Community Based Approach to Flood Early Warning in West Rapti River Basin of Nepal

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Community Based Approach to Flood Early Warning in West Rapti River Basin of Nepal

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Abstract About 300 people lose their life each year due to floods and landslides in Nepal with property damage exceeding 626 million NPR on average. Compared to other disasters in Nepal, floods and landslides are the number one natural disaster regarding economic damage and number two in causing loss of lives. The West Rapti River basin is one of the most flood prone river basins in Nepal. The real-time flood early warning system together with the development of water management and flood protection schemes play a crucial role in reducing the loss of lives and properties and in overall development of the basin. This paper presents an overview of flood problems in the West Rapti River basin, causes and consequences of recent floods and the applicability and effectiveness of the community based approach to flood early warning in Nepal. A community based flood early warning system has been set up with a collaborative effort of the Department of Hydrology and Meteorology, Practical Action, local government and non-governmental organisations. Community level disaster management committees have been formed in each of the disaster prone villages. These committees have been brought into a network of District Disaster Relief Committee, local media, the Red Cross, local police, the military units and the flood monitoring and forecasting station of the Department of Hydrology and Meteorology. The disaster management committees have been equipped and trained for warning dissemination, preparedness and immediate response. This proved to be a very effective mechanism to disseminate flood warning and respond immediately during times of disaster.

Key words floods, monitoring, forecasting, early warning, preparedness

1. INTRODUCTION

About 300 people lose their life each year due to floods and landslides in Nepal with property damage exceeding 626 million NPR on average (DWIDP 2007). The West Rapti River of Nepal is one of the most

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flood-prone rivers. Several villages in the lower part of West Rapti River near the Nepal-India border get inundated each year due to floods during the monsoon season. The Department of Hydrology and Meteorology (DHM) has been maintaining several hydrological and meteorological stations in the basin, some of which are dedicated for flood forecasting and warning. Until 2009, there was no systematic flood forecasting and warning system for the West Rapti River. In 2009, the Department of Hydrology and Meteorology assessed the flood warning level and danger level (DHM 2009). A web based telemetry system for real time data acquisition was established in 2010. At the same time, a Community Based Flood Early Warning System (CBFEWS) was set up to facilitate dissemination of warning information and immediate response to flood warning with a collaborative effort of the Department of Hydrology and Meteorology, Practical Action, local government and non-governmental organisations. This paper presents an overview of the system and its applicability and effectiveness in saving lives and safeguarding valuable assets of the communities.

2. STUDY AREA

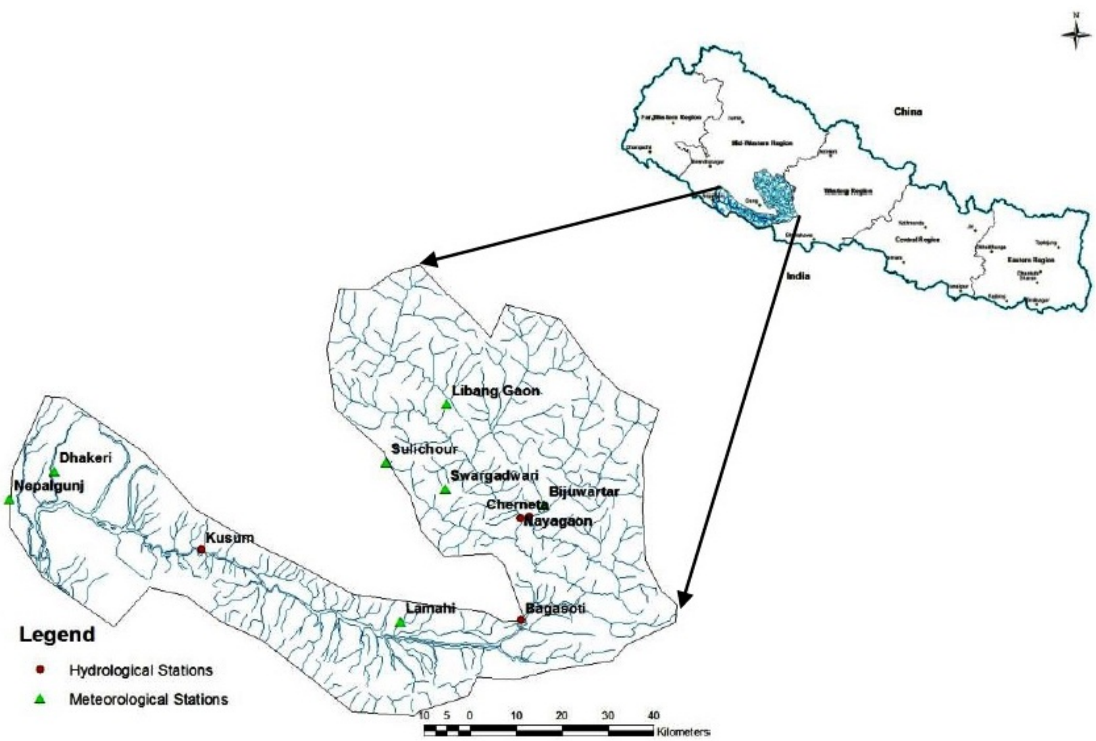

Figure 1. **Location of West Rapti River Basin**

The West Rapti River basin is located in the mid-western region of Nepal (see Figure 1). The river originates from the middle mountains of Nepal, then enters the lowlands and finally drains to the Ghagra (Karnali) River, a tributary of the Ganges River in India. It has several tributaries. Major tributaries are Jhimruk River, Mari River, Arun River, Lungri River, Sit River, Dunduwa River, Sotiya and Gandheli rivulets. Downstream of the confluence of the Jhimruk and Mari Rivers, the river is named the West Rapti River. The average slope of the basin is 16.8%. The source of runoff is due to the monsoon rainfall and groundwater.

The drainage network of the river basin and telemetry stations are shown in Figure 1. There are four hydrological stations. Two of them, at Kusum and Nayagaon, are equipped with a real time telemetry system for both water level and rainfall measurement. The Bagasoti station has a telemetry system for real time rainfall measurement only whereas Cherneta has a telemetry system for water level measurement only. Other seven meteorological stations provide real time rainfall measurements. The catchment area of the basins of Nayagaon, Bagasoti and Kusum gauging stations are 1980 km^2, 3380 km^2 and 5200 km^2 respectively.

While the upper West Rapti River basin has a temperate climate, the lower basin including the Banke district has a tropical to subtropical climate. The period from March to May is hot and dry, June to August is hot and humid, September to October is pleasant, and November to February is cool and foggy with occasional rainfall due to westerly winds. The temperature reaches 46 ^oC in summer in the lower part of the basin and falls below 2 ^oC during winter in the upper part of the basin. The study area receives summer monsoon rainfall extending from June to September, accounting about 80% of the total annual. The average rainfall for West Rapti River Basin is about 1500 mm. The relative humidity goes as low as about 60% in May to above 90% in January.

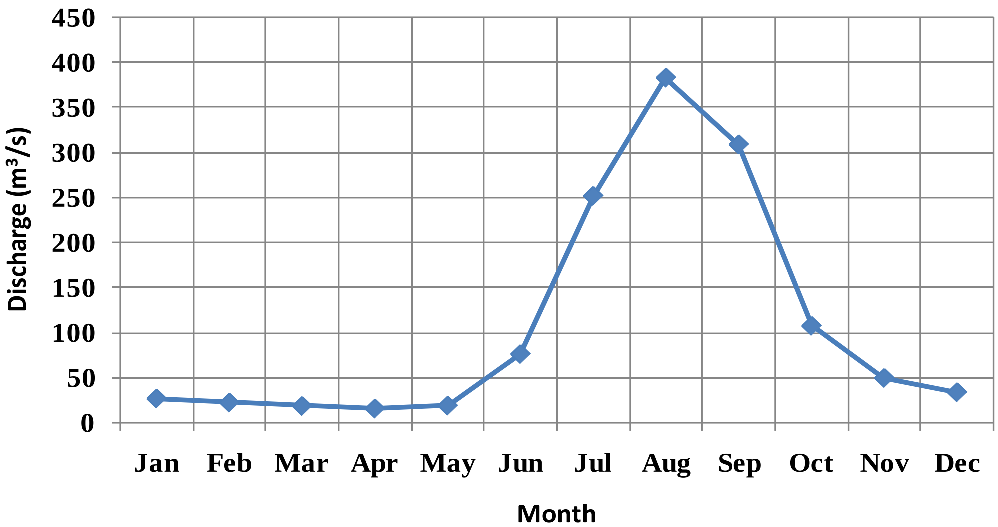

Figure 2. **Average monthly discharge at Bagasoti**

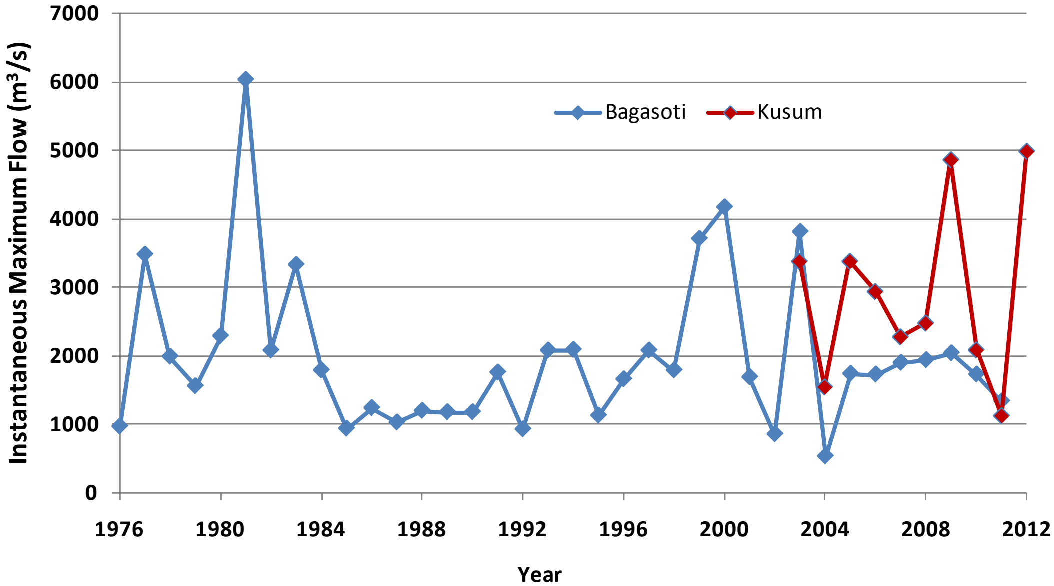

Figure 3. **Instantaneous maximum discharge at Bagasoti and Kusum (Source: DHM)**

Figure 2 shows the variation of average monthly discharge at the Bagasoti hydrological station (DHM 2008). The annual average discharge at this station is 109 m^3/s. The discharge increases rapidly from June and reaches maximum on August. Figure 3 shows the instantaneous maximum discharge of the West Rapti River at Bagasoti and Kusum. It is seen that extreme floods have occurred in 1977, 1981, 1983, 1999, 2000, 2003, 2005, 2006, 2009 and 2012 with the 1981 flood being of 100 year return period.

There are several projects in the basin. Those of note include the Jhimruk hydropower project (located in the upper basin) and the Sikta and Praganna irrigation projects (located in the lower basin). Major structures exist in the Indian part of the river basin including the Laxmanpur barrage and the Kalkaluwa embankment. There are also a number of flood control structures such as spurs and dykes constructed in Nepalese territory. The Laxmanpur barrage is perceived by the local people as an aggravating factor of the flooding in the bordering villages of Nepal. It creates inundation on the Nepalese side if the gates are not opened fully during the monsoon season. The Kalkaluwa embankment blocks the concentrated monsoonal flow of two natural drains namely Sotiya and Gandheli flowing downstream to the Indian side and prevents the spillover of West Rapti flood across the right bank of the river and thus inundating several villages in the Nepalese side. Before the construction of the embankment, flood flow from the West Rapti River used to spillover the low lying areas on the right bank on the Indo-Nepal border and flow over 13-14 km in width (ICHARM 2008). Recently, after intensive bilateral discussion between Government of India and Government of Nepal, an opening has been provided in the Kalkaluwa embankment on the Indian side for the passage of flow from Sotiya and Gandheli rivulets (JCIFM 2011).

3. FLOODING PROBLEMS

Flooding has been a serious problem for the communities of the West Rapti River basin for years. It has been more devastating to the villages bordering India than to those further from the border. The most affected villages are Betahani, Holiya, Binauna and Phatepur (see Figure 4). The deposition of sands in the farmland by the torrents originated from the Chure/Siwalik range, inundation due to flooding, and bank cutting at various locations due to rapid geomorphological changes are the major problems affecting lives and livelihoods of the people living on the lower West Rapti River basin. The Nepalgunj municipality and the other villages have been suffering from drainage congestion and inundation problems due to unplanned growth, faulty design of the drainage system and poor waste disposal practices (ICHARM 2008).

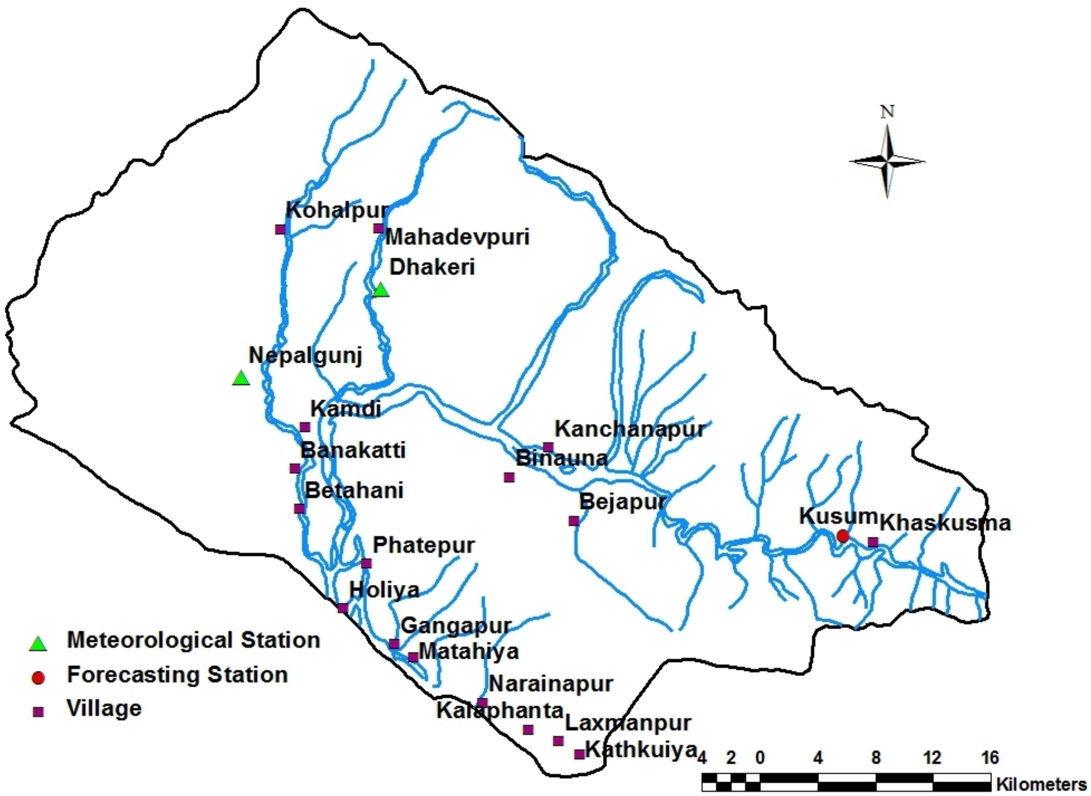

Figure 4. Banke district showing villages in the lower West Rapti basin

3.1 Causes of Flooding

The major causes of flooding in the West Rapti River basin are:

(a) Natural

i. High rainfall
ii. Soil erosion
iii. Flat topography
iv. Debris flows and sedimentation
v. River channel migration

(b) Anthropogenic

i. Blockage of drainage system
ii. Deforestation
iii. Poor planning, design and construction practices of roads
iv. Massive increase of settlements along East-West highway

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(c) Institutional

i. Lack of participatory approach in disaster management
ii. Lack of long-term comprehensive flood management plan covering whole flood prone areas

(d) Socio-political

i. Lack of public sensitivity and awareness
ii. Attitude of people and culture of neglect

3.2 Characteristics of Recent Floods

Figure 5 shows the flood discharge at Kusum from 2003 to 2012. Except in 2004 and 2011, the flood discharge is higher than the danger level discharge of 2000 m^3/s (see Gautam and Dulal 2013). There was a record high flood on 3rd August, 2012. The increased frequency of flooding in recent years together with disturbed institutional set up in the region due to domestic political conflict has severely affected people in the region. Marginalised groups are particularly vulnerable as they receive less education and live in areas that are lacking development of infrastructure that has been most affected by the flood disasters.

The year 2006 was in general a dry year for Nepal with most parts of the country receiving less monsoonal rain. But some areas in the West Rapti River basin received heavy rain triggering flooding. According to DHM records, Nepalgunj received a record high of 336.9 mm of rainfall on 27th August, 2006 (the highest 24 hour rainfall ever recorded in Nepalgunj since 1996 when records began). While on an annual basis the rainfall for 2006 was below the mean annual total rainfall for Nepalgunj, Kusum and Dang, on a seasonal (monsoon) basis, it was above the mean seasonal total rainfall for Nepalgunj (106.5% of monsoon mean total rainfall), moderately below the mean seasonal total rainfall at Kusum (96.5% of monsoon mean total rainfall), and well below the mean seasonal total rainfall at Dang (78% of monsoon mean total rainfall). Thus the flood in the lower West Rapti River basin and the study area was mainly due to the heavy downpour in the areas near to the foothills of mountains between 25th and 27th August, 2006. The instantaneous maximum flood of the Kusum station in this year was 2940 m^3/s, whereas the instantaneous flood discharge of the Bagasoti station was 1730 m^3/s (see Figure 3). This shows that the flood was mainly due to the heavy rainfall in the lower West Rapti River basin downstream of Bagasoti.

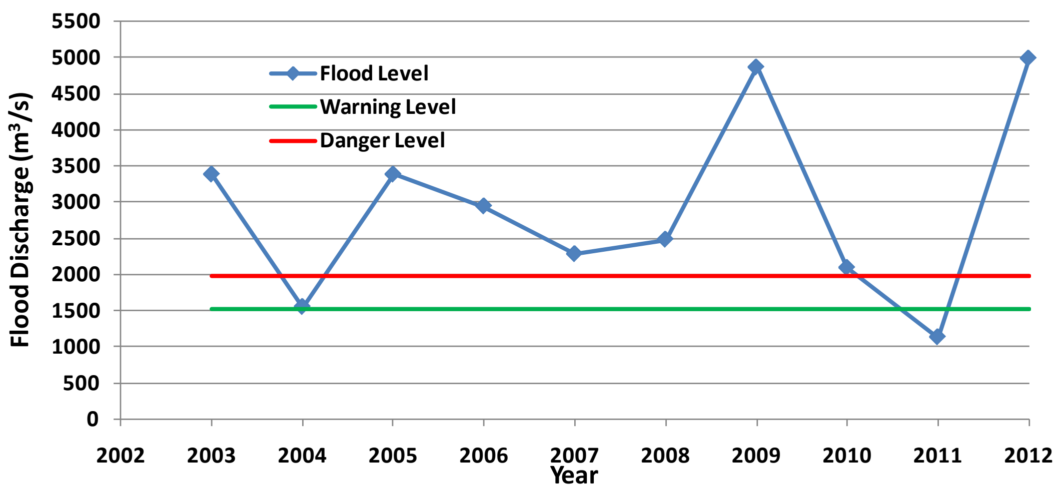

Figure 5. Flood discharge at Kusum station

In 2007, rainfall was quite high in Nepalgunj from July to September. The total monsoon rainfall in the year was about 180% higher than the mean monsoon rainfall in the station. The instantaneous

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maximum flood of the Bagasoti station in this year was 1900 m^3/s whereas the instantaneous flood discharge of Kusum station was 2280 m^3/s. This shows that the flood was mainly due to rainfall in the lowland (lower West Rapti basin) areas downstream of Bagasoti.

In terms of flood, Banke became the second most affected district in the country in 2007. At that time, the flood inundated the area for 3 to 4 days. The Dondra River (torrent) eroded the bank by 1 to 3 m along a length of 500 m of the river. The Newajigaun, Bhagawanpur and Bhojpur area was inundated for 6 to 7 days with water depth of up to 2.3 m. In Sonbarsha, people were suffering from inundation for 1 to 3 days with water depth of about 1.7 m. Similarly, Jamuni village was inundated for up to 24 hours with water depth of 0.5 m (ICHARM 2008).

Torrential rains starting from the beginning of October 2009 caused floods and landslides in the mid- and far western regions of Nepal. On 7th October 2009, the flood discharge in West Rapti River crossed the danger level and reached 4860 m^3/s (see Figure 5). In Banke district alone, 2 people died, 1456 families were displaced and 2683 families were affected (UN OCHA Nepal 2009).

4. METHODOLOGY

The methodology consists of the community based approach to flood warning. The Community Based Flood Early Warning System (CBFEWS) is a “people-centred” system that helps the communities in reducing the impacts of flooding in their area by empowering them to take timely and appropriate measures to reduce the loss of life, property and livelihood, and damage to the environment. It provides advance information on the risks to the community and disaster risk management workers for disaster prevention, preparedness and response actions.

Several factors should be considered while establishing a community based flood early warning system. These are hydrological characteristics, flooding frequency, community awareness, vulnerability, required lead time and the cost. First, the desired accuracy, achievable lead time, cost and sustainability of the system should be assessed. Then, a good rapport should be established with the communities and the technical and scientific expertise should be complemented with the indigenous knowledge of the communities. Therefore, communities and local government units should be adequately consulted before establishing the community based flood early warning system. The operational planning should include simulation exercises and mock drills for community preparedness as well as components for maintenance and system updating (Harnando 2007).

Since a communication and dissemination network is the heart of the system; preference should be given to the existing communication system. The warning message should be simple and understandable preferably in local language. False alarms should be avoided as it will erode the credibility of the system.

Hence, the following activities have been followed for establishing effective community based flood early warning system in the West Rapti River basin:

- **Area Survey, Flood Hazard Mapping and Assessment of Warning Level and Danger Level:** Practical Action and its local partner Centre for Social Development and Research (CSDR) identified Holiya, Betahani, Phatepur, Gangapur, Kamdi, Binauna and Matahiya villages as the most flood prone villages on the lower West Rapti basin in Banke district (see Figure 4). Community level exercises were carried out to map the historical flood events in the villages with the recorded flood levels at Kusum station. The community recalled from their memories the date and time of the flood at their villages, the inundation depth, time to recede the flood etc. With all these data, community sat together with a gauge reader which had historical recorded data from DHM’s gauging station at Kusum. By comparing the past flood events from communities’ memory to recorded data, the preliminary assessment of warning and danger level was carried out. The Flood Forecasting Project of the Department of Hydrology and Meteorology conducted cross-section surveys, flood hazard mapping and assessment of warning and danger level using a HEC-RAS model and GIS tools. The study recommended the warning level and danger level at Kusum forecasting station as 5.00 m (1500 m^3/s) and 5.40 m (2000 m^3/s) respectively (Gautam and Dulal 2013). Factors likely to influence the early warning system in the communities were also identified as follows:

- Power supply
- Telephone connectivity
- Private telephone ownership
- Infrastructure (roads, schools, health posts etc.)
- Technical capability of the community
- Knowledge of existing monitoring network
- Linkage with government agencies
- Indigenous knowledge
- FM radio ownership

The area survey led to the following decisions:

- Powered warning systems were simply not viable.
- Information from upstream location was required.
- Genuinely representative committees and volunteer groups had to be created, trained and their capacity built.
- There should be linkage with district level emergency service bodies and the existing disaster response mechanism.
- Local media, especially, the local FM station could play a major role in disseminating information widely.

■ **Installation of Monitoring Instruments:**

- Water Level Monitoring: There are four hydrological stations on West Rapti basin for flood forecasting purpose. These are at Kusum, Bagasoti, Nayagaon and Cherneta. The water levels were recorded three times per day manually and transmitted through VHF wireless set. In 2010, DHM upgraded three sites with CDMA/GPRS cellular web-based telemetry system under Irrigation and Water Resources Management Project supported by World Bank and one site is equipped with VHF wireless set and mobile phone for data transmission.
- Rainfall Monitoring: There are ten rainfall monitoring stations at Nepalgunj, Dhakeri, Kusum, Lamahi, Bagasoti, Nayagaon, Bijuwartar, Libang Gaon, Sulichour and Swargadwari. These stations were recording 24-hour rainfall with ordinary rain gauges. In 2010, DHM upgraded these stations with tipping bucket rain gauge and CDMA/GPRS cellular telemetry system for real time data transmission with the support from World Bank under Irrigation and Water Resources Management Project. The data have been stored in the data logger and transmitted to the web server at a frequency of five minute. This provided hourly rainfall data which is very useful for flood warning and developing a rainfall-runoff model.

■ **Setting-up of an Operations Center (OC):** The Flood Forecasting Section of DHM located at Babarmahal, Kathmandu is the central authority to collect, analyse and disseminate flood related data and information. The Flood Forecasting Section is equipped with VHF wireless set and telephone (PSTN/CDMA) for data collection. The cellular telemetry system transmits data from the stations every five minutes using internet protocol (IP) to the web based data server (www.hydrology.gov.np). The flood warning bulletin is posted on the website during flood in the monsoon season. The forecasting station at Kusum collaborates with the local communities, media and district disaster relief committee to share flood level data and warning information.

- **Communication and Warning Dissemination System:** DHM collaborated with Practical Action and CSDR to set up a community based warning mechanism. Local disaster management committees were formed in each disaster prone villages with the technical and financial support from Practical Action. The District Disaster Relief Committee, local disaster management committees, local media, the Red Cross, local police, military units and others were brought into a network with the flood monitoring and forecasting station of DHM. Figure 6 shows the community based flood warning mechanism adopted in the West Rapti River basin. Hand operated sirens, megaphones and mobile phones were provided to the disaster management committees. An electronic display board was set up at the Banke District Administrative Office, Nepalgunj. DHM's website was also redesigned to cater the information required for the effective early warning.

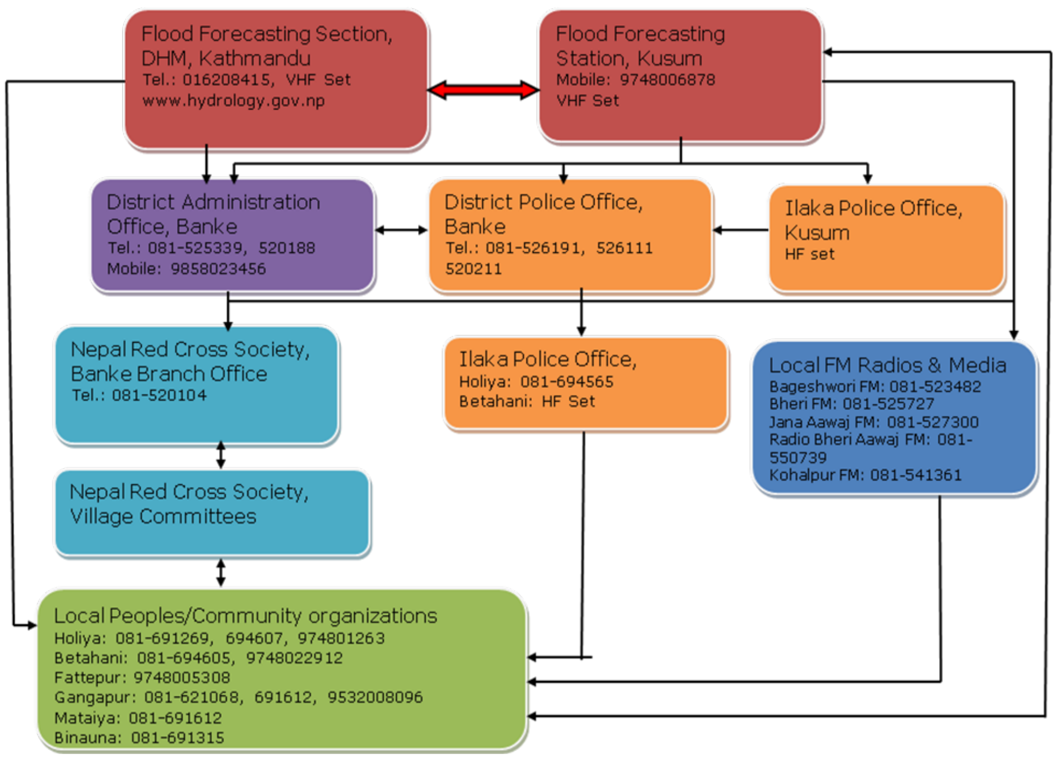

Figure 6. Communication and dissemination channel for CBFEWS for West Rapti River basin

- **Training and Capacity Building:** Practical Action launched an awareness raising program through FM radio, posters, calendars, leaflets, wall paintings, song competitions, street theatre, and schools art and essay competitions. Interviews and discussions were aired through local FM radio in local languages focusing on the issue of flooding, its causes and effects. Posters highlighting typical stages in flood preparedness, warning and response were distributed. Calendars containing images of the four stages of the early warning system, warning communication routes, critical district emergency telephone numbers and photographs of monitoring stations were printed and distributed. Leaflets were given out explaining the specific warnings and what people should do on receiving them. Wall paintings, song competitions, street theatre, and school art and essay competitions were used to highlight what could be achieved if communities could get some warning. A series of workshops were organised to have interactive discussion on effective ways of warning communication between DHM, local government officials, NGO members, community members and the media. Training was provided to local government officials, police and army personnel, community members and the media to extract and interpret flood and weather information from the DHM website. Field visits were arranged for local government officials, NGO members, community members, police and military personnel, representatives of the Red Cross and the media to get acquainted with water level and rainfall monitoring stations established by DHM. Mock drills were organized to practice use of the hand operated sirens, megaphones and the response activities of the communities to the warning.

4.1 Role of community

Monitoring and observation: Community level disaster management committees are being trained to monitor and keep records of flood level, extent and duration of flooding in their area, data and information on loss of life, people missing and damage to properties. Local knowledge on the location, time, duration, frequency, intensity and predictability of previous flood hazard will be important for an effective early warning system.

Flood warning activities: Dekens (2007) has suggested the utilisation of indigenous ways of disseminating early warning through house to house visits, the use of visual signals such as mirrors and fire, or audio signals such as drums as these are familiar to the community. In this project, the disaster management committees were able to disseminate flood warnings by using various modern means of communication made available to them such as sirens, telephones and megaphones. Some of the indigenous methods such as house to house visits and drums were also utilised by those settlements that have no access to the modern means of communication. Local people’s ability to transfer knowledge among themselves and between generations is now being used to raise community awareness about flood hazard. Community awareness campaigns consist of local songs, poems and proverbs.

Community response activities: Safeguarding people’s lives, livestock, seeds, household necessities and farm equipment is the prime response of the community after receiving a flood warning. Prompt response is necessary in moving goods and people to higher grounds, shelters or safe areas. Life jackets, boats and vehicles are now kept ready by the disaster management committees and district disaster relief committee for such eventuality. Stocks of food, drinking water and medicine are also maintained.

Instrument maintenance: Disaster management committees were trained to undertake minor maintenance of equipment available to them.

Post-event evaluation: The disaster management committees have actively taken part in post-event evaluation meetings and have shared the data and information with concerned organisations or stakeholders. This information is valuable for refining risk maps, warning and danger levels, planning relief, rescue and development activities.

4.2 Women’s participation

Women and children are the most vulnerable to natural disasters due to various reasons such as political and socio-economic condition, education and health. Cultural and social constraints, gender-biased attitudes, behaviour and stereotypes can also affect their mobility during disaster (Mehta 2007). Gender-biasness is the main cause of social vulnerability to disasters in some cultures and societies. Hence, it is necessary to involve and empower women at all stages of disaster management.

Considering these aspects, the representation of women, marginalised communities and disabled people in the disaster management committees has been given high priority from the very beginning of the formation of such committees. Women’s groups have been mobilised in community level awareness campaigns. Participation of women has been assured in every training, consultation meeting, field visits

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and stakeholders workshops.

4.3 Cooperation with Non-Governmental Organisations

Practical Action has been working in the area to strengthen the capacity of the communities to manage early warning systems to reduce the impacts of flood under European commission's DIPECHO V program. The local implementing partner of the project was the Centre for Social Development and Research. Through this project 37 hand operated sirens, 20 hand megaphones and 5 CDMA telephones, 121 life jackets and 25 boats were provided to the vulnerable communities. In the Banke and Bardiya districts, the project constructed nine bio-engineering dykes and spurs with river bank slopping technology at two sites, 24 culverts and bridges at strategic sites and 8 shelters (Practical Action 2009).

The Department of Hydrology and Meteorology signed a memorandum of understanding with Practical Action to establish the community based flood early warning system for the West Rapti River basin. The scope of the cooperation was to share the water level and rainfall data during the monsoon season, training and capacity building and development of an Early Warning Training Manual. A practitioner's handbook and facilitator's guide for establishing the community based early warning system have been developed which provide a recipe for establishing, operating and maintaining community based early warning systems (Mercy Corps and Practical Action 2010a and b).

5. RESULTS

The effectiveness and success of the community based approach was observed during floods in 2012. In 2012, there was continuous rainfall in the West Rapti basin on 3rd and 4th August (see Figure 7). The water level at Kusum started rising at 9:00 am on 3rd August and crossed the danger level at 2:00 pm (see Figure 8). Then it continued rising and reached 7.24 m (5000 m^3/s) at midnight. Water started receding at 01:00 am on 4th August. At 10:00 am, the water was below danger level and at 11:00 am, it was below warning level. The water level remained above danger level for about 20 hours.

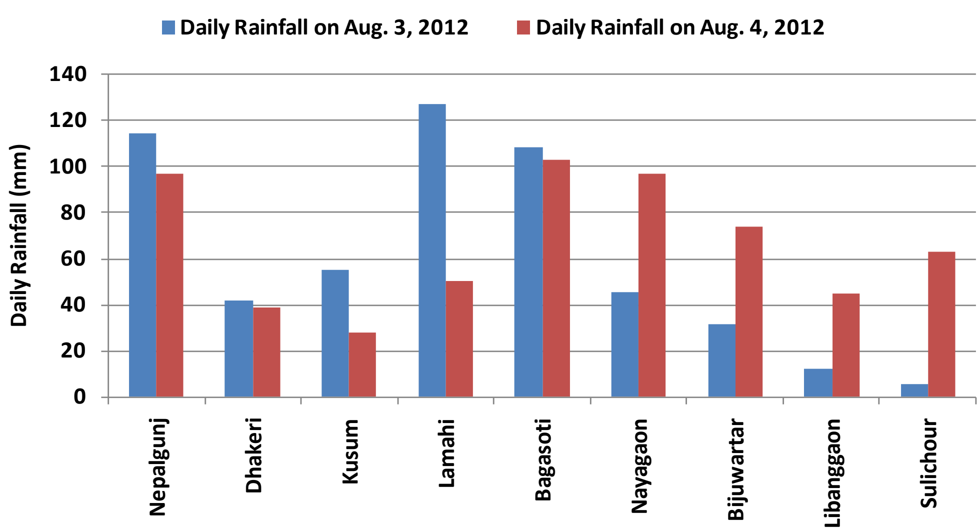

Figure 7 Daily rainfall on August 3-4, 2012 in West Rapti basin (Source: www.hydrology.gov.np)

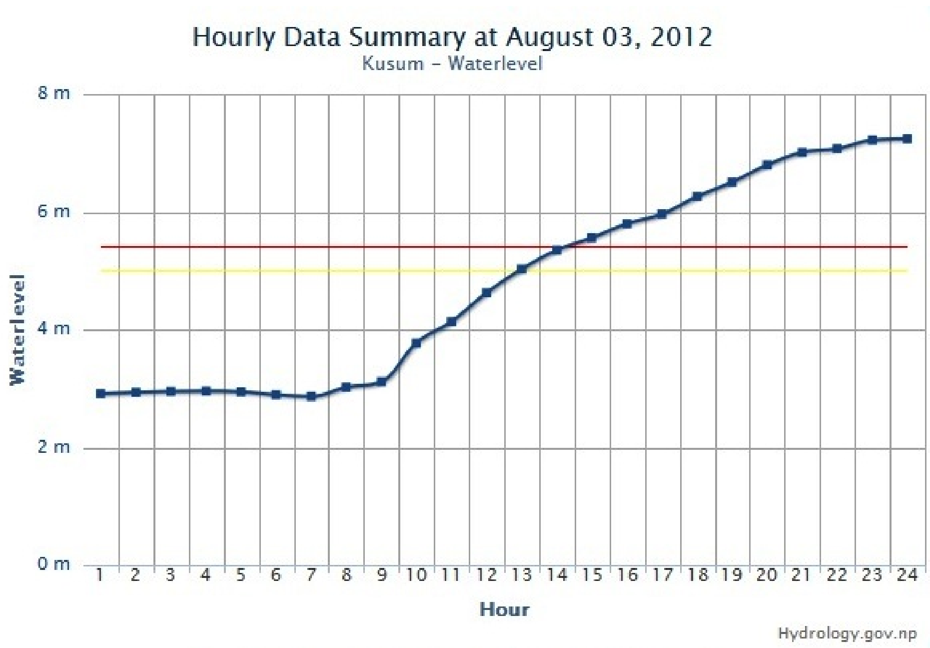

Figure 8 Water level hydrograph at Kusum hydrological station (red line: danger level)

The siren attached to the electronic display board at the District Administration Office, Nepalgunj, sounded for the first time when the water reached the warning level. The Chief District Officer (CDO) received flood information through SMS from the web-based telemetry system installed at Kusum. Immediately after the sound of the first siren and getting the SMS, the CDO informed security forces to disseminate the information to police posts of vulnerable communities. Nepal Army also disseminated an alert message to respective army posts. Local FM radios were broadcasting flood information. Local media people including TV journalists were following the flood situation from the web site of the flood forecasting project (see Figure 9).

Government of Nepal
Ministry of Environment, Science and Technology
Department of Hydrology and Meteorology
Flood Forecasting Project

RIVER WATCH

S.N	Station Index	Station Name	Water Level (m)	Flow (m^3/sec)	Warning Level (m)	Danger Level (m)	Trend	Status
1	240	Karnali at Asaraghat 2012-08-03 16:15:00	4.89	-	-	-	Falling	-
2	259.5	Seti at Dipayal 2012-08-01 15:00:00	7.35	-	-	-	Rising	-
3	269.5	Bheri at Samaijighat 2012-03-20 16:10:00	1.68	-	-	-	Steady	-
4	280	Karnali at Chisapani 2012-08-03 16:10:00	8.76	5869.40	10.00	10.80	Rising	Below Warning Level
5	289.95	Babai at Chepang 2012-08-03 15:45:00	3.40	463.00	6.50	7.00	Rising	Below Warning Level
6	291	Babai at Bhada Bridge 2012-08-03 04:39:50	4.31	-	-	-	Rising	-
7	330	Mari at Nayagaon 2012-08-03 15:11:52	1.91	-	-	-	Rising	-
8	339.3	Jhimruk at Cherneta 2012-08-03 16:18:36	2.98	-	-	-	Falling	-
9	375	West Rapti at Kusum 2012-08-03 16:21:10	5.81	2494.90	5.00	5.40	Rising	Above Danger Level
10	419.1	Kaligandaki at Kumalgaon 2012-08-02 18:07:04	3.75	1037.00	-	-	Steady	-
11	445	Budhigandaki at Arughat 2012-07-31 13:02:32	5.93	-	-	-	Rising	-

Figure 9. Real time flood information at www.hydrology.gov.np. When water level at Kusum exceeded danger level, it was shown in red with sound of siren.

The gauge reader also informed the flood situation directly to the members of disaster management committees of Holiya, Betahani, Phatepur, Gangapur, Kamdi, Binauna and Matahiya villages. It takes about 6 hours for flood waters from Kusum to reach these communities. The village disaster management committees then disseminated the message to the villagers by blowing the hand operated siren. In every village, people received flood information. People moved to higher ground and shelters with their valuable belongings, documents and livestock. They stayed at the safe place overnight and came back when water was completely gone from their houses and fields. The communities were well informed ahead and the early warning system worked well. Despite the huge flood that occurred at night time, there were no human casualties and the CDO was able to communicate with the Indian counterpart to open all the 14 gates of Laxmanpur Barrage well ahead of the flood. This prevented the worsening of the flood situation and saved valuable properties.

6. CONCLUSIONS

The community based flood early warning system considered communities as an integral part and involved them in risk assessment, communication and dissemination and immediate response activities in a participatory way. Communities have been involved in the identification of the problems, activities and the design of the action plan. Participation of elderly people, women, children, young, people with disabilities and marginalized communities made the system truly inclusive.

The system successfully established a linkage between the upstream stations with downstream communities. The water level data from the flood monitoring and forecasting station on the West Rapti River at Kusum was successfully used for early warning. A network comprising the District Disaster Relief Committee, local disaster management committees, local non-governmental organisations, local media and the flood forecasting station of DHM was formed. The communities utilized mobile phones, megaphones and hand operated sirens to disseminate the flood information at the local level. Immediate response capabilities of the communities were also strengthened. Upgrading of the existing monitoring system with the modern telemetry system and complementing it with the community based approach proved very effective in reducing flood risk as seen in the case of 2012 flood in the West Rapti River basin.

As a result of the efficient information dissemination channel and the communication system put in place, it has increased the response time by at least six hours which has substantially increased the potential of early warning system to reduce the impacts of flood in the vulnerable areas downstream. The lessons learned from this project have been now utilized in other areas by government and non government stakeholders. However, the system needs to be further enhanced by developing longer lead flood forecasting model for the West Rapti River basin. A mechanism for sharing the lessons learned and providing the feedback for improvement should also be established. A monsoon forum at the local level could serve as a mechanism which would provide a platform for interaction between the forecast provider and the users. Such a forum should be convened before and after the monsoon.

The system has sensitized the community, government and non government stakeholders on its importance as a disaster management strategy. CBFEWS is now being discussed nationally in various workshops, seminars and fora. Government institutions have already started to incorporate early warning systems into disaster risk reduction and development plans and programs. Similarly, many village development committees in Banke have incorporated early warning system into their annual activities and mobilised funds for strengthening and sustaining early warning systems. With the implementation of the plan, the communities are now better equipped to respond to flooding through provision of improved evacuation routes, boats, first-aid kits and other response materials. The communities have improved critical infrastructures such as bridges, culverts and rescue shelters at strategic sites. In this way, the community based approach to flood early warning has addressed the institutional and socio-political causes of flooding to some extent in the West Rapti River basin of Nepal. DHM – as a nodal and technical agency – played a crucial role by upgrading from traditional manual observation system to a real time telemetric system to develop a robust and effective early warning system benefiting vulnerable people on time, overcoming shortcomings and complementing the community based approach with science.

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