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Flood Vulnerability through the Eyes of Vulnerable People in Mid-Western Terai of Nepal

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Abstract

There are many studies on the flood risk mapping and analysis on various flood prone watersheds identifying vulnerability indicators and organizing them into different themes such as physical, social, economic, access to resources, communication, and gender dimensions. But there is no research on vulnerability of people to flood under climate change scenario from Nepal, where most of southern part experience flood each year in the monsoon season. This paper intends to assess the perceived flood vulnerability through the eyes of vulnerable people at the community level in two southern districts of Nepal. A total of two focus group discussions were conducted and 240 households were interviewed during field visit on Feb-May, 2012. Based on the perception of local peoples, 25 vulnerability indicators were identified and tested against a scale from 1 to 5 where 1 indicated "very low" impact and 5 "severe" impacts. The "high frequency of flood", "bank cutting/sand casting" and "damage agricultural land" was found first three highly vulnerable indicators, whereas "physical", "social" and "economic" parameters were found most vulnerable parameters. The findings of this study can be useful in vulnerability assessment and mapping of flood risk which are in turn crucial for flood management.

Keywords: Flood; Vulnerability; Parameters; Indicators

Introduction

Vulnerability can be conceptualized in many different ways along a continuum from outcome to contextual vulnerability. Outcome vulnerability is characterized by the IPCC [1] definition of the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. In contrast, contextual vulnerability assesses the susceptibility of a system to disturbances determined by exposure to perturbations, sensitivity to perturbations, and the capacity to adapt [2] Vulnerability can also be defined as the inverse of the resilience, where resilience describes the capacity of ecosystems to react against the stress. Thus, vulnerability represents the territorial system tendency to suffer damage during an extreme event. Vulnerability is also considered as the extent of harm, which can be expected under certain conditions of exposure, susceptibility and resilience [3-7].

In the context of climate change, vulnerability can be defined as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity [8]. It is determined by the resilience of a system over stress. Vulnerability analysis increase scientific understanding of climate sensitive systems under changing climatic conditions, to prioritize research efforts to particularly vulnerable sectors and regions and to develop adaptation strategies [9].

Vulnerability is also classified as biophysical vulnerability and socio-economical vulnerability [10]. Biophysical vulnerability is a term used by climate change scientists whereas socioeconomic vulnerability is used by social scientists [10]. The first one encompasses occurrence of hazard or damage incurred by the system due to action of hazard upon the system while the second one is independent of hazard and it is the inherent current state of the system or communities. In the context of flood, vulnerability is the extent to which a system is susceptible to flood due to exposure, a perturbation, in conjunction with its ability (or inability) to cope [2]. This indicates that one has to deal with a paradox while measuring vulnerability as it is difficult to define it precisely [11]. What makes people vulnerable is complex and is a million dollar question [12]. Vulnerability enhances poverty. According to Yamin et al. [13] "today's poverty is yesterday's unaddressed vulnerability".

With reference to people, vulnerability can be assessed as the characteristics and situation of a person or group that influence their capacity to cope with, resist and recover from the impact of a natural hazard [14]. There are many studies on vulnerability assessment of natural hazards especially in the last decade in which many extreme natural disasters, such as Indonesian and Japanese tsunami and hurricanes in USA and Australia, have been occurred [15]. These natural disasters have led to considerable loss of human life and tremendous socioeconomic costs [16]. However, there have been very limited studies on flood hazards, especially in the context of developing countries, particularly in Nepal [17]. Whatever the studies are done in Nepal, most of them are based on the available information in the past without or in only some extent of climate change and potential future risk of climate change related disaster [18]. It is argued that the current challenge in flood damage research is to develop a better understanding of the social dynamics of flood risk perception, preparedness, vulnerability, flood damage and flood management and to take this into

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account in a modern design of flood and flood risk management [19]. For this to happen, participatory vulnerability assessment (PVA) is crucial [20]. PVA is a qualitative way of analyzing vulnerability, which involves participation of vulnerable people themselves. PVA helps to promote meaningful participation and productive deliberation. PVA empowers or motivates vulnerable people to identify their problems and take appropriate actions. PVA helps to identify and develop right projects, policy and programs. Therefore, it is essential for building more sustainable societies [21-23].

Flood vulnerability assessment [24-28] is a multidimensional approach encompassing a large number of indicators. Vulnerability is dependent on the economic wellbeing, awareness of the people living in a society, preparedness and recovery conditions of the community. The poorest are disproportionately vulnerable and they have less capacity to adapt [29]. Lack of participatory flood vulnerability assessment has been identified as one of the major limitation in designing and implementing appropriate adaptation strategies to reduce flood risk [20]. Therefore, the aims of the study to assess the perceived surface water flood vulnerability impact at the community level in two southern flood prone districts of Nepal.

Surface water flooding is caused because the volume of water falling or flowing on to the surface overwhelms existing drainage systems [30]. It includes, pluvial flooding that results from high rainfall generated overland flow [31]. Surface water flooding is predominantly cased by short duration, intense rainfall occurring locally and upstream areas [32,33]. Therefore, surface floods are difficult to forecast.

Nepal is known as a hot spot for surface water floods. It is attributed to its three main river systems and over 6000 tributaries, fragile geology and steep topography. During the period of 36 years (1971-2006), 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 [34].

Among the others, the floods of: (1) August 2008 in Koshi River; (2) September 2012 in West Rapti River; and (3) May 2012 in Seti River are some of the hot examples of most devastating floods in Nepal. In West Rapti River catchment, which is the study area of this research, during the flood in monsoon season, at least 11 people lost their lives, thousands of villagers were displaced and nine villages were submerged in the plain areas of the catchment in 2012 [35].

Study Area

This study was carried out in West Rapti River Basin covering Banke and Dang districts of Nepal (Figure 1). It covers an area of 6,500 sq. km. Since the West Rapti River is flowing through the fertile land and thus affecting large farming communities, this river basin is considered one of the important river basins of the country from socio-economic point of views. The main tributaries of the river are Madi Khola and Jhimruk Khola. 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 2 municipalities in Dang District where as 46 VDCs and 1 municipality in Banke district. Based on census of 2011, the total population of Dang district is 5,52,583 (2,61,059 male and 2,91,524 female) and 4,91,313 (2,44,255 male 2,47,058 female) in Banke district [36].

[1]VDC is the lowest administrative unit of the government of Nepal

As noted, this basin has long history of devastating flood. Every year, during the monsoon season, many people need to be evacuated from the basin because of flood related disasters. Since people living in the flood prone area have a long experience of flood, they are capable to express the scale of perceptions against each indicator of vulnerability. It is noted here that most of the people living in this study area are indigenous, *Tharu* community. Over 80 % people are farmers and are well equipped with the indigenous agricultural practices [37] in Nepal. However, more than 90% of the people living in the study area are dependent on agriculture for their subsistence livelihood.

Methods

Two focus group discussions (FGDs) were conducted before the household survey in two flood prone districts at; (1) Priparawa of Holiya Village Development Committee[1] (VDC) of Banke district on 13 February 2012 in which 13 people were participated; and (2) Puranobazer of Lalmatiya VDC of Dang district on 14 February 2012 in which 12 people were participated. People who have firsthand experience of at least 5 year in flood adaptation strategies, such as farmers, foresters, VDC secretary, school teachers and local NGOs, were invited in these FGDs. In the beginning, a list of vulnerability indicators developed by Dixit et al. [37] were presented to participants, and then they were asked to add, delete, modify the indicators based on their own circumstances and experiences. They came-up with the list of 37 indicators. They were then further asked to narrow down and select only those indicators that were most relevant to the local area based on the past flood history. Finally, 25 key indicators were chosen (Table 1), which were similar to Dixit et al. but the wordings have been changes as per local context. The indicators thus selected were grouped into seven different parameters. These selected indicators were used in 240 randomly selected household interviews conducted from February to May 2012. The key person of the households was asked to rank these selected parameters on a 1-5 scale in which 5 refers high vulnerability and 1 very low vulnerability (Table 2). The perceptions (scale) of relevant indicators were summed to estimate the overall scores of seven parameters. The first author of this research, along with a local research assistant, had conducted the whole process of FGDs and household survey.

Out of total respondents, 56.7% accounted by male and rest were female. The maximum numbers of the respondents were in between 35 to 45 years of age which accounted 30% of the total respondents. The minimum age of the respondents was 21 and maximum was up to 66 years old. The study revealed that more than 50% (i.e. 128 out of 240) of respondents were illiterate. Out of 112 (46.7%) of the literate respondents, 20 (17.8%) are informally educated, 47 (41.9%) were educated up to primary level and 26 (23.2%) up to secondary level. It is mentioned here that the Banke district is more affected by floods in the Rapti River than those in the Dang district. It is, therefore, 61samples from Dang district and 179 from Banke district were taken for household surveys.

In addition, eleven experts working in the flood sector were asked to assign weight to these seven parameters so that the sum of weight is 100. All of them were having at least Bachelor degrees in a relevant discipline and more than 5 years work experience in the fields. Here, unlike household survey, in which preference was requested in their local and flood vulnerability contexts, the weight was given on the basis of its importance in the context of Nepal. The average weightage for each parameter were calculated by dividing its total weight by 11.

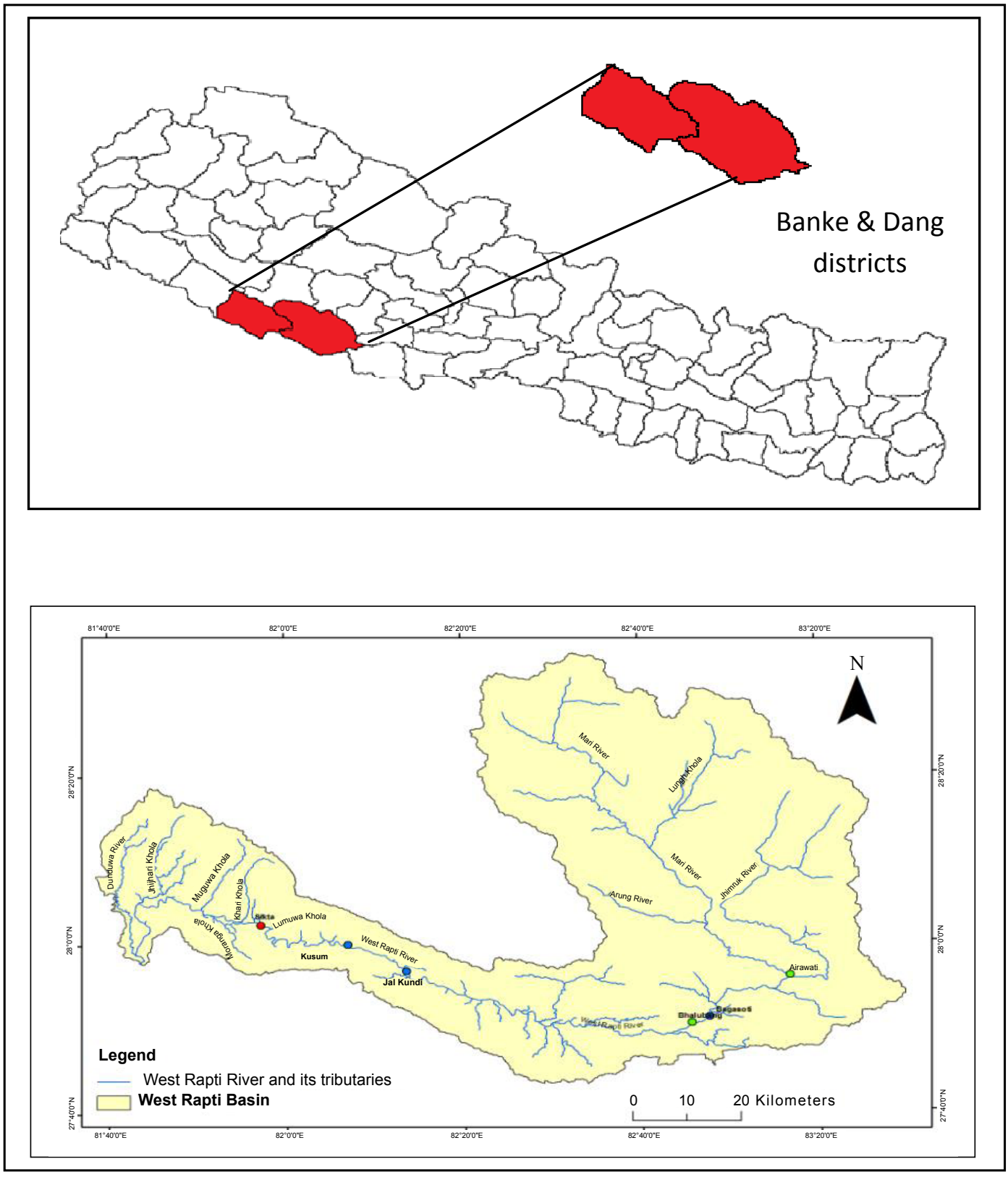

Figure 1: Showing study area West Rapti River Basin of Nepal.

Parameters	SN	Indicators
Physical	1	Frequency of flood
	2	Damage of agricultural land
	3	Bank cutting/sand casting
	4	Damage to structure on physical properties e.g. bridge, road etc.
	5	Pollution of drinking water sources
	6	Transportation and mobility
	7	House near the river banks
	8	Settlement near the river banks
	9	Change in direction of flow
	10	Damage of land by flood
Social	11	Access to education
	12	Activities of household head
	13	Mobility of the people
Economical	14	Agricultural production
	15	Land holding
	16	Value of house
	17	Sources of income
	18	Food security
Access resources	19	Access to water
	20	Access to forest
	21	Access to service centres
Communication	22	Access to communication
Gender perspective	23	Women's group formation
	24	Women participation
Psychological	25	Psychological stress

Table 1: Parameters and their indicators for vulnerability assessment (Adapted from Dixit et al. [37]).

Rank	Vulnerability categories	Magnitude	For 25 indicators
V	Severe	4.1 - 5	101-125
IV	High	3.1-4	76-100
III	Moderate	2.1-3	51-75
II	Low	1.1-2	26-50
I	Very low	1 and below	25 and below

Table 2: Vulnerability categories and their range for 25 indicators.

Finally, the vulnerability categories and their range were taken from Dixit et al. [37] and then they were expanded for 25 vulnerability indicators (Table 2). The scores of all 25 indicators for each household was summed and evaluated against the range then the number of household on particular vulnerability category was determined.

Results and Discussion

People's perception on vulnerability indicators and parameters

Vulnerability analysis was carried out based on perception of the vulnerable people in the study area considering 25 vulnerability indicators in the scale of 1-5. Out of selected indicators, frequency of flood (mean perceived scale was 4.3) was found as highest indicators for flood vulnerability followed by bank cutting/ sand casting (3.9) and damage agricultural land (3.8). Flood frequency was rated highest as majority of the respondents faced the flood problem every year. Similarly, remaining indicators were range from 3.5 to 2.5 whereas facilities of the communication scored lowest mean (2.5) value (Figure 2).

The total number of respondents and their percentage perceiving severe (5), high (4) and moderate to very low (3-1) to 25 vulnerability indicators are given in Table 3. Out of 240 respondents, 163 respondents (67.9%) mentioned that flood frequency was severe whereas only 13 respondents (5.4%) mentioned sever effect of flood is attributed to lack of communication facilities, group formation to deal with flood disaster and women participation in flood related disaster. Likewise, more than one third of the respondents rated "severe" for the bank cutting and house near the river banks indicators. "Cutting river bank", "flowing river near to the house", disturbance caused by flood in the transportation and for the mobility of the affected people "changing

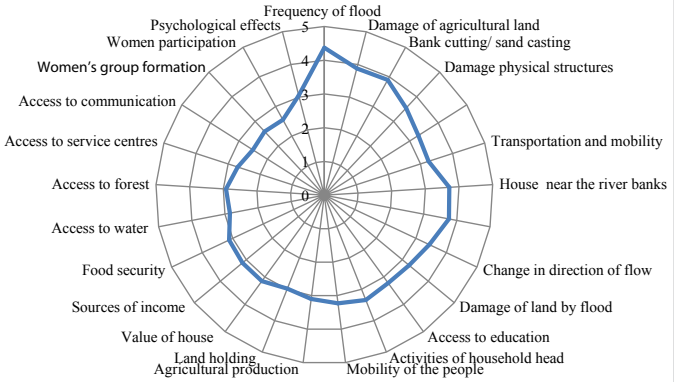

Figure 2: Average scale of perception on different vulnerability indicators (N=240).

SN	Indicators	Severe		High		Moderate to very low	
		Number	%	Number	%	Number	%
1	Frequency of flood	163	67.9	30	12.5	47	19.6
2	Bank cutting	88	36.7	88	36.7	64	26.7
3	House near the river banks	86	35.8	74	30.8	80	33.3
4	Transportation and mobility	60	25.0	99	41.3	81	33.8
5	Damage of agricultural land	51	21.3	135	56.3	54	22.5
6	Pollution of drinking water sources	37	15.4	62	25.8	141	58.8
7	Damage to structure	35	14.6	125	52.1	80	33.3
8	Mobility of the people	33	13.8	64	26.7	143	59.6
9	Psychological	30	12.5	76	31.7	134	55.8
10	Damage of land by flood	30	12.5	60	25.0	150	62.5
11	Agricultural production	28	11.7	77	32.1	135	56.3
12	Value of house	26	10.8	80	33.3	134	55.8
13	Change in direction of flow	25	10.4	72	30.0	143	59.6
14	Access to education	24	10.0	91	37.9	125	52.1
15	Sources of income	24	10.0	78	32.5	138	57.5
16	Food security	23	9.6	77	32.1	140	58.3
17	Settlement near the river banks	22	9.2	122	50.8	96	40.0
18	Access to forest	21	8.8	68	28.3	151	62.9
19	Land holding	19	7.9	69	28.8	152	63.3
20	Activities of household head	15	6.3	89	37.1	136	56.7
21	Access to water	15	6.3	56	23.3	169	70.4
22	Women participation	13	5.4	66	27.5	161	67.1
23	Group formation	13	5.4	61	25.4	166	69.2
24	Access to service centres	14	5.8	58	24.2	168	70.0
25	Communication	13	5.4	48	20.0	179	74.6

Table 3: The magnitude of the range of the vulnerability categories.

direction of flow" every year and "damage of productive land" indicated high level of flood impacts and vulnerability (first five ones with more than 20% weightage). Flood not only damage critical facilities like water supply, schools, hospitals, market but also create the problem to forest resources and animal production. Most of the schools are closed more than two months in monsoon season. Local people were facing fuel problem during monsoon season. These impacts are mainly attributed to frequent hitting by floods, thus affecting the livelihood of the local people. It should be the reason why respondent ranked flood frequency as the first one which makes them more vulnerable. "House near the river" which is getting third in ranking also support this perception. Similarly bank cutting and house close to the river possess the threat to people's basic requirements of living i.e. house. People in the study area, were also suffering from psychological problems due to flood. Others reasons enhancing vulnerability were poor social network and institutions, inequality and lack of integration. Activities and mobility of the people were reduced in the monsoon season and there were less economic activities. Similarly, agricultural production, monetary value of house and land and income sources for local people were impacted by flood. Majority of the people were interested to sale their property to move in a safe place. These could be the reasons that all of the respondents ranked each of the indicators with more than 2.5 (in the scale of 1 to 5). Similarly, majority of the respondents (N=135 or 56.3%) rated "high" for the damage of agricultural land indicators. Similarly, damage infrastructure (N=125 or 52.1%) and "affected house near to the river banks" (N=122 or 50.8%) were also rated "high" by 52.1% and 50.8% people, respectively. However, majority of the respondents rated from moderate to very low for most of the indicators (Table 3).

As noted above, the perception (scale) of relevant indicators were summed to estimate the overall scores of seven parameters. Figure 3 shows the average scale of perception on seven different vulnerability parameters (physical, social, economical, access resources, communication, gender perspective and psychological. Out of them, the highest scored "physical" parameter attained mean value of 3.6 whereas communication scored lowest 2.5. The second highest scoring parameter was "social" (3.3) followed by economical and psychological (3.1), access to resources (2.8) and gender perspective (2.6).

Average weighed scores of flood experts for seven parameters

The average weighted scores of eleven flood experts for seven parameters are given in Table 4. Among the seven parameters, "economical loss" parameter scored highest average weighted score (26.3%) followed by "physical" (20.6%) and "social" (15%) parameters. The "psychological" parameter received lowest weightage (7.7%). It is obvious that country like Nepal where people have hand to mouth problem, their thinking could centre on economical, physical and social costs.

In terms of vulnerability, average household survey score for economical parameter is third after physical and social (Figure 3). However, in terms of its importance, as shown by expert weight, economical is even more important parameter than physical and social parameters. Therefore, while making policy and plans these three parameters should be given higher priority.

As stated by Daniele [14], the vulnerability can be taken as the characteristic and situation of a person or group that influence their capacity, this study clearly shows the people of the study area are really concerned with the recurring floods that is making their livelihood difficult. Getting bank cutting and closeness of houses near the river second and third ranks show also their concerns for their future existence as flood may wash way their homes and they may become homeless. Similarly loss of agriculture production and mobility all show people's wish to have flood control in the Rapti River to save their settlements and livelihood.

Number of households with different vulnerability levels

Table 5 shows the number and percentage of households with different levels of vulnerability in the study area. The analysis showed that about 23 households (9.6%) were under the severe situation, 116 households (48%) lied in high and remaining 101 household (42.1%) were in moderate situation. None of the households were under the low and very low vulnerability categories.

Flood risk management in Nepal

Department of Water Induced Disaster Prevention, Government of Nepal is working in planning and implementing water induced disasters that includes flood disaster prevention activities too in all over the country. In the river basin level, people's embankment programme is implemented at community level where bio-engineering; bamboo matting, stone facing and sand filling activities are carried out during the monsoon season. Similarly, Nepal Red Cross Society, Banke and Dang districts and local non-government organizations are active in local level to mitigate the flood impacts and provide relief to the affected communities. They even provide the different trainings such as

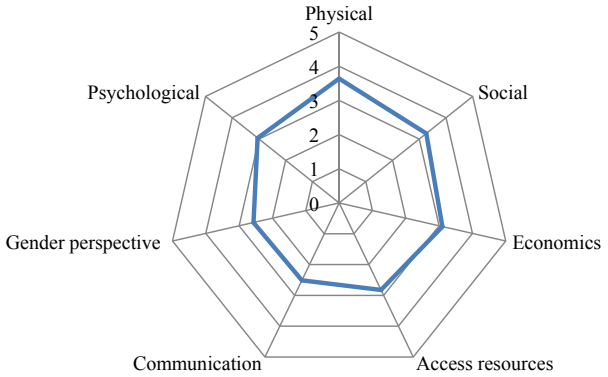

Figure 3: Average scale of perception on different vulnerability parameters.

S.N	Parameters	Average weighed scores (%)
1.	Economical	26.3
2	Physical	20.6
3	Social	15.0
4	Access resources	11.1
5	Communication	10.0
6	Gender perspective	9.3
7	Psychological	7.7

Table 4: Average weighed scores of flood experts for seven parameters (N=11).

Rank	Vulnerability categories	Magnitude range	No. of household	%
V	Severe	101-125	23	9.6
IV	High	76-100	116	48.3
III	Moderate	51-75	101	42.1
II	Low	26-50	0	0.0
I	Very low	25 and below	0	0.0
Total			240	100.0

Table 5: Number of households with different vulnerability levels based on indicators.

operating rescue, first aid and create awareness for flood risk reduction in the communities. However, there is a lack of proper coordination among these organizations. The proper coordination mechanism as envisioned in National Strategy for Disaster Risk Management in Nepal [38] can be effective in this area too for this purpose.

Conclusion

This study assessed the flood vulnerability for West Rapti River Basin using 25 indicators and 7 parameters considering perceptions of peoples who have been affected by flood for years. Among the indicators "high frequency of flood" that is troubling their livelihood many times a year was found to be the most vulnerable indicator. It is followed by "bank cutting/sand casting" and "damage to agricultural land". Household survey showed that physical parameter was the highly influential vulnerable parameter followed by social and economical parameters. However, in terms of its importance, as per expert's view, economical parameter had got the first priority.

Vulnerability assessment and mapping of flood risk are prerequisite for the flood management. Use of both scientific knowledge and experiences and perception of the local people in vulnerability assessment makes the predictions more effective. A number of institutions ranging from governmental to non-governmental organization and even private sectors are involving in flood risk management in this study area. However, there is a lack of coordination among these organizations. The coordination among such organizations can make the flood hazard management (prior, during and post flood event) in the study area more effective.

The findings of this study can be useful for making effective flood management strategy, policy and plan. This research also provides basic research framework for preliminary flood vulnerability assessments which can be applied in several other catchments in Nepal which have similar socioeconomic, topographic, edaphic and climatic conditions.

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