Impact of Flooding on People's livelihood: A case study from Kankai watershed.

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Abstract:

Flooding is a serious, common, and costly hazard that many countries face regularly. Floods occur repeatedly in Nepal and cause tremendous losses in terms of property and life, particularly in the lowland areas of the country. Hence, they constitute the main hazard. Flood vulnerability, their impact, and the resilience of communities have been assessed here on watershed at meso-level. The main objective of this study is to identify major attributes of flooding and to identify its impact on people's livelihood. The identification and mapping of flood prone areas are valuable for risk reduction. The results obtained from vulnerability assessment were used to prepare flood vulnerability map of the study area at VDC level. The potential vulnerable part of the study area was calculated. A total of 59.3 sq. km and 59.8 sq.km of the study area will be flooded in a 25-year- return period flood and 50 year-return period flood respectively. The result shows that agriculture system of the study area is in a geographically vulnerable position. The hazard prone area will considerably increase from 25-year-return period flood to 50 year-return period flood. Level of hazard shows that high hazard area will be increased and more settlement will be under the high hazard zone. Vulnerability assessment regarding flooding and climate change depict that peoples' livelihoods are worsening each year.

Keywords: floods, rainfall, impact, vulnerability, climate, disaster etc.

1. INTRODUCTION

River flooding represents the most common global hazard causing phenomenal losses. Nepal, the central part of the Hindu-Kush Himalayan, has more than 6,000 rivers and rivulets. Floods and landslides, which are triggered by heavy precipitation, cause 29% of the total annual deaths and 43% of the total loss of properties in Nepal (DWIDP 2004).The Terai region, despite comprising only 17% of the total area of the country is regarded as the granary of Nepal. Apart from hydrological phenomenon, the presence of natural or man-made obstructions in the flood path causes flooding. The problem of flooding in this region is of utmost concern due to its important role in meeting the food requirement of the country. The majority of flood disasters' victims are poor people living in the flood plain. The deteriorating consequences of flood disasters are exacerbating through self-exited poverty-cycle phenomenon (Osti, 2004). The expansion of urban areas and economic activities in flood plain is placing additional people and infrastructures at risk.

In the context of global warming, the probability of potentially damaging floods occurrence is likely to increase as a consequence of the increase in the intensity of extreme precipitation events (i.e. $\geq$100 mm/day)(Baidya etal. 2007) and the condition of glacial lakes in high mountain areas, Global Circulation Model projects a wide range of precipitation changes, especially in the monsoon: 14 to +40% by the 2030s increasing 52 to 135% by the 2090s (New etal. 2009). The monsoon precipitation pattern is changing too; with fewer days of rain and more high-intensity and incessant rainfall events.

Various definitions of vulnerability have been provided in the perspective of natural hazards and climate change (Varnes 1984; Blaikie et al. 1994; Twigg 1998; Kumar 1999; Kasperson 2001). From these definitions, vulnerability can be viewed from the perspective of the physical, spatial or locational, and socioeconomic characteristics of a region. In recent years, a number of studies have recognized the importance of estimating people's vulnerability to natural hazards, rather than retaining a narrow focus on the physical processes of the hazard itself (Hewitt, 1997; Varley, 1994; Mitchell, 1999). Cannon (2000) argued that natural disaster is a function of both natural hazard and vulnerable people. He emphasized the need to understand the interaction between hazard and people's vulnerability. Nepal's vulnerability to climate-related disasters is likely to be exacerbated by the increase in the intensity and frequency of weather hazards induced by anthropogenic climate change (IPCC, 2007). Vulnerability to flood hazards is likely to increase unless effective flood mitigation and management activities are implemented. An important prerequisite for developing management strategies for the mitigation of extreme flood events is to identify areas of potentially high risk to such events, thus accurate information on the extent of floods is essential for flood monitoring, and relief (Smith, 1997).

2. OBJECTIVE OF THE STUDY

The general objective of this study was to assess impact of flooding on people's livelihood and to identify an appropriate mitigation activities for the Kankai Watershed.

Specific objectives of the study are

- vulnerability assessment of people of floodplain area due to climate change.
- to prepare flood vulnerability map of Kankai watershed at VDC level using GIS .
- to prioritize and measure the impacts of climate change through participatory approach and statistical tools

3. METHODS

STUDY AREA

The study was conducted on Kankai Watershed in eastern Nepal. Kankai river basin lies in the south-eastern part of the country. It has tropical and subtropical climate regime. The period from March to June is predominantly hot and dry, July to August is hot and humid, September to October is pleasant, and November to February is cool and dry. The hot wave during the summer and cold wave during the winter reflects harshness of the climate in the study area. The temperature ranges up to 46^0C in the summer to 2^0c during winter. The mean daily temperature at Gaida meteorological station (25.58^0 N, 87.90^0 E, elevation 143m) has been estimated as 24.5^0C. Similarly, relative humidity (RH) is 75% and vapour pressure is 23.79. Kankai watershed falls in the class of 75-85% annual average RH. The estimated mean daily vapour pressure is 20. The average sunshine hour for almost 8 months of a year is about 80%, and falls below 50% during monsoon. The annual mean precipitation in the study area ranges from 2000 to 3000mm. The average annual precipitation at Gaida station, Damak station, Sanischare station and Ilam Tea state stations are 2734 mm, 2369 mm, 2794 mm, 1574 mm respectively. The Mainachuli gauging site (Station no. 975) has stream flow record from 1972 to date. The average monthly variation of flow at this station is shown in figure 3. The annual average discharge at this station is $58.9m^3/s$ (based on 1972-2006 data). The discharge increases rapidly from May and reaches maximum in July. The catchment area of the study basin is $1284km^2$. The altitude of its origin is about 1820m above the mean sea level. The altitude in Sukedangi near the district border of Ilam and Jhapa is about 120m, and about 70 m in the Indo-Nepal border. Fourty-eight VDCs (40 VDCs of Ilam and 8 VDCs of Jhapa) lie inside the watershed covering the Ilam and Jhapa districts. The total population of the watershed is 322951 (CBS 2003).

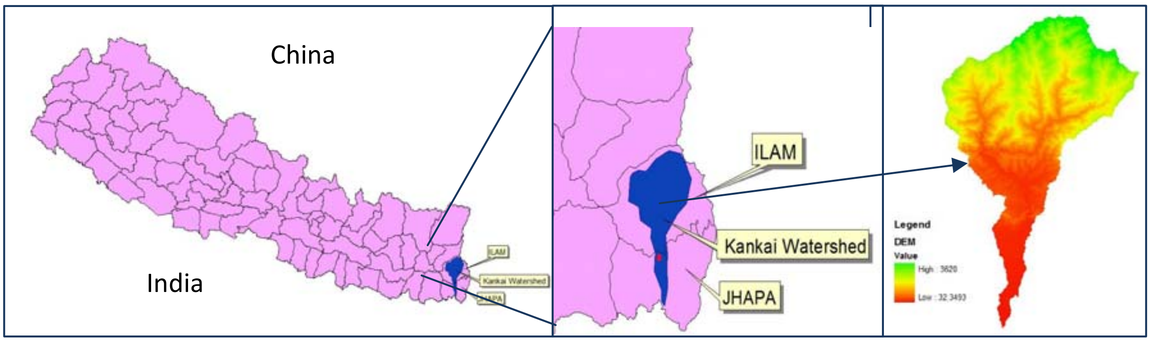

Fig. 1. Map showing Study area

Vulnerability assessment

Vulnerability assessment of the study area was carried out by two different methods:

(a) GIS based flood vulnerability assessment, where 25-year return period and 50 year return period flood were calculated through Gumbel distribution. After that with the help of HEC-GeoRAS, HEC-RAS, ARCView GIS 3.3, a flood map was produced and finally vulnerable areas were identified for 25 years flood and 50 years flood as mentioned in results; (b) another method applied to analyze past impact by the changing climate, perception of people on climate change and adaptation practice was carried out through Participatory Vulnerability Approach (PVA) tools where household questionnaire survey, interview with key informants were done within the study area. PVA is considered to be an effective tool for climate change impact studies and for developing adaptation strategies. The future impact will also be stimulated through the people’s perception and their coping capacity. Walkover survey (transact walk), time line, cause and effect, problem tree, social mapping, focus group discussion, key informant survey were used during the field survey. And finally by rating the entire variables, final vulnerability scores were calculated using a manual published by Livelihoods & Forestry Programme (2010). The formula used for calculating vulnerability score is as follows: Vulnerability Score = (Frequency + Area of Impact)*Magnitude

4. RESULT & DISCUSSION:

Impact of Flooding and Climate Change

Impacts of flooding and climate change on various social variables were analyzed using participatory vulnerability assessment & semi structured questions among 150 respondents. Perception from local people were drawn regarding climate change and flooding. The general relation between increasing flooding and climate change were identified through the people's perception. Altogether six variables were analyzed. Among them, the impact of flooding and climate change was highest in agriculture productivity through reduction in crop production mainly paddy and damage of rice fields. The other variable affected were on barren land, household, livestock. The detail is as shown below in figure 2.

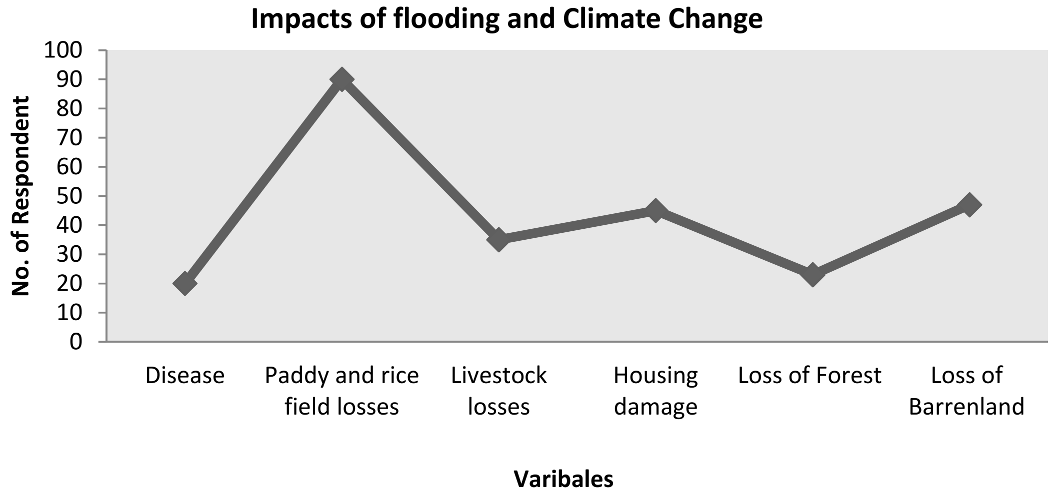

Fig. 2. Impact of flooding and climate change

Impacts of Floods

Rice and Paddy Field Losses

CBS 2003 of Nepal states that, more than 80% of people livelihood is based on agriculture and the economy of the country is also dominated by agriculture. More than 80% people live in rural areas dependent upon subsistence farming, and the economy is based almost entirely on agriculture with a single season rice crop dependent on the easterly monsoon.

Floods regularly destroy crops in the Terai and midhills of the country. Losing rice stocks and paddy fields were the single most cited problem for villagers from floods. Paddy field damage is devastating for some families and exacerbates an already precarious situation in terms of food security. During one focus group discussion in study area, villagers estimated that 60-70 per cent of the paddy fields are destroyed. It is not uncommon for some families to completely lose their rice harvest for the year. Of those families who were categorized as “wealthy”, or “having enough”, the average land area for paddy fields was 5 bighas. Some wealthy families in the assessment produce 1.5 to 2 tonnes of rice per bigha annually. They may have some rice stocks to continue feeding the family in case of losses. Those families in the “poor” category did not fare as well. They owned an average of 1 to 2 bighas, while at the same time having one additional member per household to feed than the wealthy families. After losing the rice crop following a flood, previously landed families take one to two years to find new land. Villagers said that severe floods occur around every three years, and each time up to 50 per cent of the households must find new land to farm. They also said that, in addition to being located far away, the new land may be less fertile, leading to decreased rice production from already low quantities. Finally, additional help is required to clear the new land.

If only one indicator is used to assess vulnerability from the perspective of villagers, it would be whether a family has a sufficient amount of rice throughout the year.

Table 1: Rice Sufficiency by Wealth Ranking

Rank	Status
Wealthy	Enough to sell (3-5 tons)
Middle	Enough to eat all year
Poor	Short 6 months
Very poor	Short 8-10 months

As with most of the other factors of vulnerability that are detailed below, seven VDC of Jhapa and 4 VDC of Ilam are more vulnerable than other VDC of watershed.

Livestock losses:

Although rice losses and paddy field damage is a common and immediate impact on the household, most villagers agreed that losing livestock was the most serious blow to long-term livelihood and family security.

In rural area, the family's buffalos and cows are used as a savings mechanism. When a disaster strikes or there is a medical emergency, families rely on the sale of livestock for large expenditures. They act as a safety net and are often the most valuable asset in the household. Across all wealth categories, the average family lost considerable number of livestock during major floods. Considering that in rural community one buffalo can buy enough rice to feed four or five people for an entire year, this is a terrible setback in the family's savings. Cows and buffalo also play a key role in livelihood as draught animals in the paddy fields.

Disease

Following a flood, sanitation is a major concern in the village. People reported a number of gastrointestinal diseases that would persist for weeks after a flood. This reduces the family's ability to recover from flood losses and to maintain income. This is particularly a problem when key labourers in the family become ill. For example, fishing is primarily a male occupation, so this livelihood activity is closed off when men in the family are sick. People reported there is increased number of mosquito. And in flood plain a new invasive species has appeared which is likely to be increased very rapidly, which was not seen before.

House Damaging:

Most of the houses are built high on stilts, and the area beneath the house is used storage. Nevertheless, 35 of the 150 villagers in the assessment reported housing damage ranging from slight to total loss. A farmer in Shivjung VDC area said he felt that damage to his hut was the greatest impact during the 1990 & 1999 flood aside from the destroyed rice. At the time about 96 family became homeless from Simalbadi VDC, Satasidham and Shivjung VDC.

While it is not a common problem within the community, this loss greatly impacts a few villagers very significantly. They may also be the ones who are poorer and must farm land farther away than wealthier villagers. The loss of housing at the paddy field takes considerable resources in time and effort to rebuild the shelters. It is a cost that takes way from other recovery efforts in farming or supporting the family.

Loss of Forest:
Upper part of watershed is occupied by forest. Some community forest areas are on the side of river so the flooding has direct impact on forest. Loss of forest might cause direct impact on local people's livelihood.

Loss of Barren Land:
Most barren land where animal use to graze was destroyed by flooding. From the field survey and discussion with local people they reflected that most of the barren land or grasslands were under high risk from flooding. Which has negative impact on their livelihood. Because most of the people have livestock and livestock use to graze on barren land.

Vulnerability Score
Vulnerability score for the study area was calculated using a standard method provided by "Participatory Tools and Techniques for Assessing Climate Change Impacts and Exploring Adaptation Options" a manual published by Livlihoods & Forestry Programme (2010). The different values were assigned through the questionnaire survey, key informant discussion and according to people's perception. All the rated values were analyzed using following an empirical formula. The results show that agriculture system is in much vulnerable.

(Frequency + Area of Impact)*Magnitude = Vulnerability Score

Table 2: Vulnerability Score

Sector	**Vulnerability score**	**Vulnerability in percentage**
Agriculture	50	45.87
Forest	28	25.69
Infrastructure	8	7.34
Biodiversity	2	1.83
Settlement	21	19.27

Different 5 variables were identified from people's perception during field survey. The variables were than ranked with rating value and final vulnerability score were calculated. From vulnerability assessment it was found that Agriculture system is much more vulnerable than other sector.

Flood vulnerability analysis
The vulnerability aspect of the flooding is related to the hydraulic and the hydrological parameters. The results of this assessment are summarized in Table 3 and Figures 4 and 5. The classification of flood depth areas indicated that 47.64% & 52.7% of the total flooded areas had water depths greater than 3 m. The total area under the water depth of 2-3 m was 23.83% on 25 year flood and 23.8% on 50 years flood. Flood hazard maps of the study area for 20-year and

50-year return periods was prepared by overlaying flood grid depths with the TIN. The table shows that how much area is under high risk, moderate and low risk.

25 year-return period: flood hazard map

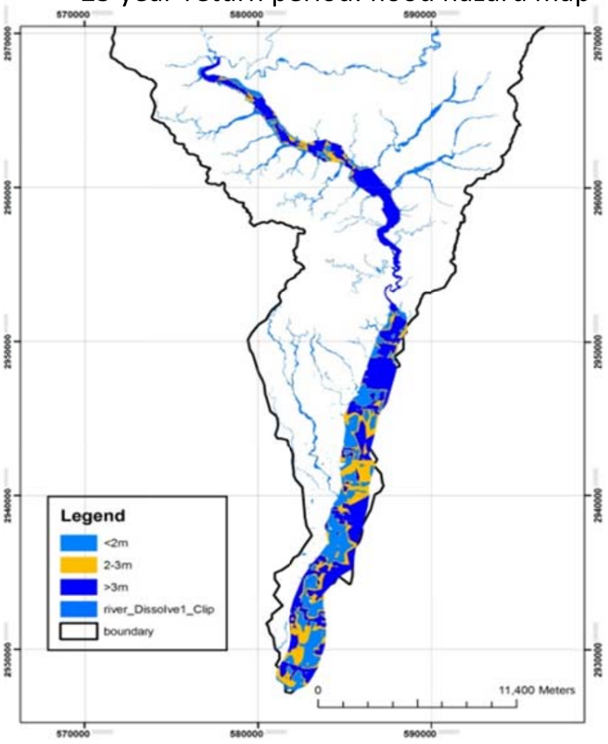

Fig. 4. Flood hazard map of the study area for 25 year return period flood

50 year-Return Period: flood hazard map

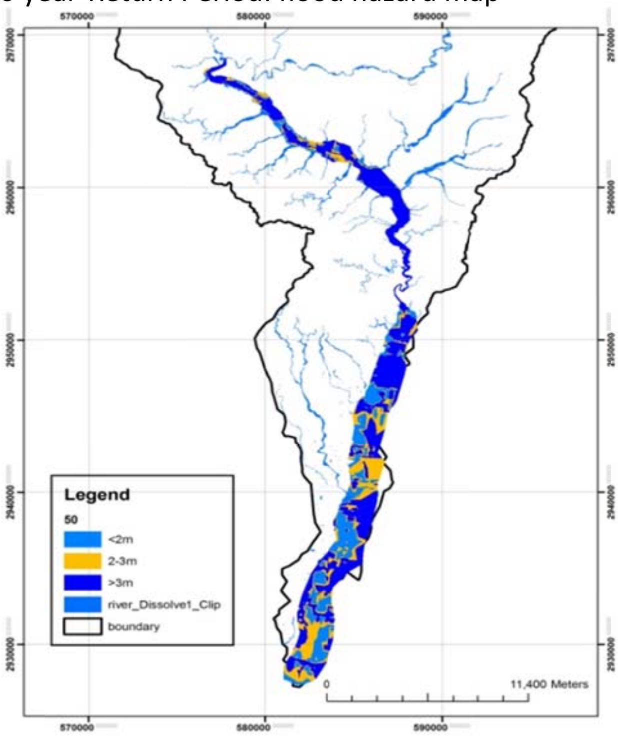

Fig. 5. Flood hazard map of the study area for 50 year return period flood

Table 3. Calculation of flood area according to flood hazard

Water depth (m)	Total flood area (km2)			
	25 year flood		50 year flood	
	Area	%	Area	%
<2m (low)	16.92	28.53	14.0	23.5
2-3m (moderate)	14.13	23.83	14.2	23.8
>3m (High)	28.25	47.64	31.5	52.7
Total	59.30	100.00	59.8	100.0

The above calculations illustrate that the total area under the water depth of more than 3.0m increased considerably with the increase in the intensity of flooding. For 25 year flood, it is observed that >3, 2-3, <2 meter were 16.92, 14.13& 28.25 sq. km respectively and for 50 year flood were 14, 14.2 & 31.5 sq. km respectively. These shows that high hazard of flood is increased in 50 years flood.

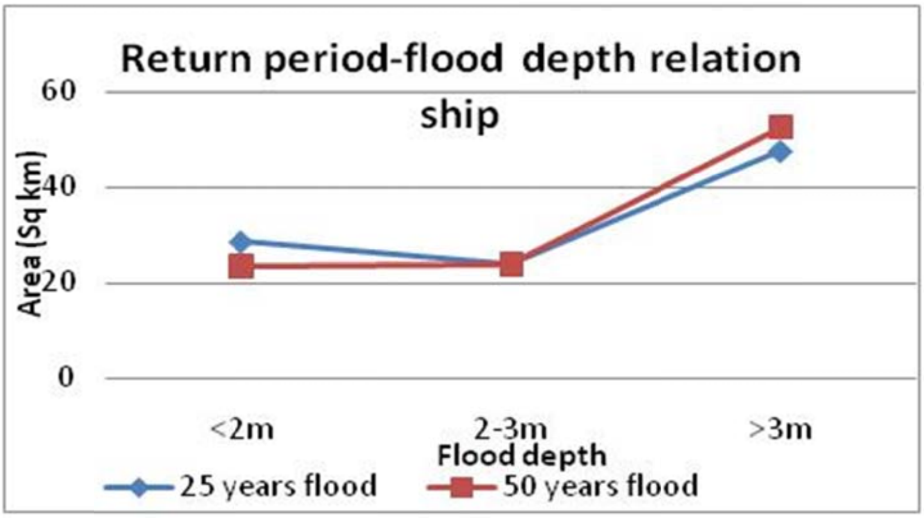

Fig. 5. flood depth-area relationship

Vulnerability Assessment of the Study Area by VDC Level

The degree of danger or threat and the levels of exposure and resilience to threat are closely associated with location. Hence, spatial vulnerability is a function of location, exposure to hazards, and the physical performance of a structure, whereas socioeconomic vulnerability refers to the socioeconomic and political conditions in which people exposed to disaster are living. VDC wise flood hazard mapping is shown in table no.5.

Table 4: VDC wise flood vulnerability mapping

VDC Name	25 years return period Flooded Area in Sq. Km			50 year return period Flooded Area in Sq. Km		
	<2m	2-3m	>3m	<2m	2-3m	>3m
Jitpur1	0	0	0.003	0	0	0.003
Banjho1	0.048	0.003	0.073	0.003	0.015	0.073
Danabari1	0.800	0.473	3.653	0.498	0.580	3.920
Ibhang1	0	0	0.08	0	0	0.080
Mahamai1	1.523	1.638	6.233	1.178	1.435	6.925
Satasidham2	1.230	0.443	2.123	1.078	0.380	2.288
Surunga2	1.930	1.860	5.540	1.558	1.793	5.990
Sarnamati2	1.153	0.715	2.403	1.045	0.700	2.525
Shivjung2	3.060	3.758	1.933	2.383	3.710	2.590
Mahabhara2	0.583	1.935	1.688	0.403	1.875	1.995
Panchgachhi2	0.760	0.158	0.285	0.725	0.190	0.313
Tagandubba2	1.185	0.560	1.333	1.015	0.583	1.480