Perceived community-based flood adaptation strategies under climate change in Nepal

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Abstract: Climate induced natural disasters and extreme events are escalating with the increased variability of climatic parameters due to climate change. This study assesses the flood adaptation strategies that are applicable at the community level in two Terai districts of Nepal. The data were collected through three focus group discussions and 210 household surveys. The study revealed that flood forecasting practices at community level included monitoring the extent of rainfall in upper catchments and identifying the position of clouds. 'Initiate communication', 'take care the affected people', and 'select the appropriate location to stay' were most preferred strategies during the flood. Similarly, 'exchanging helps with each other', 'preparing temporary settlement plan' and 'co-ordinating with government and other agencies' are most preferred post-flood adaptation strategies. Identification and assessment of locally-relevant flood adaptation strategies will help governments to choose adaptation strategies that are both effective and preferred by local people in vulnerable communities.

Keywords: flood; adaptation strategies; community; people's perception.

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1 Introduction

The worldwide damage caused by extreme flooding has been significant in recent decades. No other natural hazard has appeared so frequently, claimed more human lives, generated such economic losses and ruined more fertile land (Al-Amin et al., 2013; Douben and Ratnayake, 2006). The climate is rapidly changing, affecting people across the world (Toprak et al., 2013). In the last decade of the 20th century, floods killed about 100,000 persons and affected over 1.4 billion people (Ezemonye and Emeribe, 2011). Developing countries and their people tend to suffer the earliest and the most from climate change impacts because of high vulnerability and low resilience (Manandhar et al., 2011). The South Asian region is one of the most sensitive regions as many countries in the region have weak economies and low resilience and adaptive capacity to the impacts of the changing climate (Ahmed et al. 2012; Manandhar et al., 2011).

In the last 100 years, there has been an average global temperature increase of 0.74°C (IPCC, 2007). The temperature trend from 1976 to 2005 showed a higher increase in maximum temperature (0.05°C per year) than minimum temperature (0.03°C per year) in the context of whole Nepal (Marahatta et al., 2009) and rainfall changes varied from –3 to 36% (GoN, 2010). High rainfall regions and seasons are generally becoming wetter, whereas low rainfall regions and seasons are becoming drier (Lohani, 2007). Projected mean annual precipitation changes are from –34 to + 22, –36 to + 67 and –43 to +80% by the year 2030, 2060 and 2090, respectively (NCVST, 2009; Baidya et al., 2007). Such changes increase the possibility of climatic extremes such as irregular monsoon pattern, droughts and floods (Gautam, 2008).

Surface waters, consisting of surface drainage flowing over a tract of land and into a natural water course, may come from seasonal rains, melting snows, swamps or springs, or from all of these. Flood waters are distinguished from surface waters by the fact that the former have broken away from a stream. According to Munich (1997), flood is "a temporary condition of surface water (river, lake, sea) in which the water level and/or discharge exceed a certain value, thereby escaping their normal confines". Flooding is defined "as the overflowing or failing of the normal confines of a river, stream, lake, canal, sea or accumulation of water as a result of heavy precipitation where drains are lacking or their discharge capacity is exceeded" (Douben and Ratnayake, 2006). Problems with floods and flooding are strongly related to population, population density and standard of living, especially in the developing countries.

Most comprehensive and quoted definition of adaptation is that reported by the IPCC Third Assessment Report which defines adaptation as: "adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli, and their effects or impacts. This term refers to changes in processes, practices or structures to moderate or offset potential damages or to take advantage of opportunities associated with changes in climate" (IPCC, 2001). It involves reducing potential damages of climate change and taking advantage of new opportunities. Through the implementation of adaptation measures, the adaptive capacity of the system increases and the sensitivity reduces, thereby reducing the vulnerability of a society to the impacts of flood due to climate change (Devkota et al., 2013). Therefore, it can be concluded that adaptation is a policy, practice, or project that has the effect of moderating damages or realising opportunities associated with climate change including climate variability and extremes.

Climate change increases flood intensity and thus exacerbates public and private property damages (Malla, 2009). In Nepal, flood disasters have become more frequent, pronounced and devastating in recent decades (Regmi and Adhikari, 2007). The Mid-Western regions of Nepal are experiencing greater than expected flood frequency and intensity resulting in immense damage to lives, properties and serious losses in production every year (Marahatta et al., 2009). Climate change is likely to contribute to enhanced variability of river flow in the Mid-Western region of Nepal and increased incidence of flood events with significant impacts to poor people and rural livelihoods (Devkota et al., 2011; Sapkota et al., 2011). Indigenous people of this region have already experienced frequent drought and severe floods effects due to climate change which has resulted in huge loss of agricultural land and products (Osti et al., 2008). The 2008 flood event forced the evacuation of 142 households from Holiya Village Development Committee (VDC) (a VDC is the lowest administrative unit of the government of Nepal). In 2010, many villages remained inundated due to flash floods and hundreds of people were out of contact in Banke district. Similarly, 11 people were killed and 2000 houses hit by a deluge in the Dang district in 2012 (The Kathmandu Post, 2012). Among the others, the floods of:

1 August 2008 in Koshi River

2 July–August 2012 in West Rapti River

3 May 2012 in the Seti River is examples of some of the most devastating floods in Nepal.

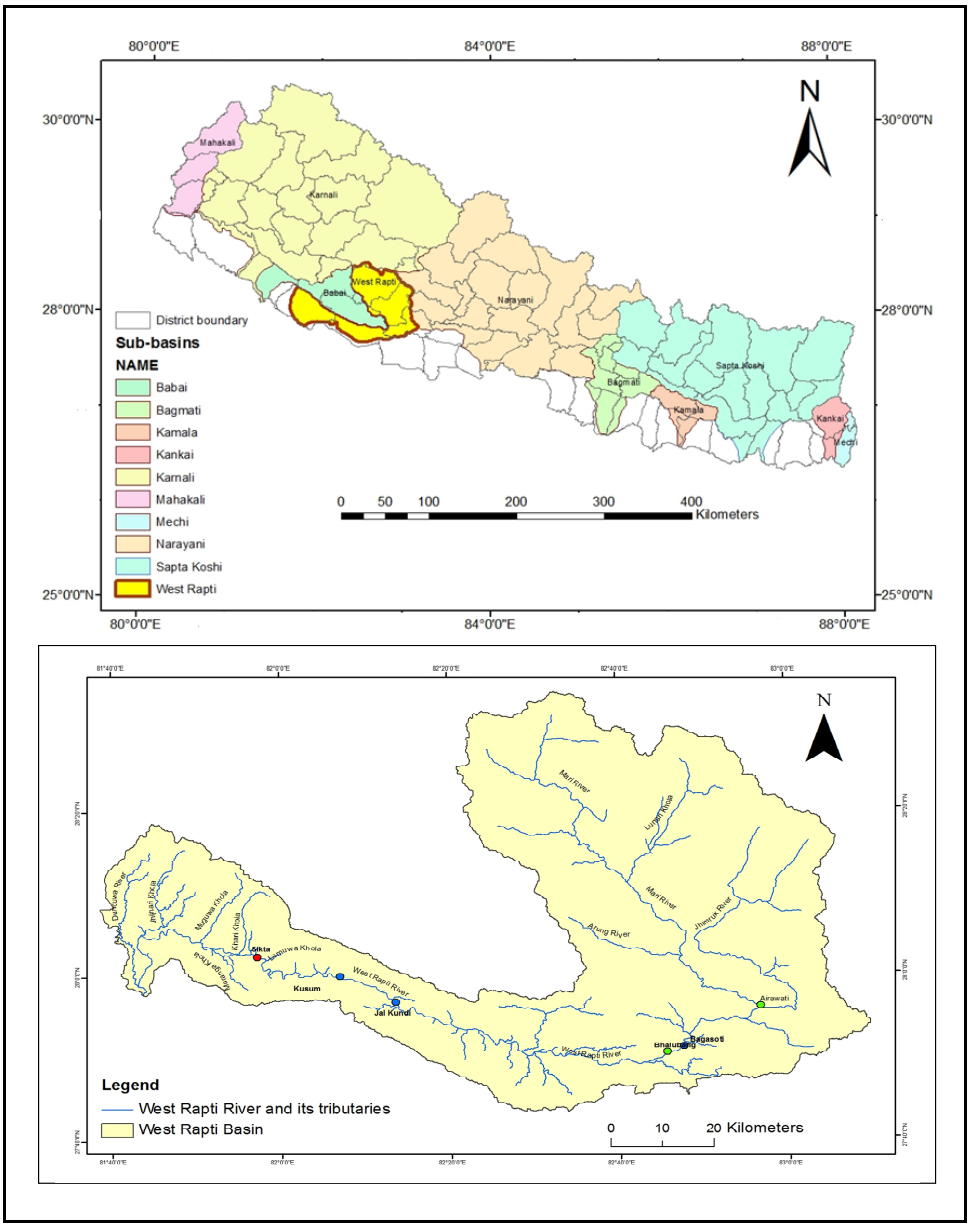
Flood risk management must rely on a proper and comprehensive flood risk assessment, which reflects the individual characteristics of all elements at risk of being flooded (Scheuer et al., 2013). An integrated approach of coupling climate change and flood adaptation strategies with long term flood information and associated risk analysis is required for selection of adaptation strategies (Dawson et al., 2011; Wrachien et al., 2011). This paper reports on community level flood management practices in the West Rapti River Basin. The people residing in the bank of West Rapti River have continuously experienced flood events for generations (Devkota et al., 2013; Khatiwoda, 2011). Acknowledging the role of communities in flood forecasting and preparedness (Maharjan, 2011; Thapa et al., 2009), this study aims to assess the indigenous knowledge of flood forecasting and determine and rank applicable adaptation strategies for pre-flood, during flood and post flood situations at the community level of West Rapti River Basin in Nepal. The study will help the government to choose appropriate adaptation strategies that are most preferred, applicable and cost-effective among many alternatives at the local level. The framework developed helps policy makers to identifying priority areas for adaptation policy interventions.

2 Methodology

2.1 Study area

This study was carried out in West Rapti River Basin of Nepal, covering an area of 6,500 km^2 within Banke and Dang districts (Figure 1). West Rapti River basin is considered one of the important river basins of the country from a socio-economic point of view as it supports large farming communities, although people living in this basin are poor. The main tributaries of the river are Madi River and Jhimruk River. Both of them originate in Lesser Himalaya, and then drain to Siwaliks and Terai Plain in the south before joining the Ganga River in India. There are 39 VDCs and two municipalities in Dang District where as 46 VDCs and 1 municipality in Banke district. Based on the census of 2011, the total population of the Dang district is 5,52,583 (2,61,059 male and 2,91,524 female), while there are 4,91,313 (2,44,255 male 2,47,058 female) in the Banke district (CBS, 2012). Over 80% of people in Nepal are farmers and the majority of these practice indigenous agriculture (Dixit et al., 2007).

Figure 1 Showing study area West Rapti River Basin of Nepal (see online version for colours)



3 Methods

Three focus group discussions (FGDs) were conducted. These included two in the Banke district at Newajau of Gangapur VDC and Priparawa of Holiya VDC on 11 and 13 February 2012, in which 21 and 13 people participated respectively, and one in the Dang district at Puranobazer of Lalmatiya VDC on 14 February 2012 in which 12 people

participated. People who have firsthand experience of at least five years in flood adaptation strategies, such as farmers, foresters, VDC secretaries, school teachers and local NGOs, were invited to these FGDs. In the beginning, they were asked to prepare a list of flood forecasting and flood adaptation strategies during three periods (pre-flooding, during flood and after flooding) that have been most commonly adopted over the past ten years. Then, they were further requested to identify those adaptation strategies that are most relevant. These most applicable strategies then formed the basis for the household survey. A total of 210 households (over 25% of the total population) were randomly selected for interview. The first author of this research, along with a local research assistant, had conducted the whole process of FGDs and household survey. During the field visit (February–May 2012), the key person of the household was requested to rank selected flood adaptation strategies against a 1–5 scale, where 1 is a least applicable option and 5 is most applicable option. The adaptation strategies for each period were ranked based on the weighted average index (WAI).

$$WAI = \frac{F_1 \times W_1 + F_2 \times W_2 + F_3 \times W_3 + F_4 \times W_4 + F_5 \times W_5}{F_1 + F_2 + F_3 + F_4 + F_5}$$

$$WAI = \frac{\sum Fi \times Wi}{\sum Fi}$$

where

F frequency of the respondents

W weight of each scale

i weight (5 = highly applicable, 4 = applicable, 3 = moderately applicable, 2 = less applicable and 1 = very less applicable).

4 Results and discussion

4.1 Effect of floods emerged from focus groups discussions

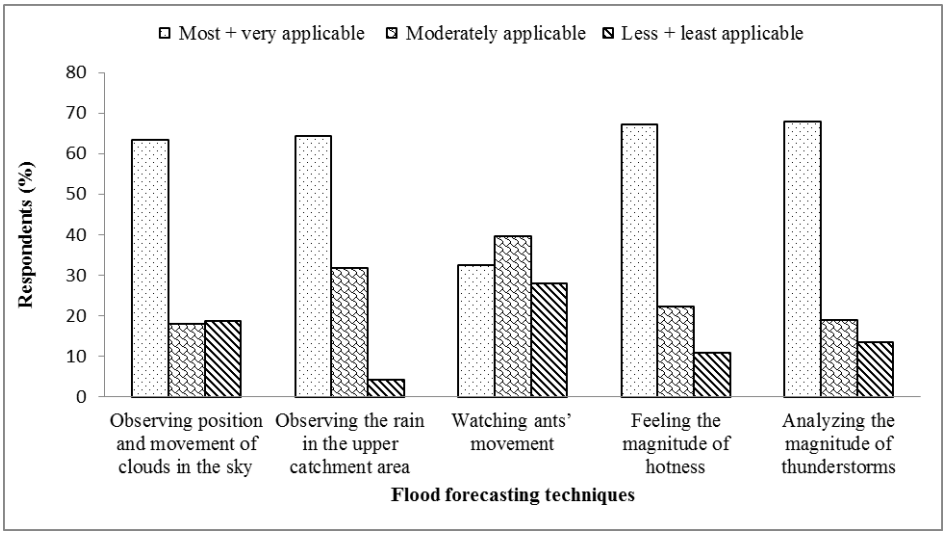
Recurrent flooding in the monsoon season in the study area is brought about by rising water levels in the Rapti River and causes significant damage to the physical infrastructure such as houses, schools, sub-health post, road, marketing centres, gabion embankments, spurs, hand pumps as well as cultivated land and livestock.

Besides the loss of infrastructure from floods, there is massive loss of life of people living along the flood plains, where victims are mostly poor and indigenous people with few resources to cope with or minimise flood effects. As a result, they lose their homes, crops, and livestock and experience major change to their day to day livelihoods during and after flooding. For example, 142 households were forced to shift permanently as a result of flooding in the West Rapti River basin in 2008.

4.2 Flood forecasting techniques

Effective flood forecasting and early warning systems can save many lives and properties. Communities are enriched with indigenous knowledge of flood forecasting and early warning practices. Five main flood forecasting techniques used over the past decade, identified from the FGDs, are shown in Figure 2. The respondents' perceptions of these techniques (in terms of percentage of respondents) are presented in Figure 2. "Observing the rain in the upper catchment area" (64.2%); "feeling the magnitude of the hotness" (67.1%); "observing the position and movement of cloud (63.3%)" and "analysing the magnitude of thunderstorms in the sky" (67.9) were rated as most applicable and very applicable flood forecasting methods by the respondents. Even though some respondents also used the practice of 'watching ants' movement' to forecast rainfall, just 39.6% of the respondents ranked it as moderately applicable. Each of these techniques could be used in the absence of others.

Figure 2 Flood forecasting techniques



The study revealed that if there is rainfall in the upper catchment area, there is a possibility of floods. This is especially so when there is a long period of high intensity rainfall in the monsoon season, the impact of which can be devastating. Communities verbalised that the rainfall alone in the Terai region (where they live) would not induce high flood levels. People also hypothesised that there is a high chance of heavy rainfall by assessing the position of clouds in the sky. They believe in a saying that if the black cloud is located in the eastern side of the sky and if there is no mobility of these clouds, then there will be heavy rain within an hour. Therefore, the colour and direction of clouds are very important for them. Likewise, unusually high temperatures in the monsoon season mean there is a very high chance of rainfall and over flowing in the river. Similarly, the magnitude of a thunderstorm is considered by these indigenous people' knowledge to be another indicator of possible rain and subsequent flooding. They also believe there is a high possibility of heavy rainfall if they see many ants moving together.

However, this indicator is considered the least reliable one among the five main techniques.

4.3 Flood adaptation strategies

Field studies ascertained that predicting flood using indigenous knowledge is an interesting feature in the study area where people are trying to minimise the possible effects of flooding through their own efforts and knowledge. It was observed and reflected during the interaction with the people that they have close affiliation with the flood and its nature. However, due to uncertain and erratic rainfall, people were found to be highly aware of the risk of flooding. The people of the West Rapti basin, who experience frequent flood events, have developed different flood management techniques for pre-flood, during flood and post flood period; some of these are given below.

Different types of pre-flood, during flood and post-flood adaptation strategies and their WAI (WAI and rankings are given in Table 1, Table 2 and Table 3, respectively. 'Flood management plan' was a most preferred pre-flood adaptation strategy with its WAI of 3.7, followed by 'pre-estimate flood risk' with a WAI of 3.3. Similarly, 'keep contact information' was ranked 3rd with a WAI of 3.2 whereas 'produce human resources' was least preferred with a WAI of 3.1.

Table 1 Pre-flood adaptation strategies at community level in % (N = 210)

Responses	*Most applicable*	*Very applicable*	*Moderately applicable*	*Less applicable*	*Least applicable*	*WAI*	*Ranks*
Flood management plan	56.7	20.5	17.1	4.8	1	3.7	I
Keep contact information	12.9	43.8	35.7	6.7	1	3.2	III
Pre-estimate flood risk	17.1	45.2	31.9	4.3	1.4	3.3	II
Produce human resources/trained manpower	13.3	39	33.3	13.3	1	3.1	IV

Table 2 During flood adaptation strategies in % (N = 210)

Responses	*Most applicable*	*Very applicable*	*Moderately applicable*	*Less applicable*	*Least applicable*	*WAI*	*Ranks*
Perfect communication at community level	49.5	23.3	20	7.1	0	3.6	I
Select the appropriate location to stay	28.6	39	29	2.9	0.5	3.1	III
Take care of the affected people	17.6	39	26.7	15.2	1.4	3.4	II

Table 3 Post flooding adaptation strategies in % (N = 210)

Responses	*Most applicable*	*Very applicable*	*Moderately applicable*	*Less applicable*	*Least applicable*	*WAI*	*Ranks*
Exchange help	57.1	12.9	24.8	4.3	1	3.7	I
Prepare temporary settlement	20	45.2	29	5.2	0.5	3.3	IV
Coordinate with government and other agencies	22.4	43.8	30	2.9	1	3.4	III
Equal distribution of resources	30.5	44.3	16.7	8.1	0.5	3.5	II

Among the 210 respondents, 119 (56.7%) mentioned that community people themselves are responsible for setting the 'flood management plan' and dividing the roles and responsibilities for the upcoming flood before the monsoon season which was seen as the most relevant flood adaptation strategy in the study area. Similarly, 'keep contact information' of the people living in the flood prone areas was another highly valued adaptation strategy which 92 (43.8%) respondents mentioned. Likewise, people mentioned that 'pre-estimation flood risk' was another important parameter for preparing flood adaptation strategy and was mentioned by 95 (45.2%) respondents. In addition, 97 (46.2%) of the respondents mentioned 'producing human resource/trained manpower' is among the top list applicable strategy.

Similarly, 'perfect communication at community level' was most applicable during-flood adaptation strategy with its WAI of 3.6, followed by 'take care of the affected people' (3.4). Likewise, 'select the appropriate location to stay' was ranked 3rd with WAI 3.2.

Moreover, the feedback on the ongoing flood adaptation strategies revealed that out of total respondents, 104 (49.5%) mentioned that 'perfect communication' at community level was the most applicable strategy. Similarly, another adaptation strategy practiced at community level during flood was to 'take care of the affected people' living in the flood prone areas. 82 (39%) respondents mentioned that it was very applicable strategy. Likewise community people mentioned that 'selecting the appropriate location' during the flood was another important adaptation strategy. More than one third of the respondents 82 (39%) mentioned that this was a very applicable strategy.

Among the post flooding adaptation strategies, 'exchange help' was ranked as the most applicable flood adaptation strategies with a WAI of 3.7, followed by 'equal distribution of resources' with a WAI of 3.5. Third was 'coordinate with government and other agencies' with a WAI of 3.4 and 'prepare temporary settlement' was considered the least applicable strategy with a WAI of 3.3.

Of the selected post flood adaptation strategies, 120 (57.1%) respondents mentioned that 'exchange help' among the community people was the most applicable post-flood adaptation strategy. Another applicable strategy was 'prepare temporary settlement' for flood affected people living in the flood prone areas, with 95 (45.2%) respondents mentioning that it was a very applicable strategy. 'Coordinate with government and other agencies' was another important adaptation strategy with 92 (43.8%) of people rating it as a very applicable strategy. Likewise, 'equal distribution of resources' was another

valued adaptation strategy. About 93 (44.3%) of the total respondents mentioned that it is a very applicable flood adaptation strategy.

5 Conclusions

This paper argues that climate change is a major cause of increasing flood hazards as evidenced by the community people's experience in the West Rapti River Basin. People in the Basin strongly believe that climate change is inducing high intensity rainfall resulting in flooding problems. Similarly, over grazing, continuous forest depletion, construction of infrastructure without assessing the monsoon flood and narrow drainage capacity of the torrents are major cause of flooding in the study area. Therefore, integrating diversified technological options including skills development, awareness and capacity building of flood affected communities into the mainstream development practices can reduce disaster risk and vulnerability. In addition, this will also help to manage the flood resistance capacities of people living in flood prone areas. Enhanced knowledge of flood forecasting, early warning systems and flood management practices are critical knowledge for flood adaptation.

Pre-cautionary measures are required to prevent massive damage from flooding in this region of Nepal. There is the need for a flood-management approach on a river-basin-wide level to provide a more coordinated and strategic protection system for these rural communities.

This research identified and prioritised pre flood, during flood and post flood adaptation strategies, as practised by local people, which can help in the design of effective plans and programmes to reduce flood damage in the study area. Furthermore, planning for immediate, medium and long term rehabilitation and recovery actions are needed particularly for vulnerable people.

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