

Disaster Risks and Community Response: A Case Study from Ilam, Nepal [†]

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Abstract: A field study was conducted in six Village Development Committees (VDCs) of Ilam district to identify common disasters linked with climate change and people's response mechanisms to those disasters in farming communities. Altogether, 300 randomly selected households facing different disaster problems were interviewed using a structured and semi-structured questionnaire, which was supplemented by direct observation, timeline analysis, a key informant interview, and a focus group discussion. In addition, secondary data were collected from the District Agriculture Development Office (DADO), Ilam, the Central Bureau of Statistics (CBS) and the Nepal Red Cross Society (NRCS), Ilam. Farmers' perceptions and the reviewed literature revealed that floods, landslides, droughts, insect pests, hailstorms, and fires comprise a major disaster risk, and they have been affecting agriculture, livelihood, physical infrastructure, and property for years. It was found that different types of loss, such as landslides, have the following risks and impacts: loss of land (45% of families) and crops (90%), property loss (10%), loss of physical resources (50%), effects on water resources (69%), loss of livestock (5%), forest degradation (72%) and loss of human life (3%). The risks and impacts of flood, drought, and fire are also presented in this study. It was also found that local communities adopt different mitigation measures for different disasters including afforestation, checking dam construction, awareness creation, contour farming, relocation, shed reconstruction, construction of plastic ponds, and conservation of local varieties (different frequencies for different measures). Social networks play an important role in mitigating disaster risks. People get help from government (38% families) and non-government (50% families) organizations, friends (22%), neighbors (44%) and relatives (20%) in the form of loans (18%), helping hands or physical support (77%), information (62%), and basic need materials (48%) to manage or respond to disaster risks. The paper suggests that local mitigation measures need to be supplemented by more sustainable solutions to make the efforts sustainable, which requires local level integrated planning and coordinated efforts.

Keywords: disaster risk reduction; agriculture; livelihood resources; adaptation; sustainable development

1. Introduction

Nepal is prone to a variety of recurring natural disasters, such as floods, landslides, snow avalanches, glacial lake outburst floods (GLOF), hailstorms, thunderstorms, cold waves, hot waves, droughts, epidemics, and earthquakes. Out of the 75 districts in the country, 49 are prone to floods and/or landslides, 23 to wildfires, and one to windstorms. A total of 64 out of 75 districts are prone to disasters of some type [1]. Natural disasters include earthquakes, fires, floods, landslides, heavy rains, droughts, famine, epidemics, and other similar natural disasters [2,3]. They include industrial

accidents or accidents caused by explosions or poisoning and any other kinds of disasters [4]. According to the Action Aid Position Paper, any situation where there is an exceptional and widespread threat to life and the subsistence that is beyond the coping capacity of individuals and/or the community is to be considered an emergency and disaster. There is a significant convergence between the problems that disaster risk reduction and climate change adaptation seek to address [5].

As shown in Figure 1, populations already exposed to climate-related hazards and effects will be at greater risk due to a projected increase in the frequency and/or the intensity of those hazards and effects as a result of global climate change.

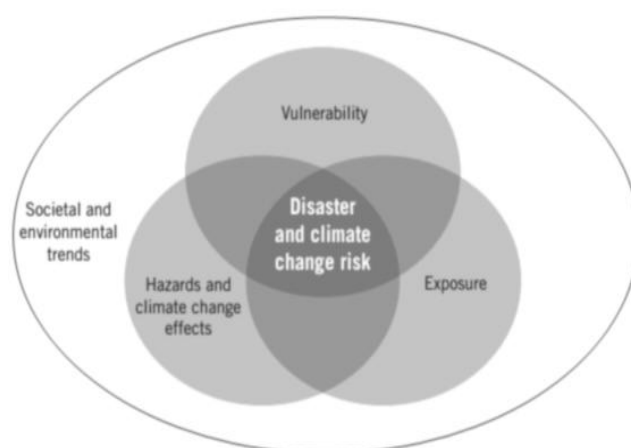


Figure 1. Disaster and climate change risk [4].

Furthermore, populations exposed to hazards may experience stresses due to longer-term changes in the climate—such as changes in seasonality, unpredictable rainfall, and sea-level rise—that affect their livelihoods and health, making them more vulnerable to all types of shocks, events and further changes. Disaster risk reduction and climate change adaptation also share a common conceptual understanding of the components of risk and the processes of building resilience. The two approaches regard risk as the product of exposure and vulnerability, either to hazard(s) or the effect(s) of climate change, or both. The greater the vulnerability, exposure, and magnitude or likelihood of the hazard/climate change effect, the greater the risk. Both exposure and vulnerability are compounded by other societal and environmental trends, e.g., urbanization, environmental degradation, and the globalization of markets [6,7]. Thus, to reduce disaster and climate change risk, exposure needs to be minimized, vulnerability reduced, and capacities for resilience strengthened in ways that address both disaster and climate change risk simultaneously, with neither approach compromising the other [8,9].

This study identified the major disasters occurring in the Ilam district, as well as documenting the indigenous knowledge of the community regarding disaster risks and response.

2. Materials and Methods

Farmers residing around Ilam Municipality and the associated disaster-prone area were the target population for the study. In particular, the study targeted residents of the six Village Development Committee's of Ilam District, Nepal, i.e., Kanyam, Chulachuli, Bhanjyang, Godhak, Namsaling and, Sangrumba. Altogether, 300 respondents were selected by applying a simple random sampling method with multiple responses.

Both primary and secondary data were collected and analyzed. Primary data were collected by using different participatory rural appraisal tools, such as focus group discussions, key informant interviews, transect walks, timelines, and community consultation. Furthermore, a household survey using structured and semi-structured questionnaires helped to gather detailed information, with 50 farmers over 30 years of age from each village were the main respondents, each with 10 years of experience facing these natural hazards. The study was based on the farmers' perceptions, the effects

of disasters and the methods they applied to cope with the situation. The secondary information was collected from various publications, such as journals, research articles, proceedings of various non-governmental organizations (NGOs) and international non-governmental organizations (INGOs), reports of the District Agriculture Development Office (DADO), the District Development Committee (DDC), the Nepal Agricultural Research Council (NARC), the Central Bureau of Statistics (CBS), the Ministry of Agriculture and Cooperatives, and the Department of Hydrology and Meteorology. Data analysis was carried out using SPSS and MS Excel.

3. Results and Discussion

3.1. Change in the Climatic Conditions

The increasing trend of rising temperatures and precipitation extremes has been observed in Nepal along with incidences of heavy precipitation that, in many cases, ultimately lead to disasters. Compared to the past 10–15 years, the climatic conditions have changed. Summer temperatures are getting hotter and the period of the summer season has also increased accordingly. Almost all respondents felt that it has become more difficult for them to tolerate solar radiation nowadays than in the previous 10–15 years. Also, the level of rainfall, drought, fog and hailstorms has either increased or decreased.

Regarding the winter temperatures, respondents said that the winters have become colder, while some claimed that winters have become milder. Fifteen years ago, the winter season started in October and remained until March. However, nowadays, the winter period has shortened from November to January. As shown in Table 1, based on the responses of the respondents, it can be said that in their perception climate extremes have increased, as 99% of respondents claimed that the weather is changing. However, according to available data on temperature from the Ilam and Kanyam weather stations, there has been very little change in the average annual temperatures (both maximum and minimum) and the information on rainfall is inconsistent between stations.

Table 1. Change in the climatic conditions of Ilam, Nepal, 2013.

Climate Changes	Percent (Multiple Response)
Change in weather	99
Increase in temperature	92.3
Change in rainfall pattern	88
Change in windstorm	65.3
Change in pattern of drought	56
Decrease in hailstorm	53.7
Decreasing erratic rainfall	48.7
Increasing erratic rainfall	31
Change in pattern of hailstorm	29.3
Decrease in fog	28
Increase in fog	23.7
Increase in hailstorm	12.3
Decrease in temperature	9.3

3.2. Major Climatic Hazards

Different past major climatic hazards were analyzed using a timeline, as it is shown in Table 2. Those hazards were investigated through group discussions with villagers before being gathered and presented on the timeline below:

Table 2. Timeline of the climatic hazards (according to the Nepalese solar system calendar bikram sambat).

Place	Event	Consequences						
Godhak	Landslides (2045) Flood (2030, 2045, 2053, 2064) Drought (2034–2035) Hail (2030 and 2064–2065) Insects (2052–2053) Snowfall (2002)	12 households washed away Loss of cardamom fields Drought effects on maize No cardamom production for 3 years Death of fish Problems with rhizome rot, whitefly Extinction of buckwheat, horse gram, and mustard Replacement of local cow breed Jure with Holstein and Jersey Arrival of new varieties i.e., tomato, cow, pea, squash and pumpkin Extinction of jackal, porcupine, rupi, and crow, and increase of rabbit and monkey Increase of <i>Variegata acranthus</i>						
		10–15 years ago, there was a problem with the dew						
		Kanyam	Flood (2090, 2011, 2025, 2069) Drought (2028) Insects Hail Snowfall (2028, 2033–2034) Hurricane (2066) Dew (2068–2069)	Loss of human life and livestock 4 households migrated Minibus carrying 14 people washed away Cardamom and broom grassland washed away No production of maize Replacement of indigenous crops with hybrid varieties Extinction of fox and jackal in the past 15 years and an increase in rabbit Problems with aphid and mosquito for 2 years Rhizome rot Destruction of leaches 1 death due to hurricane				
				Bhanjyang	Landslides Heavy rainfall Hail Drought Frost Outbreaks of new diseases	Landslides occurred 45 years ago, which killed seven people and washed away Nigure village People recall that the raindrops were so large that they made holes in roads and several other places. The rainfall was unexpected and strange, and occurred only over an area about 50 meters in diameter 12–13 years ago, in the month of Mangsir (November–December), hail shattered rice crops, causing more than 80% crop loss. The normal period for hail is Chaitra (March)–Baisakh (April) Liver fluke did not exist in the past, but now it has become a very common and sudden cause of death in healthy-looking goats		
						Chulachuli	Flood (2036, 2048, 2070) Snakes Drought (2035, 2053, 2069) Hurricane (2036) Changes in wild elephant behavior Fire Malaria epidemic (1932)	2 people died due to floods In 2044 Bikram Sambat, several households migrated At the time of paddy cultivation, drought caused a loss in productivity (1.5 man/Bigha or 90 kilograms/hectare) 1 person injured due to snake bite Several people died due to malaria Agricultural land washed away Problems with mobility due to the destruction of a check dam
								Sangrumba

One of the main reasons for the high level of vulnerability is the geology of the region itself. The soil is not very compact, and thus heavy rainfall and medium-size flooding can lead to serious erosion and landslides, with devastating impacts on farmland, houses, livestock, crops, roads, and consequently on human lives and livelihoods. Second, the population is growing, which is increasing the pressure on forests and farms. As a result, people are clearing more forests to till and grow crops, and agricultural land use practices are becoming more intense than ever in terms of cropping patterns and the use of chemical fertilizers and pesticides. Therefore, people are farming on infertile land due to infestations of disease/insects/pests, whereas some people are adopting new occupations and migrating from the area. However, migration is not a permanent solution to cope with these situations. Also, as a mitigation strategy, the people are adopting techniques such as indigenous varieties, fertilizers, water harvesting technology, conservation and the proper utilization of resources (plastic ponds, deep boring, pump sets, and sprinklers), resistant varieties and integrated pest management technology using contour farming. Also, Gavi construction and afforestation have been implemented to minimize the adverse effects of natural hazards.

3.3. Major Causes of Climate Change and Disasters

Between Bikram sambat 2002 and 2011, there were 4130 disasters recorded, resulting from natural hazards around the world, where 1,117,527 people perished and a minimum of US \$1195 billion was recorded in losses. More people and assets are located in high-risk areas due to changes in the environment such as rapid urbanization, human settlement, unsustainable development practices, ecosystem degradation, poverty as well as climatic variability and extremes, as shown in Table 3, which have led to an increase in both natural and man-made disaster risk at a rate that poses a threat to lives and development efforts.

Table 3. Major causes of the changing environment.

Changes in the Environment	Percent
Deforestation	94.3
Human behavior	89.7
Uncontrolled population	71.3
Climate change	54
Urbanization	29.7

3.4. Impact of Disasters

The following outlines the major impacts found during the study of disaster-prone sites. Table 4 shows the general impacts of disasters. A total of 93.7% of the respondents stated that water sources are drying, 97.7% noted that there is a high infestation of insects that is affecting agriculture and productivity, 42.7% noted early maturity in crops and 66% claimed that there has been an invasion of new crops as the weather changes. Furthermore, the respondents claimed that there is a problem with diseases not only in human beings, but also in animals.

Table 4. General impact of disasters.

Impacts	Percent
Infestation of insects	97.7
Drying of water resources	93.7
Decrease in productivity	89.7
Increase in crop disease	72.7
Increase in animal disease	62.3
Invasion of new crops	66
Early maturity	42.7
Flowering in forests	20.3
Disease in human beings	36.7
Increase in productivity	8.3

The general impacts of disasters can be discriminated in more detail as impacts related to agriculture, livestock and economic losses, leading to a decrease in productivity, vector diseases and loss of livelihoods, among others. As shown in Table 5 the high percentages of decrease in productivity in the three evaluated dimensions ranges between 83.3% and 95.6%.

Table 5. Impact on agriculture, livestock, and the economy.

Impacts on Agriculture	Percent of Cases
Decrease in productivity	92.5
Increase in insect infestation	87.5
Agricultural land washed away	60
Impacts on Livestock	
Decrease in productivity	83.30
Loss of fodder and foraging	77.80
Reduce in productivity of livestock	53.60
Disease	38.60
Livestock washed away	2.40
Impacts on Economic Resources	
Low productivity	95.6
Reduction in income	88.2
Disease	32.1
Starvation	4.4

3.5. Effects on the Environment of These Disasters

As shown in Table 6, most of the people stated that disasters affect the environmental conditions by different means, such as a decrease in surface water, which not only creates drought but also problems with drinking water, an increase in pollution, loss of biodiversity, and a loss of human/animal life due to diseases and insects.

Table 6. Disaster effects on the environment.

Effects on the Environment	Percent of Cases
Decrease in surface water	94.6
Pollution	74.2
Loss in biodiversity	50.3
Loss of life	6

Indigenous knowledge and natural resource management skills also provide opportunities to manage disasters. This is because the management of natural resources is a significant aspect of disaster management. Various communities in Nepal have retained indigenous knowledge and skills in managing natural resources, particularly forests and water resources, which are the major factors in both managing and causing disasters. They have skills in harvesting trees and the protection of water resources. Currently, forest resources are being managed by communities of users. This system of management of natural resources facilitates the implementation of the disaster management system.

3.6. Local Mitigation Methods

To cope with this situation, people have developed early warning and monitoring systems through different local organizations, cooperatives and social media, alternative agriculture, such as poultry raising, mushroom cultivation, tunnel/greenhouse farming, short-duration crop cultivation (e.g., hybrid cultivation), cultivation of drought-tolerant crops, and crop varieties, e.g., taro, yam, millet, sathiya local variety of maize. As well as the formation of hamlet development institutes and a social network, the mobilization of youth to create awareness, exchange the information, and facilitate participatory decisions are the major techniques that the Ilam district is implementing to lessen the calamities. Methods for mitigation of landslides, floods and droughts are shown in Table 7.

Table 7. Mitigation methods used by respondents.

Mitigation Methods for Landslides	Percent of Cases
Afforestation	97.7
Contour farming	78.9
Awareness	51.6
Check basin	48.4
Change of housing location	11.7
Reconstruction of sheds	3.1
Loans for household activities	3.1
Mitigation Methods for Floods	
Check basin	92.9
Awareness	92
Loan for household activities	13.3
Change of housing location	7.1
Reconstruction of sheds	5.3
Mitigation Methods for Drought	
Conservation and utilization of resources	89.6
Drought-resistant varieties	40.7
Construction of plastic ponds	8.6

3.7. Social Networks

A social network is a social structure made up of a set of social actors, such as individuals or organizations, and a set of the dyadic ties between these actors. The social network perspective provides a set of methods for analyzing the structure of whole social entities, as well as a variety of theories explaining the patterns observed in these structures. The study of these structures uses social network analysis to identify local and global patterns, locate influential entities, and examine network dynamics. According to respondents, their major sources of the information are radio, TV, and also relatives, neighbors, and friends. Social media allows everyone to play the role of the journalist in sharing the events that are happening around them.

There are different sources of information—such as television, radio, friends, relatives and the neighbors—and the study showed that 97% of respondents obtained information from the radio, as it is the best and cheapest means to have at home. Although the district has many more organizations, non-organizations, institutions, and clubs that are working in the field of climate change and disaster, the study showed that only 30.7% of respondents received help from these sources after a disaster.

As shown in Table 8, respondents help each other in the case of a disaster by providing basic needs, such as clothes, shelter for living and food. Some help by providing loans and others by providing information to help cope with the disaster risks.

Table 8. Means by which respondents helped each other.

Means of Helping Others	Percent of Cases
Helping hands	77.4
Information	61.6
Providing basic needs	48.4
Loans	18.3

4. Conclusions and Recommendations

The climate is changing, leading to different natural hazards and increases in life-threatening situations for humans and livelihoods. Usually natural disasters cannot be stopped still; the magnitude of disasters can be reduced if preventive measures be taken in due time for which pragmatic government policies and public awareness are of utmost importance [10]. Local people are using their indigenous knowledge and technology to cope with these disasters and reduce the risk of climate change. Some new interventions, such as rainwater harvesting for drinking and perennial agriculture, farming that conserves water and crop nutrients, the promotion of

drought-tolerant crops (e.g., sweet potato and sorghum), seed multiplication and crop diversification and communal gardening can be implemented to improve sustainable livelihoods. Not only in Nepal, natural disasters happen almost all over the world all of a sudden causing heavy loss of human life, destruction of infrastructure and properties.

Vulnerability and resilience have a mutually dependent effect on communities coping with different situations. When one increases, the other decreases, meaning that strengthening people's resilience leads to better coping mechanisms and a reduction in vulnerability. The best possible outcome of decreasing people's dependence on outside resources and assistance is that it might lead to the better stability of the district.

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