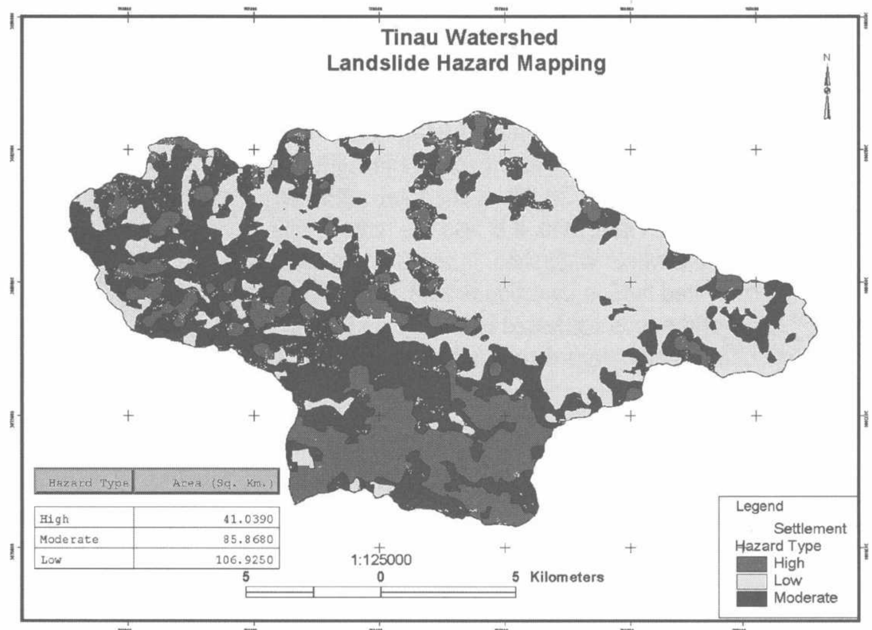
working in the watershed area, former president of identified high hazard and risk VDCs, VDCs secretary, and some members of local community development organization were invited to share the results. As per the suggestion of seminar one-day discussion programme with the local community and representatives of community development local organizations in high hazard area was organized in Madniphnat and in Chhap Koldada in order to raise awareness of local community. The discussion was concentrated to identify hazard areas and needed emergency and mitigation measures.

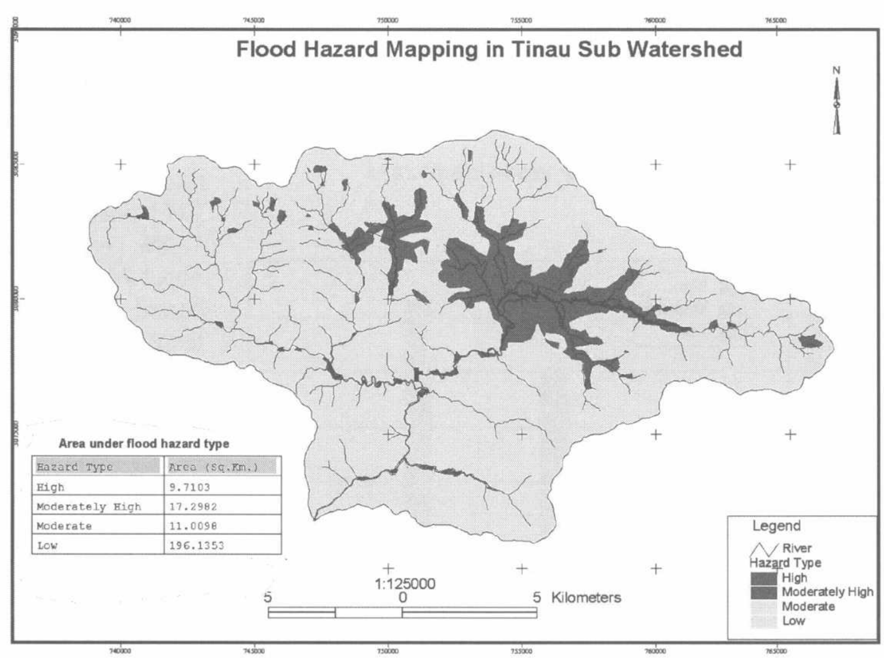
The hazard and risk maps prepared were provided to the local community. Mutual relationship was established with District Committee of Paropakar, the local social organization. Maps and major finding were provided to this organization so that community-based programme of public awareness and bioengineering measures is developed to reduce the risk of landslide in Koldada. Paropakar is working in the disaster awareness and bioengineering measure to landslide. During the implementation of project closer relationship was also been established with Nepal Red Cross Society, Palpa Branch, and Department of Soil Conservation and Watershed Management, District Office that are active in disaster management in the study area.

Results

About 202 active landslides were identified based on aerial photo/satellite image interpretation, toposheet (1993) and field observation. Out of 81 landslide scars identified in aerial photo of 1978, 63 landslide scars are found stopped. About 103 old landslide scars were identified. These landslides appear to be more dormant and more active than stabilized type. Most of the landslides are found composed of mud, soil and rock. About 55% of landslides are found depth in nature (i.e. above 3m depth) The two largest landslides in terms of the length, coverage and depth occurred in watershed with in last 40 years namely landslide of Masyam and Bausidadna of Chhap were found located in cultivated land and most destructive in nature. The landslide of Chhap appears as dormant, whereas the landslide of Masyam is active. Whereas The landslide hazard map as generated following above mentioned



Map 2. Landslide hazard map.



Map 3. Flood hazard map.

methodologies shows that about 17.6% land lie in the high hazard zone and 36.7% in the moderate hazard zone (map 2).

In terms of flood hazard zone 11.5% of the land lies under the high and moderately high hazard zone and 4.7% of land falls under the moderate hazard zone (map 3). Regarding geographical location Madni phant, the fertile valley of watershed is found severely affected by frequent flood, channel shifting and water logging. The problem of channel shifting, chute cut and neck cut is frequent in this part of region. An attempt was made to assess the impact of hazards on different land use/land cover in order to understand how the people have been managing the land resources in the light of the probability of occurrence of damaging events of landslides and floods. About 84.7% of total 27.04 km2 high and moderately high flood hazard zone lie in cultivated land, which is about 20.3% of the total cultivated land of Tinau Watershed. It is also the most fragile land of the whole watershed. In terms of distribution of cultivated land in landslide hazard zone, only 7.5% of the total cultivated land is in the high and moderately high hazard zone, which is about 20% of the total high and moderately high landslide hazard of the watershed. Whereas about 73.3 of high hazard and moderately hazard area lie in the forest landuse, which, shares 27.5% of the total area of forest land.

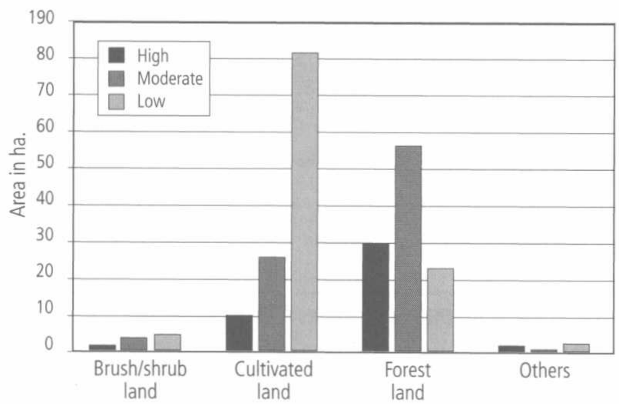


Figure 3. Landuse by landslide hazard

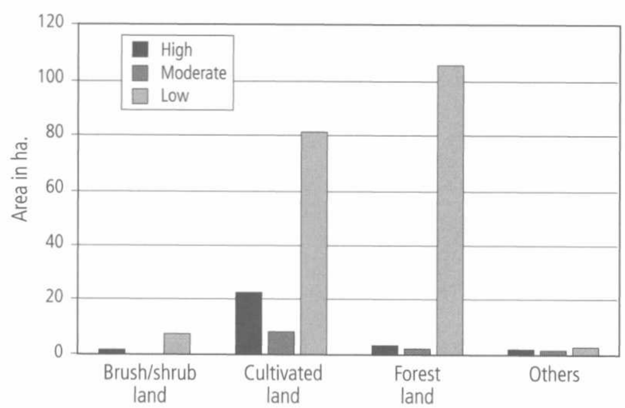


Figure 4. Landuse by flood hazard

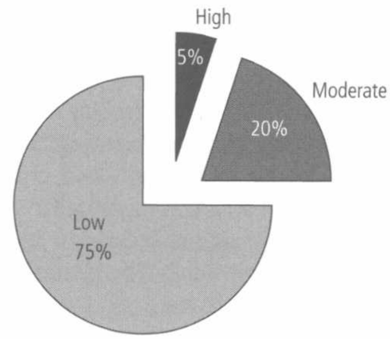


Figure 5. Distribution of house unit in different flood hazard zone

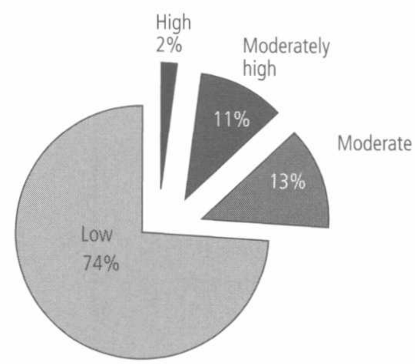


Figure 6. Distribution of house unit in different landslide hazard zone

Similarly, an attempt was made to assess the location of the house units in areas under various hazard levels. Nearly 2% of the house/buildings, i.e. 134 houses, are located in the high-hazard area and 10.8% i.e. 707 houses, in the moderately high area. About 73.74% or 4844 houses are in the low hazard area. Regarding the location of house in terms landslide hazard area, 5.4% houses are in high hazard area, 74.4% of houses are located in low hazard area and rest houses are in moderate hazard area.

Distribution of road length by road type by different hazard type is shown in Table 1. There are many active and dormant landslide scars along the Siddharth Highway. Distribution pattern shows that more than one third length of highway of sub water-shed is lie in the high hazard zone. About 0.3 km

Road type	Flood hazard				Landslide hazard		
	High	Moderately High	Moderate	Low	High	Moderate	Low
Highway	0.295	4.043	1.696	29.259	13.191	10.931	11.161
District road			2.013	2.443			4.455
Feeder road		0.32	1.501	26.396	6.3	6.997	14.834
Other road			0.211	6.746	0.865	0.609	5.477
Trail	7.355	24.873	23.101	356.349	52.159	143.017	216.191

Table 1. Length of Road (in km) by different hazard type

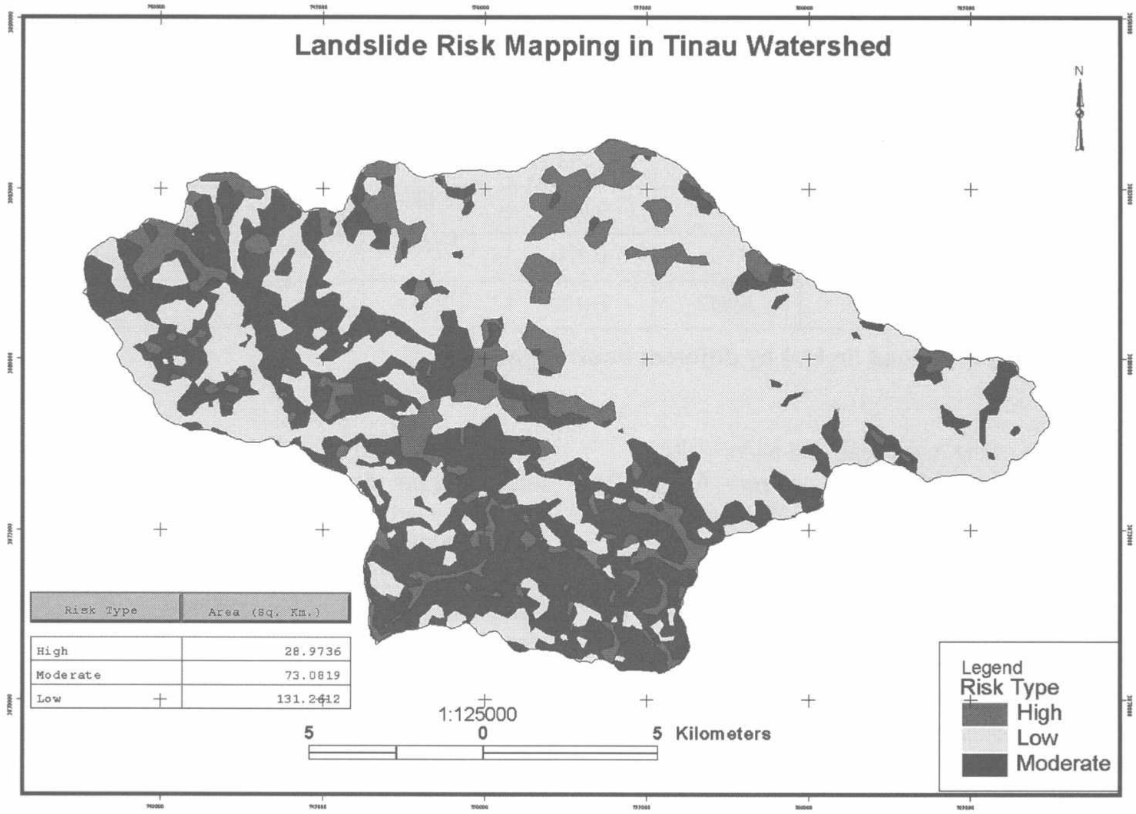
and 7.4 km of the major road and minor trails respectively lie in high flood hazard zone. About 4.04 km feeder and major road and 24.873 km minor trails are in moderately high hazard area. For landslide hazard 13.2 km out of 35.29 km highway, 6.3 km of feeder road are in high hazard area (Table 1).

About 12.4% of the total area is under the high landslide risk zone in terms of expected loss/damage to property. Similarly, about 31.3% and 56.3% of the area is under moderate landslide risk and low landslide risk zones respectively (Map 4). About 7.8% of total area is under the high flood risk zone in terms of expected loss /damage to property. Likewise, about 7.4% and 84.9% area is under moderate and low flood risk (Map 5).

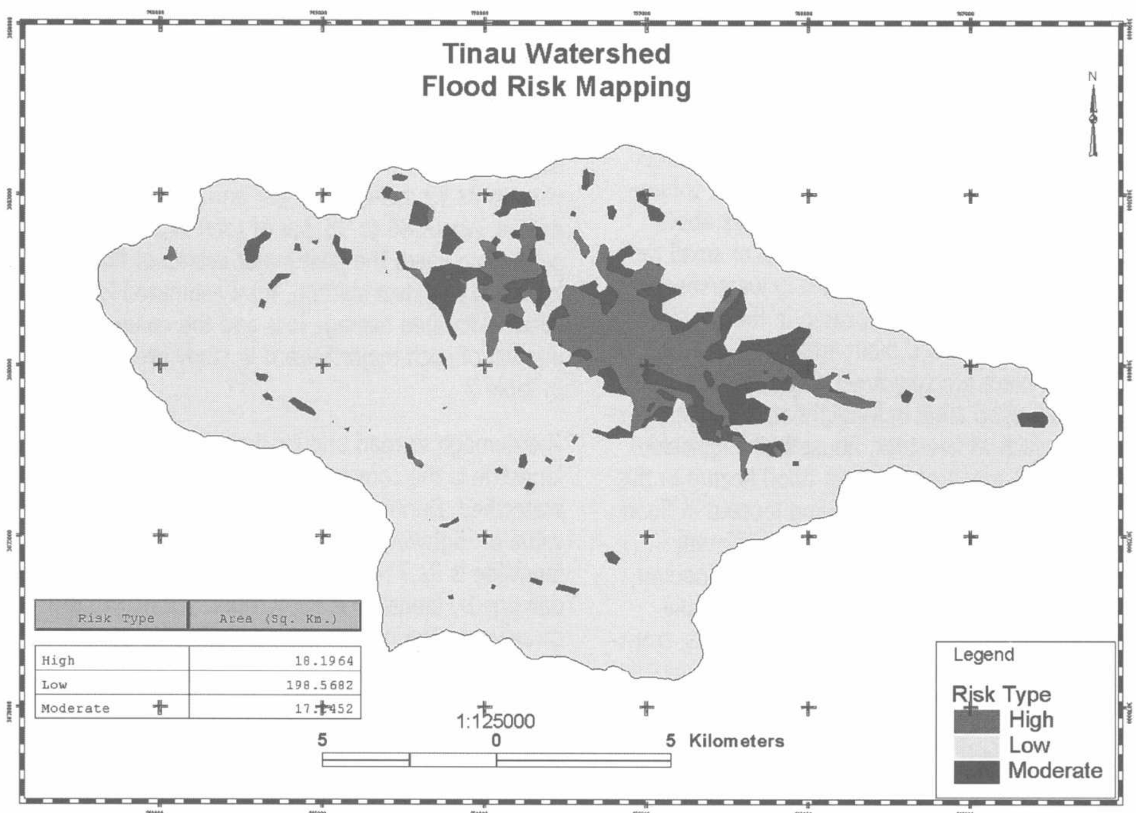
As reported by focus group discussion out of 6716 households in the watershed, 2327 households are exposed to hazards of different types. Out of them 37.26% of households belong to Magar and other hill ethnic groups, and they are found more vulnerable to hazard. In terms of economic class about 32.4% households are either marginal or small farm households. The settlement system in watershed is typical that the houses are located in the hill side and the valley and flood plain area is mainly used for cultivation. There are very few houses located in very high flood hazard zone in Madiphnat. So most of the properties such as livestock, house/building, fodder and fruit trees etc. are safe from flood hazard in this region. However the cultivated land located in flood prone area is only means of livelihood of many people residing nearby areas. So frequent flooding and channel shifting adversely affect the people whose land is located there. The canals, roads, crops and cultivated land in flood prone area are annually swept away by river flooding and regular channel shifting. In the northern part of the Madiphant some settlements are situated in very high flood risk zone. Mostly affected people form river bank cutting, channel shifting and flood in this area are poor landless tenant families. Out of 39 households of Madiphnat surveyed 12 households were of poor tenants.

The estimated value of element of risk (excluding live loss) in the watershed is Rs. 5.4 billion. The highest value in susceptible zone is Rs. 1.9 billion in Madanpokhara VDC. The loss of past major water induced hazard in watershed is found varies with the intensity of events. During the last 42 years the loss from river bank cutting is Rs.19.8 billion with per event loss of Rs. 800 thousand. Like wise the loss from major floods in last 42 years is Rs. 28.2 billion with the per event loss of Rs.2.6 million. The total loss from landslide events in past 42 years is 6.5 billion with per event loss of Rs. 300 thousands. The loss from water logging in Madiphnat since last 13 years is Rs.39 million with per annual loss Rs. of 3 million. About 86 to 98.3% of total exposed value is privately owned. The past major events of flood, landslide and river shifting, total estimated loss, per event estimated average loss and the recurrence interval of such major hazard in study area is shown in Table 2.

The damage to road and road closure due to landslide is the common phenomena of this watershed. During the past three years the total value of Highway repair after the damage by landslide is Rs 714400. The maximum loss from road damage by landslide is Rs. 420000 during the last three years. During this period altogether 39 landslide events caused the Highway closure for 446.5 hours (Table 3).



Map 4. Landslide risk mappling in Tinau Watershed



Map 5. Food risk mappling in Tinau Watershed

VDC	Duration	Period	No. of Event	Recurrence Interval	Total Loss (Rs.)	Per Event loss (Rs.)
Flood						
Chitrundhara	2038-60	22	4	5.5	2710680	677670
Bandi Pokhara	2038-56	18	2	9	214000	107000
Madan Pokhara	2018-60	42	33	1.27	116644000	3534667
Kusumkhola	2041-60	19	8	2.38	480000	60000
Kaseni	2018-60	42	33	1.27	4290000	130000
Jhadewa	2054-60	42	19	2.2	152000	8000
Telgha	2032-60	28	9	3.1	140460000	15606667
Pokharathok	2018-60	42	33	1.27	1485000	45000
Koldanda	2038-55	17	3	5.6	1253800	417950
Gothadi	2038-52	14	3	4.7	3000000	1000000
Chidipani	2018-60	42	33	1.27	9570000	290000
Humin	2018-60	42	19	2.2	1567500	82500
Devinagar	2018-60	42	6	7	385260	64210
Rupse	2018-60	42	33	1.27	231000	70000
Major Landslide						
Tansen	2038-59	21	7	3	3109100	444167.7
Chirtundhara	2036-45	19	9	2.1	1431000	159000
Bandi Pokhara	2038-55	17	5	3.4	1707000	341400
Madan Pokhara	2027-55	28	13	2.2	10936250	841250
Thimure	2032-60	28	42	0.67	4171999	99333.33
Kusumkhola	2042-60	18	16	1.13	3200000	200000
Masyam	2027-55	28	40	0.7	333333	83333.33
Khasauli	2036-57	21	28	0.75	6499080	232110
Koldanda	2038-60	22	68	0.32	28786664	423333.3
Rupse	2042-60	18	12	1.5	3264000	272000
Gothadi	2037-52	15	11	1.36	1540000	140000
Major river bank cutting/channel shifting						
Dobhan	2018-60	42	53	0.8	2863590	54030.43
Kaseni	2018-60	42	64	0.7	3040000	47500
Jhadewa	2018-60	42	81	0.5	32400000	400000
Pokharathok	2018-60	42	83	0.5	1660000	20000
Humin	2018-60	42	63	0.6	126000000	200000
Chidipani	2018-60	42	81	0.5	864000	10666.7
Madanpokhara	2018-60	42	93	0.4	23250000	250000
Rupse	2018-60	42	83	0.5	8300000	100000

Source: Field Survey, 2003

Table 2. Recurrence interval and estimated loss of major hazards in Tinau watershed

Date	Blockage duration in hrs	Landslide type	Cost (Rs.)
17/6/03	22	Rock fall	35000
18/7/03	14	slide	35000
18/7/03	3	slide	50000
17/7/03	3	slide	10000
17/6/03	2	Rock fall	3875
16/6/03	16 5	slide	12400
2/7/03	5	slide	4000
4/7/03	5	slide	4000
1/10/02	5	slide	285000
8/10/02	2	slide	110000
2/10/02	6	slide	3000
25/9/02	3	slide	1670
2/7/02	2.5	slide	NA
17/6/02	21	slide	18000
5/6/02	6	slide	NA
17/7/01	42	slide	NA
17/07/01	33.5	slide	NA
19/7/01	45	slide	NA
25/6/01	3	slide	4200
22/06/01	2	slide	420000
29/5/01	9	slide	5500
31/07/01	3	slide	4500
1/8/01	5	slide	7500
18/8/01	2	slide	3000
19/7/01	60	slide	80000
22/8/01	6	slide	9000
24/8/01	7	slide	10500
19/7/01	3	slide	4500
22/9/01	6	slide	9000
19/7/01	2	slide	3000
3/8/01	13	slide	7200
30/7/01		slide	7500
30/7/01	2	slide	3000
1/8/01		slide	3000
5/8/01	81	slide	106000
23/8/01	4	slide	10000
29/7/01	2	slide	7000
2/8/01	partially blocked		10000

Table 3. Major events of highway closure by landslide and value of repair after the damage (2000–2003)

The strategies adopted by household to minimize the risk of landslide, flood and other geomorphic hazards include evacuation from hazard area to other area, construction of small structure to control rive bank cutting and landslide, retaining wall, and tree plantation. The local people are also adopting crop calendar and stock of certain grains/crops for future insecurity to cope with uncertain disaster in future Similarly, in Madniphnat area the local community have settled their settlement in hillside area, and the flood plain is used for only cultivation purpose. It also helped them to safe the lives and loss of other assets from frequent flood hazard.

However the condition of poor people is found to severe There always food deficit to the landless, marginal and poor people. The information collected on focus group discussion shows that about 17.2% households of watershed area lives in food deficiency condition for more than 6 months and 21.3% households have food deficiency of about 1 to 3 months. The household survey of high flood and landslide hazard area shows that about 53% of households have not any such food stocking mechanism due to the food deficiency. Most of the disaster stricken poor households are found earning other lands as a tenants. However, the underprivileged caster and ethnic and women headed households have to pay additional production (certain extra portion) locally called Gunjais to the landholder.

The impact of disaster between gender is also found unequal in terms of workload, decision making power, financial status, and roles and responsibilities. It has major impact on women especially in times of disaster who disproportionately assume a greater responsibility of family.

The strategies adopted by other GOs and NGOs are mostly post disaster measures and relief distribution Some structural works have been carried out. It is only after the disaster events. Most of such efforts are found driven by the traditional relief and disaster preparedness, centralized top down approach. Contrast to it some local organization, and NGOs and District Soil Conservation office recently implementing the community based disaster mitigation programme. In this approach local communities are expected to be involved in decisions from which they were previously excluded. However, in many cases the community-based approach also found unable to address the social difference across gender, class, castes etc., which also highly differentiate the impact, response and recovery capacity of people toward disaster. The underprivileged community member like women, so called Dalit, and ethnic people are found excluded from decision-making and access and control over resources. During the period of focus group discussion, seminar and later discussion programme local people raised such issues. According to the local community member the poor and under-privileged member of community have been purposively excluding from the relief distribution. In many cases, the structural construction measures are constructed suppressing their views on behalf of elite members of community.

Lesson Learned

The GIS and remote sensing tools can fruitfully be used for landslide and flood hazard and risk assessment. The risks indicated by the combination of vulnerability maps (based on population, economic value of the property, and infrastructure) with hazard maps could be useful in prioritizing areas for the implementation of disaster preparedness plans and mitigation measures.

The failure of past relief and post disaster activities in disaster management activities shows the lack of participation of local people in the entire process of disaster management activities. There is need for the establishment of local institutions responsible for disaster preparedness. Provision should be made to strengthen such institutions through training and technical and financial support. Efforts should also be made to create awareness among the local people.

Mass poverty and low level of off-farm activities, illiteracy, and poor service facilities have contributed to the low response and recovery capacity to deal with disasters. Unless the response and recovery capacity of the local people is improved, the loss and damage are likely to increase. Therefore, disaster reduction and preparedness strategies should include components such as poverty reduction and empowerment of women and other disadvantaged groups in the community and overall development activities in sustained way.

Structural measures have been adopted in some areas in order to reduce the risk of landslides, debris flow, floods, and riverbank cutting. In the absence of construction standards and regular monitoring and maintenance of already constructed structures, the risks to disasters have further been increasing. It is in this context that equal emphasis should be given to monitoring and maintenance of the structures already developed. Similarly, efforts should be made to develop construction standards for buildings and infrastructures.

Prevailing high conflict among different groups of community in terms of resource use, decision making in community, access, share and controls over resources use or entitlement and access approach should be addressed in any disaster management activity.

Early warning system has not yet been developed. Keeping in view the lead-time of flooding between highland and lowland areas, it is essential to develop a mechanism of community-based warning system. The magnitude of landslide, debris flow, and flood events can be reduced if strong conservation measures are implemented.

Mechanisms to share the cost and benefit of conservation measures between highlands and lowlands should be introduced. It is in this context that the highland-lowland interaction should be taken into consideration while selecting areas to implement community based disaster management programmes in the future.

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