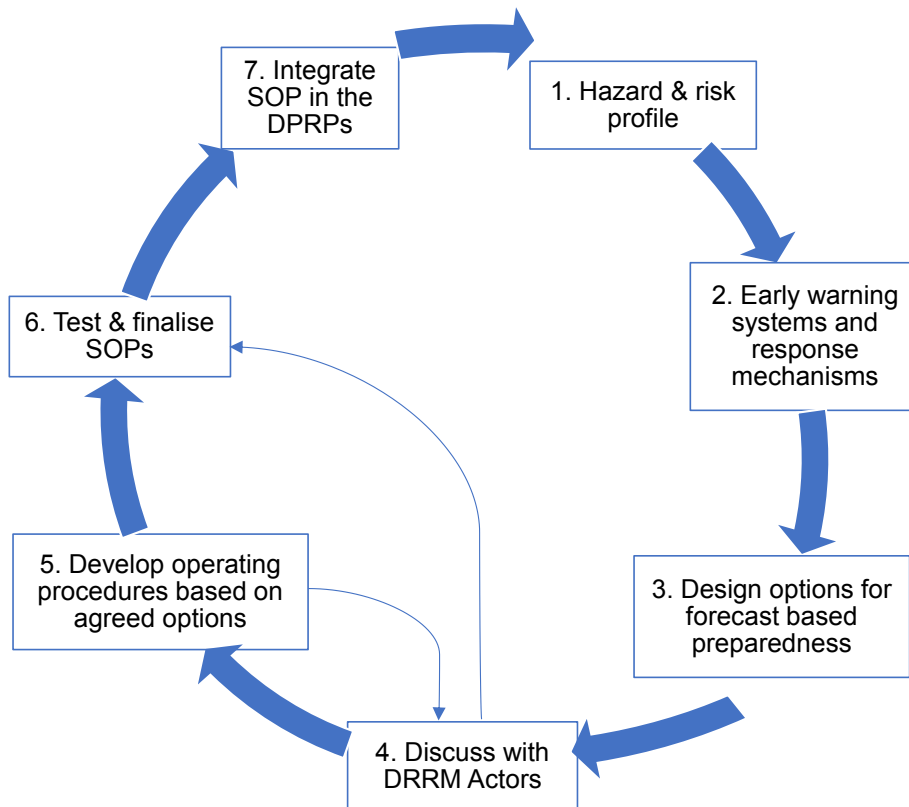


Figure 2. Steps to develop and integrate Forecast-based Actions into Disaster Preparedness and Response Plans

as potential strategies to cope with multiple hazards over time. If hazard and disaster risk profile is not available beforehand, it is necessary to carry out vulnerability and risk assessment (VRA) of the communities and sectors of concern including the impacts of climate change in the assessments. The VRA is a pre-requisite in the disaster preparedness and response planning process. It is updated regularly considering the dynamic nature of hazards, exposure, vulnerability and coping capacity of respective community and disaster risk reduction and management (DRRM) actors in the district.

2. In the second step, it is essential to examine the status of existing early warning system or setup a new early warning system if it did not exist. In our case, all districts had flood early warning system in major rivers flowing through the district. It is because whole set up of forecast-based disaster preparedness and response actions are devised and implemented building on the end-to-end early warning systems. It is noteworthy that the early warning system should have basic property to be able to accommodate multiple hazards. However, the system was utilised only for flood in our pilot case. Flood early warning system

includes a set of procedures devised to take early actions on the basis of pre-defined rainfall thresholds in the catchment and water level in the river in the upstream measured by a flood gauge or river level sensor.

3. In the third step of the process, potential options for forecast-based preparedness and response actions, including anticipatory the humanitarian actions were devised considering (1) threshold values for potential risk, (2) lead time and (3) lag time for different points of concern in each river basin. The anticipatory humanitarian actions were built on the capacity of existing flood early warning systems and available weather outlook and forecasts as shown in the Figure 3. For each river and its catchments, the threshold value of the rainfall and water level at hydrology station or a flood gauge station for normal, warning and danger level were utilised from values developed by the DHM. The DHM has set up threshold values for rainfall and flood for normal, warning and danger level for different flood prone communities in the major rivers in these districts.

Similarly, the lead time, lag time and other associated parameters to each river flood were also utilised from the department's past studies including outputs of rainfall to runoff and hydraulic models and verified with real-time examples through respective local community consultations. The lead time is considered as the travel time taken by a hazard to reach the

point of concern (i.e., a community in the downstream riverbank) after the issuance of forecast or warning and the lag time is considered as the total time required for the community to receive an alert or warning from disaster management authorities i.e., emergency operation centre and evacuate the area at risk after they receive the alert or warning. These thresholds and parameters provide trigger and management guidance for early actions against impending disaster.

The anticipatory humanitarian actions were devised following South Asia Climate Outlook and subsequent weather and flood forecasts which will be available from the Department of Hydrology and Meteorology (Figure 3). The South Asia Climate Outlook is a consensus document from South Asian Climate Outlook Forum (SASCOF), which is held every year in April to forecast southwest monsoon season (June-September). The subsequent forecasts on rainfall and flood were used from Global Flood Awareness System (GloFAS<sup>4</sup>) for 15 days, 10 days and 5 days accumulated rainfall and flood forecasts.

Similarly, three-day numerical weather prediction and rainfall forecasts were considered available from Regional Integrated Multi-Hazard Early Warning Systems (RIMES)<sup>5</sup> and

<sup>4</sup> For details visit: <https://www.globalfloods.eu/> (last visited on July 23, 2020)

<sup>5</sup> For details visit: <http://www.rimes.int/> (last visited on July 23, 2020)

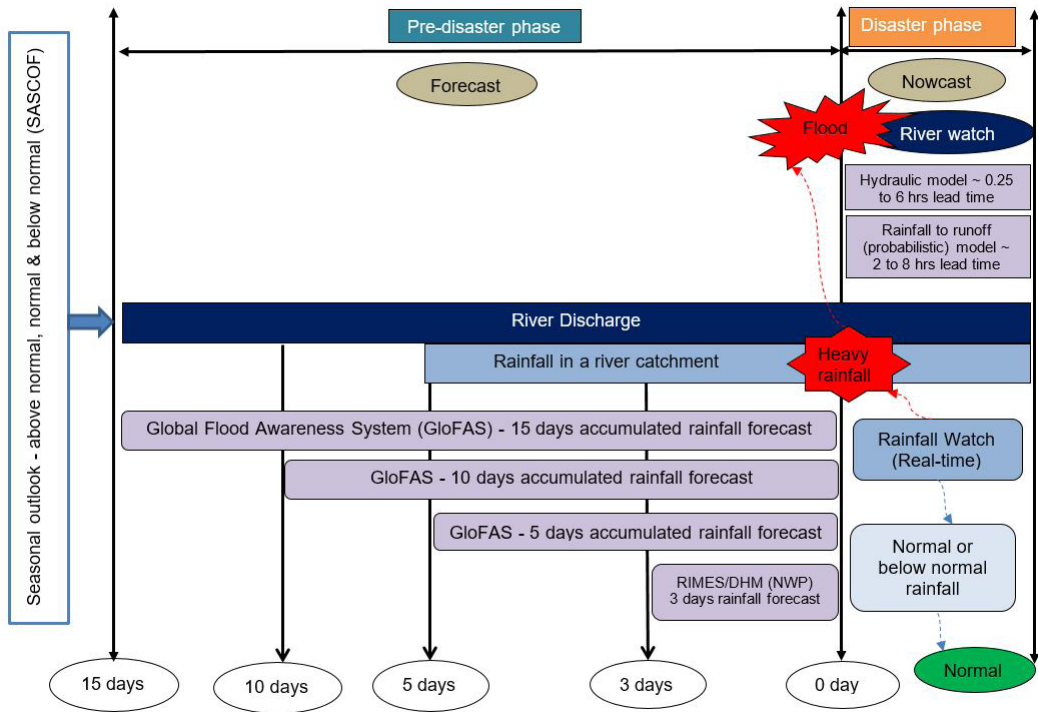


Figure 3. Forecasts used for anticipatory disaster preparedness and response actions

other sources, which were available to the department every day. The RIMES's numerical weather prediction provides 24 hour accumulated rainfall prediction separately for next 3 days along with information on other weather parameters. The Department of Hydrology and Meteorology is a member of regional and international meteorology forums and has regular access to seasonal outlooks and periodic weather forecasts as mentioned above. The department verifies and customises the available forecasts and shares the forecast information publicly on regular basis through regular weather bulletins. The department issues alert and

warning based on the rainfall and flood forecasts derived from different forecasting models.

4. In the fourth step, the options for early actions were then shared with the stakeholders including humanitarian actors in the respective districts and discussed among them by organising workshops and focused group meetings. The meetings and the workshops were essential to evaluate the options devised in step 3 and validate the applicability of the proposed actions in the target communities by the stakeholders. The integration of the early actions into the disaster preparedness and response planning starts at this step

through the participatory process. The participants discussed processes and actions triggering from the forecast and differentiated roles and responsibilities of different actors in the implementation of the planned actions.

5. In the fifth step as shown in figure 2 above, response options were revised considering inputs from the workshop and consultations and the operating procedures were drafted for each district disaster preparedness and response plan. The drafts were again shared with authorities like the Department of Hydrology and Meteorology, respective District Administration Office and National Emergency Operation Centre for their review and inputs. Their inputs were incorporated into the draft before bringing it to next step.

In this step, actions were finalised through iterative consultations such as activities devised from the Step 4 and chosen activities are documented into the operating procedures and sent to actors for their final review and feedbacks. This also helps actors to understand their roles and responsibilities and prepare own agency specific work plan to disaster preparedness and response in line with the district plan.

6. In the sixth step, the draft procedures were tested through a simulation exercise in respective district and in selected vulnerable communities involving relevant government and

non-government agencies including private sectors and community disaster management groups. The procedures and actions were finalised incorporating feedback from these testing. The simulation helps to check practical applicability of the processes and actions listed in the operating procedure of each plan. This is also opportunity to revise the draft plan incorporating learnings from the simulations.

7. Finally, the forecast-based early actions and their sequential operating procedures were integrated into each district disaster preparedness and response plan. It was then submitted to respective District Administration Office which forwards it to the District Disaster Management Committee for approval and implementation. Through this process, the flood preparedness and response workplans were modified including the early actions triggered by the forecasts and early warnings available from the DHM for different durations as shown in Figure 3 above.

### **Challenges to institutionalise forecast-based disaster response actions in Nepal**

While preparedness and response plan to monsoon-induced disasters like flood remains a priority in all the districts, there were challenges to effectively implement these plans as (1) overall governance structure was changing to adopt the federal structure, (2) there was lack of

strong legal mandate and accountability of the district and local government authorities to implement the anticipatory humanitarian actions, (3) there was lack of committed fund with non-government agencies such as Nepal Red Cross Society to implement the forecast-based actions included in the plans and (4) there was lack of adequate institutional capacity in each district to undertake the standard operating procedures that guide forecast-based actions after receiving a hazard forecast or warning. Besides, persisting culture of working in silos, dominance of traditional post-event response and relief practices and lack of accountabilities of the agencies to disaster risk reduction are major barriers to implement proactive and innovative approaches to disaster risk reduction in Nepal.

Besides, the transformational issues on the disaster risk reduction and management governance, ignorance of disaster risk in land use and physical infrastructure development are additional challenges in the country. These prevent implementation of effective preparedness and response. The unplanned infrastructures have further changed the sensitivity of land to absorb rainfall and discharge through a watershed outlet. Haphazard road construction, for example, distorts natural drainage pattern inducing landslides and debris flow even in normal rainfall. Riverbeds in Tarai are rising due to deposition of the debris. Similarly, changing climate system has increased extreme weather events with uncertainty. These all affect the efficacy of the impact-based forecasts and flood early warning. While the management capacity of the

agencies is not adequate to cope with small scale emergencies, the unplanned urbanisation in the country has brought additional challenges by aggravating the disaster risk in both, old and the new cities.<sup>6</sup>

Despite the lack of proper implementation of the procedures in many districts, the process of developing and integrating forecast-based early actions into the plan and the simulation exercises have enhanced understanding of actors on the flood early warning and importance of early action in prevention of losses and damages. Similarly, learning from these exercises contributed to the amendment of national guidelines. The revised Disaster Preparedness Response Planning Directives (MoHA, 2019) have encouraged authorities to adopt the forecast-based actions. The Directives provide policy decision makers at federal, provincial and local level the impetus to integrate forecast-based actions and their implementation procedures into disaster preparedness and response plans. Most importantly, the Department of Hydrology and Meteorology's weather and flood forecasts have improved in the recent years and the department is creating conducive policy environment to institutionalise the forecast-based actions. There are indicators that deaths due to floods have declined as the result of formal and informal initiatives to early actions building on weather forecasts and flood warnings. However, the forecast-

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<sup>6</sup> Urban population of the country increased from 17% in 2011 to 40 percent in 2014 and to 58.9 percent in 2019 (Koirala and Koirala, 2019).



based financing is yet to come into practice through strong legal and institutional measures in Nepal. Disaster risk financing strategy, which is in draft form, may provide different modes of funding for disaster risk reduction and management. As the local governments and new institutional structures at federal, provincial and local level are strengthening themselves and taking up disaster management roles, conducive environment is developing to institutionalise forecast-based actions in Nepal.

Political transformation and restructuring of local governments and overall governance structure affected the effective implementation of the improvised disaster preparedness and response plans. Consultation with actors (Nepal Red Cross Society District Chapters, Chief District Officers) revealed that the lack of financing is the major factor affecting implementation of the forecast-based early actions. The other factor was the lack of understanding among the authorities and the stakeholders about the benefit of the forecast-based early action and uncertainties lying in the forecasts. Authorities were not confident to take actions based on the forecasts fearing the public perceptions and future consequences to disaster response if the forecasts went wrong.

Lack of proper delineation of authority, responsibility and accountability between federal, provincial and local governments and different government agencies to disaster risk reduction and management remains a challenge for improving the disaster risk governance in Nepal (Bhandari

et al., 2020). Rogers and Tsirkunov (2013) highlighted that government leadership, multiagency coordination and community participation are essential for an effective early warning system. The learning from the piloting of forecast-based early actions in Nepal shows that strong political will and stability, institutional commitment and accountability as well as understanding of the wider community are prerequisites to overcome existing institutional barriers and adopt innovative advanced technology-based approaches such as forecast-based financing to early actions in the disaster risk reduction.

## **CONCLUSION AND WAY FORWARD**

Forecast-based anticipatory actions require highly coordinated planning and execution of the planned actions following the standard procedures and protocols, which should be strongly mandated by legal provisions. In Nepal, institutionalisation of an early warning system, clear legal provisions, operational mandates and accountability are the major factors determining the effective implementation and success of this new approach. The approach needs coordinated efforts and harmonised actions by multiple actors from the national to the local level. It is necessary to breakdown existing silos between different disaster management agencies to achieve the national targets of the National Disaster Risk Reduction Strategic Action Plan (2018-2030).

This study found that both the technical and managerial capacities are important

to plan and execute forecast-based early actions. The managerial capacity includes mandates to local authorities in decision making and taking early actions. The advancement in forecast technologies is a key driver to shift disaster management approach from post-event rescue and relief to effective preparedness and early actions to prevent deaths, injury, loss and damage of properties from disasters. Most importantly, institutional commitment is essential to adopt advanced technologies to improve accuracies in forecasts.

Available evidence and experiences can be helpful for scaling up of the approach in the countries like Nepal. The methodology and approach of the forecast-based early action can be reinstated and scaled up by the local, provincial and federal agencies to improve disaster preparedness and response building on the available early warning capacity in Nepal. Appropriate policy and institutional mechanisms are essential to mandate and guide the innovative investments in averting disasters.

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