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Enhancing Community Based Early Warning Systems in Nepal with Flood Forecasting Using Local and Global Models

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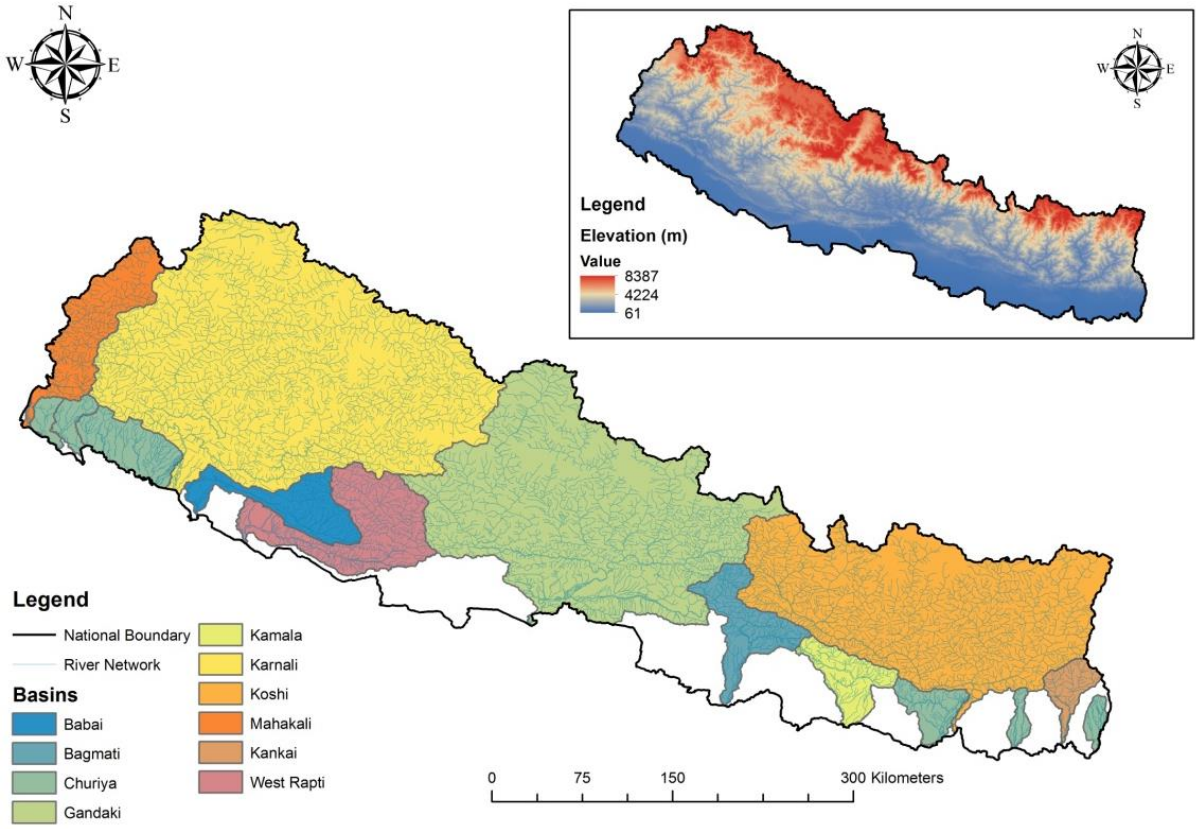
Department of Hydrology and Meteorology
Government of Nepal

PRACTICAL ACTION
Technology challenging poverty

Community Based Flood EWS in Nepal

Background

- Operationalizing effective Flood Early Warning Systems (EWS) in developing countries like Nepal poses numerous challenges
- Despite these challenges, simple real-time monitoring based Flood EWSs have been in place for the past decade
- Piloted in major river basins of Nepal by Practical Action and Nepal Department of Hydrology and Meteorology (DHM)



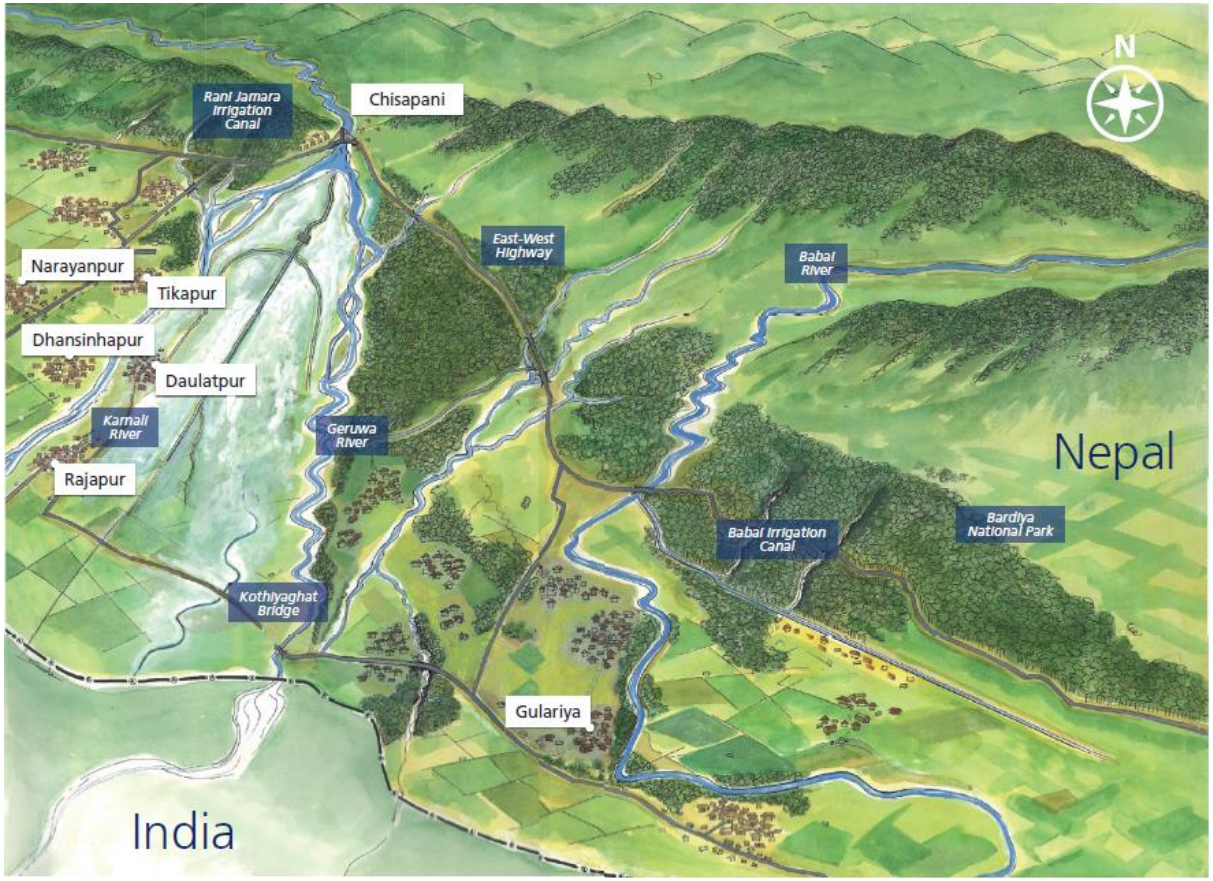
Major River Basins of Nepal. Source: Practical Action (2016)

Community Based Flood EWS in Nepal

Challenges and Constraints

- Complex topography and geology, sparse network of river and rainfall gauging stations and diverse socio-economic conditions

- Key constraint of these simple early warning systems is the limited lead time for response - as little as 2-3 hours, especially for rivers originating from steep mountainous catchments



Schematic of Karnali Basin, West Nepal. Source: Zurich (2015)

Components of Community Based Flood EWS

Nepal Experience

- Risk Knowledge
- Monitoring and Warning Service
- Response Capabilities
- Dissemination and Communication

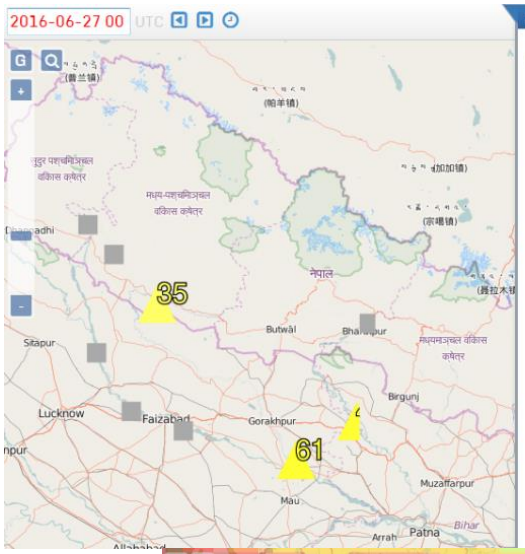
Mobile phones and web services are key to exchange and disseminate information on EWS in Nepal

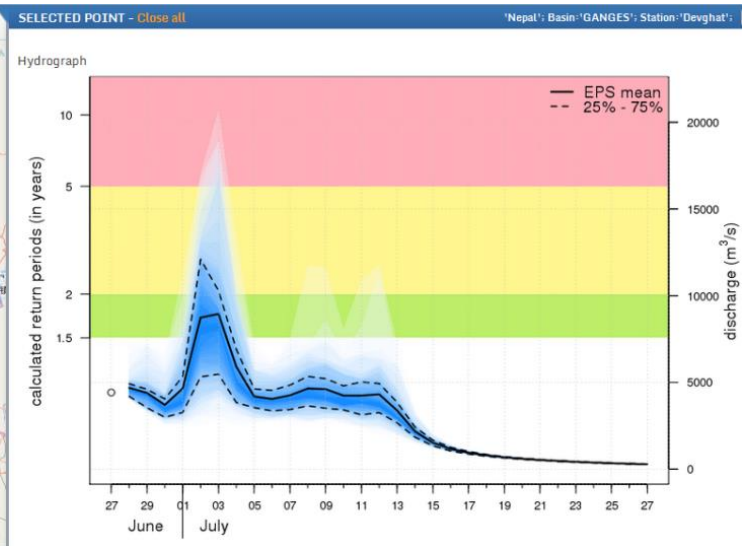
Elements of Community Based EWS. Source: Practical Action (2008)

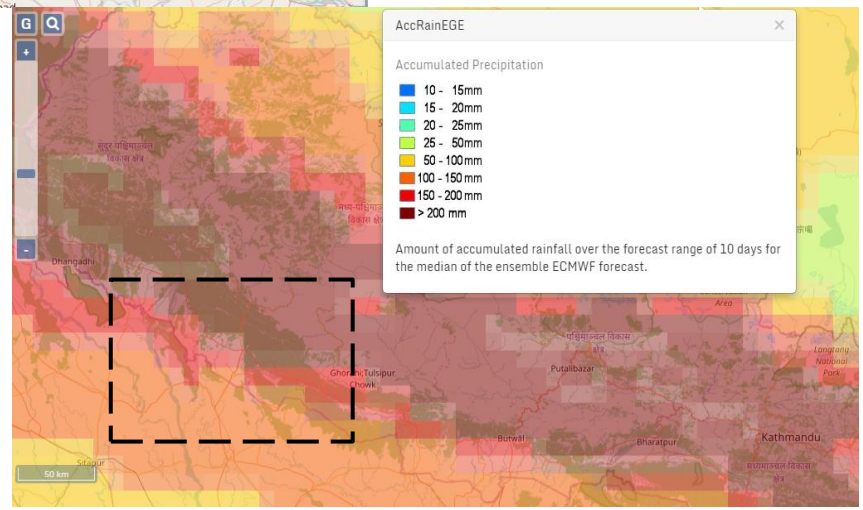
Global Models

Global Flood Awareness System (GLoFAS)

- Streamflow prediction having a temporal resolution of 14 days for major reporting points of Nepal
- Based upon distributed hydrological simulations using numerical ensemble weather forecasts from the ECMWF (European Centre for Medium-Range Weather Forecasts)
- Provides 10 day accumulated rainfall and probability (%) of exceeding 50, 150 and 300 mm of accumulated rainfall over forecast range of 10 days for the ensemble ECMWF forecasts





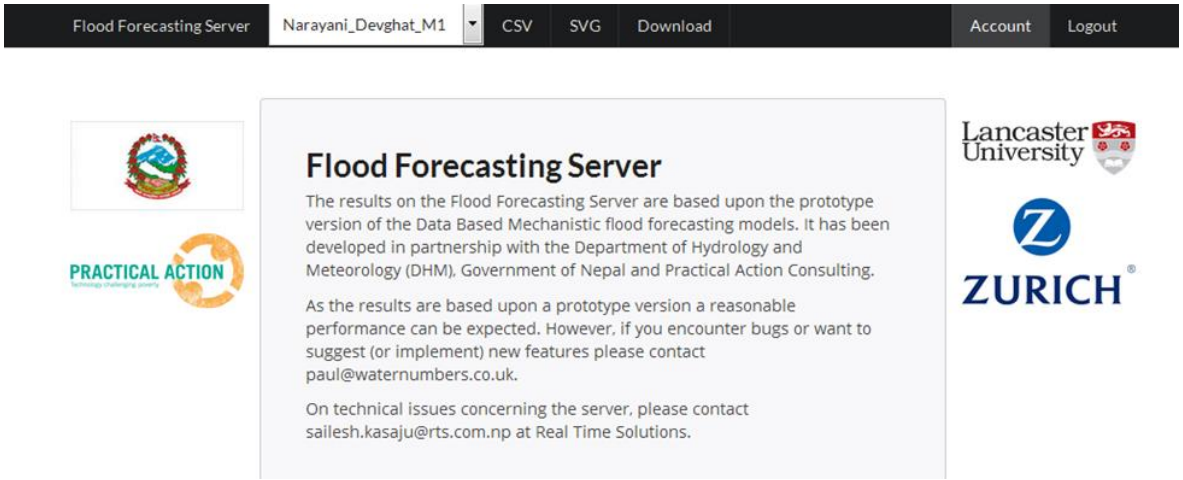


Forecast Products from Global Flood Awareness System (GLoFAS). Source: GLoFAS (2016)

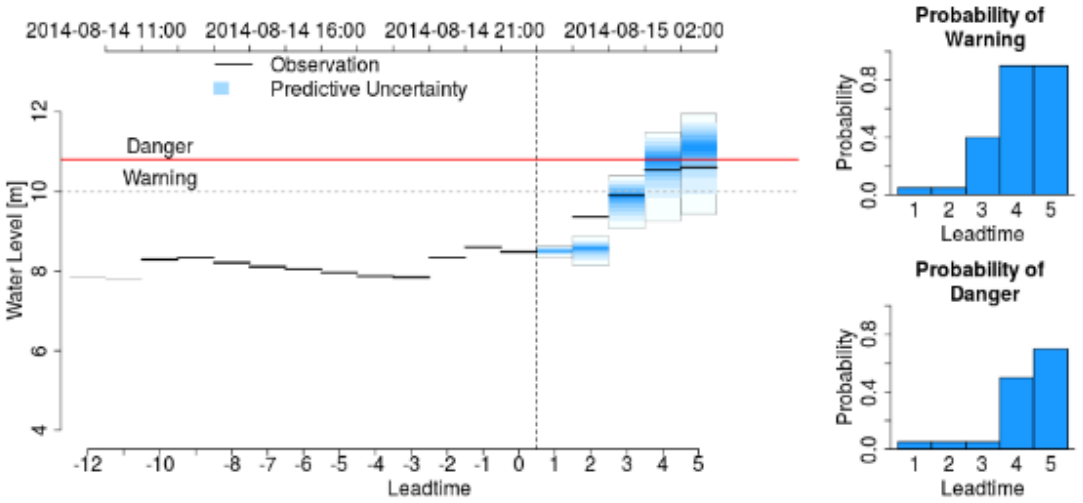
Local Models

Operational Probabilistic Flood Forecasting Model

- Low data approach to forecast water levels, developed jointly through a research/practitioner partnership with Lancaster University, WaterNumbers (UK) and the International NGO Practical Action



- Data-Based Mechanistic Modelling (DBM) techniques, the model assimilates rainfall and water levels to generate localized hourly flood predictions, which are presented as probabilistic forecasts, increasing lead times from 2-3 hours to 7-8 hours

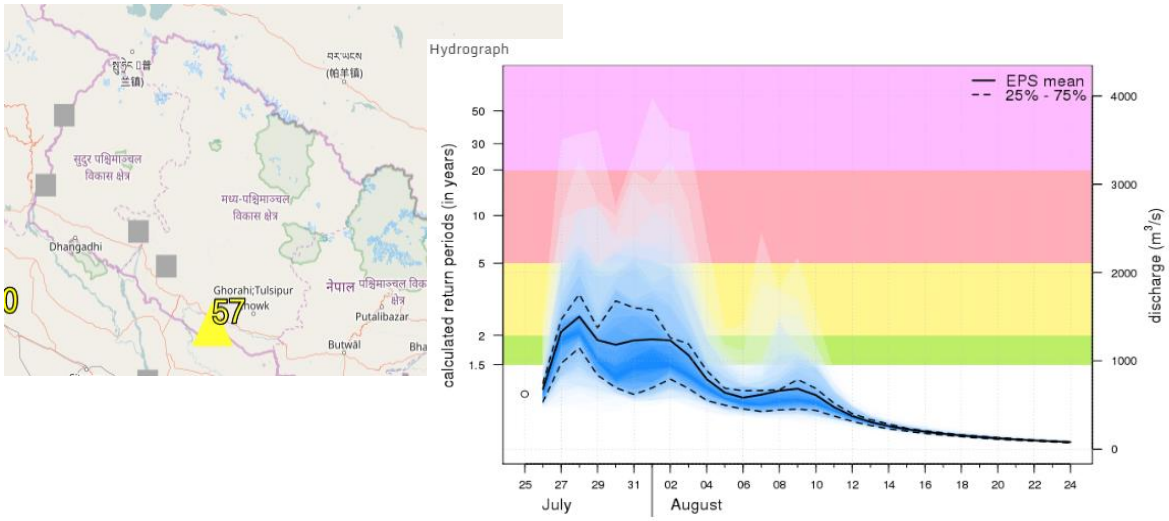


Probabilistic Flood Forecasts. Source: Smith et al., (2017)

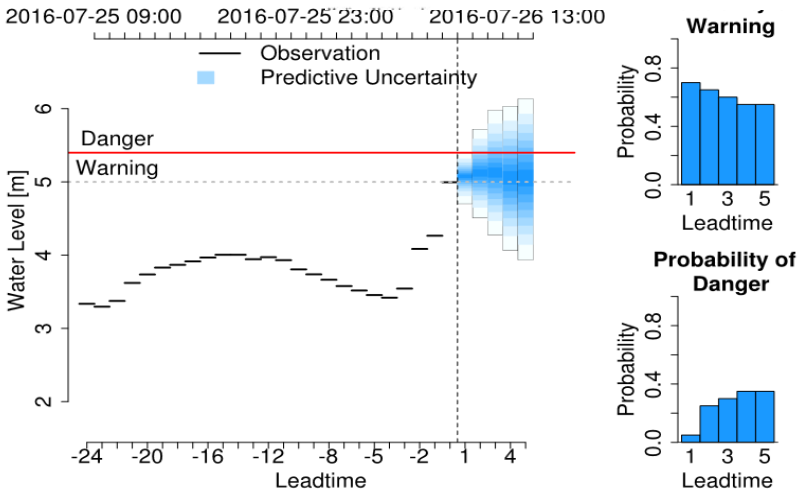
Monsoon 2016 Nepal

Global and Local Models Operationalized in West Rapti Basin

- On 25 July 2016, GLoFAS hydrological forecasts for the West Rapti indicated a sharp rise in river discharge above 1500 m3/sec (equivalent to the river warning level at 5 meters) with 57% probability of exceeding the Medium Level Alert in two days



- Rainfall stations upstream of the West Rapti catchment recorded heavy rainfall on 26 July, and localized forecasts from the probabilistic model at 8 am suggested that the water level would cross a pre-determined warning level in the next 3 hours

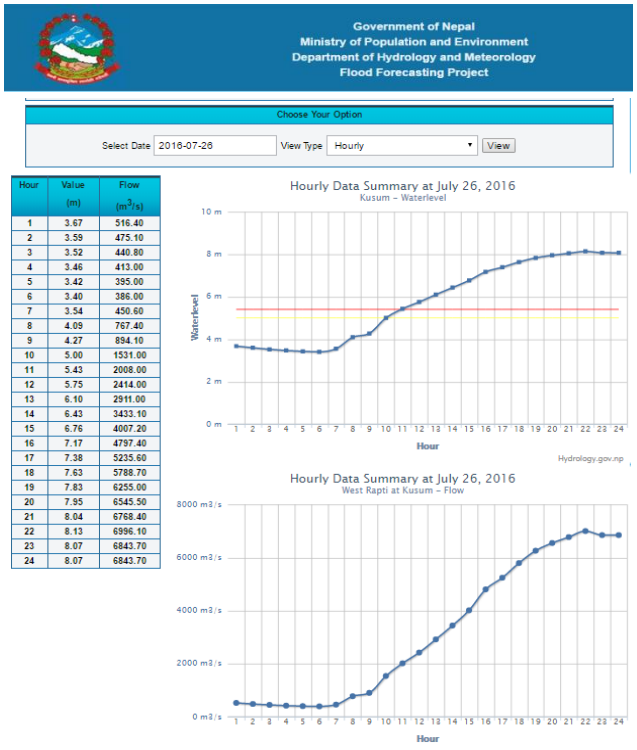


Research Into Use

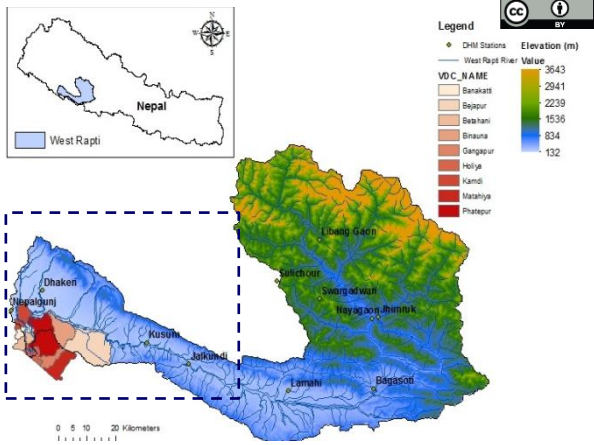
West Rapti Basin

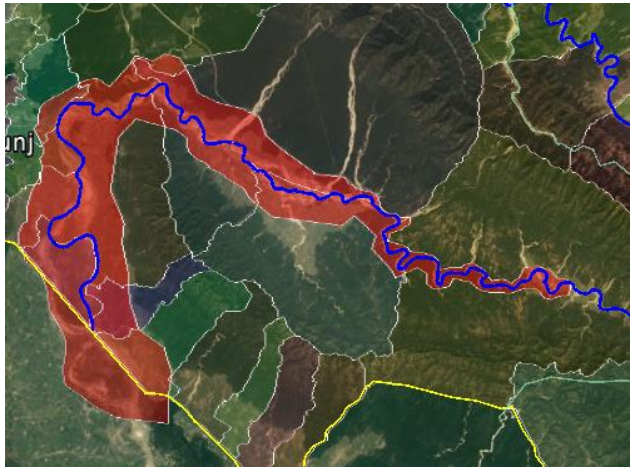
- Flood Forecasting Section at DHM issued a flood advisory, and disseminated SMS flood alerts to more than 13,000 at-risk people residing along the floodplains. Water levels crossed the danger threshold (5.4 meters) at 11 am, peaking at 8.15 meters at 10 pm on 26 July

- Extension of the warning lead time from probabilistic forecasts was significant in minimizing the risk to lives and livelihoods as communities gained extra time to prepare, evacuate and respond



Hour	Value (m)	Flow (m^3/s)
1	3.67	516.40
2	3.59	475.10
3	3.52	440.80
4	3.46	413.00
5	3.42	395.00
6	3.40	386.00
7	3.54	450.60
8	4.09	767.40
9	4.27	894.10
10	5.00	1531.00
11	5.43	2008.00
12	5.75	2414.00
13	6.10	2911.00
14	6.43	3433.10
15	6.76	4007.20
16	7.17	4797.40
17	7.38	5235.60
18	7.63	5788.70
19	7.83	6255.00
20	7.95	6545.50
21	8.04	6768.40
22	8.13	6996.10
23	8.07	6843.70
24	8.07	6843.70





Rising water level: near warning level	above warning level	above danger level	falling water level: below warning
Westrapti Kusumko jalamapan kendrama jalsataha chetawani taha najik pugekole sajag rahanuhuna anurodh chha	jalamapan kendrama jalsataha le chetawani taha par garekole sajag rahanuhuna anurodh chha	Westrapti Kusumko jalamapan kendrama jalsataha le khatara ko taha par garekole surakchhit sthan ma rahanuhuna anurodh chha	Westrapti Kusumko jalamapan kendrama jalsataha samanya awasthama farkiyekole tatkal kunai khatara chhaina

Total Number of Message Sent: 13205
Total Number of Successful Message: 9064
Total Number of Failed Message: 4141

Mobile SMS Interface. Source: Nepal Department of Hydrology and Meteorology (2016)

Science Policy Interface

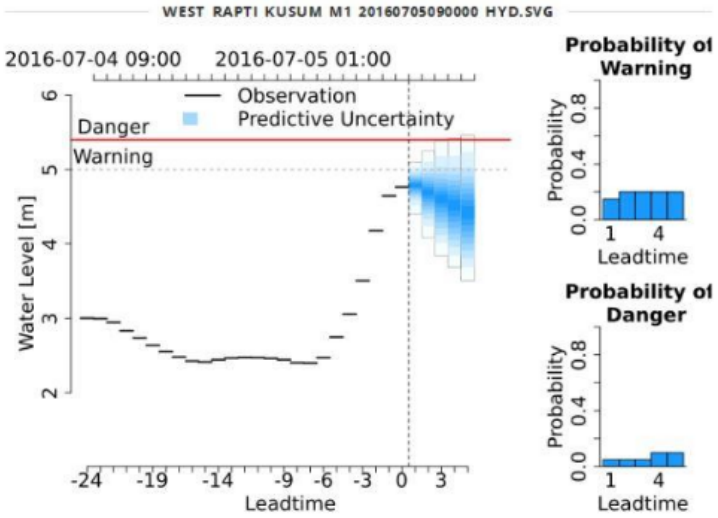
DHM utilized forecasts from Local and Global Models enabling them to produce flood advisories and make decisions on sending mobile SMS to vulnerable communities residing along the Narayani and West Rapti river basins during the 2016 Monsoon

Department of Hydrology and Meteorology
Flood Forecasting Section

Water Level Forecast for West Rapti River at Kusum

The current water level is 4.77m and it is in rising trend, the forecasted water level for coming five hours shows the probability of crossing warning level of 5m is 20% around 10 AM till 1PM and probability of crossing danger level of 5.4 m is 10% around 1PM.

Forecast Duration: 2016-07-05-09:00 to 2016-07-05-01:00



Department of Hydrology and Meteorology

Flood Forecasting Section

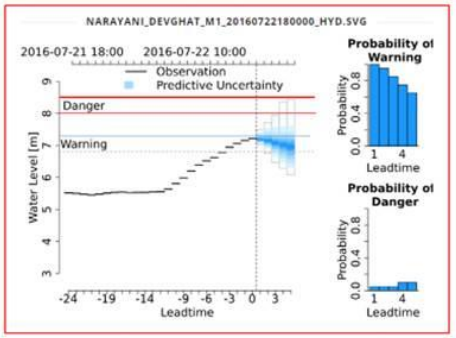
07 Shrawan 2073, 7:45 PM

Flood Alert in Narayani

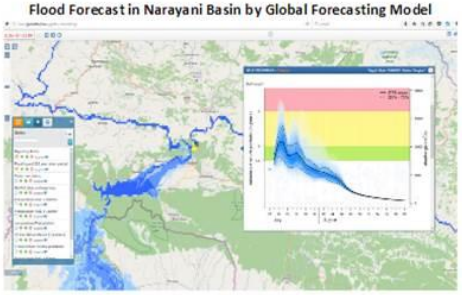
The current water level at Devghat is 7.25m and it is in rising trend, the forecasted water level for coming hours shows the probability of crossing warning level of 7.3m (warning level) is high. Hence the residence of People living near Banks of Narayani River are requested to be in High Alert Condition till tomorrow morning.

नारायणी नदी देवघाट जलमापन केन्द्रमा पानीको हाल सतह ७.२५ मि पुगेको छ र बढ्दो क्रममा रहेको छ। आगामी केही घण्टा भित्र पानीको सतह चेतावनी तह (७.३मि) माथी रहने भविष्यवाणी गरिएको हुंदा। नारायणी नदीको देवघाट भन्दा तल जोखेणी सम्मने तटीय क्षेत्रमा रहनुहुने संपूर्णमा भोली बिहान सम्म उच्च सतर्कता अपनाइदिनुहुन अनुरोध गर्दछौं।

Flood Forecast in Narayani Basin using Probabilistic Model



Flood Forecast in Narayani Basin by Global Forecasting Model



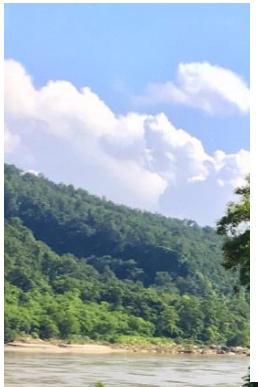
Flood Advisories for Nepal. Source: Nepal Department of Hydrology and Meteorology (2016)

Challenges and Uncertainties

Way Forward

- Forecasting tools have contributed to enhance the effectiveness and efficiency of existing community based systems, increasing the lead time for response

- Extensive research is required on appropriate ways to interpret and disseminate probabilistic forecasts having longer (2-14 days) and shorter (3-5 hours) time horizon for operational deployment as there are numerous uncertainties associated with predictions



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Community-based early warning systems for flood risk mitigation in Nepal

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Thank You
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