PROVENTION CONSORTIUM

Community Risk Assessment
and Action Planning project

NEPAL – Nawalparasi and Rautahat Districts

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Flood Disaster Impacts and Responses in Nepal Tarai's Marginalised Basins

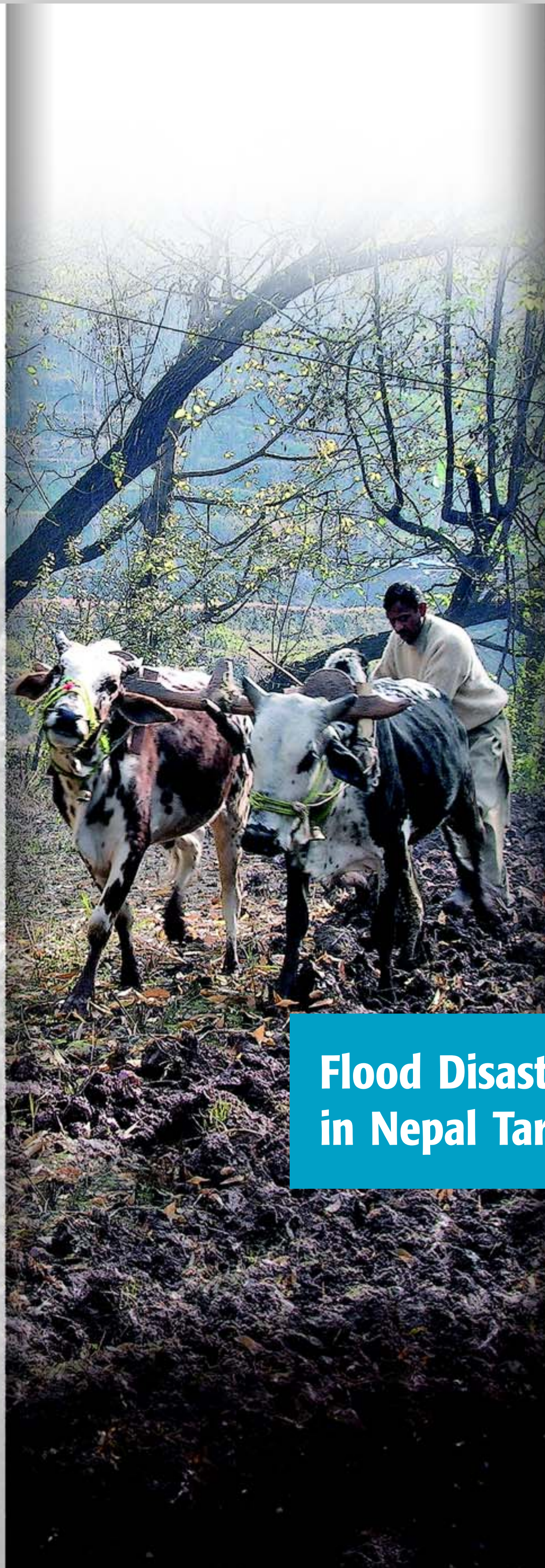
CRA Toolkit
CASE STUDY

This case study is part of a broader ProVention Consortium initiative aimed at collecting and analyzing community risk assessment cases. For more information on this project, see www.proventionconsortium.org.

Bibliographical reference: Dixit A. et. al., *Flood Disaster Impact and Responses in Nepal Tarai's Marginalised Basins*, in: Working with the Winds of Change. Towards Strategies for Responding to the Risks Associated with Climate Change and other Hazards. M.Moench, Dixit, A, (eds), ProVention Consortium, Institute for Social and Environmental Transition-International and Institute for Social and Environmental Transition-Nepal, second edition, Kathmandu, 2007, chapter 6, pp. 119 -157. Case study can be downloaded from:
(http://www.proventionconsortium.org/themes/default/pdfs/winds_of_change.pdf)

Click-on reference to the **ReliefWeb country file for Nepal**:
http://www.reliefweb.int/rw/dbc.nsf/doc104?OpenForm&rc=3&cc=npl

Note:
A Guidance Note has been developed for this case study. It contains an abstract, analyzes the main findings of the study, provides contextual and strategic notes and highlights the main lessons learned from the case. The guidance note has been developed by Ben Wisner and Stephanie Bouris in close collaboration with the author(s) of the case study and the organization(s) involved.



6

CHAPTER

Flood Disaster Impacts and Responses in Nepal Tarai's Marginalised Basins

Ajaya Dixit, Madhukar Upadhya,
Anil Pokhrel, Kanchan Mani Dixit,
Deeb Raj Rai and Madhav Devkota

Case Study Guidance Note

Country: Nepal
Location: Nawalparasi and Rautahat Districts. The coordinates of four study sties are:
a. Brahmapuri N 26° 44' E 85° 19' **b.** Bhasedwa N 27° 02' E 85° 14'
c. Rampur Khadauna N 27° 26' E 85° 43' **d.** Devgaun N 27° 29' E 83° 42'
Date: May 2007
Sector and Spatial focus: Flood related disasters and Northern Gangetic plains
Title: Flood Disaster Impact and Responses in Nepal Tarai's Marginalised Basins
Bibliographical reference: Dixit A. *et al.* (2007) *Flood Disaster Impact and Responses in Nepal Tarai's Marginalised Basins*

Abstract

The Gangetic plain is home to some of the poorest populations in the world. Their impoverished living conditions are often attributed to regular floods and drought-like conditions. Flash floods, inundation for prolonged periods, bank-cutting and sand-casting devastate life, livelihoods and property for the already poor, especially within marginalized (smaller, un-gauged) river basins. Each disaster makes the poor more vulnerable to the next and, consequently, each single disaster is converted into a process. The problem of flooding is exacerbated by built systems including flood control embankments and urbanisation which constrict natural drainage patterns. In addition, communities report increasing rainfall intensities and changes in the timing of precipitation, especially in the last few decades. This also exacerbates flooding.

This paper presents preliminary findings of a programme in the Nepal Tarai on disaster risk reduction (DRR) and adaptation to climate change. The study includes pilot testing of some strategies identified in four sites within the Bagmati and the Rohini river basins. Adaptive strategies for four communities in these two river basins have been identified using a number of tools. These are segregated as adaptation specific interventions and underlying systems for adaptation.

Technical Description

- Hazard / risk type: Flooding
- Type of assessment: Research to understand the factors that constrain and enable local communities to reduce risk and adapt to climatic and other sources of vulnerability.

Contextual Notes

- Frequent shifting of rivers has permanently displaced homes in Bhasedwa and Brahmapuri village development communities (VDCs) of Rautahat District over the last two decades. In Devgaun and Rampur Khadauna VDCs of Nawalparasi District, most displacement is temporary. Families take shelter at their relatives or in public buildings such as schools during periods of high floods.
- Prior recovery attempts in all four VDCs were primarily limited to distributing petty relief materials such as food and blankets. In some VDCs, organisations such as the Nepal Red Cross

Society, Oxfam GB and local NGOs have initiated group formation, distribution of information kits, installation of communication equipment, wooden boats and construction of small shelters.
- Construction of physical infrastructure such as canals, roads, railways and efforts in 'taming' rivers has had negative consequences. Structures, built along the Indian border, have in many instances been related to the cause of flooding. During flood periods people commute long distances in search of daily labour.
- The eastern Tarai political unrest has intensified despite a peace accord to end a decade-long insurgency. Protests (mostly violent) and unexpected and continuous strikes have affected accessibility to the communities and delayed visits to communities since January 2007. In the third week of March 2007, about 30 people were beaten to death in Gaur, the district headquarters of Rautahat. Brahmapuri, one of our study sites, is situated 5 kilometers east of Gaur.

Research and Analytical Process

- Methods / tools used: Scoping, Shared Learning Dialogues, Household Surveys, Mass meetings, Capacities and Vulnerability Analysis, Ranking, etc.
- Role of Climate Information: Climate information is non-existent. People hear weather information on radio and television programmes.

Key Insights Generated for Vulnerability Reduction and Capacity Enhancement

- In all four project sites, poor access to information and gender issues emerged as major factors contributing to vulnerability. Information refers to policies, news, radio, knowledge about relief activities, information on floods / rainfall and knowledge of selling price for local produce in nearby towns.
- Women, particularly pregnant women, lactating mothers, women who have recently given birth, elderly women, the disabled and menstruating women are more vulnerable.
- Spontaneous measures of adaptation (such as building flat-roof houses, two-story houses and houses on raised plinths) have been widely observed. Livelihood elements that are not likely to be much affected by inundation or flooding are also increasingly pursued. Examples include an increasing preference for water buffaloes over cows and ducks over goats. In addition, young men migrate in search of alternative livelihoods.
- Adaptive strategies can be categorised into climate adaptive interventions and underlying systems of adaptation. Tables A and B present the findings.

Potential Strategies Identified

See tables at the end of this guidance note.

Strategic Notes and Lessons Learned - Key Points to Emphasise

The study has provided three main lessons. First, in the last 50 years there has been reliance on the structural or macro or engineering approach to mitigate flood damage. The concerns of affected individuals, families and communities have not been systematically woven into decision- and policy making. Government policies have not contributed to building resilience for coping with floods. Second, cooperative efforts of the governments of the region have been technologically guided in a project-centric mode. Despite repeated references to flooding and the need for its mitigation in pubic discussions, cooperative efforts have not aimed at building institutions for mitigation. Third, institutional dysfunction is widespread as state agencies fail to innovate in effective responses to flood disasters.

TABLE A | Adaptation Matrix for Nepal VDCs: Adaptation Specific Interventions

VDC	Diversification	Ecosystem	Disaster Risk Reduction	Organisation and Incubation	Skill Development	Financial and Risk Spreading	Communication
Rampur Khadauna	Farming on land affected by sand casting (e.g. guava, watermelon). Productivity enhancement. Access to forest resources, diversification of income (floriculture, nurseries, etc.)	Community forest plantation	Seed bin storage, improved homes and shelter (e.g. hooks on existing flat roofs to tie tents), boats, raised roads, first aid kits, raised tubewells; *panyalo* (RWH), chlorination, hanging seed beds, improved cooking stove, spurs construction with bamboo sticks and sand-filled bags, seed banks	Self-help groups, saving and credit, community groups, train local youths to become volunteers at times of disaster	Non-formal education, community health and sanitation awareness trainings, exchange visits, gender sensitisation, accounting and leadership training, promoting biogas and briquette	Crop and cattle insurance, life insurance, savings and credit group formation by cooperatives theme	Early-warning system, rain gauges, networking through volunteer organisations, land line and mobile phones, CDMA, community FM, radio programmes, TV and press
Devgaun	Farming on land affected by sand deposition (e.g. banana, guava, watermelon),	Planting *Ajambari* on existing spurs	Installation of demonstration treadle pumps, provision of drinking water where tubewells are contaminated with arsenic	Self-help groups, savings and credit, community groups	Exchange visits to communities where farming on land affected by sand deposition is currently tried	Savings and credit group formation by cooperatives theme	Establish rain gauges at local schools and monitor daily rainfall. Transmit rainfall records to FM stations.
Bhasedwa	Promotion of sugarcane farming in areas likely affected by floods. New crops in areas affected by sand deposition (e.g. banana, guava, watermelon). House wiring	Planting trees along the floodplains and planting *Ajambari* along spurs	Making life jackets with used mineral water bottles, construction of a demonstration toilet and sanitation awareness programmes, smokeless stoves, construction of platforms in existing tubewells, support for reviving existing tubewells, alternative water supply for areas contaminated by arsenic	Train local youths to become volunteers at times of disaster	Exchange visits to communities where farming on land affected by sand deposition is currently tried	Savings and credit group formation by cooperatives theme	Establish rain gauges at schools in the upstream catchment of Lal-Bakaiya and monitor daily rainfall. Transmit rainfall records to FM stations, set up CDMA phones
Brahmapuri	New crops in land affected by sand casting (e.g. banana, guava, watermelon)	Planting trees along the Bagmati River embankment, planting *Ajambari* on existing spurs	Construction of a demonstration toilet and sanitation awareness programmes, smokeless stoves, construction of platforms in existing tubewells, support for reviving existing tubewells	Train local youths to become volunteers at times of disaster	Street theatres to demonstrate ways to protect oneself and property during floods. Training to work as reporters (especially for those who manage information centres)	Savings and credit group formation by cooperatives theme	Establish a warning system linked with the Karmaiya barrage regulating office, establish a communication centre

TABLE B | Adaptation Matrix for Nepal Sites: Underlying System for Adaptation

VDC	Education	Transport	Organisation	Livelihood	Communication
Rampur Khadauna	Training, advocacy, adult education, school support activities, scholarships for poor children	Wooden or plastic boats, temporary boats made of banana trunks and bamboo or inflated tubes	Network with organisations such as Oxfam, Nepal Red Cross Society and Dipecho supported programmes	Bicycle repair shops	Discussion platforms for policy issues, listeners' clubs
Devgaun			The village is considered a vegetable farming pocket. Organise exchange visits to promote different varieties of vegetables	Candlestick making, incense stick making, bicycle/motorbike repairing	Setting up of listeners' clubs
Bhasedwa		Use inflated tubes, rafts made out of banana trees/dried bamboo etc. to be used during times of inundation		Train local entrepreneurs to cast rings for toilet vaults and set up sani-marts	
Brahmapuri		Use inflated tubes, rafts made out of banana trees/dried bamboo etc. to be used during times of inundation	Networking among different groups formed by Dipecho, CPDR, Lutheran, Oxfam and Nepal Red Cross Society	Train local entrepreneurs to cast rings for toilet vaults and set up sani-marts	Set up mechanisms for communicating seasonal market prices at different bazaars for select commodities

Disasters can be used as opportunities for creating new avenues to allow vulnerable groups to reduce their vulnerability.

Keywords: Floods, Marginal Rivers, Disaster Risk Reduction, Climate Adaptation, Nepal Tarai, Himalaya-Ganga, North Gangetic Plains.

Resource person(s): Ajaya Dixit (adbaluwatar@wlink.com.np), Anil Pokhrel (anilpokhrel@yahoo.com), Kanchan Mani Dixit, Deeb Raj Rai and Madhav Devkota (nwcf@wlink.com.np), ISET-Nepal.

The Larger Context

Changes in precipitation will necessarily change the flow of rivers and thereby the likelihood of flooding.

The summary of the fourth IPCC report (2007) states that "With regard to changes in snow, ice and frozen ground (including permafrost), there is high confidence that based on growing evidence the following types of hydrological changes will take place:"

> "Increased run-off and earlier spring peak discharge in many glacier- and snow-fed rivers." (p. 3)

Referring to the Himalaya region in particular the report continues:

> "Glacier melt is projected to increase flooding, rock avalanches from destabilised slopes, and affect water resources within the next two to three decades. This will be followed by decreased river flows as the glaciers recede. (p. 10)
>
> Heavy precipitation events, which are very likely to increase in frequency, will augment flood risk. (p. 7)
>
> In the course of the century, water supplies stored in glaciers and snow cover are projected to decline, reducing water availability in regions supplied by melt water from major mountain ranges, where more than one-sixth of the world population currently lives. (p. 7)
>
> Mountainous areas will face glacier retreat, reduced snow cover and winter tourism, and extensive species losses (in some areas up to 60% under high emission scenarios by 2080)." (p. 11)

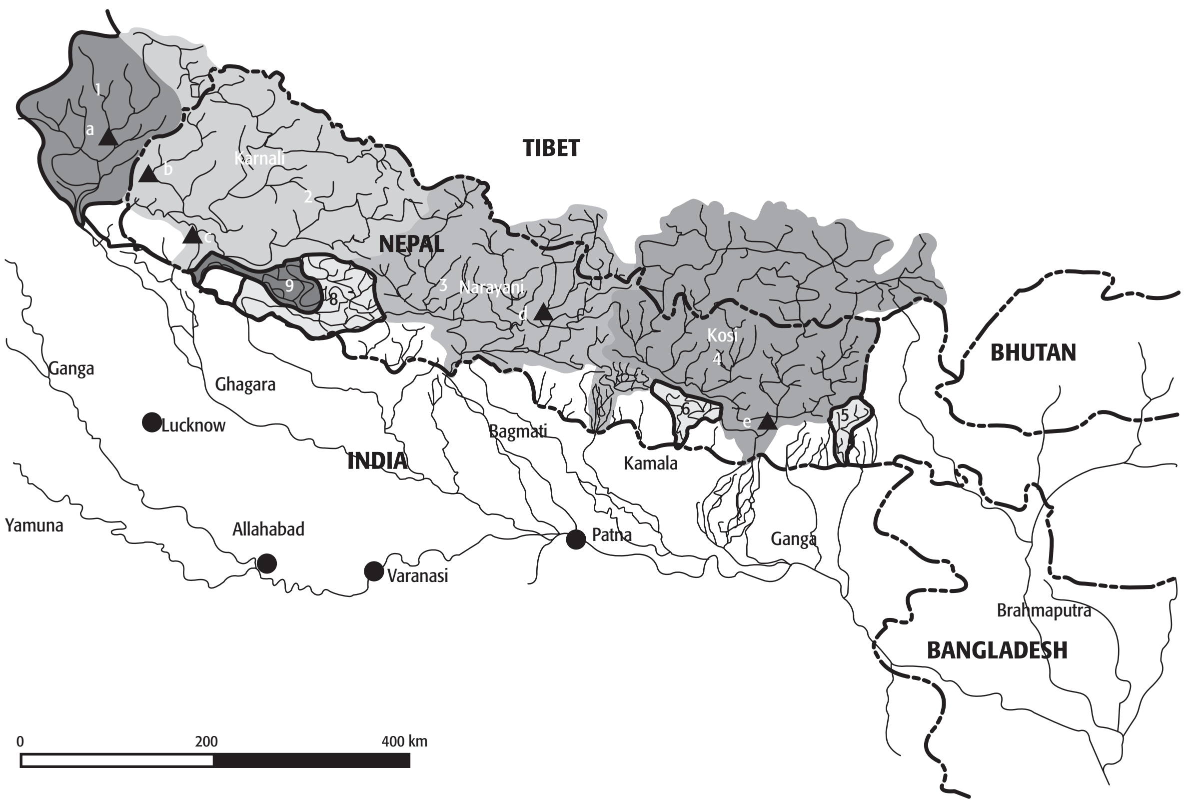
Current projections by the IPCC indicate that average precipitation levels in the Ganga Basin will increase by about 20%, and climate change projections indicate that variability and the frequency and intensity of extreme weather events such as large storms are also likely to increase. Climate change will not only affect the region's hydrology, but also alter temperature regimes, wind patterns, and storm tracks. In addition, land use patterns and aerosol pollution will directly affect local weather patterns. Impacts on the types of crops planted, the type and extent of vegetation coverage, and urban island heat effects will be significant. Changes in precipitation will necessarily alter the flow of rivers and thereby the likelihood of flooding. Paradoxically, while floods will be of greater magnitude, so, too will the incidence of drought conditions.

What exactly the impact such changes will have on the Ganga Basin is not clear — though have an impact they will. The Ganga Basin is not a homogenous land system; instead, it encompasses a highland and lowland hydro-ecological system that analysts have defined as the Himalaya-Ganga (see Figure 1 for a schematic diagram of the Himalaya-Ganga and the northern Ganga Basin). The system consists of diverse ecological zones and includes hundreds of ethnic groups that speak different languages.[1]

The highland and lowland system in the Ganga Basin encompasses Nepal, India

[1] For a discussion on Himalaya-Ganga see Gyawali and Dixit (1994).

| FIGURE 1 | The Himalaya-Ganga region and river systems



and Bangladesh. The people living in this region are among the poorest in the world. Their impoverished living conditions are often attributed to the regular floods which occur during the monsoon seasons (June-September) and to the drought-like conditions that prevail after the monsoon rains are over (Bandhyopadhyaya, 1999). This flood-drought regime is the natural outcome of the region's climate and hydrology. Since the climate and hydrology of the region exhibit micro-level variations, their impacts will differ.

Although the monsoon rains are crucial for sustaining agriculture in the Himalaya-Ganga region, they are also a major hazard. After the onset of the monsoon in June, rains saturate the moisture-deficit landscapes promoting the growth of vegetation and crops and, consequently ensuring the success of people's agriculture-based livelihoods. A few weeks after their onset, these same life giving rains are responsible for widespread flooding. Cloudbursts, landslides, mass movements, mudflow and flash floods are common in the mountains, while in the plains of southern Nepal, northern Uttar Pradesh, Bihar, West Bengal and Bangladesh rivers augmented by monsoon rains overflow their banks. Sediment eroded from the upper regions of rivers is transported to their lower reaches and deposited on the flood plains of valleys and the Tarai. Rivers cut their banks and shift laterally, creating serious problems as people lose their land and

In the Himalaya-Ganga region the monsoon rains sustain agriculture but are a devastating hazard.

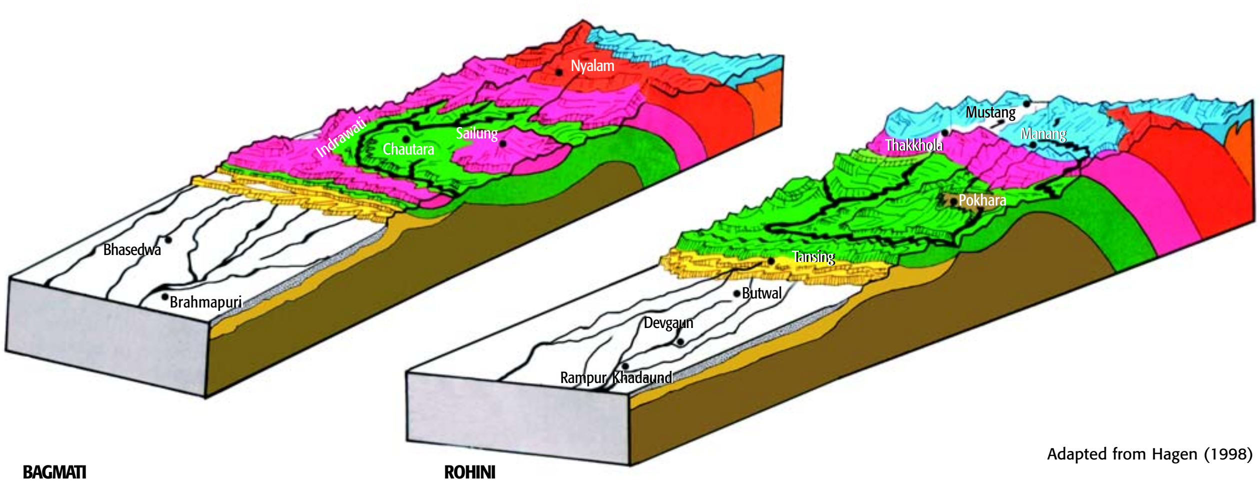
their crops, the very basis of their livelihoods. People and communities have developed livelihood systems that are adapted to such disruptions. They take advantage of the fine sediment brought by floods which increases agriculture productivity, and struggle to move the large sized sediment deposits. People face significant problems when sedimentation blocks watercourses causing stagnant water or when swollen rivers inundate the land — but when social and economic continuity is disrupted people cope. In recent years, however, these natural processes have changed due to the impacts of human interventions and it has become more difficult for people to adapt successfully. The building of embankments for flood protection, for example, obstructs tributary rivers and by blocking drainage can extend flood periods. Furthermore, because embankments are poorly maintained they frequently breach bringing large tracts of land under inundation and causing sand deposition. In short, interventions often contribute to rather than prevent flood disasters.

Rivers feed regional groundwater aquifers, serve many irrigation systems, and maintain ecosystems but are also the source of floods.

Tributaries and streams serve as a hydrological link between the upper and lower regions of Himalaya-Ganga. They also function as drainage channels transferring large volume of water received during the monsoon in upland regions, plain catchments and in delta regions to the ocean. The region's rivers constitute a densely-packed network of streams: In fact, its river drainage density of 0.3 km / km^2 reflects just how close the drainage channels are (Shankar, 1985). Nepal alone has more than 6,000 rivers totaling about 45,000 km in length. The tributaries of the Ganga River in Nepal contribute 71 % of its natural historic dry season flow and 41 % of its total annual flow. The rivers of the Ganga Basin are both a boon and a bane to the population of the region: while they feed regional groundwater aquifers, serve many irrigation systems and maintain ecosystems, monsoon flooding in these very rivers brings widespread devastation.

The rivers of Nepal can be classified broadly on the basis of their dry season flow as Himalayan, Mahabahrat and Chure. The four major Himalayan rivers (the Kosi, the Gandaki, the Karnali and the Mahakali) exhibit a sustained dry season flow derived from snow and

| FIGURE 2 | The hill plain composite showing portion of Bagmati and Rohini basins



Adapted from Hagen (1998)

glacier melt. According to Sharma (1977), snowmelt in Nepal begins in March and continues till August, when monsoon rains also add to the flow. The seven Mahabharat rivers originate below the snowline in the middle hills and drain the region located between the Himalayan basins. They are spring-fed and augmented by the monsoon rains. The third type of rivers originates in the Chure range and run parallel to the Himalaya. Composed of fluvial deposits of the Neogene age (Upreti and Dhital, 1995) the Chure range is the active stage of the tectonic movement of the lower Himalaya (Hagen, 1998) and is made up of debris eroded over the last 40 million years. Its elevation varies from 150 to 1,800 meters. The hydrology of the several Chure rivers is characterised by individual peaks, a fact suggesting that their discharge is highly influenced by rainfall. When there is no rainfall, these rivers exhibit very low flow, almost zero in the upper reaches. In the lower reaches, however, groundwater and base flow and contribute to flow and these reaches may contain significant discharge even in the dry season. The flow of these rivers usually peaks in July or August, but the exact timing depends on the volume of rainfall. Because slopes are steep, Chure rivers flow with high velocities until they reach the Tarai, where the high energy generated is dissipated as rivers form meanders once they emerge onto the plains. The nature of the riverbeds and the pattern of channels of a Chure river vary according to its reaches. In the upper reaches, the steep slope bank-cutting and mass movement processes result in a high sediment load. In the Tarai, the same rivers will meander and change course. The hydrological characteristic of these rivers have not been studied in detail and their flooding results in more damage and devastation than is thus far understood while they collectively cause more devastation than the other two types. Despite their hazardous nature, these rivers are not on the radar screen of the national governments of the region, which instead focus their attention on the major tributaries of the Ganga River i.e. the first and second

Most smaller rivers are not on the radar screen of the national governments but are the locus of major flood events.

Flash flood is a major hazard in valleys of the mountains.

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type rivers. The Chure rivers are termed marginalised rivers. This definition emerged in the Duryog Nivaran meeting in Dhaka in 1995.[2]

Chure rivers flow first across the Nepal Tarai and then across the contiguous landmass of Uttar Pradesh, Bihar, and West Bengal. Their catchments extend from Uttar Pradesh in the northwest to the Darjeeling hills in the east and the Ganga River in the south and have an area of about 80,000 km^2. The area is crisscrossed by hundreds of a third type of river. In Nepal, the Chure rivers drain a total of around 18,860 km^2 consisting of the Chure range and the Tarai. The catchments of most individual Chure rivers are generally less than 350 km^2. These rivers are used extensively for irrigation and thus support agriculture, the local economy and community livelihoods. Using pumps and wells the contiguous groundwater aquifers are drawn on to meet drinking and irrigation needs. As these rivers flow from Nepal to India, they acquire a trans-boundary character.

The recession of glaciers in the Himalaya range will affect the overall water balance in the respective basins but the exact nature of its impact needs more investigation.

The Tarai region of Nepal is an extension of the Gangetic plain. Together they are home to millions of people who practice agriculture-based livelihoods. In the last five decades, the region has witnessed tremendous growth in infrastructure development. Roads, irrigation canals, railway lines, flood control embankments and urbanisation have all constrained drainage and thereby further exacerbated the impact of flooding. Both, the Nepal Tarai and the Gangetic plain are somewhat isolated from technological and economic globalisation but nonetheless are affected indirectly. In particular, commuting and migrating to seek employment have reshaped livelihood systems while the social and political communication systems are undergoing rapid changes. Such changes add new layers to the people's ability to adapt to the regular occurrence of flood and drought.

As mentioned above, the impacts of hydro-meteorological hazards induced by climate change need to be disaggregated according to ecological zone. Each region, the plains, the hills and the mountains must be viewed differently in order to assess critical impacts. The recession of glaciers in the Himalaya range, for example, will affect the overall water balance in the respective basins but the exact nature of its impact needs more investigation. Glacial melt may further exacerbate the risk associated with Glacial Lake Outburst Floods (GLOFs). Other differences include the fact that Nepal's western hills and Tarai experience more days without rainfall than the eastern hills and the eastern Tarai. At the same time landslides, mud flows, debris flows and *bishyari* (landslides into rivers) are common in the middle mountains. Floods inundate areas in the Tarai, where instances of bank-cutting and sediment deposition on productive land may increase.

This paper explores the nature of flood disasters in two regions in the Nepal Tarai. It presents our experiences in assessing flood hazard and vulnerability in selected village development committees (VDCs) with the objective of piloting disaster risk reduction activities and adaptation plans.

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[2] BDPF, Duryog Nivaran and BUET (1995)

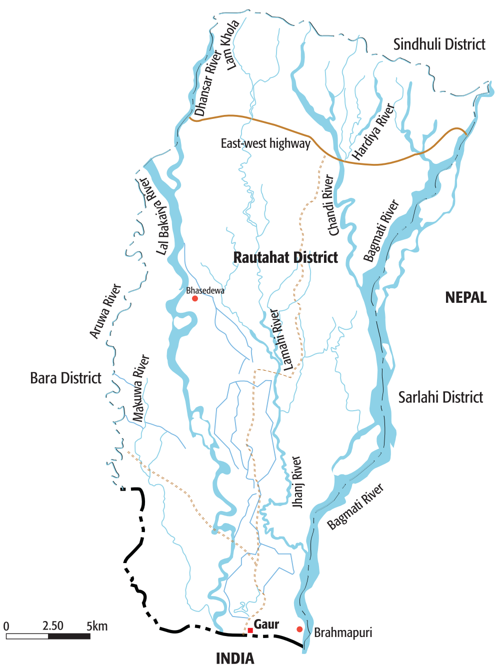
Study VDCs

The study includes a series of case studies and investigations of two districts of the Nepal Tarai, which are susceptible to flooding. The study sites are situated in the lower Bagmati and the Rohini river basins. Our earlier adaptive study project (Moench and Dixit, 2004) was based on empirical evidence collected in eight VDCs. It focused on the situation in the head, middle and tail reaches of the two basins.[3] Altogether 1,008 households were surveyed then. For the current adaptation / DRR pilot phase, the selection of VDCs was based on the following criteria.

- Presence of a partner organisation,[4]
- Incidence of human induced flood hazards and
- Characteristics of the rivers.

On the basis of the above criteria, four VDCs, two in each river basin were selected, Rampur Khaduana and Devgaun in Rohini Basin, and Bhasedwa and Brahmapuri in Bagmati Basin. The latter two villages are located in the *doab* (between river areas) of the Bagmati and Lal Bakaiya rivers in Rautahat District, while Rampur Khadauna and Devgaun are located in Nawalparasi District of Nepal (Figure 3).

| FIGURE 3 | Rautahat and Nawalparasi (Tarai) districts along Bagmati and Rohini rivers



[3] See Moench and Dixit (2004). Poudel *et al.* (2004) has done a study of flood hazard in Rautahat District.

[4] The boundary partners of the study are the Center for Disaster Mitigation (CDM) and the Support Oriented Organisation (SOS) and the Community Support Organisation (CSO).

The findings about these VDCs are expected to help in the development of adaptation plans and in the implementation of selected key measures which will serve as pilot activities in disaster risk reduction.

Monsoon rainfall is the primary cause of flooding in all four VDCs, which as a result experience inundation, bank-cutting and sand deposition. In Rampur Khaduana, drainage congestion exacerbates the adverse effect, while in Brahmapuri, embankments built in the state of Bihar along the border of Nepal and also along the lower reaches of the Bagmati River in Nepal have a similar result. The VDCs studied are indicated in Figure 3. The VDCs in the Rohini Basin are located upstream of the study villages in Eastern Uttar Pradesh.

Drainage congestion exacerbates flood effects.

Nature of Hazard

All three types of rivers discussed above have contributed to flooding in the Himalaya-Ganga since time immemorial. Widespread damage over the last century was caused by numerous floods including those in 1927, 1954, and 1972. More recent flood disasters took place in 1987 and 1988 in Bangladesh, in 1993, in the Bagmati River of Nepal and in 1998, in parts of Nepal and Eastern Uttar Pradesh which drain the Rohini River, Bihar, West Bengal and Bangladesh The monsoon of 2007 has also resulted in widespread flooding and brought devastation on a large scale in Nepal, India and Bangladesh. This flood was caused by excessive rain but specific details, such as, those about the nature and magnitude of the rains have yet to be analysed. In the following sections, we highlight the impacts of the 1993 and 1998 floods.

1993 Bagmati Flood

In 1993, central Nepal received very high rainfall because of a low monsoon weather system. This affected the catchments of Agra, Belkhu, Malekhu, and Mahesh kholas, which drain the northern Mahabharat face, as well as the Jurikhet, Mandu, Manahari, Lothar and Rapti kholas, which drain the southern face. These sub-basins are located in the Gandaki River system. The Kulekhani river in the Mahabharat range flowed into the Bagmati before the Kulekhani Hydroelectric Project was completed in 1981. The cloudburst also affected this project. The storm then moved eastward and settled over Ghantemadi in the catchments of Marin and Kokajhar kholas of Sindhuli District in the Bagmati Basin (MOWR, 1993). Both are tributaries of the Bagmati River. A station in Tistung in the Kulekhani catchment recorded 540 mm of rainfall in 24-hours on July 19, the maximum 24-hour rainfall ever recorded in the history of Nepal. The resultant massive swelling of the Bagmati and its tributaries caused major flood devastation in the mid-hills and the lower Bagmati Basin. It severely damaged the Bagmati barrage, its equipment, its gate control system, sections of the main canal, and the housing colony for staff.

The flooding in the Agra, Belkhu and Malekhu kholas of the Gandaki River system had a devastating impact on their watersheds, while the washing out of the bridges along the Prithvi Highway isolated the capital Kathmandu from the Tarai. When the flooding in the Jurikhet khola severed the penstock pipe of the Kulekhani HEP, the country lost almost half its total installed electricity capacity from the Integrated Nepal Power System (INPS).

TABLE 1 | **Loss of Life and Property due to 1993 Floods in the Bagmati Basin**

District loss	Affected		Death	Houses damaged		Land loss (area in ha)	Livestock loss (Km)	Infrastrctures					Food grain loss	Total Worth (NRs)
	HHs	Popn.		Completely	Partially			Road	Bridge	Dam	FMIS building	Public		
Bhaktapur														
Kathmandu	10	58*	2	8	0	3	159	0	0	0	0	0	0	867,274,750
Lalitpur	0	0	6	57	51	135	0	0	1	0	1	0	0	**
Makwanpur	14,748	101,482	242	1,732	1,879	4,656	665	7.92	16	1	251	118		119,864,381
Kavre	2,958	10,642	20	914	92	1,030	159	0	0	0	0	0	0	86,274,750
Sindhuli	11,051	59,142	52	1,206	1,314	4,061	1,930	26	41	5	6	24	1,186	86,349,764
Rautahat	14,644	89,146	111	2,003	4,541	1,366	3,211	40	13	0	1	37	31,673	899,680,261
Sarlahi	15,560	83,265	687	7,066	8,494	25,966	17,736	266	81	4	117	184	0	1,118,918,500

Note * Generated data
** Missing data

Source: Developed from Photo Album, Disaster of July 1993 in Nepal, December DPTC (1993)

As a result of the floods, about 1,300 people died nation-wide with about 111 from Rautahat District. In all, 73,606 families were affected and 39,043 houses were fully or partially damaged. About 43,330 hectares of fertile land was washed away by floods or covered by landslide debris and 367 kilometres of the road that connected the capital with the Tarai and its retaining structures were damaged. Six major bridges and twenty-five culverts were damaged or washed away. In addition, approximately 37 large and small irrigation systems and thousands of farmer managed schemes were damaged. Furthermore, 213 wooden and suspension bridges were washed away. Altogether 452 schools, health posts and government buildings were damaged (DPTC, 1993). The extent of loss is shown in Table 1.

1998 Rohini Flood

The 1998 monsoon rains in the Rohini Basin arrived during the last week of June and were fully established by the beginning of July. The monsoon began in the lower catchment of the basin and spread over the foothills of the upper catchment in the north. The months of July and August 1998 were exceptionally wet, with both the upper and lower regions receiving high rainfall. In addition, several cloudbursts also occurred, particularly in the upper catchment where the number of cloudbursts and wet days was greater than it was in the lower catchments. In fact, the rainfall in the region was three times higher than the normal. According to the Meteorological Department, the total rainfall in Gorakhpur as of August 20 was 1,232 mm, a record in and of itself. Then, on August 24, a record rainfall of 460 mm in 24-hours fell.

The impact of the flood was not limited to Parasi and Eastern Uttar Pradesh; it also caused widespread damage in Bihar, West Bengal and Bangladesh. According to the un-starred questions in the *Rajaya Sabha,* India lost 1.393 million ha of crops, a total comprised of 1.224 million ha in Bihar, and 0.131 million ha in West Bengal. The damage in Bangladesh was still more devastating. Almost two-thirds of the country (100,000 km^2) was submerged. The inundation continued for 65 days, marooning 33 million people, of whom 18 million needed emergency food and

Upper catchments experience major cloudburst events.

© A Pokhrel

Blocked aqueduct causes drainage congestion.

The 1998 flood was caused an exceptionally wet monsoon in conjunction with a major cloudburst.

health services (Ahmed, 1999). The flood caused serious damage in Dhaka, seriously affecting the health, housing, food, security, employment, communications and livelihood of the urban population (Nishat *et al.*, 2000). The rainfall recorded in 1998 was among the highest recorded in recent times but could be a regular event in the natural cycle of the region. However, since rainfall events have not been monitored on a long-term basis it is difficult to draw conclusions regarding trends or changes in periodicity and attribute them to impacts of global climate change. The flood affected 279 families in different parts of Nawalparasi District. It washed away about 24 hectares of land and damaged property worth over Rs. 680,000. Because of the low gradient in the lower region, inundation was widespread and long-lasting. The havoc created in the *doab*[5] life was widely reported in the local media. From the first week of July till the end of August, death, inundation, house collapse, cutting of banks, breaching of embankments, blanketing of land with sand, disease and damage to infrastructure, including roads, bridges and power lines prevailed.

In Uttar Pradesh, the districts of Gorakhpur, Gonda, Baharaich, Sravasti and Balarampur Siddharthanagar were affected. Floodwaters disrupted road and train services. About 1,300 people

[5] For details, see Report on Eastern Uttar Pradesh Flood by People Commission (1998).

TABLE 2 | Loss of Life and Property due to 1993 Floods in the Rohini Basin

District loss	Affected		Death	Houses damaged		Land loss (area in ha)	Livestock loss (Km)	Infrastrctures					Food grain loss	Total Worth (NRs)
	HHs	Popn.		Completely	Partially			Road	Bridge	Dam	FMIS building	Public		
Nawaparasi	279	1,604*	***	2	**	24.04	0	**	**	**	**	**	**	680,000
Rupandehi	1,446	8,315*	18	128	**	0.14	1	**	**	**	**	**	**	68,190,300

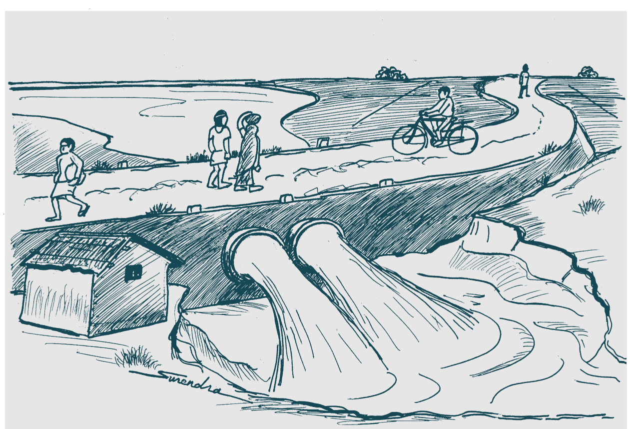
Note * Generated data
** Missing data
*** Not clear whether there were no deaths or the data is missing. Ethno-history of two study VDCs does not report any deaths.

Source: Developed from Photo Album, Disaster of July 1993 in Nepal, December DPTC (1993)

and an estimated 2,800 livestock died in the districts of Gorkhapur, Maharajgunj, Deoria and Kushinagar. Gorakhpur became an island after blocked the road that linked the city to other cities. Nearly 95 % of the affected dwellings were huts. In most of the affected villages floodwaters remained for three months. Sand deposition affected 11,253 ha of land in 148 villages; the depth of the sediment deposited ranged from one to seven feet. Water-borne diseases caused additional deaths.

The 1998 flood was not an aberration. Nine years later, in 2007, the region faced a similar situation as flood waters caused by the monsoon rains swept the South Asian landscape. In parts of the Ganga Basin in Nepal, India and Bangladesh, flooding inundated large areas, killed hundreds and displaced millions. Agricultural and other losses were high but are still being assessed. Disease has spread throughout much of the flood-affected region, affecting both rural and urban populations. The monsoon flood of 2007, although above long-term averages, is far from unprecedented. Indeed, floods are a regular feature of life in the basin, important for soil fertility, aquifer recharge, and a healthy regional ecology. As the misery of so many inhabitants of the basin clearly demonstrates, current approaches to flood management are unable to mitigate the impacts on human lives and livelihoods. If climate change projections prove accurate and flood events become more frequent or extreme, this inadequacy will increase.

Climate change will alter flood hazards and probably increase them.



Natural and Social Characteristics of the VDCs Studied

In order to examine the context of flood hazard and vulnerability, we examined the natural and social characteristics of the case study sites.

Floods lead to inundation bank cutting and sand deposition.

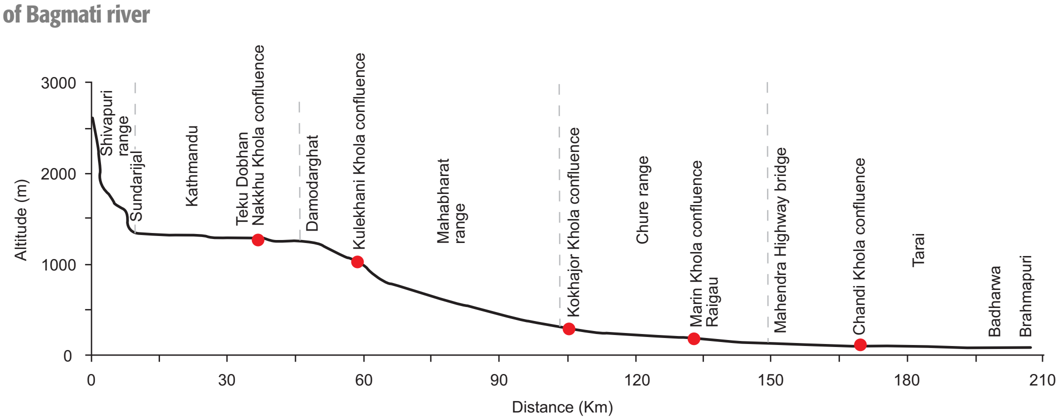
Natural Characteristics

Bagmati Basin

The Bagmati River Basin in central Nepal covers an area of about 3,750 km^2. The river's watershed includes parts of eight districts: Kathmandu, Lalitpur, Bhaktapur, Makwanpur, Kabhre, Sindhuli, Rautahat, and Sarlahi. The Bagmati River begins north of Kathmandu, at Shivapuri, and drains out of Nepal into Bihar, where it joins the Kosi River near Badla Ghat in Khagaria before joining Ganga River. Nakkhu, Kulekhani, Kokhajor, Marin, Lal Bakaiya and Chandi are its major tributaries. The two study villages are located in the *doab* of the Bagmati and Lal Bakaiya rivers.

The Lal Bakaiya River begins in a small *dun* (valley) of Makwanpur District and flows to Rautahat District before joining the Bagmati in Bihar a few kilometers downstream of the Nepal-India border. In Makwanpur Districts, it is called Bakaiya, but when it reaches the Tarai and takes on a reddish tinge from the soil of the Chure range it is known as Lal Bakaiya. The catchment area of the Lal Bakaiya River is 168.75 Km^2, and its average high flood discharge during the monsoon is 2,365 m^3/s at Karmaiya. Though its catchment is five-times smaller than that of the Bagmati River, Lal Bakaiya causes more damage. Floods in the river last for just four or five hours but river flow is flashy and brings a lot of sediment load. Bank-cutting and sand deposition are common in adjoining VDCs. Lal Bakaiya, as well as the Lakhandehi, Ratu, Jhanj, Kalinjor and Fuljor rivers drains the Chure range and the Nepal Tarai before joining the Bagmati in Bihar, but the catchment areas of these rivers are not included in that of the Bagmati River in Nepal.

FIGURE 4 | **Profile of Bagmati river**



Note: The red dots in the profile indicate points where tributaries join the Bagmati River.

Source: DWIDP (2005)

FIGURE 5 | **Schematic view of Bagmati and Lal Bakaiya rivers and dependent area**

Flooding within the lower Bagmati *doab*, where the river gradient is about four-meters per kilometer, is a consequence of morphological disruptions in the Bagmati and the Lal Bakaiya. Both rivers are embanked and extend far into Nepali territory. Bairgaina Block of Bihar is situated between the Bagmati and Lal Bakaiya rivers and borders Rautahat District of Nepal. The entire block is surrounded by embankments in a structure known as a 'garland embankment'. The northern portion of this embankment runs parallel to the Nepal-India border, obstructing natural drainage. As a result, the river floods areas within Nepal, including Gaur Municipality and Brahmapuri VDC.

Rohini Basin

The Rohini is a tributary of the West Rapti River, which in turn flows into the Gandak River north of Gorakhapur. Though it begins in the Chure, the river crosses the Indian border after draining parts of Rupandehi and Nawalparasi districts. Most of the area it drains is in the 1,960 km^2 district of Nawalparasi, which has four distinct geographical zones: the hills, the inner Tarai, the Chure and the Tarai. The Parasi plain is a continuation of the north Gangetic land system. In Nepal, the average north-south width of the Tarai plain varies between five and 40 km. The catchment area of Rohini lies between the municipality of Butwal in

Embankments constrain natural drainage.

Chure rivers are flashy in nature.

Rupandehi and the Daunne hills of Nawalparasi District. The eastern part of Butwal located in the watershed of the Tinau River also drains into the Rohini. Thus, the Rohini and its tributaries drain the area lying between the Narayani (the Gandak) River in the east and the Tinau River in the west. Its main stem begins at Chauranghi in the Chure hill and flows into the basin's western section. A number of tributaries (*nala, kholsa, khahare,* khola and streams) flow into the main-stem as it flows south. As they flow, the tributaries change course, split into distributaries and captures neighbouring streams. In Nepal, the tributaries of the Rohini are the Jharahi, Dhanewa, Bhumahi, Bhaluhi and the Somnath. Each begin as an ephemeral stream (*khahare)* on the southern slope of the Chure and later joins the Rohini before that river enters Uttar Pradesh at Mishrauli of Nautanawa Block.

Of the Rohini's total length of 122 km, 43 km lies in the *bhabar* and upper Tarai of Nepal; the rest is in India. The Rohini has a total catchment area of 2,686 km^2, 794 km^2 (30 %) of which is in Nepal. This 30 % contributes more run off than that generated within the lower catchment in India, because the catchment in Nepal receives more rainfall. Of the total area in Nepal, 505 km^2 is in Parasi District and 289 km^2 in Rupandehi. The Rohini River system and its tributaries drain almost all of the Parasi Tarai. The Jharahi and Dhanewa rivers join each other after they flow into India and together are called the Chandan River. With its tributaries from Nepal and Uttar Pradesh, the Rohini joins the West Rapti River near Gorakhpur. The drainage area of the river in the plains of both Nepal and Uttar Pradesh is contiguous to that of the Tinau (called the Kuda in Uttar Pradesh) in the west and the Gandak in the east.

The slopes of the Rohini River and its tributaries change within a few kilometres of their origin in the Chure range. Because the gradient is low, they have a tendency to meander and deposit sediment. Even though the slope is high, sediment deposition is greater in the upper reaches because the bulk of the sediment is derived from mass wasting, and consists of cobbles and pebbles, which readily settle out. Finer sediment, in contrast, moves further downstream. The lower reaches of the Rohini receive sediment from the upstream sections as well as from the erosion of bed and banks. With the cessation of rainfall, flow velocity reduces and large amounts of sediment begin to be deposited in the riverbed and on flood plains, while suspended loads are transferred still further downstream. In the lower reaches because the stream gradient is less than 0.1, the effects of floods are severe.

TABLE 3 | Summary of Characteristics

Characteristic	Bagmati Basin		Rohini Basin
	Bagmati River	Lal Bakaiya River	
Area (km^2)	3,750	806	194
Length (km)	207	116	The longest main within Nepal is 43 km.
Maximum Elevation	2,716	2,135	Begins at 850m at Chure drops to 100 m.
Minimum Elevation	71	72	
District	Kathmandu, Lalitpur, Bhaktapur, Makwanpur, Kabhre, Sindhuli, Rautahat, and Sarlahi	Makwanpur, Bara, Rautahat	Nawalparasi and Rupandehi
Tributaries	Manahara, Bishnumati, Nakkhu, Marin, Kayan, Kokhajhor, Chandi, Manusmara	Lohajor, Bakaiya, Bunda, Hile, Majhi, Simat, Burani, Sukaura, Jyamire, Harda, Dhansar, Bhavar	Jharahi, Bhaluhi, Dhanewa

Social Characteristics

In the following sections, we discuss the socio-economic conditions of the four VDCs based on information collected at the ward level using tools such as transact walking and semi-structured interviews. Transects and interviews were conducted with local NGOs, CBOs and network staff and with volunteers to gather information about flood problems, as well as about adaptation strategies and their advantages and disadvantages.

The 20,399 inhabitants of the four VDCs live in 3,066 households, about the same number in each VDC. The two VDCs of Rohini Basin house 9,756, while those of the Bagmati Basin house 10,586. The economic status of the people is poor. For the most part, families suffer food shortages. In Devgaun, for instance, just 62 % of the population produces enough food for more than six months, while in Rampur Khadauna, Bhasedwa and Brahmapuri the equivalent figures are 69, 77, and 62 % respectively (Table 5).

As shown in Table 6, literacy rates in Brahmapuri, Bhasedwa, Rampur Khadauna and Devgaon VDCs are 34, 39, 52 and 49 % respectively. Literacy is higher in the two Rohini Basin VDCs than in the Bagmati Basin VDCs. In all VDCs female literacy is substantially lower than male.

Brahmapuri has the largest proportion (41 %) of landless households and Rampur Khadauna, the least (19 %). Between 9% and 14 % of landless households in the four VDCs rent land for agriculture purposes, while the remaining landless households earn a livelihood through daily wage labour. In Brahmapuri, only 27 % cultivate private lands, in all three other VDCS the proportion is 40 %. About 40 % of landowners rent their land to others.

TABLE 4 | Households, Population and Area of Study VDCs

District/VDC	Household (Nos)	Total Population	Male	Female	Area (km²)	Population density
Nawalparasi	98,340	562,870	278,257	284,613	1126	500
Devgaun	845	5,424	2,819	2,605	9.44	575
Rampur Khadauna	659	4,389	2,273	2,116	3.75	1,170
Rautahat	88,162	545,132	282,246	262,886	2162	252
Bhasedawa	935	6,254	3,252	3,002	9.75	641
Brahmapuri	627	4,332	2,230	2,102	9.19	471

Source: Field Survey (2006)

TABLE 5 | Household Food Sufficiency by Months

VDC		Not enough 3 months	Enough for 3 months	Enough for 6 months	Enough for 9 months	Enough for 12 months	Surplus HHs	Total HHs
Devgaun	Number	237	138	140	103	135	92	845
	Per cent	28	17	17	13	16	11	
Rampur Khadauna	Number	118	156	174	93	74	44	659
	Per cent	18	24	27	15	12	7	
Bhasedhwa	Number	404	199	97	136	60	39	935
	Per cent	44	22	11	15	7	5	
Brahmapuri	Number	258	152	90	72	37	18	627
	Per cent	42	25	15	12	6	3	
Total HHs								3,066

Source: Field Survey (2006)

The amount of land in the Bagmati Basin used for agriculture is decreasing, the amount in Rohini is constant, and in Rampur Khadauna it is increasing (See Figure 6 (a) and (b)).

We asked villagers to assess the impact of floods. Their responses are listed in Table 8. Villagers identify bank cutting, sand deposition and inundation as the main impacts.

TABLE 6 | Literacy Rate (%) (for Population 6 Years and Above)

VDC	Female		Male		Total	
	population	%	population	%	population	%
Devgaun	2,605	35	2,819	67	5,424	49
Rampur Khadauna	2,116	31	2,273	68	4,389	52
Bhasedhwa	3,002	20	3,252	44	6,254	34
Brahmapuri	2,102	28	2,230	52	4,332	41

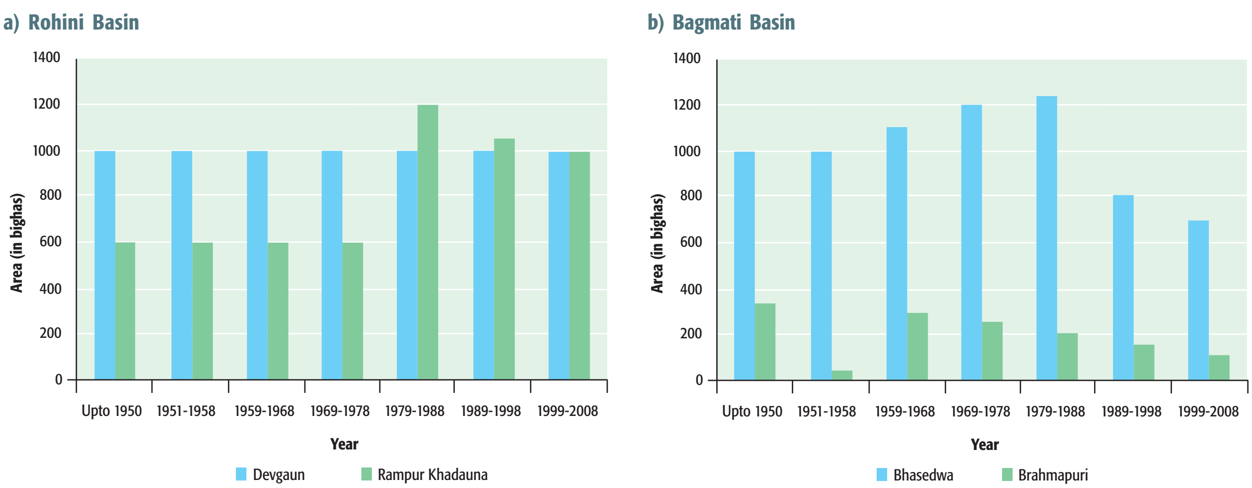
Source: Field Survey (2006)

TABLE 7 | Land Tenure Type

VDC	Households under different land tenure					
	Own land cultivated	Rented to others	Own plus rented	Rented	Landless	Total households
Devgaun	335 (40)	83 (10)	224 (27)	107 (13)	96 (12)	845
Rampur Khadauna	263 (40)	66 (10)	210 (32)	64 (10)	56 (9)	659
Bhasedhwa	368 (40)	120 (13)	210 (23)	85 (9)	152 (17)	935
Brahmapuri	167 (27)	59 (10)	142 (23)	84 (14)	175 (27)	627

Source: Field Survey (2006)

FIGURE 6 | Status of agricultural land



Assessing Context of Flooding

Since the objective of the study was to identify activities that would enable communities to adapt and to help disaster risk reduction, it adopted a bottom-up approach beginning with affected communities and backed up with insights from research and central-level functionaries. Primary information was generated through participatory rural appraisal (PRA) techniques and a household survey. The following specific methodologies were used.

1. Reconnaissance visits to the concerned districts, including the headwaters of the rivers
2. A social map of the hazards in each VDC was prepared and transposed on a topographical map (1:25,000) of the VDCs.
3. The number of households in the identified hazard zone was listed and their vulnerability assessed.
4. A time line recording trends was prepared
5. Individual-, local-, and national-level shared learning dialogues (SLDs) about people's perceptions of flooding, damage (land, crop, human life, animal life) and impact on pre-, during and post-flood situations were conducted.

Ethno-History and Trend Analysis

Before we discuss the state of vulnerability the affected and the results of the SLDs, it is useful to recount the ethno-history of flooding in the region. The analysis of floods in Bhasedwa and Bramhapuri VDCs of the Bagmati Basin shows that large-scale devastation occurs during extreme events such as the one in 1993, but that in other years as well, agricultural land is inundated and houses are damaged.

Rohini Basin

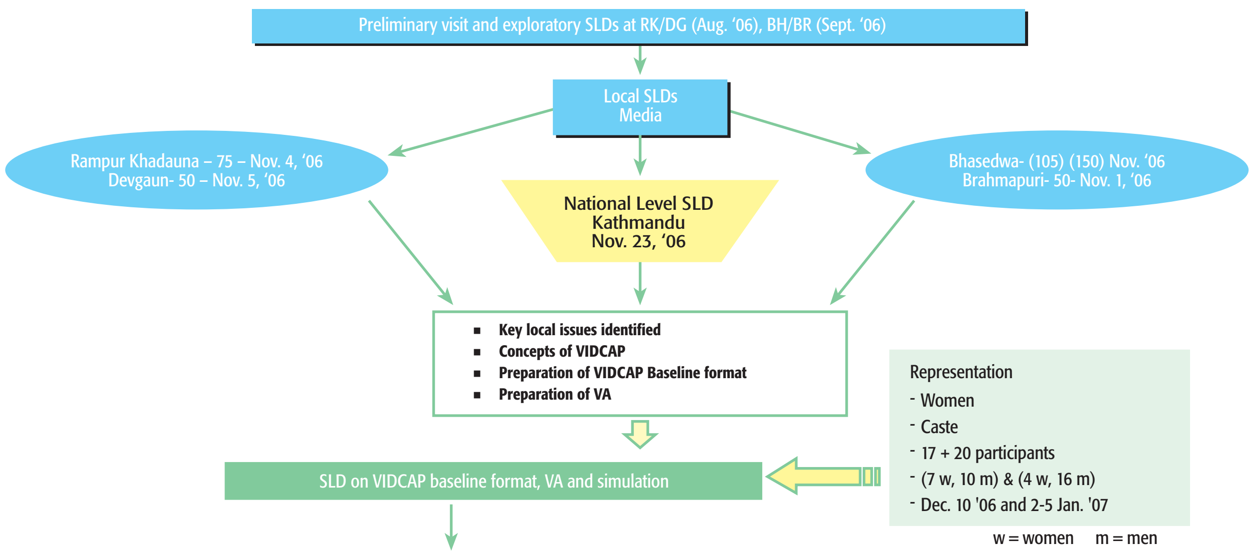
Historical analysis of floods, populations and natural resources in Rampur Khadauna and Devgaun VDCs of Nawalparasi, Rohini Basin shows that floods are neither sudden nor unexpected. Floods in the Piruda River in the northeast and the Bhaluhi River in the northwest damage cultivated land and crops in Devgaun VDCs. In 1950, 2,100 people lived in 400 homes and cultivated 1,000 *bigha* of land. The current population is 5,424 living in 841 households but they own only 993 *bigha*

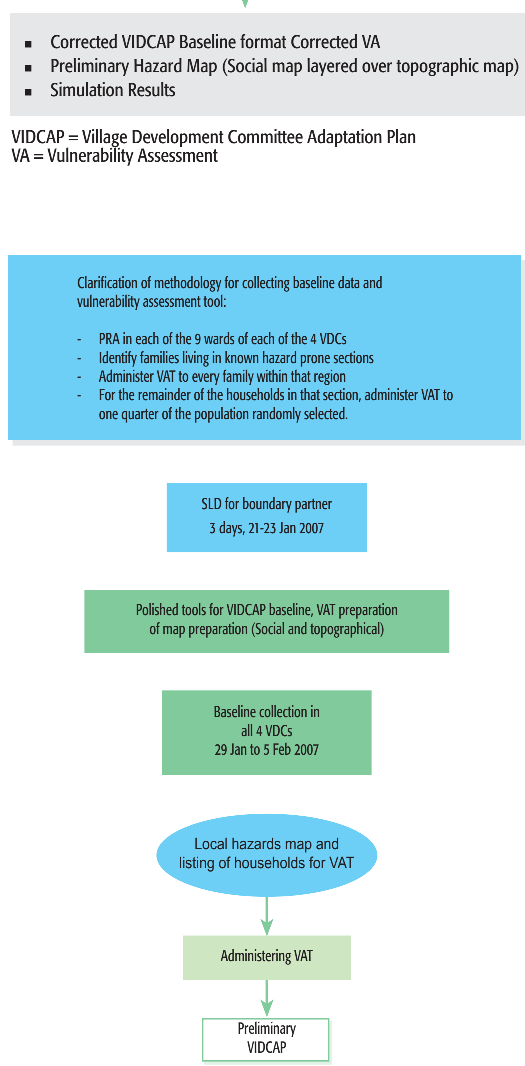
TABLE 8 | Effects of Flood

VDC	Bank cutting		Sand deposition		Inundation		Property damage and loss of lives			
	Cultivable land	Other use	Cultivable land	Other use	Cultivable land	Other use	House	Cowshed	Human	Livestock
Devgaun	29	15.5	11	10	990	63	80	85		150
Rampur Khadauna	45				1,095		44	40		
Bhasedhawa	175	8	246	25	10		25	40	2	10
Brahmapuri	58		76		35		14	41	1	

Source: Field Survey (2006)

FIGURE 7 | Methodology schematic





of cultivated land. Small-scale irrigation began in 1951 and pumpsets were introduced in 1969. An irrigation canal serves about 500 *bigha* in Devgaun, but the supply of water is unreliable.

The Dhanewa River flows from the northeast south and the Jharahi River flows from the southwest to encircle the boundaries of Rampur Khadauna. The population of the village in 1950 was 2,000 and 800 *bigha* of land were cultivated. The survey in May 2007, showed that the population had increased to 4,884 living in 664 households and that 1,190 *bigha* of land were cultivated. Untill 1968, Rampur Khadana had five *bigha* of forest which met the villagers' needs for firewood and fodder, but it was cleared and converted into agriculture land. The Dhanewa and Jharahi rivers began to cause flood damage in 1961. Inundation is currently most severe in wards 7, 8 and 9.

There was no motorable road in the village untill 1992. The main road linking

Rampur Khadauna to Parasi is graveled while local roads are paved with bricks. Small drains were built in the VDC after 1993.

Local people mentioned that untill 1970 flooding improved productivity in some sections of Devgaun VDC. The river water brought clayey loam suitable for growing *rabi* crops such as *arahar* (yellow lentils), peas, gram and *masuro* (red lentils). Merchants from nearby Indian towns came to the village to buy the harvests. In the last thirty years, productivity has declined substantially and crops such as *arahar*, peas, *masuro* and gram are not grown anymore.

Bagmati Basin

Floods in the Lal Bakaiya River affect Bhasedwa while floods in the Bagmati River affect Bramhapuri. Each year both rivers create havoc during monsoon. The Bagmati has moved three kilometers westward in recent years resulting in a loss of land and depositing sand on a substantial area. Before 1969, villagers claim that floods were not a problem. In 1966, the Indian Railways diverted the Bagmati from its western to eastern channel in order to protect the railway lines. Wooden piles were dug and spurs constructed along the western channel. These interventions altered the local river dynamics and exacerbated the impacts of flooding on Bramhapuri.

About 100 households in Bramhapuri have been displaced in the last two decades and only 100 of 334 *bigha* of agriculture land remain. In Bhasedwa, about 600 households were displaced. About 700 *bigha* out of a total of 1,250 *bigha* is cultivated in Bhasedwa. In the decades of 1959-1968, 1969-1978 and 1979-1988, respectively 20, 30 and 200 *bigha* of forest was cleared in Bhasedwa.

TABLE 9 | SLD and Vulnerability Assessment Matrix

Step	Activity
I	Identification of VDCs representing head, tail strata of the river.
II	Identification of local hazards within each VDC.
III	Preparation of timeline and Ethno-history of floods.
IV	PRAs at ward level of four VDCs
V	Vulnerability Assessment in each VDC.

The figures indicate that the extent of deforestation has increased almost seven-fold after the floods in 1970 and 1975, which damaged 100 and 10 *bigha* of cultivated land respectively. Fifty households were displaced in 1978 and 50 *bigha* of land were destroyed between 1979 and 1988. During the 1993 floods 100 households were displaced and 40 *bigha* of cultivated land was damaged. Another 100 households were displaced and crops growing on 100 *bigha* were destroyed when the Bagmati canal embankment began breaching after 1999. The extent of flood devastation is perceived to be increasing and the communities lose cultivated land, crops, livestock and property each year. At the same time, the degradation of forest and grazing land is rapid.

In both basins floods are a regular phenomenon.

Embankment along Brahmapuri.

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TABLE 10 | **Ethno-History of Floods in Devgaun**

Year	Event
1969	10 *kattha* of land affected by bank cutting. Floods inundated ward numbers 1, 3 and 4. Flood waters also brought clayey loam increasing productivity.
1970	Ward numbers 2, 5 and 6 were inundated.
1990	Water from Bhaluwai and Piruda rivers inundated the village. Water released in the Gandak canal exacerbated the problem because cross drainage structures have insufficient water way. The settlement of ward number 7 and 8 were affected and the crops destroyed.
1996	The river washed two spurs in ward number 1 displacing 5 houses of Yadav Gaon. Those displaced live close to the *Hulaki Sadak.*
1998	All settlements of ward numbers 1, 2, 7 and 8 and the cropped areas were affected. In ward number 1, four *bighas* of land was destroyed by bank cutting while 10 households were displaced. They bought land in Sarawal VDC. Flood in Pidruda River resulted bank cutting in ward number 8 and washed away a Muslim graveyard (5 *bigha* of land). Sand deposition affected eight *bigha* of land In ward number 4.
2003	Floods inundated settlements of ward numbers 1, 7, 8 and all farmlands. Parts of ward number 9 was inundated. All crops destroyed. The productivity of land is decreasing.

FIGURE 8 | **Flood hazard map of Devgaun**

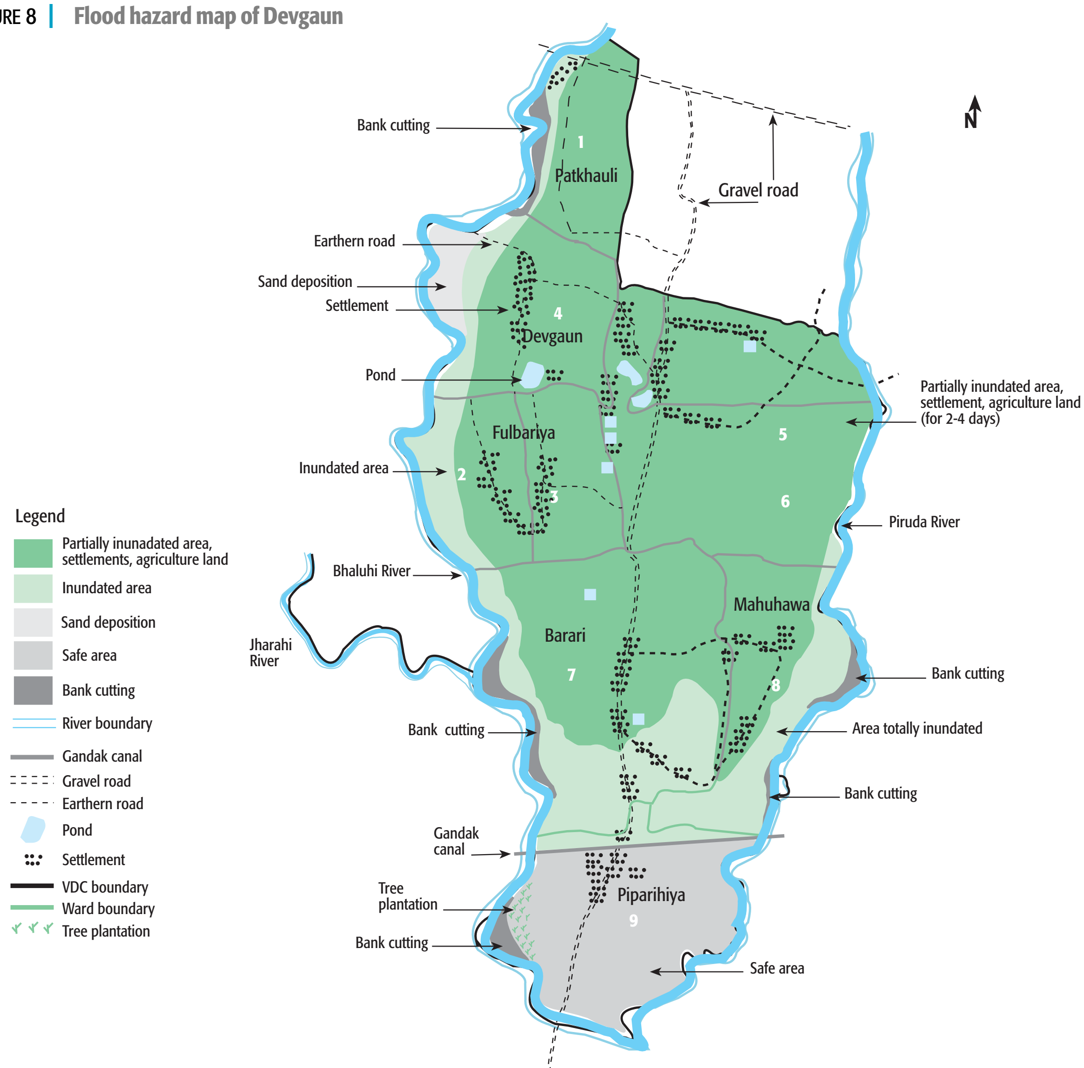


TABLE 11 | Ethno-History of Floods in Rampur Khadauna

Year	Event
1961	Early records of inundation in the village date back to this year. All houses of ward number 9 along with agriculture lands were under water. However, the flood was not devastating. It started receding after 10-12 hours. The flood deposited clayey loam over the fields. This resulted in a harvest boom for crops such as grams, lentils, peas and early paddy. The nature of flooding changed in the later years.
1979	Gandak Irrigation Canal was constructed during 1979-80. However, the area received irrigation only after 1984. The main canal runs perpendicular to the ground slope. Cross drainage structures were designed and implemented with insufficient water ways. This causes flooding in the settlements of ward numbers 7, 8 and 9. All crops in the fields were lost. Paddy seed had to be sown repeatedly. In some areas inundation was minor and paddy harvest was better.
1982	Two persons died in floods. The Dhanewa River gradually became larger and joined the Jharahi resulting a flooding. The settlements of ward 8 and 9 and all crops were submerged for 4 days. The Jharahi River changed course in 1961 after Sugauli Dam was constructed at Haripur VDC. Ward 1 and 2 were affected by bank cutting and inundation.
1990	The widening of Dhanewa River resulted in inundation of houses of ward numbers 7, 8 and 9 and all crops for 4-5 days. Gandak canal receives no water when required but in the monsoon excess water was released in the canal exacerbating flooding.
1991	Flood caused death of one person. Bank cutting by Dhanewa and Jharahi rivers was severe. No action was taken. Whenever there was rain in the northern catchment, people realised that flood will come after 1 or 2 days.
1996	Communities of ward numbers 1, 7, 8 and 9 are temporarily displaced. People took shelter at the school and returned to their homes only after water receded. The confluence of two rivers changed and altered the flooding pattern. The bed level also increased. Since river bed was higher than the fields, the flood water easily found its way into the fields. People from ward number 1 left their homes to live temporarily in ward numbers 3 and 4.
1998	The VDC was submerged. Crops in 1,000 *bigha* were destroyed.
2000	July floods inundated houses of ward numbers 7, 8 and 9. People along with their belongings and cattle moved to safer places at higher grounds. Some went to live with their relatives. About 1,100 *bigha* of agriculture land was inundated.
2003-2005	Flooding was recurrent. People used boats to commute when the village was inundated.

FIGURE 9 | Flood hazard map of Rampur Khadauna

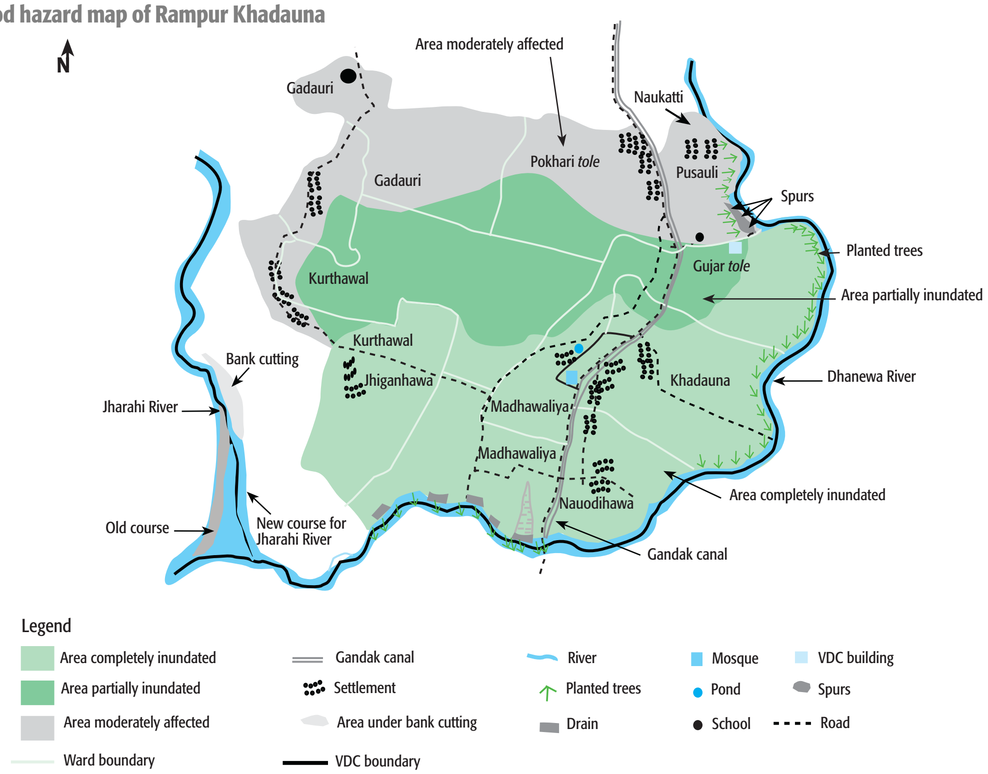


TABLE 12 | **Ethno-History of Floods in Bhasedwa**

Year	Event
1937	A September flood destroyed paddy before it was harvested. About 200 *bigha* of land was destroyed due to inundation and sand-casting. It damaged the paddy crop. However, the village was not damaged.
1965	Before paddy could be harvested floods buried more than 1,000 *bigha* of land under sand. The settlement was unharmed.
1970	Bank cutting washed away the forest of ward number 1. In other wards, sand deposition affected around 100 *bigha* of land. The land could not be made arable for long time.
1975	Sand deposition destroyed 200 *bigha* of land. Parts of forest and local pastures were also lost.
1978	Flood destroyed crops of 50 *bigha*. It also affected 50 households of Dholbaja *tole*. The population of ward number 5 was resettled by clearing forest near Hanumangad of the same ward. No effort was made to prevent bank cutting.
1985	Floods continue to destroy large tracts of land. The problem became recurrent after this year. Farmed land, pasture and orchards were lost. Between 1985 and 1991 around 100 *bigha* of land was lost due to bank cutting. No efforts were made to minimise the losses. In 1991 DDC and District Irrigation Office (DIO) supported construction of spurs made of bamboo piles. Sand bags were also placed. But the problem continued.
1993	An unprecedented flood occurred in the early hours (4:00 am) of 21 July. As it was time to start herding cattle to pastures some people were already awake. They warned the rest of the villagers providing much lead time for people to reach higher grounds. There was no loss of life. The entire village was under water. Bank cutting was rapid. 100 households belonging to ward number 6 (Chamar *Tole*) were displaced and went to live in a neighboring VDC. The poorer people took shelter at their relatives' homes. Some struggled to salvage their belongings by lighting petro-max at night. Sand deposition destroyed around 100 *bigha* of land. On August 10 another flood occurred. Its ferocity was lower than that of the July 21 flood but the flood led to widespread, rapid and devastating bank cutting. Within an hour, 262 feet of bank eroded.
1995-2003	Bank cutting was worse than in 1993. The flood of August 13, 1995 took 50 feet land. Floods of August 16, 17 and 18, 1997 led to bank cutting of 10 *bigha* of cultivated land. This flood washed away road linking the village to the north. The floods of July 21 and 25, 1998 displaced 25 households of Pokhara *tole*. Families moved at night. After the flood, more than 150 households have migrated and the trend continued until 2003. Everyone living in the *purano basti* of Bhasedwa migrated elsewhere.
2004	This flood was devastating compared to 1993 floods. The floods of 1993 had pushed an entire settlement to *naya basti*. The 2004 floods did not spare this basti - the settlement and surrounding fields were inundated. All *dalits* of ward number 2 and 3 were displaced. They started living in camps set up at Bhasedwa Primary school. The floods damaged the canal system of Bagmati Irrigation Project (BIP). A 250 meter long embankment and a spur built by BIP had not been complete as the construction began late. The embankment congested flow which became a serious hazard. The entire embankment including the spur was washed away. The soil used for building embankment and spur was spread over 100 *bigha* of land. Farmers still have not succeeded in recovering the land today.
2005	BIP constructed a 400 meter long embankment and a spur. This initiative has saved land behind the embankment. However, land areas both upstream and downstream of embankment face increased inundation and sediment deposition.

FIGURE 10 | **Flood hazard map of Bhasedwa**

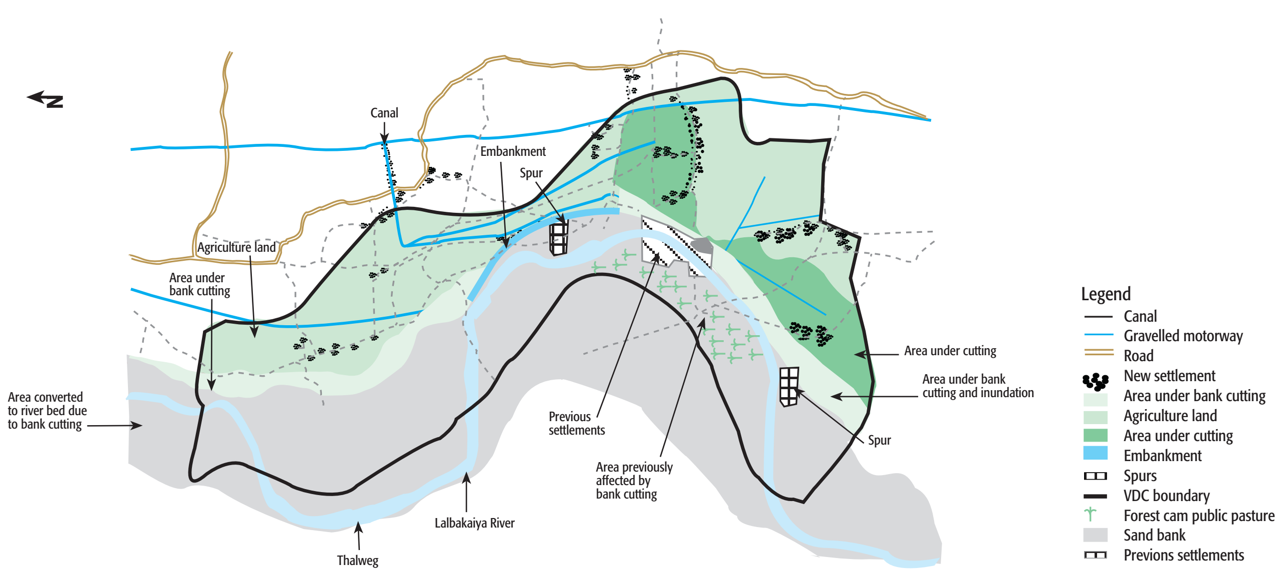
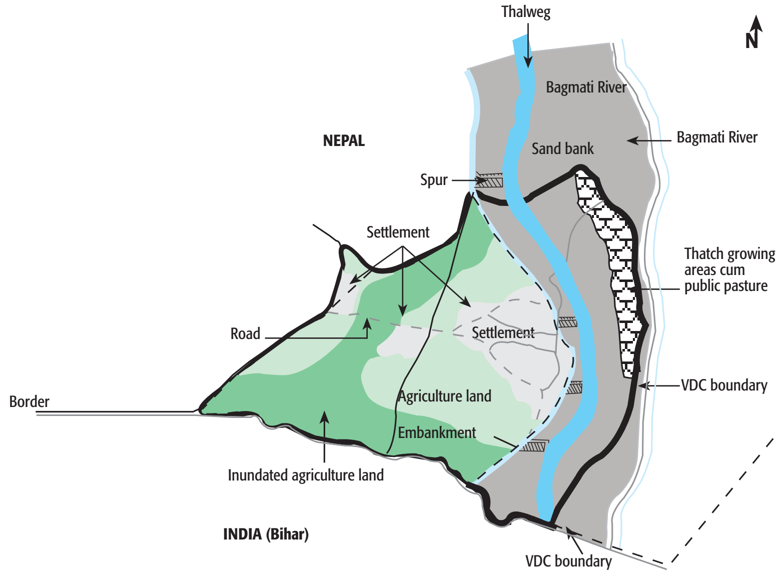


TABLE 13 | Ethno-History of Floods in Brahmapuri

Year	Event
1954	A major flood resulted in sediment deposition over the lands. Entire paddy crop was lost. Farm land looked like sand banks and could not be farmed for subsequent 7 years. During this period people faced food shortage. The river also brought tree trunks and deposited them in the fields. Some people collected the timber, sold them and made their living. People built resting places on stilts and lived on it for many days. Cooking was done on *machan.* Some families stacked one bed over the others to keep them dry. During the 7 year food shortage period, the richer households bought food from local and regional markets while the poor households migrated to India and neighbouring village in search of menial jobs. The remitance money they earned helped sustenance.
1960	Local initiatives to construct an irrigation system by damming Bagmati began. This was done to rejuvenate the land affected by sand deposition. The canal system irrigated 17 % of the land lying east of the village. The efforts to irrigate western areas resulted in the flooding of the village. In anguish people destroyed the dam and the initiative came to an end.
1961	Floods deposited silty-loam over areas affected by sand deposition in 1960 floods. Bagmati River flowed in two channels east and west of Brahmapuri. The westward channel accomodated the major flow while the eastward channel looked like a small irrigation canal. The westward channel of the river continuously impacted the Indian railway line in Bihar.
1966	The Indian Railway diverted flow of Bagmati from the western channel to eastern channel with the objective of protecting the railway lines. To that end wooden piles were driven and spurs were constructed in the western channel. Indian Railway provided compensation to farmers who owned land adjacent to the eastern channel. The farmers initially did not agree but later realised that river was gradually moving towards the eastern channel across the border. They agreed to be compensated.
1973	Bank cutting was a major problem after the river began flowing along the eastern channel.
1978	Nun toli of ward number 9 was displaced.
1993	Unprecedented flood occurs in the early morning (at 4:00 am) of July. In the village, the depth of flowing water was 5 feet. Villages as far as Barhathwa were inundated. The flood also washed an elephant. People could not move from the village in the dark because the entire village was inundated. People stacked beds, climbed roof, trees or to some raised place for safety. One boy was washed away. A woman lost both her sons along with her goats and oxen. Stored food became wet. People could not cook food even after the flood water receded. The houses were filled with muck for around 3-4 days. Relief agencies arrived only after the flood receded. People had to travel to Gaur to receive the relief materials because roads were damaged. Both rich and poor were equally affected as the stored grains had been damaged. Relief distribution was available continuously for three months which helped people to get back to their lives. All the households in ward number 8 were displaced. About 70 *bigha* of land was affected by sand deposit.
1998	Between 1998 and 2002, households of ward numbers 2, 6 and 7 continued to be displaced. The high school in Brahmapuri was washed away by the flood of 2002. The school did not reopen for almost one year.
2003	The lower section of Bagmati was embanked and spurs were constructed with assistance from the Government of India. This intervention has minimised bank cutting and flooding. However, Gaur municipality continued to be inundated.

FIGURE 11 | Flood hazard map of Brahmapuri



Vulnerability Assessment

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Inadequate drainage capacity results in failure of culverts.

One of the major focuses of the study was assessing the extent of vulnerability. The theoretical aspects of vulnerability are discussed in chapter 4 and were used to define the parameters in this assessment. Published literature, reports and documents were reviewed to select the parameters and several rounds of discussions were held with experts and knowledgeable persons. A checklist consisting of 25 parameters was prepared and discussed among the team members and the local communities. The components were as follows: a. physical, b. social, c. gender-related d. economic, e. access to communication, f. access to resources and g. psychological (Table 15). The parameters were weighted as shown in Table 14.

The tool thus developed was administered to all households in the four VDCs. Care was taken to ensure that households in each of the hazard sites identified above (See Figures 8,9,10 and 11) were included.

TABLE 14 | Vulnerability Ranking

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

TABLE 15 | Parameters of Vulnerability

	Parameters	Indicators
I	Physical	1 Frequency of flood
		2 Effects of flood
		3 Bank cutting/sand casting
		4 Damage to structures
		5 Effect of inundation – pollution
		6 Effect of inundation - on mobility
		7 House located along the banks
		8 House located next to embankments
		9 House located in the direction of flow
		10 Flood damaged - land types
II	Social	11 Access to education
		12 Head of household
		13 Mobility-less or no-mobility
III	Economic	14 Food sufficiency
		15 Land holding
		16 House types
		17 Source of income
		18 Food security
IV	Access to resources	19 Access to water, sanitation and health institutions
		20 Access to forests
		21 Access to service centres
V	Communication	22 Communication
VI	Gender Perspective	23 Group formation and funds collection
		24 Women participation in SHGs
VII	Psychological	25 Psychological

TABLE 16 | Aggregate and Ward Wise Vulnerability Assessment

Ward no.	Devgaun				Rampur Khadauna				Bhasedhawa				Brahmapuri			
	SV	HV	Rest	Total	SV	HV	Rest	Total	SV	HV	Rest	Total	SV	HV	Rest	Total
1	0	55	58	113	0	35	29	64	0	26	18	44	0	24	5	29
2	0	12	79	91	0	44	22	66	0	43	17	60	0	17	29	46
3	0	27	52	79	0	33	5	38	1	156	39	196	23	66	7	96
4	0	4	50	54	0	19	47	66	1	115	7	123	0	103	11	114
5	0	11	63	74	4	98	9	111	1	103	14	118	11	62	0	73
6	0	25	59	84	0	57	19	76	0	202	44	246	2	99	5	106
7	0	65	63	128	0	60	29	89	0	25	2	27	0	39	6	45
8	0	68	59	127	0	61	13	74	0	65	1	66	1	84	1	86
9	1	49	45	95	0	35	40	75	0	32	23	55	0	32	0	32
Total	1	316	528	845	4	442	213	659	3	767	165	935	37	526	64	627
Percentage	0	37	62.5	100	1	67	32	100	0.3	82	17.7	100	6	84	10	100

Notes: 45 Households of all 4 VDCs fall in severely vulnerable class (1.4 per cent), 2051 households of all 4 VDCs fall in highly vulnerable class (67.0 %), 970 households of all 4 VDCs fall in rest other classes (31.6 %). (The rest classes include moderately vulnerable, vulnerable and low vulnerable).

Nature of Vulnerability

Ward-wise results are presented in Table 16. These include households in the severely and highly vulnerable categories. Overall, 37%, 68%, 83% and 90 % of the populations in Devgaun, Rampur Khadauna, Bhasedhawa and Brahmapuri respectively are in the highly vulnerable category.

In all VDCs, poor access to information about policies, relief and climate issues emerged as the factors contributing most to vulnerability. There are no mechanisms for providing weather-related information or early warnings at the local level in any VDC. National radio and TVs do broadcast information on the daily temperatures and rainfall recorded at selected stations, but people rely on local indicators such as dark clouds to discern if it is likely to rain. The information on vulnerability collected was shared with the representatives of the VDCs and used to formulate pilot adaptive measures. Another factor was the gender imbalance.

TABLE 17 | VDC-Wise Vulnerability According to the Dis-aggregated Parameters

Component with magnitude of vulnerability	VDC wise households in different vulnerability class			
	Devgaun	Rampur Khadauna	Bhasedhawa	Brahmapuri
Physical				
Severe	-	57 (9)	16 (2)	65 (10)
High	100 (12)	376 (57)	637 (68)	336 (54)
Moderate to low	745 (88)	226 (34)	282 (30)	226 (36)
Total	845	659	935	627
Social				
Severe	9 (1)	3 (0.5)	4 (0.4)	5 (1)
High	180 (21)	101 (15)	158 (17)	104 (17)
Moderate to low	656 (78)	555 (84.5)	773(83)	518 (82)
Total	845	659	935	627
Economic				
Severe	207 (25)	220 (33)	447 (48)	482 (77)
High	291 (34)	233 (36)	341 (36)	87 (14)
Moderate to low	347 (41)	206 (31)	147 (16)	58 (9)
Total	845	659	935	627
Access to resources				
Severe	198 (23)	205 (31)	122 (13)	176 (28)
High	517 (61)	296 (45)	763 (82)	412 (66)
Moderate to low	130 (16)	158 (24)	50 (5)	39 (6)
Total	845	659	935	627
Access to communication				
Severe	474 (56)	423 (64)	599 (64)	375 (60)
High	6 (1)	1 (0)	-	-
Moderate to low	365 (43)	235 (36)	336 (36)	252(40)
Total	845	659	935	627
Gender perspective				
Severe	524 (62)	186 (28)	516 (55)	489 (78)
High	19 (2)	87 (13)	46 (5)	19 (3)
Moderate to low	302 (36)	386 (59)	373 (40)	119 (19)
Total	845	659	935	627
Psychological				
Severe	-	-	-	2 (0.3)
High	2 (0.3)	1 (0)	-	1 (0.2)
Moderate to low	843 (99.7)	658 (100)	935 (100)	624 (99.5)
Total	**845**	**659**	**935**	**627**

Shared Learning Dialogue (SLD)

SLD is a useful iterative tool of engagement.

A total of seven SLDs with flood-affected persons and key informants (KI) were carried out at each VDC. An attempt was made to include equal numbers of men and women in each SLD, but this was not always possible. To ensure that women were represented in SLDs, local partners were asked to visit villages and request women representatives to actively participate. The community suggested the timing and duration of the meetings. All proceedings were recorded so that the mix of Bhojpuri / Maithili and Nepali languages used in the discussion could be transcribed in Kathmandu and summaries prepared in English. Partnership with locally-based NGOs was helpful in conducting the SLDs.

A separate national-level SLD was also held. The discussions were recorded and summaries produced. Later SLDs in the VDCs were not recorded because the security situation in the Nepal Tarai deteriorated. The facilitators took notes during the discussions which were compiled to produce synopses. The findings from SLDs, hazard maps, vulnerability mapping and PRAs carried out at the ward level contributed to the conceptualisation of village-level adaptation action plans for all four VDCs. Past experiences from local organisations and other I / NGOs such as Oxfam GB, the Nepal Red Cross Society, and the Lutheran World Service were also referred to.

The major challenge during the SLDs was to estimate the extent of property lost due to floods in the past as people tended to exaggerate because they believed support agencies would not assist better off people. Organisations such as the Agricultural Department and the Poverty Alleviation Fund have conducted meetings and surveys in the past and some organisations even helped form groups, but people complained that there were no tangible benefits to the village and that work was limited mostly to collecting names and other information. People suspect that money is allocated by agencies but lost before it reaches the village level. The community repeatedly asked us what programmes would follow the SLDs and surveys.

Interacting with women was difficult even when women facilitated the discussions. This was especially so when they attempted to find out the difficulties faced by pregnant and menstruating women and new and lactating mothers during times of floods. Villagers were unwilling to reveal their experiences even to female community workers. The lack of toilets and the inability to commute were mentioned as major problems.

Bank-cutting is a major hazard as it does not spare even well-off landowners. Some landowners have lost all their assets in past floods. They lamented that their lineage would die out because no one would want to marry into their families.

Difficulties were encountered while carrying out SLDs. People wanted to know the political affiliation of the facilitators. They would ask, 'Which political party do you work for?' and complain that it is very hard to touch base with their political leaders. People also enquired about the benefits they would get from the study.

BOX 1 | **National SLD**

A one-day national SLD on Flood Disaster Risk Reduction was organised in Kathmandu on 6 November, 2006 after several rounds of local-level SLDs were held. The objective was to discuss approaches that organisations in Nepal take in order to reduce flood disaster risk and to share perceptions from field. The meeting aimed to initiate discussions on the link between disaster risk mitigation and long-term development while sharing by sharing experiences. Representatives from organisations involved in water management and disaster prevention, NGOs, INGOs and the media participated in the SLD. The discussion focused on perceptions of hazard and organisational activities as well as on adaptation approaches to risk mitigation. Both climate-related and non-climate-induced disasters were discussed. Some of the key issues identified during the national SLD were as follows:

- Embankments have both positive and negative roles.
- Opportunities must be communicated to the local level, and awareness about disaster risk mitigation increased.
- The problems faced by rural residents do not get priority in the media.
- The National Disaster Mitigation Act of 1982 needs to be revised to incorporate preparedness, resettlement and rehabilitation aspects of disaster victims.
- Though awareness has increased people do not incorporate preventive measures such as retrofitting elements while building homes.
- Highway construction is a major cause of increased landslides.
- Communities need to be made aware of the adverse impact of roads and embankments.
- Financial measures such as insurance and micro credit are useful tool in disaster risk reduction.
- Disaster mitigation needs to be integrated into regular development programme such as water supply, sanitation and irrigation.
- Spillage of faeces from pit latrines is a hazard during flood.
- The lack comprehensive policy about issues of compensation, insurance and livelihood debilitates disaster risk reductions efforts.
- Communities seek compensation for properties lost due to flooding and submergence but laws are not very clear on this count.
- The red mark the Department of Water Induced Disaster Prevention (DWIDP) uses to delineate the extent of vulnerability on their maps drives land prices down. Many communities do not favour such a practice.

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Local level share learning dialouge.

BOX 2 **Local SLDs**

The participants of local SLDs involved representatives of the four VDCs, Bramhapuri, Bhasedwa, Rampur Khadauna and Devgaon VDCs. During the SLDs participants discussed on flooding, the physical social characteristics of the region including changes in flow condition and impact of structures.

The Bagmati and the Lal Bakaiya River systems
Both rivers are sources of hazard in the monsoon. The rainfall in its hilly catchment is high and some pockets get cloudbursts. The result is immediate flooding. The 1993 flood was one such event. The lower region of Rautahat District is affected by embankments and other structures that constraint drainage causing prolonged inundation.

Though smaller than the Bagmati, the Lal Bakaiya is a flashy and turbulent river. Its head catchment is situated between the Chure and the Mahabharat ranges and the area receives high rainfall. The overland flow is collected and discharged through the narrow Chure gorge that travels with high velocity carrying sediment and debris load. This river causes bank cutting and much sand deposition.

The Rohini River system
The flooding of mainly the Jharahi and Dhanewa rivers affect Rampur Khadauna and Devgaon. Embankments and canals cause drainage congestion exacerbating the effects. The rising level of the river beds is another threat.

The following issues were identified

- Climate is changing due to the excessive use of natural resources, environmental degradation and human activities.
- There is no early warning system. People use their senses to feel the direction and movement of the air to predict possible rainfall and consequential flooding. A timely forecast could minimise the impact of flooding and help locals take preparedness activities.
- Flooding usually occurs at night when every one is asleep.
- Floods come even if it does not rain locally.
- Inundation lasts from a few hours to a few weeks depending upon the volume of rainfall.
- During floods, the members of the communities help each other without any discrimination based on religion, caste or political ideology.
- In all villages flooding affects women more than men.
- Embankments and check dams can minimise flood effects.
- In Bramhapuri the community use a local school building as a shelter during floods. In Rampur Khadauna, Oxfam GB has provided two boats to be used for rescue purpose.
- Bamboo and other trees on the river banks help minimise bank-cutting.
- Local communities have organised to form saving and credit groups in Bramhapuri, Rampur Khadauna and Devgaun.
- All of the villages have road system and access to communication such as CDMA. They listen to FM radio services.
- The government has made little effort to mitigate flood impacts in the villages. The communities seek support from government departments but do not know whom they should approach.
- None of the VDCs have government office, health post, sub-heath post, veterinary or agriculture service center. Villages have primary schools.
- Floods bring alluvial soil that improves agriculture and timber, which can be used as fuel.
- Flooding also destroys paddy, wheat and potatoes.
- *Masur*, *parwal*, watermelon, *aalas* and *aluwa* are planted on land covered with mix of sand and clay.
- The Nepal Gandak Canal passes through Rampur Khadauna and Devgaun but the supply of water for irrigation is unreliable.
- Groundwater table in Devgaun is between 60 and 70 meters deep and is difficult to tap for irrigation.
- Ram Gram, Butwal and Narayanghat in Nepal and the towns across the border in Uttar Pradesh are potential markets for the agriculture produce of Rampur Khadauna and Devgaun. Chandranigahapur and Gaur in Nepal and Baraganiya in Bihar are potential markets for farmers of Brahmapuri and Bhasedwa.
- Embankments built along the banks of the Bagmati, Lalbakaiya, Jharahi, Dhanewa and Bhalui rivers occasionally breach. Bank-cutting is common.
- The poor and so-called low-caste families are most seriously affected by floods.
- Agricultural production is decreasing and poverty increasing. The poor get displaced each year and become landless.
- In the aftermath of floods epidemics are common. There is no organised response to alleviate the spread of diseases. Mechanism to provide medical support is very poor.
- Groundwater contamination due to arsenic is high in both Rauthaut and Nawalparasi districts. People need to be provided with support to mitigate biological and arsenic contamination of water.
- Flat roofs on the houses would help save household assets.
- Young males migrate to cities in India, Kathmandu and abroad seeking employment. They send remittances home.
- The government of Nepal does not subsidise fertilisers for farmers, who rely on Indian markets for their purchase. This causes huge difference of the produce.

Adaptation Strategies Identified

In the course of the SLDs the following measures to support adaptation were identified:

- Establishment of a simple early warning system to communicate and forecast the weather and flood dated information.
- Providing information about rainfall is important because it triggers all floods.
- Enhancing understanding concerning the influence of human interventions on flooding.
- Improving the existing canal to enhance the reliability of irrigation.
- Making arrangement for boats to evacuate villagers.
- Providing support to improve homes and evacuation shelters.
- Introducing appropriate measures to make use of groundwater in income-generating activities.
- Retaining and stabilising rivers banks.
- Insuring livestock and grains.
- Training and building the capacity of local communities.
- Providing of sanitation and drinking water facilities during floods.
- Supporting self-help-groups (SHG)
- Providing skill training for pursuing alternative livelihoods.
- Establishing fodder banks for livestock.
- Providing access to improved seeds for agriculture.
- Improving access to fertilisers and other inputs.
- Preparing VDC-level plan for adaptation.
- Improving drainage.
- Using flood-damaged river banks and flood plains for economic benefit.
- Mitigation of arsenic and bacteriological contamination in drinking water.
- Conducting community forestry activities.
- Establishing information centres.

Using visual and audio recording to capture nuances of the dialogues was useful though it required the study team to put in additional time, resources and commitment. Others researchers and facilitators need to be made aware of the value of recording, but caution is necessary while recording in conflict environments. Indeed, in all cases, the prior approval of the community has to be sought.

Since the CVA method used is static, it is difficult to capture dynamic vulnerability. Furthermore, major questions exist regarding how CVA can be incorporated into operational disaster risk reduction programmes. One way could be to provide a picture of the changing context of vulnerability by conducting CVAs at different times before and following floods. The study team intends to use this approach after the monsoon season of 2007. We hope it will help capture differences and thereby provide a basis for assessing the relevance and feasibility of the method.

Continuing dialogue with a community through SLDs is clearly a useful approach. It provides a realistic understanding of the concerns of the community and helps design support measures which build local capacity for adaptation. In other words, it can help those affected by flood disaster to identify effective responses, save assets, avoid diseases, and rebuild livelihoods. Many development programmes have aimed to achieve such outcomes but are hamstrung because they focus on the conventional top-down methods. Locating a bottom-up programme like ours within the larger framework, in contrast, can help begin the process of engaging with the root causes of vulnerability while devising practical measures to respond to the immediate needs of achieving improved security from flooding.

Conclusions

A more logical response to mitigating flood disasters is to ensure unhindered drainage.

This study has provided a broad overview of the impact of flood disasters on four VDCs situated in the Nepal Tarai along two trans-boundary rivers. The VDCs are located in the south of Nepal contiguous to the plains of Uttar Pradesh and Bihar and are typical of many communities living in the Nepal Tarai.

The study has shown that sustained monsoon rains and cloudbursts in river catchments are the main trigger of flooding in Nepal. In many cases, infrastructure constructed to improve living conditions and provide security against floods has, however, actually added to the misery of VDC residents by slowing drainage and increasing the extent of inundation. The impact of flooding is an outcome of both social and economic factors as well as political and historical processes. Gender inequity further accentuates vulnerability. Although we did examine this aspect in detail, the ongoing turmoil and violence in the Nepal Tarai is an additional debilitating factor. Very little real-time information is available about any given flood situation as the mobility of the people is limited due to inundated roads, frequent road blocks due to *bandh* (political action of closing roads) and poor security. The remoteness of the area adds to the problem. It is likely that stories of human misery will abound in the study villages and elsewhere after the 2007 monsoon rains receded and the affected regions are more accessible.

We can argue that flood disaster risk reduction needs to undergo a paradigm shift if it is to find salience in the changing social and physical context. For mitigating flood damage, structural or engineering approaches, despite their limitations, continue to get preference over softer methods. The concerns of affected individuals, families and communities have not been systematically woven into this approach to policy making. Governmental policies have not helped build resilience to floods or the ability to cope with their effects. Institutional dysfunction is widespread: state agencies fail to innovate and make their responses to flood disasters effective. Poor drainage and waterlogging are widespread and their impact on communities is serious.

The primary reason for flooding is high rainfall during the monsoon combined with interventions that block drainage. While the rainfall sustains region's agriculture, when the land becomes totally saturated, excess overland flooding that river channels cannot accommodate spills onto the land adjoining river banks causing prolonged inundation, loss of crops and land, and other damage. A logical response to mitigating flood disasters is to ensure that there is unhindered drainage of floodwater into rivers and to reduce vulnerability. Hydro-meteorology, disasters as opportunities and adaptive responses are issues worth highlighting.

Hydro-meteorology

Achieving effective disaster risk reduction requires developing a better understanding of the study region's hydro-meteorological character. The collection, collation and dissemination of data on rainfall, river flow, sediment-load and geomorphology are essential. To capture the variability exhibited by micro-climates, we need more stations to monitor rainfall and other climatic parameters in the Tarai and mountainous regions. The data from such stations can help improve our understanding of the climatic conditions of the region. They will also be useful for forecasting and thus enabling preparedness for minimising flooding provided that the data they collect can be disseminated, interpreted and analysed in time. Particularly in fields such as disaster mitigation where responses depend on a combination of basic scientific and wide social factors, it is critical that society has the capacity to analyse data and identify their needs and alternatives.

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Stream unable to flow through existing culvert is flowing along Nepal's east-west highway in Bardiya.

Disasters as Opportunities

Though they are part and parcel of the region, flood hazards have disruptive effects on societies and communities. One flood disaster makes the poor more vulnerable to the next and, in consequence, converts a single disaster into a series of disasters. Flood hazards become social disasters as victims are created by economic and social differences. Yet, disaster can be used as an avenue to create new mechanisms to enable vulnerable groups and those repeatedly affected by hazards to reduce their vulnerability. To that end, strategies should be formulated in such a way that they strive to change the pattern of relationships and institutional arrangements that exacerbate vulnerability to floods or any other natural hazard.

A disaster can also be used as an opportunity by planners and scientists to understand the processes within a particular geographical area, where interaction among natural, economic, social, and developmental activities result in a particular level of impact during flood events. Such an understanding would help those concerned identify new avenues for action. Though such window of opportunity may not always catalyse change or provide incentive for putting in place a more proactive approach to disaster risk, they do lay bare the inner weakness of a society, which can be used as a forensic opportunity to examine the existing interrelationship. Their usefulness to policy process may not be direct but cannot be underestimated.

One area to focus on is on understanding how livelihoods are affected, readjusted or rebuilt in a post-disaster situation. Changes in patterns and strategies adopted for making a livelihood need to be examined. The links between livelihood strategies and the environment are exposed in the aftermath of a disaster. Mitigation strategies must suit social and ecological environments and help build livelihoods. The majority of the affected people in the four VDCs studied are

The links between livelihood strategies and the environment are exposed in the aftermath of a disaster.

disadvantaged by their location and their actual hardships often go unheard when mitigation strategies are planned. By ensuring that space is created for their voices to be heard, their relative isolation can be ended. The hardships of those hit by a disaster and the support they see as necessary should be the prime concern when mitigation strategies are formulated.

How policy translates into procedures in the field is important.

Another aspect of disaster risk reduction involves analysing the driving forces that have framed national policy regarding disaster mitigation and how that policy has changed over time. Questions regarding how policy translates into procedures in the field and how it matches (or does not match) the requirements of the affected people require much deeper analysis. The answers to these questions can be useful in the execution of institutional innovations.

Adaptive Approach

Practical methods for minimising the negative social impacts of floods can often be found by building on the actions that families already take and by designing interventions which can accommodate changing situations. Such interventions need to address the challenges that a flood hazard poses as well as its impacts. In the case of floods, for example, local people often seek safety from rising floodwater by moving to higher ground, planting flood-resistant or early ripening variety crops, and stockpiling some food and emergency supplies including basic medicines, though such examples are very few. Poor access to basic drinking water, sanitation, basic health services and food stuff, however, continue be a major problem for the millions marooned. It is clear that these services must be made available, but the how question remains unanswered. We need

to continue institutional innovations to help improve access to safe drinking water during floods.

Strategies that assist people in developing alternative and less vulnerable livelihoods and reducing their susceptibility to flood hazards may be a more effective response than focusing exclusively on structural measures to control floods. An appropriate strategy might be, as people have traditionally done, to build houses on stilts or on high points ('islands') for respite during flooding. Such an approach would allow flood water to drain quickly and thus remain standing for a shorter period; it also would not interfere with the beneficial deposition of fertile silt on agricultural land. Community forestry activities can help promoting biological shield as buffer zones along the flood plains.

A control-focused approach based on embankment building, in contrast, separates rivers from their flood plains and nullifies the benefit of flood spreading. Overall, approaches that attempt to reduce the vulnerability of people to flood hazards by enhancing capacity and by building on existing mitigation actions may be more effective. An added local benefit is that people can implement these measures in their localities without major institutional restructuring. Some strategies are already being employed while others were identified in course of the study.

In the long term, building transport and informational infrastructures that do not impede drainage may prove to be effective in mitigating flood disasters. It is worth repeating that roads must be designed so they do not hinder drainage. Managing drainage is a challenge for the community of civil engineers in South Asia; national engineering codes will need revision and new insights incorporated in water education stream. We need to focus on the formulation and implementation of appropriate laws and on compliance with municipal codes. This is an arena for continued thinking and investigation. Improving preventive health care facilities and diversifying livelihoods are other challenges. These are elements of governance which need to evolve in any given geographical, social and political context.

In the End

Flood hazards are widespread and have different negative impacts on different communities and households. During the monsoon in South Asia large-scale inundation causes hardship to people in the plains, while landslides, mud and debris flow affect people the hills. Governments of South Asian nations need to focus on approaches that are rooted in the nature of the problems, whether rural or urban areas. People in

Improving preventive health care facilities and educational institutions and diversifying livelihoods can build adaptive capacity.

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Roads and transportation help mobility but poorly designed bridges can constrain drainage and exacerbate flooding.

rural areas face disadvantages stemming from the lack of educational and basic heath services, job insecurity, poorly diversified livelihoods, underemployment and unemployment. In addition, prevailing policies often discriminate against women and deny economically and socially disadvantaged communities access and entitlement to assets. The market tends to take advantage of people rather than the other way around; marginalised farmers often cannot negotiate good bargains. An effective response to flood disaster mitigation calls for the creation of pro-poor policy regimes and the allocation of resources to vulnerable groups. The devolution of political power can make measures for minimising the impacts of flooding more effective.

The government must facilitate the creation of a level playing field for unbiased regulation, monitoring and facilitation.

The government must facilitate the creation of a level playing field through unbiased regulation, monitoring and facilitation. In its turn, the market must innovate in order to create asset-building opportunities. Uncontested, both the government and market show tendencies towards centralisation and rapaciousness. Egalitarian social auditors, using critical rationality, must provide a balance. When all three social solidarities are balanced, the terrain will be in a creative tension, thereby making an effective response to flood disaster mitigation possible.

In the plains of the Himalaya-Ganga human settlement has evolved adapting to flood and low flow conditions in rivers. The notion of totally controlling flooding is neither possible nor desirable. Flood damage mitigation approaches need to begin by ensuring drainage and minimising flood risks at local levels. This reorientation needs to be supported by a framework of governance which focuses on empowering communities to build their assets and resilience. Such initiatives need to be part of a societal process in which there is space for a regulatory hierarchic state, an innovative individualistic market and cautionary social auditors to remain in a creative balance.

The implementation of this study coincided with one of the most difficult and tumultuous period in Nepal history, as the country moves towards social and political restructuring. As expected, regional groups and other interests are being expressed but have yet to be resolved through political negotiations. Also Nepal's Tarai region is in a state of turmoil. One manifestation of the confusion has been violence. In fact, Rautahat District saw one of worst examples of carnage in Nepal's history as thirty persons were killed in a single event of political violence. Despite the sense of insecurity, the presence of locally-based groups enabled the study to go ahead.

Needless to say the capacity to respond to the impacts of change, including those induced by climate change, is essential. Referring to the Himalayan region, the fourth IPCC (2007) report has suggested that "heavy precipitation events, which are very likely to increase in frequency, will augment flood risk." The communities in the lower Bagmati and Rohini regions face such a risk. This study has enabled us to better understand the nature of vulnerability of the communities to such a risk and how their ability to adapt could be enhanced and the risks minimised as Nepal and Nepali societies continue to undergo transformative change. The exact way in which this understanding will contribute to policy-making is an issue for the future.

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