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People's Perspective on Flood Hazard and Adaptation Strategies in the Koshi River Basin of Nepal

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Abstract-*The people residing the plain region of the Koshi River Basin have been encountering flood disasters annually. Flood has disrupted their livelihood and caused huge loss of properties and lives. People of the area, thus, have a long experience living with the flood. The study was carried out to assess local people's perception on flood related issues, degree of preparedness to deal with flood disaster, adaptation measures and their preference. Although the people of the study area has been practicing various methods at household as well as community level to mitigate the probable loss from the flood in different phases viz. pre-flood, during flood and post-flood events, degree of preparedness and adaptations measures were found not sufficient along with lack of modern technique of flood forecasting. The study found that flood adaptation measures can be made more effective through community level initiatives and participation than that at household level at all phases. Structural and non structural flood management approach seems plausible to get relieved from the flood problem of the area.*

Keywords*: Koshi River Basin, Flood, Adaptation Strategy, Mitigation, People's Perception.*

I. Introduction

Flood hazard is the probability of occurrence of a potentially damaging flood event of a certain magnitude within a given time period and area (Brooks, 2003). The increased volume of rainfall during the past decades has intensified the flood problem in the world. Flood is one of the foremost natural disasters which accounts for approximately one third of all natural disasters in the world (UNISDR, 2012).

Marahatta et al. (2009) argued that a significant change in precipitation, temperature and other climatic parameters in a particular area significantly affect the biophysical and socioeconomic circumstances. This means African and Asian countries are going to be socio-economically more vulnerable in the coming days because they are mostly dependent on natural resources for their livelihood. Developing countries especially from Asian continent is much affected by floods and the countries like India, China, Philippines, Iran, Bangladesh and Nepal are highly vulnerable to flood (WWAP, 2006). It indicates that the majority victims of flood disasters are poor and marginalized people who are the first casualty of such incidents and who lack adequate means to take protective measures and have very little capacity to cope with the loss of property and income (IPPC, 2001). On the other hand, Nepal is well known all over the world as a hot spot for flood disaster. According to the UNDP report on "Reducing Disaster Risk: a Challenge for Development", Nepal ranks 12th in the world in terms of the proportion of its population (23.74%) exposed to the threat of flood annually.

As the topography of the country is steep and rugged with fragile geology and very high intensity of rainfall during monsoon, causes flood especially in the southern part (Terai plain) of the country. For hundreds and often thousands of people each year monsoon related flood results in massive loss of property, erosion of land, loss of irreplaceable assets, and loss of livestock. During the period of 36 years (1971-2008), more than 2,846 lives have been lost; 349 people have been injured; 1041 buildings have been damaged; 196,955 ha of productive land has been lost; 31,117 livestock died and 3,713 million Nepalese Rupees (US$ 59, 88 million; 1 US$=NRs 62) worth of properties have been lost due to floods (Devkota et al., 2013).

Among others, flood of Koshi River in 2008 is one of the hot examples of most devastating floods in Nepal as the river broke its embankment at Kusaha VDC in Nepal submerging several districts of Nepal and India. It displaced 45,000 people from three severely affected villages (Haripur, Shreepur and Pacchim Kusaha) of the Sunsari District of Nepal (Minute of UN OCHA, 29 March 2009 cited in Shrestha *et al.* 2009). About 3.065 million residents from 1,704 villages in North Bihar were similarly affected (Mishra, 2008), and around 4,648 ha of agricultural land and crops were washed away in Nepal (Minute of UN OCHA, 29 March 2009 cited in Shrestha *et al.* 2009). The damage caused by the Koshi flood of 2008 is the biggest in five decades of flood history in Bihar (Kale, 2008). It can be considered one of the worst flood events in the entire flood history of Nepal.

Due to the frequent flooding in the plain area of the Koshi River Basin, people of the area have a long experience living with the flood. They have, therefore, the capacity to share their immense knowledge about the

causes and impact of floods and the adaptation measures they have been following in different phases of flood, viz. pre-flood, during and post-flood events to mitigate damaging effects of the flood. On the other hand, there is modern approach of flood forecasting and adaptation. Integration of the local knowledge with the modern one can make the flood adaptation strategies acceptable to the community and sustainable. Further it will help to devise the policy and programs of flood adaptation that fit the local aspiration and need. With this backdrop, this study was carried out to assess local people's perception on flood related issues and their preference on adaptation practices in the Koshi River Basin. Based on the information, flood adaptation strategies to be followed in the study area were proposed.

II. Methodology

1.1. Study Area

The study was carried out in the flood plain region of the Koshi River Basin within the Nepalese territory (**Figure 1**). There are two administrative districts, viz. Saptari to the right and Sunsari to the left of the river respectively. There are 114 Village Development Committees (VDCs) and 1 municipality in Saptari district whereas 49 VDCs and 3 municipalities are there in Sunsari district. The population of Saptari district is 639,284 and that of Sunsari district is 763,487, making the total population of the study area of 1,278,568. The total household of these two districts are 283,505 (121,098 in Saptari and 162,407 in Sunsari district) (CBS, 2011).

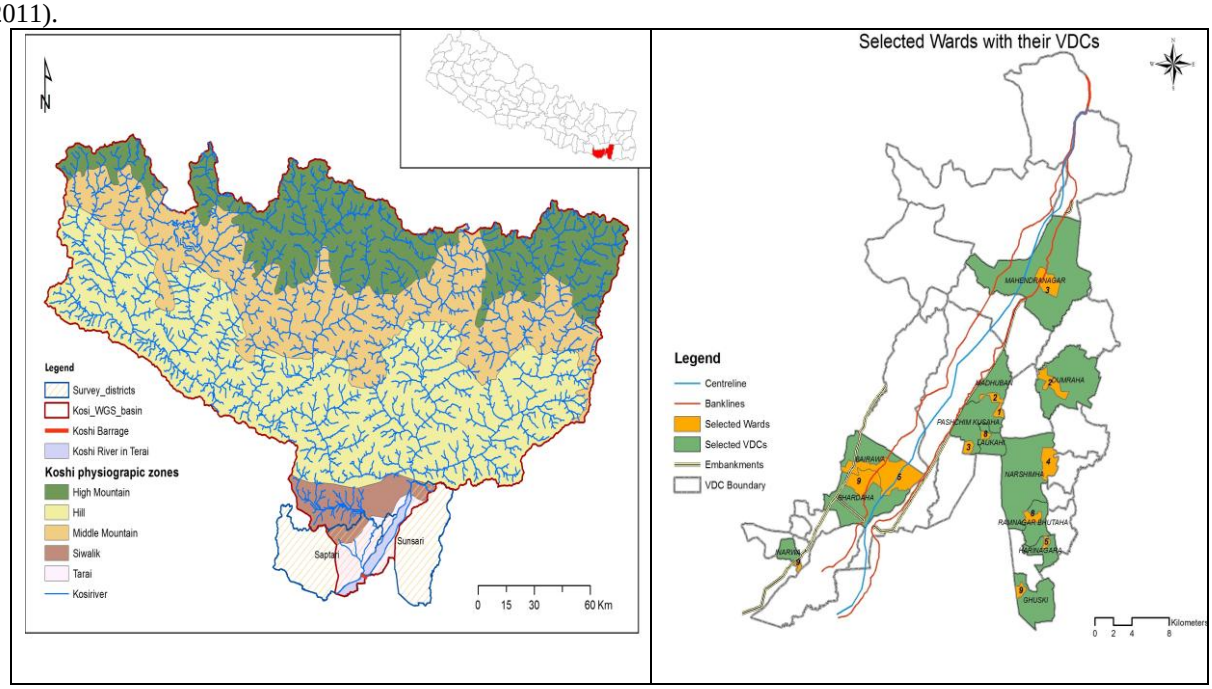

Figure 1: Selected VDCs and Wards of Two Study Districts (Saptari and Sunsari)

1.2. Sample Size Estimation

Household survey was carried out to collect the necessary data and information required for the study. The sample size, i.e. the total number of household to be surveyed, was determined with 95% confidence level and 5% error (degree of accuracy) by using the following formula:

$$Sample\ Size = \frac{\chi^2 * N * P * (1 - P)}{d^2 * (N - 1) + \chi^2 * P * (1 - P)}$$

Where,

χ^2= tabulated value of Chi-Square @ d. f. = 1 for desired confidence level and degree of accuracy i.e. for 0.05 = 3.84

N = population size (1,278,568)

P = population proportion (assumed to be 0.50)

d = degree of accuracy (0.05)

1.3.

1.4. Selection of Sample Sites and Sample Size Distribution

Multistage sampling technique was used to select sample sites as given below.

i) Sunsari and Saptari districts which lie in the both sides of the river and of high flood risk districts of Nepal according to National Adaptation Programme of Action (NAPA), 2010 were purposively selected.

ii) The inundation depth for 100 years flood without embankment estimated by HEC-RAS model simulation was considered for site selection. Sample areas within the two districts were selected based on the inundation pattern under the flood in three distinct categories; a) Less affected (< 0.5 m inundation depth); b) Moderately affected (0.5 m to 1.0 m inundation depth) and c) Highly affected (> 1.0 m inundation depth). This classification is based on the following assumptions.

- If the inundations depth is less than 0.5 m, disruption of general activities will be there. However, an adult person can do movements easily and vehicle movement can take place to transfer the goods and people from the affected place to safer one. Even children and adult can survive the depth of this level and an average house can withstand this level of inundation without much damage.
- When the water depth crosses 0.5 m movement of the people and vehicles become very difficult. Only adult can go from one place to another with difficulty. Household damage will be significant. People and animal can survive if it does not go beyond 1.0 m. External rescue is needed during flood.
- If the inundation depth goes beyond 1.0 m, no movement is possible, damage to properties is significantly high and chance of survival of the people and animal is less.

iii) In order to select wards (the smallest administrative unit) and the sample size distribution following steps were followed;

a) Listed out all the VDCs of both districts considering the above mentioned categories, i.e. inundation depth.
b) Only wards equal and above 50 % area affected (in all three categories) were considered. The total number of wards sort listed came out to be 70 (**Table 1**).
c) Proportionate sampling technique was applied to distribute samples for all three categories within two districts. However, care was taken in such a way that there were 30 samples in each ward and had to fall at least one VDC in each district.
d) A total of 13 wards from 13 VDCs (10 from Sunsari and 3 from Saptari) were selected randomly. The wards selected are shown in **Figure 1**.

Table 1: Number of Wards Selected and Sample Size Distribution

Categories	Less affected	Moderately affected	Highly affected	Total HH
Sunsari	7	9	39	55
Saptari	2	8	5	15
Total	9	17	44	70
% of total HH	13	24	63	100
No. of Sample HH	49	93	241	384
Nearest sample (30HH/ward)	60	90	240	390+2*=392
Total no. of wards selected	2	3	8	13
Sunsari (ward selected)	1	2	7	10
Saptari (ward selected)	1	1	1	3

*2 households from pre-testing also included

1.4.1. Selection of Household for Survey within a Ward: Total 392 households were selected from 13 wards for household survey. The nearest households from the road head was selected as the first household for survey. Then the following households were selected in every next ten households. Basically household head (main person of the house, husband or wife) was selected as key respondent from that particular house. If the household head of the selected house was not available that house was skipped and the next nearest house was selected for the survey.

1.5. Selection of Parameters: Semi-structured questionnaire was administered for household survey to assess people's perception of the study area on different indicators or parameters. There is, generally, more than one cause that may result an event (e.g. phenomenon like flood results from intense rainfall or deforestation) or an event that may produce different effects (e.g. impacts of a flood event on people lives or property) or various methods can be used to achieve an objective (e.g. methods of flood mitigation by structural or non-structural measures). Establishment of such parameters (causes, effects or methods) was one of the important tasks before conducting household survey to assess the local people's perception on various parameters. It was done in two steps: i) Probable parameters were listed out based on available literature and researchers' experience and ii) Finalization of the parameters were done in local and national level stakeholders' consultation workshops held in Sunsari and Kathmandu, respectively.

1.6. Method of Analysis : The information collected from household survey was analyzed using Statistical Package for the Social Sciences (SPSS). Depending on the nature of the questions, the perception of the respondents on a given parameter was measured on a least preferred to most preferred (1-5) scale i.e. Likert Scale. It is mentioned here that the respondent can give the same number (weightage) for more than one parameters, if he or she believes that two parameters have equally significant or influential. The mean

scores obtained on this scale was compared and used to determine the perception of the respondents. All the perception related questions/issues were ranked based on the Weighted Average Index (WAI) calculated as;

$$WAI = \frac{f_1 w_1 + f_2 w_2 + f_3 w_3 + f_4 w_4 + f_5 w_5}{f_1 + f_2 + f_3 + f_4 + f_5}$$

$$WAI = \frac{\sum f_i w_i}{\sum f_i}$$

Where,

f = frequency of the respondents

w_i = weight of i case [the most preferred case, $w_5 = 5$; preferred case, $w_4 = 4$; average case, $w_3 = 3$; less preferred case, $w_2 = 2$ and the least preferred case, $w_1 = 1$].

Level of influence of a parameter was classified based on WAI values (values range: 1- 5) as given in **Table 2**.

Table 2: Classification of Parameters

SN	Range of WAI Values	Degree of Influence	Class
1	4-5	Very Influential	I
2	3-4	Influential	II
3	2-3	Average Influential	III
4	1-2	Less Influential	IV

III. Results And Discussion

1.7. Demographic and Socio-economic Characteristics

The major demographic and socio-economic characteristics of the study area are given in **Table 3**. There are 52% male and 48% female in the study area. It is in the contrary to the district demographic composition of 49% male and 51% female. The people, generally male, who went abroad for job opportunities were not accounted in the census survey (CBS, 2011) resulting less male population in the district. However, in this survey total family members of the household were enumerated. Children (< 10 years) and old age people (> 65 years) are generally considered more vulnerable to flood hazard. They account almost one fourth (below 10 years: 22% and above 65 years: 4%) of the total population. The average household size of the area is of 7 members, which is higher than the national average of 4.88 and even of Terai region where average HH size is 5.27. In Nepal, general observation tells that the poorer a family, higher is the HH size. **Table 3** shows that more than three fourth of the people are having income less than $1. Poor family with a low level of family consciousness has a desire of more children especially of male children for old age security might, thus, be the causes of higher family size in the study area. The literacy rate in the study area is 68% which is slightly higher than the national average of 66%. However, the people with less than a secondary education are more than 60%.

Table 3: Major Characteristics of Sampled Household

Characteristics		Value
Population	Male	52 %
	Female	48%
Age distribution	<10	22%
	10-65	74%
	>65	4%
Average family size		7
Literacy Status	Illiterate	32%
	Primary (class1-5)	29%
	Secondary (class 6-10)	22%
	SLC and above	16%
Main income sources (Occupation)	Agriculture	52%
	Waged /skilled labor	24%
	Business	9%
	Others*	7%
Income Status (per capita per day, $)	< 0.5	47%
	0.5 to 1	29%
	1 to 2	20%
	> 2	4%
Assets holding	Avg. Landholding (ha.)	0.57
	Avg. Livestock holding (no.)	9
Access to drinking water	Own house	35%
	Neighbor's house/community	4%
	Tube well	61%

*Note: Others include foreign employment, government service, and public service.

The major income source of the study area to sustain their livelihood is agriculture which accounts 52% of the total household. It is followed by waged labor/skilled labor (24%). In Nepal if a farmer holds a land between 0.2 and 0.5 hectare (ha), he is considered as a small farmer. Medium farmers have land holding of above 0.5 ha and below 2 ha while large farmers are those who have land area above 2 ha. Since an average landholding of the surveyed households is 0.57 ha, the people of the study area can be considered as medium farmers. Further, the average livestock holding was found to be 9. It accounts only cows and buffalos. The majority of households (61%) depend on community tube well for drinking water while only 35% have drinking water facility in their own house. These figures show that the communities living in the study area are socio-economically poor. This result shows that people of the study area are quite vulnerable to flood hazard as floods impact adversely to the poor people more; especially whose livelihood is agriculture dependent and subsistence in nature.

1.8. Perception on Causes of Flood

To assess the perception of the people on the causes of flood in the study area, they were asked to rank the flood causing parameters from 1 (the smallest cause of flood) to 5 (the biggest cause of the flood) during the household survey. Two parameters under natural causes and 5 parameters under manmade totaling 7 causes were considered responsible for flood (**Table 4)**. "Intense rainfall", "Overflow of river and the stream", "Lack of embankment protection" and "Deforestation" were perceived as the major causes of flooding (Class I with WAI >4.0) by the people of the study area. In Terai plain land gradient is very small. If there is an intense rainfall, even of short duration, the area gets inundated. Rivers or streams of the area has also small slope whose bank gets overtopped frequently almost each year which in turn floods the adjoining settlements or agricultural land. Communication with the people revealed that they were suffering from such recurrent floods every year. People living in the study area were quite aware that the Koshi flood of 2008 was the result of embankment breaching. Several past researches considered that one of the key reasons of Koshi flood of 2008 as the outcome of institutional dysfunction and governance deficit (Dixit, 2009). Furthermore, Mishra (2008) also argued that the Koshi embankment breach was the outcome of negligence of duty by the duty bearers and lack of accountability at different levels. Similarly, Shrestha et al. (2009) has pointed out five direct reasons in the perspective of institutional aspects. Among them lack of monitoring and maintenance of the embankments is the one. Deforestation is another key reason of flooding. Because of the deforestation, the rainfall turns into flood immediately. It shows that the perception of the people on the causes of flood is quite rational.

Table 4 shows that the "Lack of proper land use management" falls in Class II as its WAI is between 3 and 4. It can be taken that people consider this cause as of moderate importance for flooding in their area. Remaining two parameters viz. "Traditional agricultural practice" and "Extraction of boulder from the river" received low weightage (WAI < 3). It shows that most of the people of the study area consider these parameters as minor determinants to flood disaster.

Table 4: Peoples Responses on Causes of Flood

Causes of flood		Very small cause	Small cause	Moderate cause	Big cause	Very big cause	Total	WAI	Class
Man-made	Deforestation	1	10	58	105	218	392	4.4	I
	Lack of proper land use management	21	67	116	159	27	390	3.3	II
	Lack of proper embankment protection	1	6	24	130	231	392	4.5	I
	Traditional agricultural practices	104	129	114	30	12	389	2.3	III
	Extraction of boulder and sand from the river	118	67	60	98	48	391	2.7	III
Natural	Intense rainfall	1	1	8	78	294	382	4.7	I
	Overflow of rivers and stream	1	0	7	111	263	382	4.7	I

1.9. Impacts of Flood

1.10. Impacts on Property

Majority of the respondents mentioned that flooding was the main problem they had been facing every year during the rainy season. This study found that adverse impact of the flood on peoples' properties (agricultural land, house or animal shed) was more in the region close to the river. **Figure 2** presents the responses of the people on the impacts of flood on their main property especially, house and animal shed with respect to the distance from the river. About 18% houses and 10% animal sheds located less than 100 m from the river were completely swept away by the flood in the past. Similarly, the percentage of household as well as animal shed which had partly been damaged was found decreasing with the increasing distance from the river. The highest percentage of houses (33%) and animal sheds (30%) located in less than 100 m from the river had

their wall partly damaged by floods. About 53% and 46% respondents residing in the range between 100-500 m from the river mentioned that they have water logging problem inside the house and animal shed respectively during the flood season. Although damage to the property by flood inundation depends on the distance and elevation of the considered location or type of house or animal shed, the findings of the study, however, indicates that people living close to the river are more vulnerable to floods.

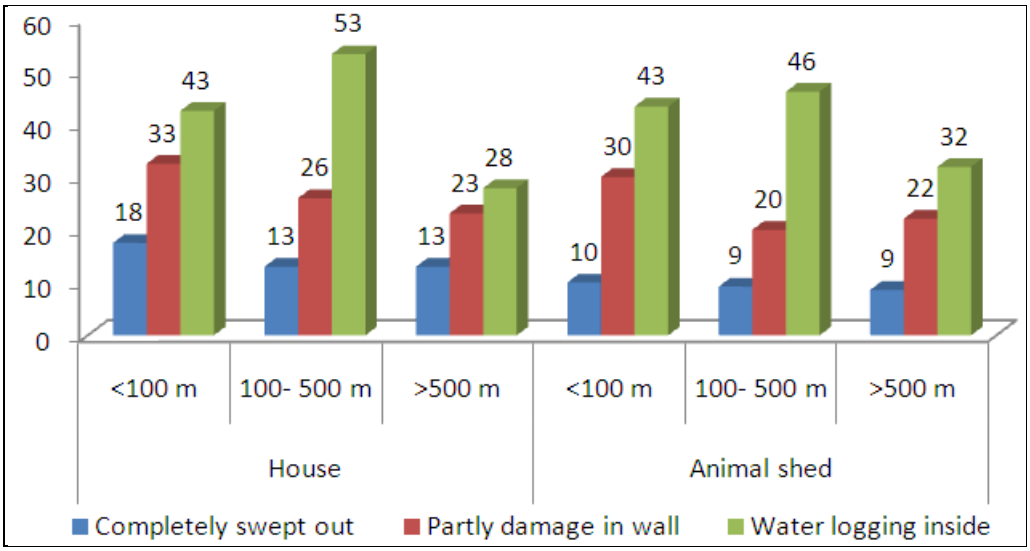

Figure 2: Flood Impact on the Different Properties

The depth and duration of water logging is very crucial parameter from the perspectives of health of the people and their livelihood, and damage the flood imparts to the crops. It was reported that the duration of water logging in the study area varied from less than one day, even only during raining to more than 3 days (**Table 5**). About 60% of the respondents mentioned that they faced water logging problem inside their house and in the animal sheds for more than 3 days. Similarly, more than 80% reported that their crop land get inundated for more than 3 days. Depth of inundation is more than 1 m (above the waist of the adult) in more than one fourth of houses and animal sheds while it is almost 50% of their cropland. These values for inundation durations are reasonably high in flat terrain because of low velocity of accumulated water. These figures show the level of acuteness of flooding in the study area.

Table 5: Depth and Duration of Water Logging

Particulars		House		Animal shed		Crop land	
		HH	%	HH	%	HH	%
Duration of water logging	Only raining time	13	6	14	6	7	3
	Less than one day	26	11	30	14	4	2
	Less than three days	56	24	42	19	27	13
	More than three days	136	59	130	60	163	81
Depth of water	Less than 1 m	142	37	114	29	40	10
	More than 1 m	108	27	109	28	181	46

1.11. Impact on Crop Production

Respondents were asked whether they could able to cultivate flooded land or not after flood. About 45% of the respondents replied that they were able to cultivate flooded land after flood whereas 18% respondents replied negatively. 43% responded that their production was decreased while very few people, only 2%, mentioned that their production was increased after flooding. The most commonly observed impact of flood on cropland was sedimentation of about 1-2 m thickness. Such deposited sand on the cropland by the flood forced farmers to change their cropping pattern. Few farmers were producing sand-friendly vegetables in the flooded area after flood. This implies emphasis should be given on the need of exploring the possible support to strengthen the adaptation capacities of the local people through introducing crop varieties that suit to the flooded area.

1.12. Human Casualties

Local people of the studied sites indicated that flood hazard had also impacted on human casualties and injuries. One of the farmers in Pacchim Kusuha VDC informed that they have to stay alert whole night at the time of monsoon and/or intense rainfall as they do not have any early warning system in their village. It was

reported that at least 13 people were injured and 2 were killed by floods during the last 5 years period in the study area.

1.13. Degree of Preparedness and People's Perception

1.13.1. Degree of Preparedness

The degree of preparedness is inversely proportional to the probable loss of properties and lives by flood disaster. Flood evaluation map, evacuation place and early warning system (EWS) are important indicators in this regard. Food hazard evaluation map gives the information about the probable flood hazard area and degree of flood risk whereas EWS gives the information on timing of flood occurrence in the particular area. In order to evaluate knowledge of the respondents about hazard evaluation map, evacuation place and EWS, questions were asked whether they were aware of these indicators or not during field survey. The percentages of respondents who mentioned that they were aware of hazard evaluation map, evacuation place and EWS were 18%, 44% and 36% respectively. However, majority of the respondents (97%) replied that they do not have specified flood evacuation place in their community. They mentioned that they used to go nearby school or any high altitude place during flood. More than 68% respondents mentioned that they had very limited access to first aid facilities at individual as well as the community level. All these facts show that the degree of preparedness is quite poor and people are vulnerable to flood risk in the study area. It shows the need of at least basic preparedness to cope with flood hazard so that loss of lives and property from flood disaster can be minimized.

1.13.2. Local Flood Forecasting Techniques

The types of local flood forecasting techniques that people of the study area have been employing for generations are shown in **Table 6**. They believe these indicators are useful for flood forecasting at local level. The data on the table shows that people believe on the "Water level in the river" as the most reliable forecasting technique when compared to other ones (WAI =3.4, ranking in the first place). However, "Magnitude of the hotness" and "Position and movement of cloud" are also fall in Class II. It shows that all these parameters bears more or less equal significance in terms of flood forecasting to the people of the study area. These three techniques have been practiced for generations and should have produced expected results in the past. People had, thus, preferred these techniques for flood forecasting with moderate degree of confidence. These three techniques were rated as more reliable flood forecasting methods as perceived by more than 64% respondents in the case of West Rapti River Basin of Nepal (Devkota et al. 2014). Since any of these techniques did not fall in Class I, people either do not have strong belief on these methods as reliable flood forecasting techniques or did not have common views on them.

People believe that if water level in the river is raised, people can guesstimate that there is a high possibility of flood in any time. Similarly, if the magnitude of hotness is high, there will be a high chance of rainfall and flood particularly in the monsoon season. High temperature escalates evapo-transpiration which ultimately triggers heavy rainfall and floods (Nyong *et al.* 2007). Likewise, the local people think that the position and movement of cloud is another important indicator of possible rain and consequent flood. They used to guess the chance of heavy rainfall by assessing the position of the black cloud in the sky. Black clouds contains high amount of moisture and is one of the indicators of highly humid air in the atmosphere. Possibility of having rain is, thus, high if there is black cloud in the sky. It is interesting to note that "Monitoring of the rainfall in the upper catchment area" obtained the lowest WAI among them. However, its value is also close to other parameter, indicating its moderate reliability in the eyes of the people living there.

Table 6: Flood Forecasting Techniques

Types	Least Preferred	Less Preferred	Moderately Preferred	Preferred	Most Preferred	Total	WAI	Class
Position and movement of cloud	116	28	67	74	85	370	3.0	II
Rainfall in the upper catchment	120	45	64	67	73	369	2.8	III
Magnitude of the hotness	57	49	115	110	40	371	3.1	II
Water level of the river	45	67	76	46	137	371	3.4	II

1.13.3. People's Preferred Early Warning Method

Communities in the study area have traditionally responded to flood based on their existing capacity. The response in the past was not well organized. Communities only responded when the disasters happened. The effective early warning for flood disaster is lacking in the study area. Majority of the respondents felt that due to lack of preparedness, they had to suffer from more losses in the past.

The WAI value of people's perception on five selected methods for the flood early warning is presented in **Table 7**. Among the five methods respondents preferred most are the Radio, information from neighbor and Siren. FM radio has become very popular to the common people of Nepal in these days as its price is very low and they are handy. Even mobile phone can be used as FM radio, accessibility of which is high these days. About 60% of the rural household has access to mobile phones (CBS, 2011). Information from neighbors is reliable while alarm/siren is easy to detect. They might, thus, have fallen in Class I with WAI value more than 4. The newspaper received lowest WAI value i.e. 2.1 showing the lowest preference media for flood early warning. It may be because they have less access to newspaper or its news is not of real time. It is interesting to note that TV received moderate preference. It might be because they cannot watch TV when they want. It might be attributed to long hour of electricity outage.

Table 7: Respondent's Perception on Reliable Media for the Flood Early Warning

Reliable Media	Least Preferred	Less Preferred	Moderately Preferred	Preferred	Most Preferred	Total	WAI	Class
Radio	5	3	31	139	214	392	4.4	I
Newspaper	148	87	120	31	3	389	2.1	III
TV	41	26	74	187	64	392	3.5	II
Neighbors	5	10	41	199	137	392	4.2	I
Siren	11	13	29	113	226	392	4.4	I

1.14. Flood Adaptation Practices at Local Level

Adaptation is the best way to deal with flood disaster in developing countries like Nepal. This section discusses flood adaptation activities for three phases of flood disaster i.e. pre-flood, during flood and post-flood at household as well as community level.

1.14.1. Pre- flood Adaptation

Pre-flood adaptation practices can save the possible loss of lives and properties of the people living in flood prone area substantially as goes the saying "Prevention is better than cure" in health sector. The commonly practiced methods at household and community levels are discussed under this heading.

a) Household Level

The people of the Koshi River Basin consider flood disaster as a part of their lives. They have developed and have been practicing some measures in order to minimize the flood risk. The most common practices currently existing in the study area under pre-flood adaptation measures were "Raising the floor level of the house", "Make drains" around the properties e. g. house, animal shed, "Prepare emergency kit" which contains dry food and medicine, "Move children and old peoples away from home" and "Move valuable property away from home". The WAI value for each parameter is listed in **Table 8**. All WAI values are less than 3.0 except raising of floor whose WAI value is in between 3.0 and 4.0. It implies that none of them are very effective adaption measures to them for the flood hazard they are encountering. However, "Raising the floor level of the house" was reported as more appropriate strategy than others. This technique was found common technique used in that area to reduce the flood risks during the monsoon season at household level. Maharjan et al. (2011) also find in their study that Tharu community has started to construct double storey housings in Kailali and Kanchanpur districts either to store food grains and to escape themselves from flood due to occurrence of frequent floods,.

People create small drainage around their houses, cropland and animal shed, as poor drainage system is the foremost reason of flooding. Moving of property in other places received very low score. It shows the impracticability of doing this activity when they are not quite sure if the flood actually occurs. Besides, in the discussion with some respondents during the survey, some of them mentioned about the additional adaptation practices, such as "keep sleeping beds at a higher level (especially for highly vulnerable people such as child and elderly people)", "Storing sufficient food materials (beaten rice, salt, sugar, noodles, dried fish and pulses)" and "keep valuable documents such as citizenship certificates, the house and land ownership certificates.

Table 8: Pre-flood Adaptation Measures at Household Level

Measure type	Least Common	Less Common	Moderately Common	Very Common	Most Common	Total	WAI	Class
Raise the floor level of house	28	39	79	71	92	309	3.5	II
Make drains	98	98	79	23	4	302	2.1	III
Move the valuable property away from home	189	60	30	12	10	301	1.7	IV
Move children and old peoples away from home	155	59	36	44	7	301	2.0	III
Prepare emergency kit (dry foods & medicine)	135	73	57	24	11	300	2.0	III

b) Community Level

The community level pre-flood adaptation measures were classified based on the respondent's perception on them as given in **Table 9.** The proposed measures were "Flood management plan", "Keep contact information of the local people", "Estimation of flood hazard", "Train manpower" and "Arrange first aid facilities". The WAI values of all adaptation parameters are greater than 4 except "Estimation of flood hazard". Further these values are very close to each other (**Table 9**). This means that all of them are preferred adaptation strategies and equally important for minimizing flood risk. It was found that pre-flood preparation of such activities was, generally, made by the community with people's participation based on the lesson learnt from the previous flood events of the area. It creates the ownership of the program and awareness on the community people. Pre-estimation of flood hazard received the least score. It may be because estimation of flood magnitude is very difficult for them and they failed many times in the past.

Table 9: Pre-flood Adaptation Measures at Community Level

Measures Type	Least Common	Less Common	Moderately Common	Very Common	Most Common	Total	WAI	Class
Flood management plan	1	16	39	159	177	392	4.3	I
Keep contact information of the local people		8	86	215	83	392	4.0	I
Estimation of flood hazard	7	45	111	156	73	392	3.6	II
Train manpower	9	20	38	152	173	392	4.2	I
Arrange first aid facilities	4	8	23	175	182	392	4.3	I

1.14.2. During Flood Adaptation

a) Household Level

Five major activities were identified as the key flood adaptation measures which were adopted during the flood at household level. They are "Releasing of domesticated animals", "Move the valuable property into the safe place", "Rescue kids and elderly people", Shouting and running away" and "Use sand bags to divert water" as given in **Table 10.** WAI values in the table show the level of respondent's preferences on different strategies. It is noted that all WAI falls in class III. It tells that none of them are quite preferable measures for them. However, "Shouting and running away" and "Rescuing kids and elderly people" got higher WAI values, showing their preferences to these activities over others. People know that shouting makes the nearby persons aware of the flood and they can take necessary steps to mitigate probable flood risk. Since elderly people and children are the ones, who cannot help themselves, need the help of trained young people to transfer into the safe places during the flood time. It can avoid the loss of lives of such vulnerable people.

Table 10: Currently Practicing Measures at Household Level during Flood

Measures Type	Least Common	Less Common	Moderately Common	Very Common	Most Common	Total	WAI	Class
Release domesticated animals	106	53	65	66	39	329	2.6	III
Move the valuable property into safe place	144	39	28	43	68	322	2.5	III
Rescue kids and elderly people	93	53	45	78	64	333	2.9	III
Shouting and running away	120	24	41	69	84	338	2.9	III
Use sand bags to divert water	106	69	73	59	20	327	2.4	III

b) Community level

Three key adaptation measures during flood were identified as the community level adaptation strategies. They are "Warn the community people about the flood using appropriate method", "Rescue people of old age and children" and "Take care of affected people" (**Table 11**). All these three adaptation measures were found useful measures from the perspective of the people of the study area as all WAI scored more than 4.0. All these flood adaptation methods help to reduce the probable damage or loss of properties and lives to the minimum level. This should be the reason why people of the study area gave high importance to these activities.

Table 11: During Flood Adaptation Measures

Measures Type	Less Common	Moderately Common	Very Common	Most Common	Total	WAI	Class
Warn the community people about the flood using suitable method	5	27	166	194	392	4.4	I
Rescue people especially old aged and children	4	33	174	181	392	4.4	I
Take care of affected people	2	19	182	189	392	4.4	I

1.14.3. Post-Flood Adaptation

a) Household level

When water level decreased to a safer level, people returned to their houses and took measures which they think appropriate and within their reach to rehabilitate. During this stage, they assess the damage caused by flood informally to prepare them so that immediate plan could be made for action in the priority basis. The WAI values of the people for three options are presented in **Table 12**. None of the options are very effective or pleasing to them. However, it is clear from the figure that people do not want to migrate to other places instead wanted to return to their original place. Their preference is to repair and stay on the old house, if it is repairable.

Table 12: People's perception of the preferred option of adaptation after flood

Important Measures	Least Common	Less Common	Moderately Common	Very Common	Most Common	Total	WAI	Class
Prepare temporary sheds	0	73	123	155	28	379	3.4	II
Repair damaged house	0	17	73	229	71	390	3.9	II
Migration	153	61	38	39	41	332	2.3	III

b) Community Level

The list of community level post-flood adaptation activities and people's perception was presented in **Table 13**. "Manage food and housing for flood affected people", "Exchange help" to each other to bring the situation and livelihood to the original level received WAI value more than 4.0. Similarly "Coordinate with government and other agencies like NGOs, CBOs" that are supporting the flood affected people and "Fair distribution of resources to affected people" are other two parameters having WAI value more than 4. All these fall in Class I. It shows that these activities are very important to them to regularize their livelihood after the flood event. "Prepare temporary sheds" was considered as the least preferable option for the community in comparison to others. However, in this stage all these activities are equally important as their WAI value is more than 3 and need to carried out simultaneously as much as possible to return people's life to normal. Devkota et al. (2014) also found that exchange help within the community people was the most application adaptation measures.

Table 13: Important measures after flooding at community level

Important measures	Less Common	Moderately Common	Very Common	Most Common	Total	WAI	Class
Manage food and lodging facilities for affected people	1	9	116	265	391	4.7	I
Prepare temporary sheds	73	123	155	28	379	3.4	II
Exchange help	1	58	206	125	390	4.2	I
Co-ordinate with government and other agencies	13	57	187	130	387	4.1	I
Fair distribution of goods received from various agencies	3	16	143	227	389	4.5	I

The WAI values presented in different tables (**Tables 8-13**) indicate that adaptation measures that are to be carried out at community level are more than 4.0 while those are of household levels have value less than 3 and even 2. We can, thus, infer from these figures that flood adaptation measures can be made more effective through community level initiatives and participation than that at household level at all stages i.e. pre-flood, during and post flood. It is natural that the scale of impact that a flood impart is vast and is beyond the capacity of a household to handle it even it solely impacts a single household.

IV. Strategies For Flood Disaster Management/Adaptation At Local Level

The information obtained from the above analysis show that the following flood management strategies should be adopted for different flood disaster phases to minimize flood damage in the study area.

1.15. Pre-flood Phase

Real time flood forecasting either through real time rainfall monitoring and flood prediction using modeling technique or real time flood monitoring at upstream, in time dissemination of the flood risk information to the people using effective warning system are the modern approach of preparedness to reduce the flood risk in the developed part of the world. However, these aspects are lacking in the study area and great loss of properties has been taking place for centuries. To reduce flood risk, following activities are recommended as pre-flood phase management strategies.

a) Flood hazard evaluation map is to be prepared for the study area for flood of different magnitude.
b) Flood evacuation places are established and route to reach such locations are made clear by involving community people in this process.
c) Real time flood forecasting system need to be established.
d) An effective early warning system that fits the local level of consciousness and local condition should be developed.
e) Strong capabilities should be developed at community level through training to handle various aspects of flood.
f) A comprehensive repository of information such as names, contact details, etc. is created, maintained and made easily accessible to all stakeholders. A network that is capable of timely collection of flood related information and rapid dissemination of relevant information and warnings to the community people should be established.

Since there is a significant relationship in the way flood disasters and development affect each other, any development plans of the study area should include flood management plan from the beginning. Detailed disaster management plans that are tailored to local needs should be developed so that the community can respond systematically and effectively to flood disasters. While preparing such disaster plan, essential services to affected people staying in the designate evacuation areas are to be ensured. Local government should develop guidelines suitable to the local condition for flood adaptation. It is useful to build up risk sharing or risk transfer mechanism to lessen the burden of loss of property and lives because of flood.

1.16. During Flood Phase

The first priority during flood phase is to minimize loss of lives by undertaking rescue efforts to the affected people. The following activities are envisioned during this period.

a) People brought to temporary shelter should get health and sanitation services that helps to prevent an outbreak of disease.
b) An immediate priority after a flood disaster is to bring the basic infrastructure such as roads, public buildings, airfields, communication network etc into operating condition.
c) A security mechanism that functions effectively to prevent looting and other anti-social activities during flood disaster should be in place.
d) A relief packages in the most efficient manner to the affected people should be there. Relief should be provided to all the affected people without any discrimination of class, gender, caste, religion and region.

1.17. Post-Flood Phase

The main activities needed in this phase to bring the life of the affected people into normal condition are:

a) A detailed damage assessment i.e., housing, industry/ services, infrastructure, agriculture, health/education, assets etc., must be conducted before commencing reconstruction and rehabilitation activities.
b) A policy of assistance to help the affected to restore damaged houses and dwellings should be made.
c) In conjunction with relevant agencies, local authorities shall institutionalize mechanisms to address beneficiary grievances at various levels, as well as explore innovative ways of dispute minimization by involving the community.

Integration of local knowledge and modern techniques can make the flood adaptation more effective in all phases. However, structural measures like flood control reservoir can only provide the permanent relieve from the flood problems in the Terai region of the Koshi Basin.

1.18. Role of Various Institutions for Mitigation of Flood Disaster

Adaptation to flood disaster has been emerged as an important developmental challenge in the study area from the historical time. Various institutions (District Development Committee, Village Development Committee/Municipality, I/NGOs, Community Based Organizations and Private Sector) can play different and important roles for flood disaster mitigation. Their roles and responsibilities should be defined properly. District Development Committee should act as the coordinating agency for this purpose.

V. Conclusions

People living in the floodplain of the Koshi River had been facing flood problems every year especially during the monsoon season. Adverse impact of the flood on peoples' properties like agricultural production, house or animal shed was observed in this region, more in the area close to the river. However, the level of preparedness was found poor. It demands the need of at least basic preparedness to cope with flood hazard so that loss of lives and property from flood disaster can be minimized. No modern technique of flood forecasting was in place in the study area. People preferred radio or siren as the media for the flood warning.

People of the study area has been practicing various flood adaptation activities in three phases of flood disaster i.e. pre-flood, during flood and post-flood at household as well as community level. The calculated WAI values for community level are more than those calculated for household levels for all phases. It tells that flood adaptation measures can be made more effective through community level initiatives and participation than that at household level at all phases.

Raising the floor level of the house was considered as more appropriate strategy than others at household level during pre-flood phase. The WAI values of flood management plan, keep contact information of the local people, train manpower and arrange first aid facilities were found greater than 4. It indicates that these measures are considered by the people of the study area as the preferred adaptation measures for this phase at community level.

Releasing of domesticated animals, moving the valuable property into the safe place, rescuing kids and elderly people, shouting and running away and using sand bags to divert water are considered flood adaptation measures at household level during the flood event. However, people did not feel adequacy on these methods as the WAI value of each parameter is less than 3. On the other hand warning the community people about the flood using appropriate method, rescuing people of old age and children and taking care of affected people were considered very necessary activities during this phase as the WAI values are more than 4 for all of them.

Regarding household level post flood adaptation measures, none of the options (preparation of temporary sheds, repairing of damaged house and migration) were considered pleasing to the people. However, it is clear that people do not want to migrate to other places instead wanted to return to their original place. Managing food and housing for flood affected people, exchanging help to each other to bring the situation and livelihood to the original level received WAI value more than 4.0. Similarly coordination with government and other agencies that are supporting the flood affected people and fair distribution of resources to affected people are other two parameters having WAI value more than 4. It shows people of the study area like these community level flood adaptation strategies.

For any development plans in the study area should include flood management plan from the beginning. Integration of local knowledge and modern techniques can make the flood adaptation more effective. However, structural measures like flood control reservoir can only provide the permanent relieve from the flood problems in the study area.

References

[1]. Brooks. N, (2003). Vulnerability, risk and adaptation: A conceptual framework. Working Paper 38, Tyndall Centre for Climate Change Research. University of East Anglia: Norwich.
[2]. CBS, (2012). National Population and Housing Census 2011. Central Bureau of Statistics (CBS), National Planning Commission Secretariwt, Government of Nepal, Kathmandu, Nepal.
[3]. Devkota R. P, Maraseni TN, Cockfield G, Devkota L. P (2013). Flood Vulnerability through the Eyes of Vulnerable People in Mid-Western Terai of Nepal. Journal of Earth Science Climate Change 4: 132. doi:10.4172/2157-7617.1000132
[4]. Devkota R. P, Geoff Cockfield, Tek Narayan Maraseni, 2014. Perceived community-based flood adaptation strategies under climate change in Nepal, International Journal of Global Warming, Vol.6, No. http://www.academia.edu/8328400/Perceived_community-based_flood_adaptation_strategies_under_climate_change_in_Nepal
[5]. Dixit, A. (2009). Kosi Embankment Breach in Nepal: Need for a Paradigm Shift in Responding to Floods, Economic & Political Weekly, 7 February.
[6]. IPCC, (2001). Climate Change 2001: Scientific Basis. A Contribution of Working Groups to the TAR of IPCC [Watson, R.T and core writing teams (eds)]. New York, NY,USA: Cambridge University Press.
[7]. Kale, V.S. (2008). Himalayan Catastrophe that Engulfed North Bihar, Journal Geological Society of India, 7:713-719

[8]. Marahatta, S., Dongol, B. & Gurung, G. (2009). Temporal and Spatial Variability of climate change over Nepal (1976-2005), Practical Action Nepal, Kathmandu.
[9]. Maharjan, S.K., Sigdel, E.R., Sthapit, B.R. and Regmi, B.R. (2011), "Tharu Community's Perception on Climate Changes and their Adaptive Initiations to Withstand its Impacts in Western Terai of Nepal", International NGO Journal, Vol. 6 No. 2, pp. 35-42.
[10]. Mishra, D.K. (2008). "Bihar Floods: The Inevitable Has Happened", Economic & Political Weekly, 6 September
[11]. NAPA (2010). National Adaptation Programme of Action (NAPA), Government of Nepal, Ministry of Environment, Kathmandu, Nepal.
[12]. Nyong, A, Adesina, F & Elasha, BO (2007). The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel, Journal of Mitigation and Adaptation Strategies for Global Change, vol. 12, no. 5, pp.787-97.
[13]. Shrestha R. K, Rhodante Ahlers, Marloes Bakker and Joyeeta Gupta (2009). Institutional Dysfunction and Challenges in Flood Control along the Transboundary Kosi River: A Case Study of the Kosi Flood 2008.
[14]. http://www.earthsystemgovernance.org/ac2009/papers/AC2009-0496.pdf retrieved on 2013-12-10
[15]. S. K. Maharjan1*, E. R. Sigdel2, B. R. Sthapit3 and B. R. Regmi4, 2011. Tharu community's perception on climate changes and their adaptive initiations to withstand its impacts in Western Terai of Nepal, International NGO Journal Vol. 6(2), pp. 035-042, http:// www.academicjournals.org/INGOJ retrieved on 2014-12-2
[16]. UNDP, (2004). Reducing Disaster Risk: a Challenge for Development, United Nations Development Programme, Bureau for Crisis Prevention and Recovery, One United Nations Plaza, New York, NY 10017, USA
[17]. UNISDR, (2012). United Nations international strategy for disaster reduction, available at: http://www.unisdr.org (last access: 31 March 2012).
[18]. WWAP (2006). UN World Water Development Report. World Water Assessment Programme WWAP, Paris.