GOVERNMENT OF NEPAL
Ministry of Home Affairs

NEPAL DISASTER REPORT 2009

The Hazardscape and Vulnerability

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Nepal Disaster Report:

The Hazardscape and Vulnerability

Ministry of Home Affairs (MoHA) and Nepal Disaster Preparedness Network-Nepal. (DPNet)

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Preface

Nepal Disaster Report: The hazardscape and vulnerabilities is an indication of Nepal's resolve to tackle the challenges posed by natural disasters. For a country facing the difficulties of socio-economic development, efforts to address the risks of disasters are necessary because disasters undermine social and economic well-being. By highlighting challenges and presenting the way forward, this report shows the growing sense of urgency and the need for seriousness in reducing disaster risks in Nepal.

The preparation of the report highlights the concerns of disaster mitigation and by presenting the hazardscape and vulnerabilities of its people, attempts to provide a glimpse of the challenges facing the country. Because it is the first of its kind, the report has not been able to comprehensively capture the country's entire disaster risk management terrain. It recognises the need to evolve a more nuanced approach for the second Nepal Disaster Report.

The preparation of this report brought together various individuals engaged in disaster risk reduction activities. Those involved in preparation of this report recognise that both this product and the process used to prepare it are merely instruments to achieve the goal of building resilient households and communities. The key to achieve this goal is to implement learning from past efforts in disaster risk reduction.

As awareness of disaster risk reduction grows, so too do expectations of people who seek solutions to the problems they face, minimise risks and protect their lives. The Government of Nepal (GoN) is cognisant of its responsibility and will endeavor to translate the ideas presented here into practice. We need to collectively confront the challenge that disasters pose to our future.

Acronyms

APF: Armed Police Force
APN: Asia-Pacific Network
ARI: Acute Respiratory Infection
CBO: Community Based Organization
CDAF: Central Disaster Aid Fund
CDRC: Central Disaster Relief Committee
CDS: Center for Disaster Studies
DAO: District Administration Office
DDC: District Development Committee
DHM: Department of Hydrology and Meteo rology
DIS: Digital Information System
DMC: Disaster Management Committees
DMG: Department of Mines and Geology
DMSP: Disaster Mitigation Support Programme
DoI: Department of Irrigation
DPNet: Disaster Preparedness Network
DPTC: Disaster Prevention Technical Center
DRM: Disaster Risk Management
DRR: Disaster Risk Reduction
DSCWM: Department of Soil Conservation and Watershed Management
DWIDP: Department of Water Induced Disaster Prevention
EU: European Union
EWS: Early Warning System
FAO: Food and Agriculture Organization
FECOFUN: Federation of Community Forest Users Nepal
FEDWASAN: Federation of Drinking Water and Sanitation Nepal
GBM: Ganga-Brahmaputra-Meghna
GHI: Geo Hazards International
GIS: Geographic Information System
GPS: Global Positioning System
HFA: Hyogo Framework for Action

HKH:	Hindu Kush Himalaya
IAHS:	International Association of Hydrological Sciences
IASC:	Inter Agency Standing Committee
ICAO:	International Civil Aviation Organization
ICIMOD:	International Centre for Integrated Mountain Development
IDNDR:	International Decade for Natural Disaster Reduction
IFRC:	International Federation of Red Cross and Red Crescent Societies
INGO:	International Non-Governmental Organization
INPS:	Integrated Nepal Power System
INSARAG:	International Search and Rescue Advisory Group
IPCC:	Intergovernmental Panel on Climate Change
ISDR:	International Strategy for Disaster Reduction
JICA:	Japan International Cooperation Agency
LARED:	Latin American Research Education and Development
LRMP:	Land Resource Mapping Project
LSGA:	Local Self Governance Act
MDGs:	Millennium Development Goals
MoAC:	Ministry of Agriculture and Cooperatives
MoHA:	Ministry of Home Affairs
MoWR:	Ministry of Water Resources
NA:	Nepal Army
NACEUN:	National Association of Community Electricity Users - Nepal
NAST:	Nepal Academy of Science and Technology
NCDM:	Nepal Center for Disaster Management
NCRA:	Natural Calamity Relief Act
NDAC:	National Network of Disaster Affected Community
NDC:	National Development Council

NDMP:	National Disaster Management Policy
NEA:	Nepal Electricity Authority
NEC:	Nepal Engineering College
NFIWUAN:	National Federation of Irrigation Water User's Association Nepal
NGO:	Non-governmental Organisation
NP:	Nepal Police
NPC:	National Planning Commission
NRCS:	Nepal Red Cross Society
NSET:	National Society for Earthquake Technology
OCHA:	Office for the Co-ordination of Humanitarian Affairs
OECD:	Organisation for Economic Co-operation and Development
OFDA:	Office of U.S. Foreign Disaster Assistance
PMAF:	Prime Minister's Disaster Relief Aid Fund
SAM:	South Asian Monsoon
SAR:	Search and Rescue
UNCHS:	United Nations Center for Human Settlements
UNCRD:	United Nations Center for Regional Development
UNDMS:	United Nations Disaster Management Secretariat
UNDP:	United Nations Development Programme
UNICEF:	United Nations Children's Fund
USAID:	United States Agency for International Development
VDC:	Village Development Committee
WEC:	Water and Energy Commission
WECS:	Water and Energy Commission Secretariat
WFP:	World Food Programme
WHO:	World Health Organization
WMO:	World Meteorological Organization
WRA:	Water Resource Act
WWF:	World Wildlife Fund

GOVERNMENT OF NEPAL
MINISTRY OF HOME AFFAIRS

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Foreword

Nepal is a country with a high risk of the occurrence of hazards' impacts and disasters, is very well known and documented. The risk of the occurrence of disasters is high, the resources to mitigate and minimise the risk are few, but there is always something that can be done to reduce disaster risks. As a matter of fact, disaster risk reduction is not just a question of resources, but it is a question of will and most importantly the coordinated efforts of all the concerned organisations and agencies to prevent, mitigate and respond to the threats and impacts of hazards. There is always something that can be done in order to reduce the risk of disasters.

In recent years, many significant efforts have been carried out to identify the disaster risk reduction activities in Nepal in order to optimize the outcomes of implementation followed by positive impact. The Government of Nepal, international community, I/NGOs and all organisations interested and involved, as well as communities and individuals, worked together to design the National Strategy for Disaster Risk Management in Nepal, which includes key concerted activities that need to be implemented in the country to reduce risk and prevent disasters.

At the same time, during this year of 2009, more coordinated efforts were made by the Government of Nepal, the United Nations Development Programme and the UN System, the International Federation of Red Cross and Red Crescent Societies, the World Bank, the Asian Development Bank and the donor community, under the framework of the UN International Strategy for Risk Reduction that identified five key groups of disaster risk reduction activities that can, and should, be implemented in the short and medium terms in order to have a significant reduction of disaster risk in the country. These efforts showed again that disaster management and risk reduction are, by definition, multidisciplinary activities that must be developed, implemented and evaluated in a coordinated manner by all stakeholders involved in this process.

The Government of Nepal is glad to present this document "The Nepal Disaster Report: The Hazardscape and Vulnerability", as an important step in disaster risk management in Nepal. This document describes the main hazards the country is prone to, their characteristics and some disaster risk reduction activities that should be implemented to reduce their occurrence and/or their effects. This document intends to provide disaster managers with information to identify specific disaster risk reduction activities for specific hazards and in specific disaster prone areas. Identification of hazards, assessment

of vulnerability and risks and evaluation of response capacity are the first activities to be conducted if we want to focus disaster management and optimize its results.

It is the objective of this report to help disaster managers to reduce risk at all levels mainly national, district and local, by being used in the design and implementation of disaster management programmes, plans and specific activities always within the framework of the National Strategy, the Five Flagship Programmes and the Hyogo Framework for Action (HFA); all disaster management activities should be compatible and be part of the overall ongoing disaster management process in Nepal. This will lead not to scattered activities or duplication of efforts, but to a continuous and effective reduction of risk in the country.

This report would be useful for researchers, students and the general public to know more about hazards, disasters and risk reduction to understand better their behavior, effects, consequences and how risk can be reduced at all levels and by all segments of our society.

The Government of Nepal, in general, and the Ministry of Home Affairs, in particular, finds this contribution is useful and hopes to help improve our knowledge and understanding of hazards and disaster management. The Nepal Disaster Report 2009 is the first of its kind and of others that will be produced in the future to continue enhancing the understanding of hazards and the ways to prevent disasters through risk reduction and disaster management. It is only through the knowledge of hazards, its characteristics, effects and consequences that paves the way on how the effective disaster management can be brought into practice in an adequate manner.

The knowledge of hazards and their root causes will definitely provide us better prospects to design the operative early warning systems. The understanding of their effects will give us the opportunity to build less vulnerable structures, and the description of their consequences will allow us to mainstream disaster risk reduction into the development agenda.

Disaster management and risk reduction, again, are only possible if all individuals and organisations work together towards a common goal: to have a safer and disaster free Nepal.

Let's do it together.

(Dr. Govind Prasad Kusum)
Secretary
Ministry of Home Affairs
Government of Nepal

Acknowledgement

The Ministry of Home Affairs (MoHA), Government of Nepal wishes to thank the United Nations Development Programme in Nepal, for the assistance provided to produce this report. At the same time, the MoHA would like to thank the European Commission for Humanitarian Aid Department for its financial support to conduct this study.

The MoHA offers its thank to Mr. Ajaya Dixit of NWCF Nepal for finalizing this report with high professionalism and technical standards. We also acknowledge the contributions made by DP-NET and its member organisations including the OXFAM for their support in collecting information and publishing of the report.

The MoHA hopes that this report would be a helpful document in developing strategies and programmes to reduce the disaster risk and its effects in Nepal.

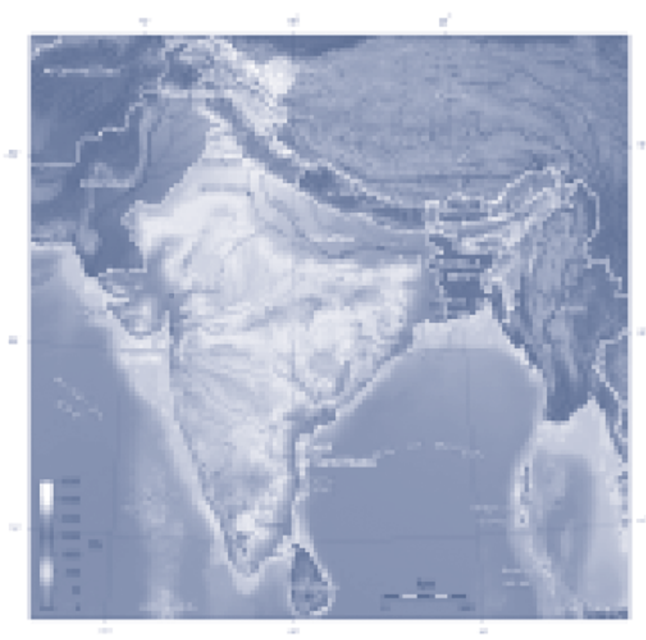
Chapter-1

Nepal in the Himalaya-Ganga

The Himalaya-Ganga system is a generic name given to the unique highland-lowland interactive system of South Asia including the flora and fauna it supports (Figure 1.1). As the crow flies, this system extends about 160-200 kilometres from north to south, spanning six geological and climatic belts varying in altitude from above 8,000 to just about 60 metres above mean sea level at Kechana in Jhapa District in east Nepal. They are the Tibetan plateau, the high Himalaya, the midland hills, the Mahabharat lekh (Range), the Chure (the Siwalik range) and the Tarai. This region is home to the highest mountain range on Earth—the Himalaya—and is the source of rivers such as the Ganga, the Indus, and the Brahmaputra, rivers which are both a boon and a bane to the millions living in the region.

Nepal is a part of this system. Its population comprises dozens of ethnic groups speaking nearly 100 languages and organised under a rich plurality of social systems. The country falls under the influence of the monsoon, which lasts from June to September and is marked by large regional and temporal variations in rainfall. The rainfall is generally sharp and intense though the date of onset and the magnitude, duration and intensity of rainfall varies tremendously at all scales, the macro, the meso and the micro. In the rain-shadow regions of the Tibetan plateau such as Mustang District climatic conditions are dry and desert-like, while Pokhara in the immediate south receives very high rainfall. In a large area of the catchment, orographic effects cause large local variations, even within a single valley. Sudden cloudbursts, which can generate up to 500 mm of rainfall in 24 hours, are common in Nepal.

FIGURE 1.1: Nepal in Himalaya Ganga System



Because it varies so drastically in altitude and precipitation, Nepal has a remarkable range of climates, ranging from tropical to alpine ecosystems. Within its 147,181 square kilometres, Nepal nurtures about 118 ecosystems, 75 types of vegetation and 35 types of forests. These ecosystems support 635 species of butterflies, 185 species of fresh water fish, 43 species of amphibians, 100 species of reptiles, 860 species of birds and 181 species of mammals (Bhuju *et al.*, 2007).

After the Rana regime fell in the 1950s and contact with the outside world increased, Nepal began to take steps to provide its population with basic services such as drinking water systems, irrigation canals, hydropower projects, mobility through road networks and suspension trail bridges, health, telephone communication, banking service and education facilities. Many of these development efforts have emphasised sustainability: they strove to reduce poverty, increase food security, and promote soil conservation, manage forests through community participation, and mitigate disaster risks. Success, however, has been limited (see tables 1.1a and 1.1b) because majority of the population still remain to be provided with these services. The challenges associated with providing services and improving natural resource management are exacerbated by the lack of institutional capacity and financial resources within Nepal. The country's complex geo-physical context only complicates matters.

Table 1.1a: Matrix of Development Indicators

Political region	Ecological region	Total population in 2001	Average coverage in %			Infant mortality rate (no. per 1000)	Adult literacy rate (%)	
			Drinking water	Sanitation	Electricity		Average	Female
Eastern	Mountain	401,587	66	53	19	54.5	50.90	40.41
	Hill	1,643,246	60	52	22	46.0	56.70	40.51
	Tarai	3,299,643	54	41	34	59.73	55.04	37.59
Central	Mountain	554,817	82	47	32	76.66	42.00	34.70
	Hill	3,542,732	72	58	66	50.87	58.66	39.01
	Tarai	3,934,080	73	32	34	65.14	44.14	32.86
Western	Mountain	24,568	78	38	64	88.46	56.26	37.19
	Hill	2,793,180	77	61	41	49.94	60.63	45.39
	Tarai	1,753,265	83	36	38	50.50	53.76	37.13
Mid-Western	Mountain	309,084	75	28	6	129.79	32.21	19.48
	Hill	1,473,022	73	24	15	86.02	46.20	34.79
	Tarai	1,230,869	63	39	29	89.22	53.85	39.57
Far-Western	Mountain	397,803	84	15	5	128.85	39.73	24.87
	Hill	798,931	81	27	17	96.59	45.32	28.50
	Tarai	994,596	75	38	26	83.91	56.36	37.62

Source: CBS (2001)

Table 1.1b: Matrix of development indicators

Political region	Ecological region	Mobility		Access to services			Rates of migration	
		Suspension bridges (Number)	Road (km.)	Banks (Number)	Telephones			
					Lines distributed (Number)	% of HHs serviced	In	Out
Eastern	Mountain	237	72	7	2587	2.35	10.9	89.1
	Hill	505	1043.74	21	9182	6.36	14.8	85.2
	Tarai	0	2365.42	15	59409	13.24	75.6	24.4
Central	Mountain	228	548.59	7	1626	1.82	12.9	87.1
	Hill	338	2773.58	24	263904	70.58	67.2	32.8
	Tarai	11	3334.9	21	55045	14.88	67.1	32.9
Western	Mountain	54	-	4	253	1.33	42.7	57.3
	Hill	1206	2068.73	30	42370	11.38	10.4	89.6
	Tarai	25	886.64	9	30193	8.14	88.7	11.3
Mid-Western	Mountain	76	-	10	994	5.36	10.5	89.5
	Hill	265	998.99	16	5553	2.66	20.2	79.8
	Tarai	18	1216.21	9	17872	5.14	78.8	21.2
Far-Western	Mountain	195	119.7	7	693	0.76	12.6	87.4
	Hill	195	703.44	10	2444	1.69	9.1	90.9
	Tarai	18	694.55	6	15268	3.89	95.5	4.5

Source: CBS (2001); Telephone data from Nepal Telecom

Physical context

About 83 per cent of Nepal falls within the mountainous region, while the remaining 17 per cent lies in the northern part of the Ganga Basin plain. Nepal can be divided into eight physiographic units that roughly run east to west (see Figure 1.2): (1) the Tarai (2) the Chure or Siwalik range, (3) the Dun valleys, (4) the Mahabharat Range, (5) the Midlands, (6) the Fore Himalaya, (7) the Higher Himalaya, and (8) the Inner and trans-himalayan valleys. The altitude and width of each subdivision is presented in Table 1.3 and their unique physiographic characteristics are shown in Figure 1.2. The Mahabharat and the Higher Himalayan Range are the two physiographic units that control the rainfall and the climate zones of the country.

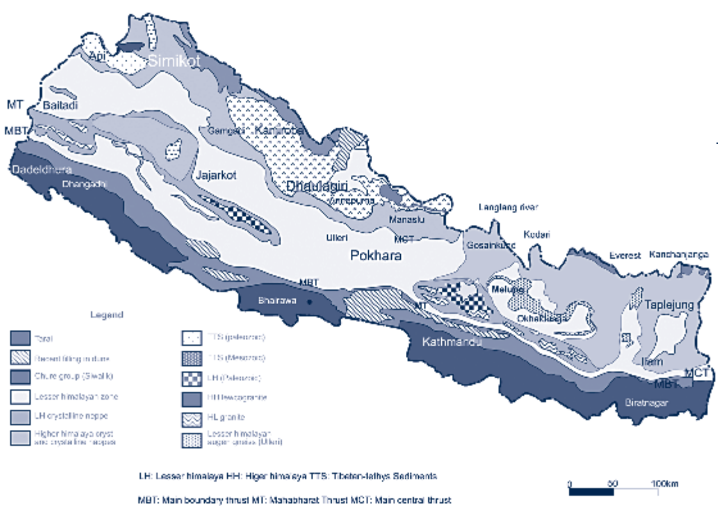


FIGURE 1.2: Physiographic sub divisions of Nepal (Upreti, 1999)

Table 1.2: Geomorphic and climatological characteristics of Nepal

	Region	Width (km)	Altitude (m)	Mean temp (°C)	Precipitation (mm)	Broad vegetation
1	Tarai	20-50	100-200	20 – 25	1100 - 3500	Tropical tress, Shorea Robusta forest)
2	Chure Range	10-50	200-1300			
3	Dun valleys	5-30	200-300			
4	Mahabharat Range	10-35	1000-3000	10 – 20	275 - 2300	Khote Salla (Pinus roxbughii), Deodar (Cedrus deodara), Gobre Salla (Pinus wallichiana).
5	Midlands	40-60	200-2000	<10	150 - 200	Rhodedrondrron, alpine meadows
6	Fore Himalaya	20-70	2000-5000			
7	Higher Himalaya	10-60	>5000			
8	Inner and Trans-Himalayan valleys	30-100	2500-4000			

Source: For geomorphic units, Upreti (1999); other data, CBS (2001)

The characteristics of the social systems of the Nepalis who live in this highland-lowland composite are summarised in Table 1.3.

Table 1.3: Social characteristics of Nepal

Political region	Ecological region	No. of districts	Total population (2001)	Population density (ppl./sq km)	Cultivated land under permanent crops (ha)	Population density per ha of cultivated land (person/ha)
Eastern	Mountain	3	401,587	38	209,705	1.9
	Hill	8	1,643,246	153	470,656	3.5
	Tarai	5	3,299,643	454	549,214	6.0
Central	Mountain	3	554,817	88	131,326	4.2
	Hill	9	3,542,732	300	441,167	8.0
	Tarai	7	3,934,080	422	553,045	6.0
Western	Mountain	2	24,568	4	564	43.6
	Hill	11	2,793,180	152	387,327	7.2
	Tarai	3	1,753,265	333	308,707	5.7
Mid-western	Mountain	5	309,084	14	68,769	4.5
	Hill	7	1,473,022	107	199,545	7.4
	Tarai	3	1,230,869	168	264,218	4.7
Far-western	Mountain	3	397,803	50	108,013	3.7
	Hill	4	798,931	118	167,668	4.8
	Tarai	2	994,596	205	201,707	4.9
Total						

Source: CBS, 2001

FIGURE 1.3: In Mid-Western Nepal, the northern edge of the Ganga plain (the Tarai) in the forefront and the Chure Range in the background

Geology is a key determinant of Nepal's hazardscape. Geologically, from south to north, Nepal can be divided into five major zones separated by faults (see Figure 1.5) (Upreti, 1999), namely: (1) the Tarai and the foreland basin (the northern edge of the Indo-Ganga plains), (2) the Chure Range, (iii) the Lesser Himalaya, (iv) the Higher Himalaya, and (V) the Tibetan Tethys Himalaya. Since the rock type, metamorphism, and physiography of each is unique, each is threatened by different hazards.

The Himalaya, the youngest mountain range on Earth, were produced by the world's most recent tectonic activity. The Himalayas began forming around 50 million years ago (Le Fort, 1996) when the northward-moving Indian tectonic plate first collided with the Asia plate after floating near the South Pole for about 70 million years (see Figure 1.6). Even after making contact, it continued to move north, in the process slicing, breaking, folding and uplifting India's front edge and forming the Himalaya, the highest mountains on our planet. The Himalaya systems were responsible for first bringing the summer rains, to South Asia 17 million years ago (France-Lanord *et al.*, 1993) and significantly affect the climatic conditions of the region. The Himalaya range cause rain clouds sweeping in from the Bay of Bengal by the monsoon winds to release their burden of precipitation south of the range.

FIGURE 1.4:
The rugged topography of the Chure range in Western Nepal

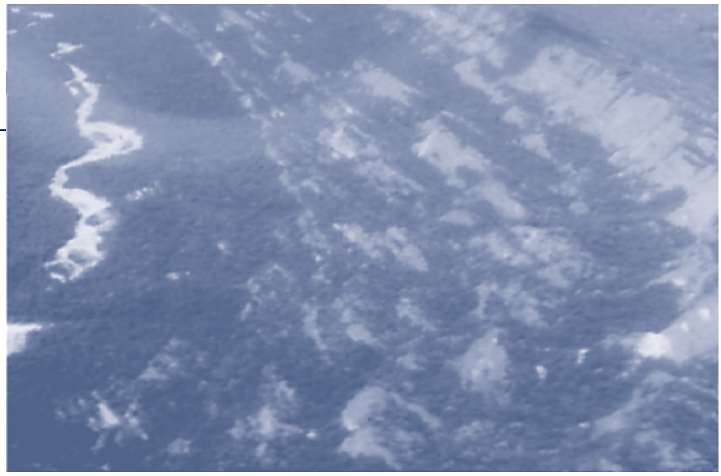
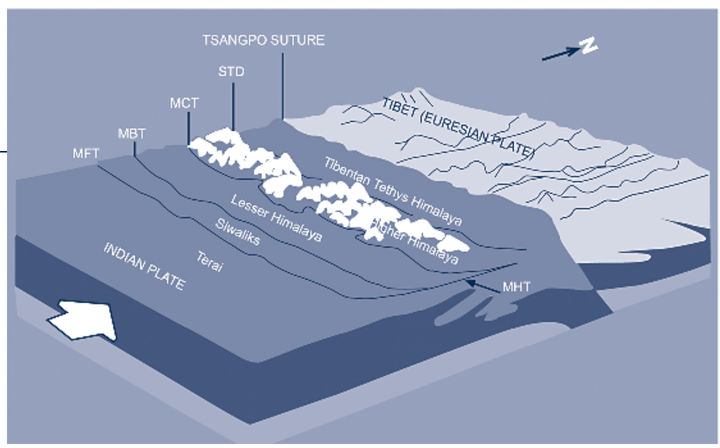


FIGURE 1.5:
Main structural features and geologic divisions of the Himalaya



The Indian plate continues to move northward 20 millimetres a year and converges with the Asian plate below Tibet (the southern edge of Eurasia), thereby generating the force required to push the Himalaya upward and making it the most dynamic range in the world. Recent global positioning system (GPS) measurements using satellites show that the central part of the Nepal Himalaya northeast of Kathmandu is rising 7±2 mm per year (Billham *et al.*, 1997).

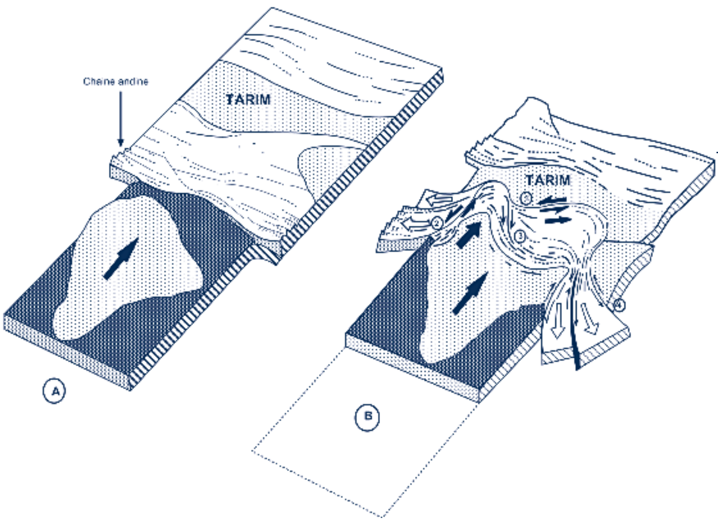


FIGURE 1.6: Northward movement of Indian plate across the Tethys Sea.

The sharp incline of the land in the Himalayan region has a profound effect on natural hazards. Figure 1.7 presents the north to south profile in eastern Nepal from the Ganga plain to the Mount Everest, where the land rises almost nine kilometers within a horizontal distance of about 160 kilometers.

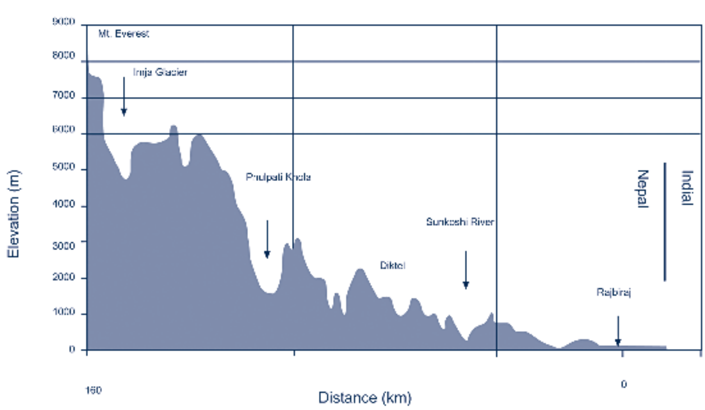
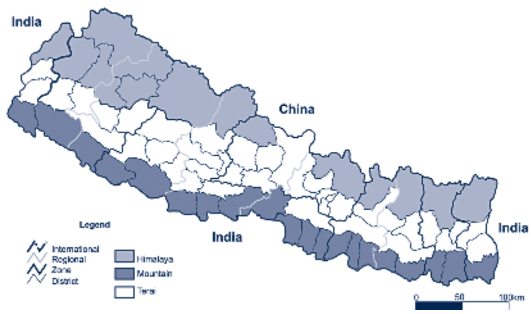


FIGURE 1.7: A north-south topographic profile across eastern Nepal between Rajbiraj town in the south to Mount Everest in the north.

Box 1.1: Administrative divisions

For administrative purposes, Nepal is currently divided into five development regions and 75 administrative districts. The districts are further divided into smaller administrative units called village development committees (VDCs) and municipalities. Each VDC is composed of nine wards (the smallest administrative unit) and in municipalities, the number of wards ranges from nine to 35. Currently Nepal is being organised into a federal democratic republic, but the nature of the new divisions have not yet been decided.



The architecture of the Himalaya is formed by five thrusts in the upper crust of the Indian plate which are the Main Central Thrust (MCT); the Main Boundary Thrust (MBT); and the Main Frontal Thrust (MFT), and a normal fault, the South Tibetan Detachment System (STDS). This system forms the base of the Tethyan sedimentary series of the Himalaya. All three faults merge along the Main Himalayan Thrust (MHT) below the mountain ranges. The continuous convergence of the Indian and Asian plates stores energy in the region over a period of time and their sudden release causes earthquakes. Since the mountains are young, they generally have steep slopes with high relief, producing a dynamic geomorphology. The rocks are highly folded and crosscut by a large number of faults and fractures. Since these steep slopes receive heavy rainfall during the monsoon, the region is vulnerable to landslides and debris flows and, in consequence, to a high rate of natural regional sedimentation.

Climate and rainfall

Nepal has a tropical to sub-tropical climate in the plains of the Ganga in the south and arctic-like condition in areas above 5,000 metres in the north (see Figure 1.9 and Table 1.2) (Kansakar et al. 2004). The Tarai and the Chure Hills have tropical to sub-tropical climates. As elevation increases, temperature decreases (for every 1,000m upward, the temperature drops by 6.5 °C) making the valleys in the Middle Mountains warmer (sub-tropical) than the ridges which are cooler. The High Mountain and High Himalaya have a cold climate.

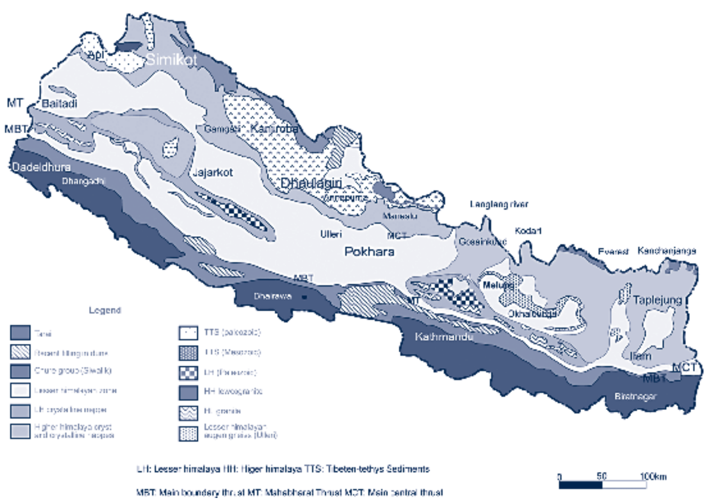
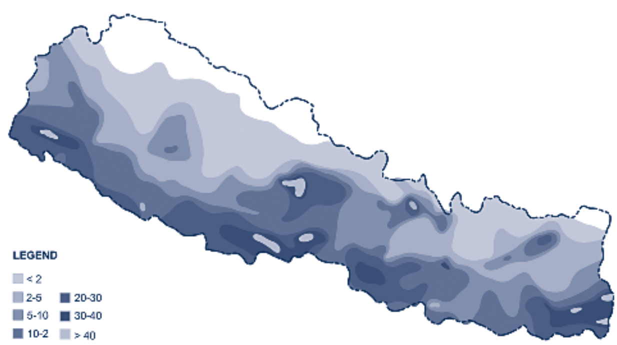


FIGURE 1.8: Geological map of Nepal (Upreti, 1999)

Precipitation in Nepal is associated with the South Asian monsoon (SAM) system. Records show that most locations in Nepal receive about 80 per cent of their annual precipitation as rainfall during the months between June and September; precipitation between November and February accounts for the remaining 20 per cent. Studies show that rainfall patterns are influenced by climatological phenomena including the El Nino/ Southern Oscillation as well as changes in regional-scale land and sea surface temperature (Mirza, 2003).

This broad presentation of climatic zones does not capture the real spatial and temporal variation of rainfall distribution across the country. Precipitation decreases from east to west during the summer monsoon, whereas, the winter monsoon shows the reverse trend. In addition, micro-level variations are common because of orographic effects. Rainfall is characterised by seasonality and high local variations in the amount of precipitation.

FIGURE 1.9: Distribution of the highest 24-hour rainfall events (higher than 100 mm) across Nepal The thick dashed line shows the alignment along the Mahabharat range



Source: modified after ICIMOD (1996)

Studies also indicate that local variations in rainfall amounts and timing can be high, with ridges receiving four to five times the amounts that valleys do (Higuchi et al. 1982; Barros and Lang, 2003). These differences demonstrate the role of orography and convective processes in the precipitation system in the country. At elevations above 3,000 metres, the amount of precipitation tends to decrease with elevation (Ichiyanagi *et al.* 2007). At the same time, south-facing slopes (windward side) receive more rainfall than north-facing (leeward side) slopes, as the latter are in rain-shadow regions. Barros and Lang (2003) found that monsoon rainfall events were generally concentrated during mornings and nights with the peak occurring at night. The location and density of meteorological stations across are inadequate for capturing the spatial and temporal variations of micro-climates in the country. For example, there are very few stations on hilltops; almost all are located in lower valleys.

TABLE 1.4: Selected extreme rainfall events

Year	Date	Recorded rainfall (mm)	Region /Stations	Country	
1880	18 September	1,048 (2 days)	Nagina, Uttar Pradesh	Garhwal India	*
1902	26-27 September	770	Dharmapur	India	**
1915	11-13 June	720	Nagibabad	India	**
1924	September	770 (3 days)	India	India	*
1931	24 June-8 July	4,798	Cherrapunji	India	**
1950	12 June	546	Teesta Valley	India	**
1954	24-30 July	500 (heavy			
	22-25 August	rainfall for 4 days)	Affected about		
			15,000 km² of		
			Sun Koshi River	Nepal	***
1959	7 September	409	Tansen	Nepal	***
	10 October	473	Anarmanibirta		
1960	29 July	503	Musikot	Nepal	***
1968	3-5 October	1,044	Padamchen (Darjeeling)	India	**
	5-6 October	465			
	25 August	505	Gumthang	Nepal	***
1969	5 August	1,001	Labha-Phaperkheti	India	**
	5 August	742	Aligarh-Gorubathan	India	**
1972	17 May	4,032	Teesta Valley	India	**
1974	28 July	405	Barahakshetra	Nepal	***
1977	10 June	460	Teesta Valley	India	**
1978	20 May	1,800	Teesta Valley	India	**
	15 July	322	Hariharpur Gadhi	Nepal	***
	15 July	301	Tiger Tops	Nepal	***
	16 July	304	Ramauli Bairiya	Nepal	***
	19 July	376	Hetauda	Nepal	***
1979	2-6 October	900 (3-day point fall)	Upper Arun Basin &Num	Nepal	***
1980	12 September	431	Bajura	Nepal	****
1981	28 September	350	Garakot	Nepal	***
	28 September	381	Khanchikot	Nepal	***
	29 September	342	Chapkot	Nepal	***
	29 September	446	Baluwa	Nepal	****
	30 September	420	Mane Banjayang	Nepal	****

TABLE 1.4: Selected extreme rainfall events cont'd...

Year	Date	Recorded rainfall (mm)	Region / Stations	Country	
1982	13 September	401	Semari	Nepal	****
1984	15 September	344	Hariharpur Gadhi	Nepal	***
	15 September	330	Damak	Nepal	***
	16 September	342	Sinduli Gadhi	Nepal	***
	16 September	381	Chandra Gadhi	Nepal	***
	17 September	355	Bahun Tilpung	Nepal	***
	17 September	403	Triveni	Nepal	***
	16 September	437	Kankai	Nepal	****
1986	August	296	Nibuwatar	Nepal	****
1987	9-13 August	800 (3-day point fall)	Sapta Koshi Basin	Nepal	***
1990	26 August	257	Amlekhganj	Nepal	****
	27 August	453.2	Hetauda (NFI)	Nepal	****
	27 September	438	Hetauda (industrial dis.)	Nepal	****
	27 August	438	Makawanpur Gadhi	Nepal	****
	27 August	230	Beluwa	Nepal	****
1993	20 July	540.0	Tistung	Nepal	****
	20 July	482.5	Hariharpur Garhi	Nepal	****
	21 July	399.0	Amlekhganj	Nepal	****
	20 July	385.0	Markhu	Nepal	****
	20 July	373.0	Daman	Nepal	****
	21 July	437.0	Patharkot	Nepal	****
	6 September	355.0	Parasi	Nepal	#
	6 September	398.0	Dumkibas	Nepal	#
	21 July	403.2	Sindhuligadhi	Nepal	#
1994	10 September	304.3	Beluwa	Nepal	#
	10 September	300.6	Rajaiya	Nepal	#
	15 August	285.0	Dharan British Camp	Nepal	#
	15 August	246.3	Dharan Bazar	Nepal	#
1995	13 Aug	330.0	Karmaiya	Nepal	#
	17 June	270.0	Aizealukhark	Nepal	#
	12 August	234.0	Rangchani	Nepal	#
	24 June	230.3	Rumjakot	Nepal	#
	12 August	286.4	Nijgadh	Nepal	#
1996	13 July	253.3	Tahahara	Nepal	#
	14 July	354.0	Butwal	Nepal	#
	14 July	298.6	Bhairhawa	Nepal	#
	13 July	295.1	Damak	Nepal	#
	11 July	346.7	Shyano Shree (Chepang)	Nepal	#
1997	10 August	319.2	Sitapur	Nepal	#
1998	3 August	362	Bardhaghat	Nepal	##
	3 August	378.0	Farauli	Nepal	##
	3 August	363.0	Pipariya	Nepal	##
	3 August	407.0	Padari	Nepal	##
	3 August	495.0	Parasi	Nepal	##
	9 July	310.0	Basantapur	Nepal	##
1999	6 October	203	Katai	Nepal	#
	11 July	310.0	Dumkibas	Nepal	#
2000	24 April	240.7	Jajarkot	Nepal	#
	8 June	236.2	Koilabas	Nepal	#
	3 August	319.3	Daman	Nepal	#
	3 June	339.5	Janakpur Airport	Nepal	#

*Data sources: *HPC (1999), **Kale (1998), *** SMEC (1993), ****ICIMOD (1993) and #DHM (Records) and ## NWCF (Records). For details see Dixit and Moench (2006)*

Because the Chure and the Mahabharat ranges are the first mountain barriers northward-moving monsoon clouds coming from the Bay of Bengal encounter, these areas get heavy precipitation (Figure 1.9). As the stream of monsoon clouds enters the interior of Nepal, part follows a westerly course and part follows river valleys in a northerly course. It takes nearly one month for the monsoon to cross the country and reach the western border of Nepal. In the winter, the westerlies move from west to east. In both cases, the intensity of rainfall varies with space and time. The annual precipitation in the Mahabharat region is around 2,500-3,000 millimetres and cloudbursts that bring up to 500 millimetres of rain in 24 hours are common (see Table 1.4). Such cloudbursts, which occur at intervals of about eight to ten years, bring disasters such as landslides and floods and result in deaths and damage to property and infrastructure.

A disaster hot spot

As one of the least developed countries of the world, Nepal faces serious threats from disasters, which occur with appalling regularity—over 900 every year on average. Data of last three decades (see tables 1.5a, 1.5b, 1.5c and 1.5d) show that climate-related disasters accounted for almost 25 per cent of deaths, 84 per cent of adversely affected people and 76 per cent of economic losses. It is clear from these numbers that proactive Disaster Risk Reduction (DRR) strategies and policies are important and must receive high priority in policy-making.

Table 1.5a Disaster Losses in Nepal during 1971-2006 (37 Years)

S.N.	Events	Death	Injury	Peoples affected	Buildings destroyed	Buildings damaged	Land loss(Ha)	Livestock death	Reported Direct Loss (Million NRs.)
1	DROUGHT	1	-	1,512	-	-	329,332	-	10
2	EARTHQUAKE	873	6,842	4,539	33,710	63	-	2,257	72.8337
3	EPIDEMIC	15,529	37,773	323,896	-	-	1	78	0
4	FIRE	1,081	735	218,128	62,634	2,762	352	113,922	6,244
5	FLOOD	2,864	349	3,315,781	70,115	1,041	196,955	31,117	3,713
6	FOREST FIRE	24	13	10,718	1,698	18	3,173	82	1,031
7	LANDSLIDE	3,899	1,188	480,069	16,799	1,209	21,797	9,046	835
8	OTHER	2,385	2,670	360,725	3,917	388	290,323	79,935	2,030
TOTAL		**26,656**	**49,570**	**4,715,828**	**188,875**	**5,482**	**841,954**	**236,459**	**13,885**

Source: NSET, 2008

TABLE 1.5b: Loss of lives due to various disasters in Nepal from 1983 to 2007

Year	Floods & landslides	Fires	Epidemics	Wind, hail, and thunder storms	Earthquakes	Avalanches	Stampedes	Total
1983	293	69	217	0	0	0	0	579
1984	363	57	521	0	0	0	0	941
1985	420	52	915	0	0	0	0	1387
1986	315	96	1101	0	0	0	0	1512
1987	391	62	426	2	0	0	0	881
1988	328	23	427	0	721	14	71	1584
1989	680	109	879	28	0	20	0	1716
1990	307	46	503	57	0	0	0	913
1991	93	90	725	63	0	0	0	971
1992	71	97	1128	20	2	0	0	1318
1993	1336	43	100	45	0	0	0	1524
1994	49	43	626	47	0	0	0	765
1995	203	73	520	34	0	43	0	873
1996	258	61	494	75	3	4	0	895
1997	78	45	947	44	0	9	0	1123
1998	276	54	840	23	0	0	0	1193
1999	209	46	1207	22	0	3	0	1489
2000	173	53	141	26	0	0	0	393
2001	196	26	154	41	1	0	0	418
2002	441	14	0	6	0	0	0	461
2003	232	16	0	62	0	0	0	310
2004	131	10	41	10	0	0	0	192
2005	141	28	34	18	0	21	0	242
2006	141	28	34	18	0	0	0	221
2007	216	34	9	54	0	9	0	322
Total	**7,341**	**1,275**	**11,989**	**695**	**727**	**114**	**71**	**22,223**

Source: MoHA (2005, 2008)

TABLE 1.5c: Disaster wise estimated losses (2001-2007) NRs x106

Year	Floods and landslides	Fires	Wind, Hail and thunderstrom	Earthquakes	Total
2001	919.4	239.25	128.32	1.99	1,288.96
2002	251.09	246.25	38.69	3.82	539.85
2003	4169.51	94.74	11.91	0	4276.16
2004	234.78	734.96	20.17	0	989.91
2005	219.29	121.03	0.77	0	341.09
2006	131.56	247.75	2.65	0	381.96
2007	1831.54	228.76	24.15	0.07	2,084.52
Total	**7757.17**	**1912.74**	**226.66**	**5.88**	**9,902.45**
%	**78.34**	**19.32**	**2.29**	**0.06**	**100.00**

Source: MoHA (2008)

Nepal is a disaster hot spot due to the vulnerability of the population and the regular and frequent occurrence of different natural hazards. It is the country's social context—its low level of development and institutional dysfunctions—that particularly intensify the impacts of disasters. By global standards, Nepal ranked 23rd (See Table 1.5d) in the world in terms of the total natural hazard-related deaths in two decades from 1988 to 2007 with total deaths reaching above 7,000 (IFRC, 2007). It is in seventh position for deaths resulting as a consequence of floods, landslides and avalanches combined, and in eighth position for flood-related deaths alone. A UN Report (2008) shows that 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. Globally Nepal ranks very high in terms of relative vulnerability to earthquakes and water related disasters respectively. Given its small size and how few people live here in comparison to the other countries featuring in the top slots, these rankings are particularly high and underscore the high annual human toll of disasters such as floods, even during 'normal' years.

Box 1.2: Types of natural and human-induced hazards in Nepal

Types of Hazard	Prevalence
Natural	
Earthquake	All of Nepal is a high-hazard earthquake zone
Flood (inundation, bank cutting and sediment deposition)	Tarai, Middle Hills
Landslide and landslide dam breaks	Hills, Mountains
Debris Flow	Hills and Mountain, severe in areas of elevations greater than 1,700 m that are covered by glacial deposits of previous ice age
Glacier Lakes Outburst Floods (GLOF)	Origin at the tongue of glaciers in Higher Himalaya, Higher Mountains, flow reach up to middle Hill regions
Bishyari	Mid hills and chure
Avalanche	Higher Himalaya
Fire (forest) southern-	Hills and Tarai (forest belt at foot of most Hills
Drought	All over the country
Storms/ Hailstorm	Hills

Human -Induced	
Epidemics	Tarai and Hills, also parts of Mountain region
Fire (settlements)	Mostly in Tarai, also in mid-Hill region
Accidents	Urban areas, along road network
Industrial/Technological Hazards	Urban industrial areas
Soil erosion	Hill and mountain region
Social Disruptions	Follows disaster-affected areas and politically disturbed areas

Adapted from Dixit (1990 and 1996)

A 2005 World Bank report which identified high disaster risk regions where development efforts need to be better informed and designed to reduce natural disaster-related losses in the future[1] found that more than 90 per cent of the population of countries like Bangladesh, Nepal, the Dominican Republic, Burundi, Haiti, Taiwan, Malawi, El Salvador, and Honduras live in areas of high relative risk of death from two or more hazards (See Figure 1.10). Another key finding of the report was that poor countries in the developing world are more likely to encounter difficulty adapting to disaster-related losses and bearing the costs associated with disaster relief, recovery, rehabilitation and reconstruction.[2]

The Ministry of Home Affairs (MoHA) reports that in the last twenty years (1983-2003), 21,246 people lost their lives because of disasters (MoHA, 2004). Fifty-five per cent of those deaths were caused by epidemics and 32 per cent were caused by floods and landslides. When missing persons are included, the numbers soar. In 2003, which was a normal rainfall year, 232 people died due to floods and landslides, 58 people went missing, 76 were injured and a total of 7,167 families were affected. Other losses included 865 animals, 3,017 houses and 174 cattle sheds. The estimated loss for that year was NRs. 4169.51 million.

[1] *Natural Disaster Hotspots: A Global Risk Analysis1 Natural Disaster Hotspots: A Global Risk Analysis*

[2] *The details on Nepal from http://www.ldeo.columbia.edu/news/2005/03_29_05.htm*

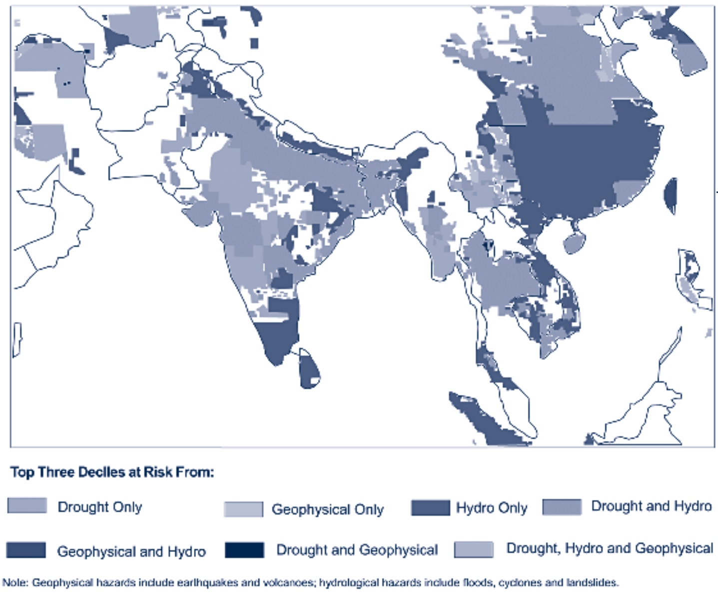


FIGURE 1.10: Global distribution of highest risk disaster hotspots by hazard type measured in terms of total economic loss risks

Organised efforts for DRR in Nepal began in 1982 when the government of Nepal promulgated the Natural Calamity Relief Act (NCRA). Since then, governmental and non-governmental organisations have tried to respond to disasters and to reduce risks through preparedness, rescue and recovery, and reconstruction and rehabilitation activities. Though these efforts are few and far between, the practices they involved could be a major source of learning if they were distilled and made available to all DRR efforts which seek to minimise risks to people, community, social and economic systems.

TABLE 1.5d: Global deaths resulting as a consequence of natural hazards, 1988-2007

Work ranking	Total deaths		Total deaths excluding those arising as a consequence of heat-waves and insect infestations		Flood-related deaths		Flood, landslide and avalanche related deaths	
	Country	No of deaths	Country	No of deaths	Country	No of deaths	Country	No of deaths
						1561		2717
1	Indonesia	182,950	Indonesia	182,950	Venezuela	30,252	Venezuela	30,270
2	Bangladesh	159,987	Bangladesh	157,816	India	27,516	India	29,952
3	India	107,747	India	98,395	China P Rep	26,388	China P Rep	28,302
4	Pakistan	83,498	Pakistan	82,287	Bangladesh	7,924	Bangladesh	7,924
5	Iran Islam Rep	72,924	Iran Islam Rep	72,924	Pakistan	6,479	Pakistan	6,960

TABLE 1.5d: Global deaths resulting as a consequence of natural hazards, 1988-2007 cont'd...

Work ranking	Total deaths		Total deaths excluding those arising as a consequence of heat-waves and insect infestations		Flood-related deaths		Flood, landslide and avalanche related deaths	
	Country	No of deaths	Country	No of deaths	Country	No of deaths	Country	No of deaths
6	China P Rep	44,112	China P Rep	43,922	Viet Nam	3,822	Indonesia	4,811
7	Sri Lanka	36,211	Sri Lanka	36,211	Indonesia	3,566	**Nepal**	**4,553**
8	Venezuela	30,466	Venezuela	30,466	**Nepal**	**3,397**	Viet Nam	4,139
9	Soviet Union	25,823	Soviet Union	25,823	Afghanistan	3,096	Afghanistan	3,868
10	Philippines	22,811	Philippines	22,811	Haiti	2,960	Philippines	3,510
11	France	21,379	Turkey	20,196	Somalia	2,608	Haiti	2,960
12	Italy	20,538	Honduras	15,386	Thailand	2,087	Somalia	2,608
13	Turkey	20,266	Afghanistan	12,886	Iran Islam Rep	2,078	Brazil	2,409
14	Spain	15,472	Viet Nam	11,555	Ethiopia	1,886	Iran Islam Rep	2,151
15	Honduras	15,386	Thailand	11,301	Brazil	1,754	Thaliland	2,134
16	Afghanistan	13458	Haiti	7,357	Mexico	1,563	Ethiopia	1,925
17	Viet Nam	11,555	Japan	6,913	Korea Dem P Rep	1,505	Tajikistan	1,859
18	Thailand	11,301	United States	5,820	Tajikistan	1,492	Colombia	1,839
19	Germany	9,630	**Nepal**	**5446**	Philippines	1,460	Mexico	1,634
20	United States	7,389	Nicaragua	4,037	Algeria	1,274	Korea Dem P Rep	1,505
21	Haiti	7,357	Algeria	3,852	Colombia	1,267	Algeria	1,289
22	Japan	6,985	Colombia	3,412	Cambodia	1,127	Mozambique	1,134
23	**Nepal**	**5,554**	Russia	3,299	Mozambique	1,047	Cambodia	1,127
24	Russia	5,219	Mexico	3,077	Morocco	1,029	Morocco	1,060
25	Mexico	4,172	Somalia	2,959	Korea Rep	941	Peru	1,035

Source EM-DAT: The OFDA/CRED International Disaster Database, ww.emdat.be-Universite Catholique de Louvain - Brussels - Belgium. Visited 5 March 2009. The data base provided by UNDP, Kathmandu.

Nepal is also prone to climatic hazards such as hailstorms, snow avalanches, cold and heat waves which result in considerable loss of life and properties. They produce localised effects of thunderbolts, which is another common killer in Nepal. About 27 people die every year and over 33 are injured (MoHA, 2004). Existing records show that thunderbolt is common during the pre-monsoon months of April, May and June, and can occur in other months as well. Avalanche and heavy snow fall cause losses of human life. Unexpected and heavy hailstones occasionally destroy paddy, millet, wheat and maize contributing to food deficit in remote districts.

Box 1.3 Economic loss caused by disaster

Because 33.8 per cent of Nepal's GDP is generated by agriculture, much of which is dependent on rainfall rather than irrigation, the country's economic wellbeing is highly sensitive to major and periodic droughts (World Bank, 2008). Floods and landslides take their toll every year too, resulting in losses of human life, crops and infrastructure. Nepal is ranked high in the world in degree of disaster-affectedness (see Table 1.5 a, b, c and d): despite its small population and land area, it records a high annual human death toll caused by floods, even during normal rainfall years. These rankings are a clear indication of the need for effective DRR strategies. The country's macro-economy appears to be more affected by drought than by other natural hazards. The explanation for this apparent elasticity in the face of other hazards is complex. One reason is that the regularity of the occurrence of floods and landslides makes it impossible to directly quantify the benefits of year in which floods and landslides do not occur at all. A second reason is that the nutrients brought by flooding actually increase agricultural productivity.

A third reason has to do with Nepal's decade-long violent conflict, which posed substantial methodological challenges to assessing the economic costs of disasters. Damage to physical structures during the conflict, particularly administrative buildings and communication infrastructures, totalled about NRs. five billion. A 2004 study by the National Peace Campaign put the total cost of the conflict over the period from 1996 to 2003 alone at $66.2 billion, while a Department for International Development (DFID) study estimated the cost to be 8 to 10 per cent of GDP[3]. Though the human losses during the insurgency were significant, we posit that it is the extent of physical losses which are more instructive in terms of assessing the costs of disasters though the conflict caused such great losses that those associated with disaster become trivial in comparison[4].

The fourth reason that the true economic impact of disasters remains buried is the nature of the Nepali economy: it is dominated by the informal sector and weakly linked to formal

[3] *The National Peace Campaign and DFID documents are both cited in Ra and Singh (2005).*
[4] *The conflict from 1996 to 2006 resulted in about 11,300 deaths, considerable internal displacement, disruptions to the delivery of essential services, including health and education, and a decline in new investment (NPC, 2007; NSET, 2008).*

institutions. For this reason, much income, including that from informal border trade in rice and other commodities and inflows of remittances, goes unreported. This unofficial income not only makes it difficult to assess the impact of disaster using official data alone but also cushions the impact of disasters on the formal economy, in particular by reducing pressure on the formal balance of trade and on foreign exchange reserves.

Although some of the above reasons do in fact minimise the impact of disasters on Nepal's macro-economy, there is plenty of evidence to suggest that, collectively, disasters are debilitating the economy of the country. Disasters affect the development of human capital via their impact on education and health. The direct losses (human and economic) associated with disaster can also lead to a wide array of indirect and secondary effects. Direct losses include physical damage to capital assets, including buildings, infrastructure, industrial plants, standing crops, grain stores, livestock and social infrastructure, as well as the loss of human life and mental and physical wellbeing. Indirect and secondary effects are disruptions in the flow of goods and services stemming from direct losses, including reduced output, loss of earnings and loss of employment. The secondary effects of a disaster have both short- and long-term socio-economic consequences for GDP growth, fiscal and monetary performance, the balance of payments, foreign reserves, indebtedness, and the scale and incidence of poverty. Despite this evidence that disasters do have devastating economic impacts, there have been relatively little macro-economic or financial analyses in Nepal. Unfortunately, this dearth of study limits the ability of the government to act upon its stated commitment to disaster risk reduction.

Also lacking are sufficient scenario-based analyses of the potential economic consequences of disasters. Two scenarios of note are the likely outcomes of an high magnitude and intensity earthquake striking Kathmandu Valley (see Box 6.1) and a more recent study that has attempted to synthesise existing scientific and socio-economic information about the impacts of climate change in Nepal Himalaya (NCVST, 2009). The NCVST study attempted to assess the pattern of vulnerability climate change will expose citizens to by considering past climate hazards such as cloudbursts, floods and drought as signature events. Drought is critical because while Nepal's agricultural performance is tied to climatic factors, this linkage is poorly articulated in the country's policy processes. Delayed or inadequate rainfall has a pervasive impact in Nepal, but one which is difficult to quantify in monetary terms. The damages associated with drought are mostly limited to crops and livestock, and can be severe when livestock become less productive as fodder supplies decline. As the sale of milk is a major income-generating activity, families forced to sell livestock because they who cannot feed them, suffer a drastic decline in household income.

Obviously rain-fed crops suffer in a drought, but, depending on soil moisture condition, base flow in streams, water levels in ponds and other storage bodies, and the level of the groundwater table, irrigated crops can also be severely impacted. The lack of timely rains can delay planting and also result in pest outbreaks. In contrast, earthquakes have little impact on standing crops, excluding localised losses occurring as a consequence of landslips and landslides. However, they can cause widespread destruction of infrastructure and productive assets, including agricultural infrastructure and networks that facilitate the distribution of agricultural inputs and produce. Floods, for their part, can cause extensive physical damage both to infrastructure and to agriculture, particularly if floodwaters recede slowly, leading to water-logging and resulting in the deposition of unproductive sediment on fields and in irrigation canals. Floods are also associated with increased incidences of pestilence and blight, both of which reduce crop yields. Crop losses, in turn, can increase the volume of food that needs to be imported and have serious implications on the balance of payments and stock of foreign exchange reserves. To the disproportionate detriment of poor families, prices may be forced up if the country's perennial shortages of food staples are exacerbated by disruptions to the transport network.[5]

The inundation due to breach of the 2008 Koshi embankment offers insights into the challenges involved in quantifying losses in monetary terms. The direct losses arising as a consequence of the breach included damage to about 5,000 ha of agricultural land and to a total of 17 km along different stretches of the East-West Highway. In addition, thousands of livelihoods were

[5] *The frequent closure of highways by different groups making political demands further hampers mobility and the supply of essential goods and agriculture produce. Such strikes compound existing food insecurity.*

lost, the education system was thrown into chaos and general wellbeing suffered. The damage to the highway prevented farmers from moving agricultural produce from the Eastern Tarai to any point west of the Koshi River, reducing sales and undermining livelihoods. There was considerable loss of productive assets such as agricultural tools, machinery, housing, household assets and livestock.

The 2008 Koshi flood was reported to have had a significant inflationary impact on the prices of commodities, particularly those of onions, potatoes and firewood (IASC, 2008). Following the embankment breach, the prices of perishable food items such as bananas and vegetables fell sharply in regions east of the Koshi River. At the same time, prices increased in markets in western Nepal because the flooding had severely disrupted the movement of goods along the East-West Highway (IASC, 2008; WFP, 2008).

In addition, the inundation caused by 2008 breach damaged underground optical fibres, phone lines and pylons, disrupting telecommunications (ADB, 2008c; IASC, 2008; Pathak, 2008). The damage wreaked on high-voltage electricity transmission pylons disrupted the India's supply of electricity to the Integrated Nepal Power System (INPS) and increased the duration of power cuts in Nepal. The costs of disrupted communications and the lack of electricity were high but they have not been systematically assessed. Arriving at a precise assessment of the full cost of the losses caused by the 2008 Koshi embankment breach and, indeed, of any other flood or any other disaster, including droughts, is difficult.

Unless it develops effective DRR strategies, Nepal will not achieve its development goals. Such strategies including assessing the cost of losses and doing that entails overcoming both conceptual and methodological challenges. Despite the difficulties, it is necessary to have such assessments in order to make future investments effectively contribute to the development of Nepal's social, economic and human capital. Now that the violent conflict has ended it is expected that there will be greater investments in and higher inflows of foreign aid to Nepal (NPC, 2007). How such resources can be used to make Nepal and the Nepali people more resilient in the face of climate-related and other forms of hazards should be a key consideration.

Climate change scenario

Nepal's vulnerability to climate-related disasters is likely to be exacerbated by the increase in the intensity and frequency of weather hazards induced by anthropogenic climate change (IPCC, 2007). As one of the countries in the world sensitive to the effects of climate change, Nepal must act fast and needs support of the international community. The country's maximum mean temperature shows steady decadal rise (MoPE, 1999). Analysis of maximum temperature data from 49 stations of the country for the period 1971-94 reveal warning trends after 1977 ranging from 0.06 °C to 0.12 °C per year in most of the Middle Mountain and Himalayan regions, while the Chure and Tarai (Southern plains) regions show warning trends of less than 0.03 °C per year (Shrestha *et al.*, 1999). In the same period, the global average for surface temperature increased by 0.6±0.2 °C in the last century. The trend in Nepal suggests that the IPCC projection is too conservative and that landlocked areas will warm at a rate faster than the global average.

A recent analysis of climate change scenario (NCVST, 2009) in Nepal broadly concurs to the above findings and presents following key insights:

- Global Circulation Models (GCM) projections indicate an increase in temperature over Nepal of 0.5-2.0 °C, with a multi-model mean of 1.4 °C, by the 2030s, rising to 3.0-6.3 °C, with a multi-model mean of 4.7 °C, by the 2090s. There is very little differentiation in projected multi-model mean temperature changes in different regions (East, Central, West) of Nepal.
- GCM outputs suggest that extremely hot days (the hottest 5% of days in the period 1970-1999) are projected to increase by up to 55% by the 2060s and 70% by the 2090s
- GCM outputs suggest that extremely hot nights (the hottest 5% of nights in the period 1970-1999) are projected to increase by up to 77% by the 2060s and 93% by the 2090s
- GCMs project a wide range of precipitation changes, especially in the monsoon: -14 to +40% by the 2030s increasing -52 to 135% by the 2090s.

The monsoon precipitation pattern is changing too, with fewer days of rain and more high-intensity rainfall events. Both trends have resulted in an increase in the magnitude and frequency of water-induced disasters like landslides, debris flow, and floods. With global warming happening faster than previously anticipated, it is crucial that Nepal accord priority to adaptation to climate change, especially as the country's poor will be disproportionately affected. In fact, since a number of international development partners are already exploring ways to support Nepal in adapting to such impacts, national interest in adaptation and DRR has increased. This challenge is made more complex because making climate change projections will be difficult and a great deal of uncertainty exists in the projection given the limitations of GCMs, RCMs and observational datasets for the region. As a result any projections must be interpreted and used cautiously (NCVST, 2009), which however should not be construed a barrier to assessing vulnerability and assessing options for adaptation and in implementing DRR activities.

The United Nation's Intergovernmental Panel on Climate Change (IPCC) warned last year that glaciers in the Nepal Himalaya are receding faster than in any other part of the world: "If the Earth continues to warm at its present rate, the likelihood of them disappearing by the year 2035 or sooner is very high." Himalayan glaciers are retreating at rates ranging from 10 to 60 metres per year. Many small glaciers (<0.2 sq. km.) have already disappeared and vertical retreats of as much as 100 metres have been recorded during the last fifty years. Almost 20 per cent of the glaciated areas in Nepal (above 5,000 metres) are expected to be snow- and glacier-free if the air temperature increases by 1 °C and a 2 °C rise which could result in the loss of almost 40 per cent of the total area under snow. Three and four degree could result in the loss of about 58 and 70 per cent of areas covered in snow and glaciers respectively. The resultant changes in regional water resources are projected to have negative impacts on hydropower generation, irrigation, and drinking water supply.

The glaciers in Asia have been retreating and thinning over the past 30 years but losses have accelerated in the last decade. The Himalayan region has the largest concentration of glaciers outside the polar caps. With glacier coverage of about 34,000 sq. km, the region is aptly called the "Water Tower of Asia"; it provides around $8.6x10^6$ cubic metres of water annually. The approximately 15,000 glaciers in the Himalaya occupy about 17 per cent of its area and another 30-40 per cent of its area experience seasonal snowfall (Vohra, 1978). This snow and ice feeds seven of Asia's great rivers: the Ganga, Indus, Brahmaputra, Salween, Mekong, Yangtze and Huang Ho, which provide water to more than 1.3 billion people (WWF, 2005). The rapid melting of these glaciers and snowfields will alter the regional hydrological system significantly as melt water draining from them regulates the hydrology of the Indian sub-continent. Snow melt releases water during the dry season and helps maintain flows in the rivers during non-monsoon months though it contributes only about 10 per cent of total runoff (Sharma, 1977). Jianchu *et al.* (2007) and Barnett et al. (2005) suggest that snowmelt from the Himalaya provides about 9% of Ganga's River flow.

The recently observed changes in climate have already also had impacts on biodiversity and ecosystems; they are responsible for changes in the distribution and population sizes of species as well as in the timings of reproduction and migration and have increased the frequency of pest and disease outbreaks. As has been observed in other parts of the world, the vegetation regime in Nepal is expected to push northward. If warming continues at the present rate for the next couple of decades, plant species will not be able to migrate in time to adjust and may become extinct. Indeed, several plants and animals are already threatened and there has also been a noticeable loss in bio-diversity in Nepal. Agricultural species may be at particular risk as the intensity and frequency of drought continues to rise; studies indicate that crop yields have declined.

Climate change, in addition, with temperature rises can accelerate drying of biomasses which in turn will increase the incidences of forest fires across the nation. On the other hand, depletion of water resource triggered by climatic anomalies will continue to exacerbate the water-related diseases such as cholera and diarhoea. These epidemics will occur frequently and lead to more avoidable death without taking measures for mitigation.

Objectives of the report

This report aims to present some of the lessons learnt from DRR activities in Nepal. Its objectives are twofold:

1) To present information related to disasters in Nepal in a single volume and
2) To analyse the historical and institutional contexts that help turn hazards into disasters.

Approach To NDR

Preparing the report involved the participation of several institutions and individuals who have worked in disaster risk management in Nepal and an editorial committee coordinated by the MoHA was formed to facilitate its publication. Members in the committee include representatives of Disaster Preparedness Network-Nepal (DPNet-N), Eco-Nepal, United Nations Development Programme (UNDP), Oxfam GB Nepal and Action Aid Nepal and Ajaya Dixit of Nepal Water Conservation Foundation provided conceptual and editorial support. The committee commissioned papers on the science of hazards, earthquakes, fires, floods, landslides, droughts and legislation. The papers were presented in a half day seminar and later reviewed, commented upon and synthesised.

DRR activities must focus on two core issues: improving the indicators listed in tables 1.1(a) and (b) and building the institutional capacity needed to deal with, manage and reduce the impact of disasters. These efforts must recognise the complex physical environment of the country and will require learning from of past efforts.

The next chapter presents conceptual foundation of DRR activities. In the subsequent chapters flood, landslide, drought, earthquakes, fire and anthropogenic disasters like accidents and epidemic are presented. Chapter 9 discussed the country's legislation and institutions related to DRR. In chapter 10 conclusions are drawn.

Chapter-2

Disaster Risk Reduction: Conceptual Foundation

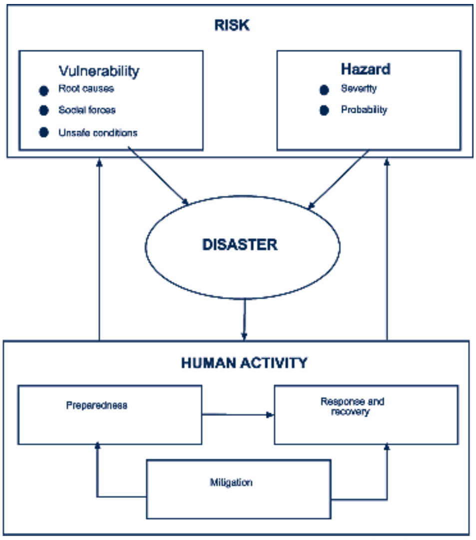
The increase in damage and loss from disasters globally poses serious challenges to human society. Data from 6,384 events which occurred from 1974 to 2003 show that climate-related hazards such as windstorms, droughts, extreme temperatures, floods and wave surges account for almost 75 per cent of global disasters (Hoyois and Guha-Sapir, 2004). Disasters result in the loss of human life and damage to social and economic systems, and it is the poor and marginal communities which are most severely impacted. In fact, the losses and depletion of assets that occur due to disasters are a major reason for chronic poverty. Disasters also disrupt basic ecosystem processes and serve as breeding grounds for disease. Recurrent disasters undermine the ability of communities, regions and nations to meet many basic development goals. The Hyogo Framework for Action (HFA) recognises this inter-linkage and appropriately suggests that DRR is essential if the UN's Millennium Development Goals (ISDR, 2005) are to be met.

Most academic or policy-related studies of disasters focus on the significance of naturally triggered events independently of human activities (Blaikie *et al.*, 1994). The magnitude of a hazardous event, the probability of its occurrence, and the extent of its impact vary, but in some cases this data can be estimated within a certain margin of error. This natural science approach suggests that disasters are departures from normal social operations and that recovery from a disaster means returning normalcy. Policy-makers, donors, relief and development agencies usually subscribe to this view and treat disasters as isolated events that break the continuity of normal life. Their support is guided under the assumption that emergency assistance in the form of relief mitigates the hardship caused by a hazard and attempts to restore the status quo. Thus, every year, government, donor, and even non-governmental organisations find themselves providing similar relief measures and very little efforts are made to change the reasons a particular population is vulnerable.

This top-down approach to disaster mitigation has been used since the Industrial Revolution and more particularly since the 1950s. It fails to involve those affected by a disaster in implementing strategies which can help minimise the impact of a hazard before it even occurs. As a result, its 'solutions' do not promote adaptation. Instead, they involve taking and monitoring physical measures and rely on structural methods that involve large engineering works and modification of stock and flows. Under this paradigm, a 'natural hazard' is virtually synonymous with a 'natural disaster,' though, in fact, the latter can be averted or at least mitigated.

A growing body of research suggests that natural disasters are not the same as natural hazards; instead, they are created by the coincidence of hazards and socio-economic factors which render individuals and families vulnerable. This perspective acknowledges the normalcy of natural hazards and focuses on reducing vulnerability to these recurrent events. This vulnerability guided approach focuses on the various ways in which social systems make people susceptible to natural hazards and strives to eliminate them. Vulnerability is defined as the capacity of a person or a group to anticipate, cope with, resist, and recover from the impact of a natural hazard (Blaikie *et al.*, 1994) and is a dynamic condition. The interrelationship between vulnerability, hazards and disasters is shown in Figure 2.1.

Figure 2.1: Interrelationship among flood hazard, vulnerability and risk



source: Etkin (1999)

In many developing countries, the day-to-day life of the majority of the population is no different from the conditions which prevail in the developed world only during a disaster. People are vulnerable even during normal times, not because they are ignorant about hazards or because their perception of risk is erroneous. They are vulnerable because they have little freedom to choose how and where they live. Instead, social and political contexts decide for them. Low-income and asset-poor families, for example often have no choice but to settle in flood plains because of prevailing agrarian relations and because the economic and political processes make it impossible for them to own land in safe places. They are vulnerable because they are marginalised and excluded. Such individuals, families and communities find it difficult to rebuild their livelihoods after being exposed to a natural hazard.

Consideration of social and political contexts demonstrates conclusively that disaster is the outcome of both vulnerability and hazard. A hazard is the probability in a given period of time that an extreme natural phenomena will affect a given area (UNCHS, 1981), while vulnerability is the probability that any physical, structural or socio-economic system will be damaged, destroyed or lost because of a natural hazard. According to International Strategy for disaster Reduction (ISDR) vulnerability is the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard defined as a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.[6] Since vulnerability depends on social, economic and political contexts, it is dynamic and can be reduced by strengthening resilience. It is the magnitude of a natural hazard and the degree of vulnerability which together determine the level of risk that there will be a disaster, which can be defined as the loss of and damage to people and properties and the interruption of normal activities.

Economic, social, and political structures and the interrelationships among them during normal times determine the vulnerability of various sections of population to disasters. These factors determine who has access to resources of various types, including material benefits, social clout and decision-making power. Evidence from a number of case studies points to the fact that the poor and dispossessed, who live at the margins of any society's social, economic and political spaces, suffer the most from disasters. Because they have little access to basic resources such as land, food and shelter, health and education, their resilience to disasters is low. In short, disasters reflect the unresolved problems of society during normal times, problems which affect the way people are impacted by hazards. According to Blaikie *et al.*, (1994) vulnerability is determined by three factors:

- root causes such as limited access to power, structures and resources; political ideologies; and economic systems,

6 *The definition is taken from http://www.unisdr.org/eng/terminology/terminology-2009-eng.html accessed on 3rd October 2009.*

- dynamic pressures such as the lack of institutions, training, and skills as well as macro-forces such as urbanization and population growth, and
- unsafe conditions, including dangers in the physical environment, local economy, social relations and public actions and institutions.

Conducting an analysis of social factors will expose these conditions of vulnerability and identify the root causes of why some people are repeatedly harmed by hazards. Successful responses to disaster mitigation need to consider the how and why behind who is hit by hazards in addition to trying to understand the characteristics of hazards. Only then can their impact on society be mitigated.

Because disasters are by nature disruptive, they provide a unique avenue into identifying social relationships that are hidden during normal times. They are forensic moments that provide opportunities to change existing relationships by creating new arrangements. The vulnerability of marginalised groups which are repeatedly affected by disasters can be reduced when these old relationships are transformed. It is for this reasons that the development initiatives undertaken between disasters, especially those that rework power structures, play a vital role in mitigating the harmful effects of hazards. Strategies must strive to reform those relationships and institutional arrangements that worsen societal vulnerabilities so that they will instead foster resilience. Communities, families and individuals affected by disasters must be involved in all stages of such initiatives, from decision-making to implementation.

In recent years, disaster risk reduction activities have undergone a fundamental change: disaster risk reduction is now considered as an integral part of development in normal times. The differences between the conventional and the alternative approach are summarised in Table 2.1.[7]

[7] *Disaster and Vulnerability in South Asia Programme for Duryog Nivaran: A South Asian Initiative on Disaster Mitigation. ITDG, Sri Lanka, 1995.*

This report emphasises practical points of intervention that can build upon existing patterns of change and social responses to disasters and how they can be translated into action. It also broadly outlines key patterns in the wider processes of socio-economic changes within which this report must be interpreted. Any efforts at disaster risk reduction must acknowledge both physical characteristics and social and economic contexts, or, in other words, both hazard and vulnerability (see Figure 2.2). By conceptualising disaster as a combined outcome of hazard and vulnerability, we can pursue a wider range of actions that reduce risk, actions that include activities which address root causes, dynamic pressures and unsafe conditions for individuals, households, communities and organisations.

Table 2.1: Perspective on disaster management

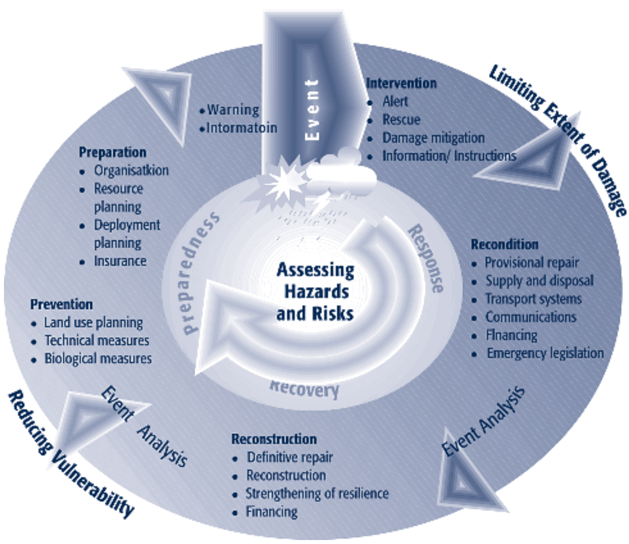
Dominant perspective	Alternative perspective
Disasters/conflicts are viewed as isolated events.	Disasters are part of the normal process of development.
The linkage between disaster and conditions in society during normal times is not analysed in detail.	Analysing linkages with society during normal times is fundamental for understanding disasters/conflicts
Technical solutions dominate.	The emphasis is on solutions that change relationships and structures in society with a view to reducing reduce people's vulnerability and strengthening their capacity to respond and adapt.
Centralised institutions dominate intervention strategies and the participation of people, who are treated as 'victims,' is relatively low. Implementing agencies have little accountability and their processes tend not to be transparent to the affected people.	Decentralised institutions dominate in intervention strategies and the participation of people is seen as paramount. People are treated as 'partners' in development and disaster mitigation. Ensuring accountability and transparency is emphasised.
Interventions are made after an event occurs.	The mitigation of disasters and conflict is seen as an inherent part of the development process and is the fundamental aim of relief.
The objective of intervention is to re-establish the status quo.	Disasters and conflicts are viewed as opportunities for social transformation. It is recognised that neither nature nor society can, or should, return to the status quo following a major stress. Disasters are opportunities to encourage 'good' forms of development rather than continuing mal-development.

Disaster cycle

Reducing the risk of disaster is associated with three steps: preparedness, response, recovery before next hazard occurs (see Figure 2.2). Many of the elements identified in this cycle, including strengthening resilience, diversifying livelihood, planning, providing insurance and developing early warning information, reduce vulnerability before the next event and help people and regions respond to and thereby minimise the impacts of a hazard.

Disaster risk reduction measures are undertaken in order to build local resilience. They strengthen the social capacity to respond to changing conditions, including the stresses inflicted by disasters.

Figure 2.2: Disaster cycle



Source: Swiss Civil Protection (Quoted in Moench and Dixit, 2007)

A holistic approach to disaster risk reduction includes all three process of disaster management—preparedness, rescue and recovery—and as such both minimises the destruction and disruption caused by disasters and provides long-term methods to deal with them. The preparatory measures undertaken are both structural and non-structural.

Preparedness: Activities taken in advance to ensure effective response to the impact of hazards include the issuance of timely and effective early warnings and the temporary evacuation of people and property. Social and technical feasibility as well as cost and benefit considerations determine which preventive measures needs to be implemented in areas frequently affected by disasters. By building awareness and promoting education about risk reduction and by changing attitudes and behavior, a culture of prevention can be nurtured.

Relief: The provision of interventions during or immediately after a disaster to help save the lives and meet the basic subsistence needs of those affected is known as rescue and relief. Its duration can be immediate, short, or protracted.

Recovery: Recovery involves taking decisions and actions after a disaster in order to restore the pre-disaster living conditions of the community, while at the same time encouraging and facilitating those adjustments needed to reduce future risks. Recovery (rehabilitation and reconstruction) provides an opportunity to develop and apply disaster risk reduction measures.

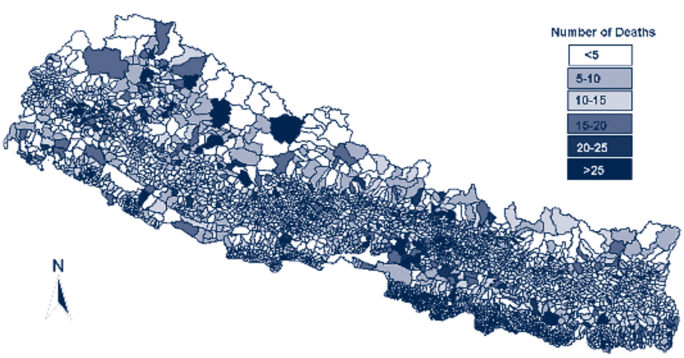
Box 2.1 Nepal's DesInventar database

Nepal Society for Earthquake Technology (NSET) has established a disaster information management system called DesInventar with funding from UNDP and approval from the government. This computer-based database, which was developed by LA RED in Latin America in 1994, helps inventory the occurrence of large as well as small disasters and hazards. It analyses data, characterises the attributes of disasters and presents the results in geo-referenced maps and charts. Data on disasters which occurred between 1970 and 2007 have already been processed. This data includes the characteristics and effects of hazards, notably their types, locations, effects (in terms of numbers of casualties as well as damage to physical objects), and losses.

Another advantage is that it can be adapted to the local context of disasters. In fact, special attention is paid to registering small, "everyday" disasters that are usually invisible at the national or global scale. Since the information is geo-referenced, the data, as well as its interpretation and analysis, are expressed appropriately in time and space, The system also allows for depicting data cartographically, graphically and in tabular form by administrative, physiographic or political division.

The database includes information on the following types of hazards. For the period from 1970 to 2007, DesInventar has data cards for 15,388 disasters and reports of 27,256 deaths, which means an average loss of more than two human lives every day. About 57 per cent of deaths were caused by epidemics, 15 per cent by landslides, and 11 per cent by floods. Fires, which account for 25 per cent of the total, are the most frequently occurring disaster. Epidemics and floods (with 18 per cent each) are the second most frequent type of disaster. NSET is continuing to update the database.

accident [8]	Frost	landslide	snow storm
avalanche	GLOF	leak	storm
biological disaster	explosion[9]	liquefaction	strong winds
boat capsize	famine	panic	structural collapse
cold wave	fire	plague	thunderstorm
drought	flood	pollution	hailstorm
earthquake	forest fire	rains	
epidemic	heat wave	sedimentation	



VDC-Wise distribution of deaths due to natural disasters as depicted in DesInventar

Adapted from Global Assessment of Risks Nepal Country Report (2009)

[8] *Caused by natural phenomenon*
[9] *Caused by natural phenomenon*

Actions that help the population respond to the impacts of disasters and adapt to climate change have received considerable attention in recent times. These conditions help us understand vulnerability in all disasters, including epidemics and man-made disasters like oil spills and factory explosions, and to implement measures to minimise that vulnerability. Studies in South Asia indicate that the vulnerability and social impacts associated with climate-related disasters are influenced by at least eight conditions (Moench and Dixit, 2004), as listed below.

1. The nature of livelihood systems within a region, in particular the extent to which individuals and households are able to diversify income strategies and incorporate non-farm components, many of which are less vulnerable to disruption via natural disasters than agriculture is;
2. The ability of people to migrate or commute in order to access agricultural or non- agricultural sources of income outside of areas affected by drought or flooding;
3. The ability of information, goods and services to flow into and out of affected areas;
4. The differential social capital and institutional checks and balances that households have access to, including education, community institutions such as self-help groups, formal institutions such as government departments and banks, non-government organisations, the media; and social networks;
5. Existing patterns of differential vulnerability created by gender, income and social position;
6. The nature of physical infrastructure (roads, houses, water supply systems, etc.), in particular:
    a. the degree to which such infrastructure is vulnerable to being disrupted by floods and droughts; and
    b. the extent to which such infrastructure allows people to maintain their livelihoods during times of drought and flooding by serving as a point of refuge, helping to protect assets, and facilitating the movement of goods, services and people;

7. The ability of households to obtain secure sources of drinking water for domestic uses (whether such water supply security is developed through local sources, long-distance transport through water markets or rural supply schemes); and
8. Natural resource conditions, particularly the degree to which ground and surface water systems are disrupted. Specific indicators include:
   a. long-term declines in water level and sources, which serve as a major warning signal that irrigated agricultural systems are increasingly vulnerable to droughts;
   b. the increased presence of structures (such as roads, bridges, embankments for railways and flood control) that interfere with the existing patterns of natural drainage, which serves as an indicator of the greater likelihood of flooding.

A comparison of tables 1.1(a) and (b) with the eight outcomes listed above makes it clear that Nepal's population is vulnerable to disasters. Disasters adversely affect Nepal's entire economy but the poor and vulnerable suffer the most because they have limited options for rebuilding their livelihoods after a disaster. The poor have few assets, limited access to formal financial institutions and limited opportunities to diversify their livelihoods. They are forced to reduce their consumption of food, take their children out of school, and sell livestock. Although such steps can provide immediate help to the poorer households, it will have a negative effect on their future. DRR efforts need to be mainstreamed in order to change this overall context. This is a challenge that Nepal must tackle with utmost priority.

Box 2.2: Disaster and poverty

Nepal's progress in reducing the level of absolute poverty from 42 per cent in 1996/97 to 24.8 per cent[10] in 2008/09 (a drop of almost 18 per cent in just 12 years) has more to do with the increase in the flow of remittances than with any targeted measures which the government adopted in its five-year plans, one of whose aims was to reduce the proportion of the population living below the poverty line by increasing local employment opportunities (NPC, 2007). It unlikely that Nepal can expect progress in poverty reduction if the country does not address natural hazard vulnerability, particularly as the impacts of climate change grow more serious. According to the MoHA (2008), the high levels of structural, non-structural, social and institutional vulnerabilities of Nepal to various natural and human-induced hazards will severely impede its ability to achieve its millennium development goals (MDGs).

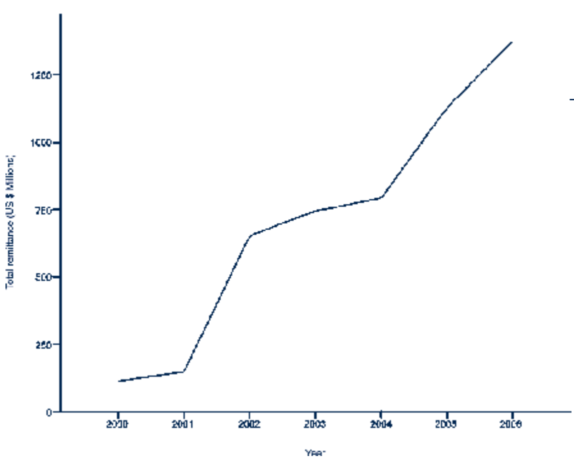
According to the UN MDG monitoring initiative, Nepal is on track to achieve only one of its eight MDG goals, that relating to reducing child mortality.[11] Most of the remaining goals can be achieved only if Nepali institutions become more robust than they are at present or if the goals themselves are lowered. As things stand, disasters will probably undermine the likelihood of achieving four goals in particular: reducing poverty, reducing hunger, improving child health and attaining universal education. The GoN and the UNDP (2008) recognise that it is the poor people of Nepal who will be disproportionately affected by natural hazards, as their livelihoods are largely dependent on climate-sensitive natural resources and their capacities to cope with extreme climatic events are very weak. The fact that so many Nepalis rely on natural resource-dependent livelihoods to survive poses a serious challenge for human development though evidence that non-climate-dependent alternatives such as service sector livelihoods are being embraced is encouraging (NCVST, 2009). Even in this changing livelihood picture, however, weather vagaries and the impacts of more frequently occurring climate change-induced disasters will continue to wreak devastation and undermine wellbeing.

[10] *Koirala, K.R., 2009: Nepal's Poverty Level Down to 24.8 per cent. Asian Tribune www.Asiantribune.com/?q=node/16787 retrieved on October 1, 2009.*

[11] *http://www.mdgmonitor.org/country_progress.cfm?c=NPL&cd= retrieved on 8 October, 2009*

Since the mid-1990s, the number of Nepalis who have migrated to labour markets in the Gulf, Malaysia and South Korea in addition to traditional destinations in Indian cities, has soared. This mass exodus has created significant challenges to meeting the country's MDGs. The lure of employment continues to be the main pull factor behind this movement, while the decade-long Maoist insurgency was one of the push factors. The result has been a shortage of agricultural labour, a decline in agricultural production and an increase in the vulnerabilities of marginalised households comprising women, the young and the old. According to many villagers, life in Nepali villages has become more difficult and they place the blame on the depleted active population and on capricious weather patterns that include delayed monsoon rains, intense cloudbursts and floods, and the migration of weeds and plant disease vectors to higher altitudes as temperatures increase. Both agricultural production and livestock-rearing have plummeted as remittance inflows allow villagers to buy their food from cities instead of growing it in vulnerable rural hamlets (DST, 2008). The only saving grace of the present exodus to the job market is the value of remittance inflows: it dwarfs both government revenues and foreign direct investments .

Total remittance flows to Nepal



Despite its obvious relevance, there has been little formal analysis of the quantitative relationship between poverty and vulnerability to natural hazards in Nepal. One study by NSET

(2008) somewhat counter-intuitively suggests that there is a negative correlation between the incidence of flood disasters and levels of poverty: geographical areas affected by floods have lower poverty rates. Since these findings cannot be substantiated in the face of widespread qualitative evidence, the authors of the study recommend further investigation. In contrast, a more recent study, also of floods in the Tarai and poverty, suggests that the impact of climate-related shocks will have a devastating effect on Nepal's social and economic development. In particular, the predicted increase in the number and intensity of flood disasters will prevent many Nepali households in the Tarai from rising above the poverty line (NCVST, 2009). This 2009 study also suggests that even under median climate change projections, the flood impact on each household in the Tarai will double and that the number of households affected by floods directly will increase by 40 per cent. Its anomalous findings on floods notwithstanding, the 2008 NSET study does indicate a similarly positive correlation between the incidence of landslides (a climate hazard-related phenomenon) and poverty: rates of poverty are higher in areas where more people have been impacted by landslides.

The above findings underscore the need for more disaggregated analyses, especially as the character of Nepali households, the nature of poverty and the influence of various institutions are changing. In the last decade, the market, for example, has emerged as a dominant institution for providing goods and services in many Nepali settings. The NCVST report (2009), quoting the household budget survey of Nepal Rastra Bank, suggests that in 2005/2006 a Nepali average household spent 61 per cent of its total expenditure on goods and services. Three decades earlier, in 1973/1974, the same figure was just 33.2 per cent.

The emergence of the market as a mechanism for distributing services once provided by the government or obtained from the natural environment has made local inhabitants increasingly reliant on imported goods and services. This shift has inflicted greater hardship upon the poor-, low- and fixed-income households, who traditionally relied on ecosystem and government services. These groups are in a bind: they can neither control price fluctuations in the market nor fall back on traditional, informal means of accessing goods and services because either the government has withdrawn from its basic responsibility or ecosystem services have degraded. To make matters worse, unscrupulous speculators and middlemen extract a windfall from economic turmoil by hoarding goods, charging exorbitant prices, and defrauding middle-class and poor customers.

These emerging dynamics require that we redefine poverty, though arriving at such a definition will probably not be easy. In their conceptual schema, most international agencies define poverty as a complex phenomenon caused, among other things, by deprivation of wellbeing, lack of material assets or income, low levels of health provision, poor or no education, and food insecurity (UNESC, 2001; UNDP, 2007). In practice, however, this rich definition is reduced to a simple economic measure—a one-dollar-per-day threshold. Below this income level, it is considered that a household lives in absolute poverty and is unable to meet the minimum levels of food, energy, and shelter needed for basic survival (World Bank, 2007). The one-dollar indicator certainly does have value in its ability to quantify and assess progress towards increasing income as one of many aspects minimising poverty, but it is insufficient.

The near-universal tendency to see such a simplistic measure as the sole measure of poverty is problematic not only because it ignores fluctuations in exchange and inflation rates (which, because of economic globalisation, are important even at the local level), but also because the approach does not capture the diversity of deprivations poverty entails. An attempt made to address the limitations of the one dollar-per-day measure in reflecting regional and local contexts led to the creation of an additional income threshold—two dollars a day. With this addition, we can make a distinction in the severity of poverty, but the fundamental flaw in the prevailing paradigm of measuring poverty in only monetary term remains.

The sought after new definition of poverty needs to capture not only income but also the many other factors contributing to poverty, including access to education, health, food and nutritional security, access to natural resources, and social marginalisation. It also needs to take into account whether or not people labeled as 'poor' actually see themselves in that light. Their definition of poverty and their visions of how to escape it also need to be considered. Certain local elements are also embedded in the changing perception of poverty, as the table below indicates (DST, 2008). Summarising changing perceptions of poverty in mid-Nepal, the table demonstrates that poverty is not only materially but also socially defined: social considerations determine how different people perceive poverty and the different strategies they pursue to alleviate it in the social system undergoing transformations due to inroads of telephone, mobile phones and visual media changing aspirations, expectations, and education.

Changing Perception of Poverty along the Mustang-Gorakhpur Corridor in Nepal

Locations	Who are considered poor?
Ghandruk, Kaski District	Subsistence agricultural farmers, occupational – traditionally marginalised castes – such as tailors and agricultural tool makers; those without 'hotels' or tea shops along the trekking routes; and those not working abroad (USA, UK, Japan, Malaysia, Europe, Korea, Gulf)
Putali Bazaar, Syangja District	Those who do not own bus/truck or micro-bus capable of transporting necessities between road-heads and villages, and whose sons/daughters are not in government services or other forms of pensionable employment. Those with large land holdings (old category of wealth) but much of it lying fallow because of lack of agriculture labour.
Madan Pokhara, Palpa District	Those without cash generating farming (vegetables, coffee) and not involved in micro household business, such as weaving or other artisan skills. Those without higher education, beyond high school.
Dudhraksha, Rupandehi, District	Household with a drunkard male (usually head of family) who spends majority of earnings on liquor and quarrels with family members and neighbours.
Shankar Nagar Rupandehi, District	Unemployed even though with bachelors level education. Those with property but with much of it lying idle or abandoned because of the out-migration of skilled family members to Europe or Australia.
Marchawar Rupandehi, District	Those without quality-education (not necessarily just a formal school-leaving certificate) who are not able to take advantage of what NGOs and government agencies have to offer because of the absence of effective education. A degree is not enough to get employment. Education must be relevant to helping people gain employment in the highly competitive market.

Source: DST (2008)

The process of disentangling the links between disaster and poverty is fraught with both conceptual and methodological challenges. Definitions of, approaches to, and measurements of poverty need to consider the wide range of factors that contribute to poverty and to people's experience of it, and, perhaps even more importantly, those factors that enable or create barriers to the efforts of individuals and households to move out of poverty. Whether poverty results from disaster or from some other sources, these conceptual and methodological challenges remain. Since it is the poor who are vulnerable to disasters, it is their definition of poverty which will be helpful in formulating effective disaster risk reduction strategies.

Chapter-3

Floods and Flood Management

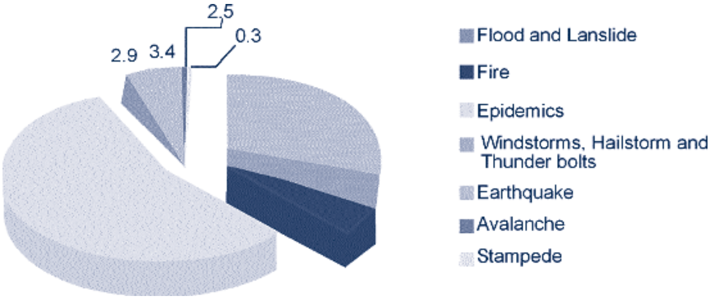
"The task is not just to preserve water resources to sustain life, but also to reduce the capacity of water to take life away. …we can and must reduce the number and impact of disasters by building sustainable communities that have the long-term capacity to live with risk." Kofi Annan, United Nations Secretary-General (8 October 2003)

The Himalaya-Ganga River Basin system is home to some of the poorest people in the world, in part because of its climate and hydrology. Many Nepalis, Indians and Bangladeshis who live here have been reduced to abject poverty because of regular flooding during the monsoon season from June to September and drought-like conditions throughout the rest of the year (Bandhyopadhyaya, 1999). This annual flood-drought pattern exhibits great micro-level variations in its nature and impact but across the region people regularly face the devastation of torrential downpours, landslides and floods as well as of low water tables and dried up springs.

Traditional hydrological text define a flood as an unusually high stage the river at which the stream channel becomes filled and above which it overflows its banks (Wisler and Brater, 1949). In other words, flooding occurs when the volume of water in a water body exceeds its total carrying capacity or when flow exceeds the capacity of a river channel. The expanse of flood submerges land and settlement. Under such circumstances, water overflows onto land used for agriculture, housing, roads, recreation, commerce, or industry. Our ability to deal with floods determines whether water remains a life-providing element or becomes a destructive force which destroys human life, social stability and economic development. Flooding is determined by long-term meteorological patterns and their interdependence with physical processes that influence the atmosphere. Because our knowledge of these complex dynamics is limited, our understanding of floods is also limited.

Inundated agricultural land and settlement in the Tarai

FIGURE 3.1A: Death caused by various disasters (1983-2005) in %



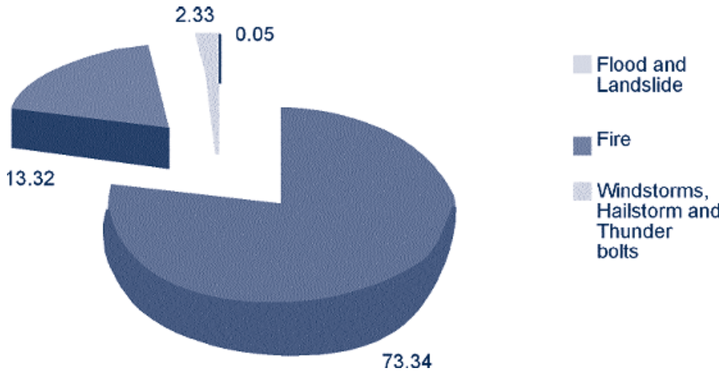


FIGURE 3.1B: Estimated loss due to disasters 92001-2007) in NRs

The exact nature of a flood depends on both local and regional climatic and geomorphic processes. While floods have occurred since human first began settling on the flood plains of rivers like the Tigris, Nile, and Indus, it only in the last few centuries that the world has witnessed major floods resulting in great losses of life and property. The five deadliest floods in recorded human history are shown in Table 3.1.

TABLE 3.1: Major floods in human history

Death toll	Event	Location	Date
2,500,000–3,700,000	Various rivers	China	1931
900,000–2,000,000	Yellow River (Huang He)	China	1887
500,000– 700,000	Yellow River (Huang He)	China	1938
230,000	Indian Ocean tsunami	India (mostly in Tamil Nadu), Thailand, Maldives	2004
231,000 (86,000 from the flood; 145,000 from disease)	Failure of Banqiao Dam due to Typhoon Nina	China	1975

Source: http//en.wikipedia.org/wiki/flooding

The conditions leading to a flood may be natural or anthropogenic. The natural properties of a watershed, including relief, precipitation type, vegetation cover, and drainage capacity, determine the magnitude of a flood. At their headwaters, rivers often drain steep areas and produce water flows of high velocity and can cause water levels in flat, low-lying downstream areas to rise several metres in a few hours.

Anthropogenic factors which have contributed to an increase in flooding include rapid population growth and the settlement of the flat, low-lying areas most susceptible to flooding. The increase in built-up and impervious areas also intensifies the likelihood of floods because natural drainage is blocked and rainfall runoff increases. Anthropogenic-induced climate change, by altering the regional hydrological cycle and increasing the frequency and intensity of extreme rainfall events also has a hand, and has the felling of trees in small and moderate watersheds (Hofer and Messereli, 2006). In recent years, economic losses due to flooding have increased in both developed as well as developing countries.

Despite the devastation they cause, floods are also beneficial: they replenish freshwater bodies, augment wetland areas, and recharge groundwater. In addition, frequently occurring small floods deposit alluvial soil on floodplains, increasing their fertility.

Floods: national context

Nepal's more than 6,000 rivers and rivulets, with a total of 45,000 km in length, support irrigated agriculture and other livelihoods, but also wreak havoc in valleys and in the Tarai when they overflow. The river drainage density of 0.3 km/ km^2 is an indication of how close the drainage channels are (Shankar, 1985) and susceptible to floods. Flooding in Nepal damages crops and property and often results in epidemics; the poor are the most vulnerable. The major events of floods in Nepal are listed in table 3.2.

The records of the MoHA do not differentiate between the loss of life and property caused by landslides and that caused by floods, so it is difficult to accurately estimate flood loss alone though we do know that large-scale floods occur in the Tarai and affect large numbers of people every year. The Bhabar region is prone to the flash flooding of the ephemeral rivers that originate in the Chure Range, rivers which frequently change their course and transfer sediments, causing their bed levels to rise constantly. As they flow south towards the Tarai these rivers also affect large areas during the monsoon, with three significant physical impacts: inundation, bank cutting, and the deposition of silt on floodplains and agriculture land. Each impact requires a different and specific response.

The border areas of the Tarai face flooding of a different kind. Here it is the drainage congestion by embankments built along rivers in Bihar and Uttar Pradesh which results in the inundation of land in Nepal. The construction of infrastructure, particularly roads, also interferes with natural drainage and as

TABLE 3.2: Recent Floods in Nepal

Death Toll	Event	Location	Date
1,336	Monsoon cloudburst	Central Nepal, India, and Bangladesh	1993
429		Central Nepal	2002
65,000 lost their homes	Koshi River inundation	Nepal and Bihar	2008
40	Mahakali River flood	Western Nepal	2008

Source: MoHA (2008), OCHA 2008a and 2008b

is the case in the hills, the rising of river bed levels renders populations vulnerable even in times of moderate flow. This problem also requires its own set of specific rescue and relief activities as well as the preventive measures like the opening of natural drainage channels.

Floods are also common in the mountains, where glacial lake outburst floods cause considerable damage to areas downstream of the breached moraine.

BOX 3.1: Border inundation

Some of Nepal's problems are paradoxically attributable to human interventions to control flooding. Many villages in the Tarai are flooded every year because barrages and embankments built in India, by interfering with natural drainage, cause water-logging. The embankments built along the Kamala, Bagmati, Karnali, Banaganga and West Rapti rivers in India close to the border have constrained the flow of the rivers and contribute to the inundation of about 27 border localities. This problem can be minimized by ensuring unconstrained natural drainage.

Based on Dixit (2008)

Causes of floods in Nepal

In Nepal, floods are a natural phenomenon during the monsoon. The impacts they cause depend on both natural conditions and the characteristics of the population; together these factors determine the scale of loss. The major causes of flooding in Nepal are listed below.

a) Rainfall variability

Flooding results from the unequal distribution of rainfall in time and space. More than 80 per cent of the rainfall in the country occurs during the monsoon from June to September. The average annual rainfall is 1,627 mm (Alford, 1992). Torrential rainfall and cloudbursts that bring over 400 mm rainfall in a single day are common in the Mahabharat Range (see Table 1.4) and often cause heavy floods. Rainfall intensity during a single hour is equally high, with over 40 millimetres common in the lower Mahabharat and Chure ranges. In 1989, Pokhara recorded a tremendous 88 millimetres in one hour, and Bhusal et al. (1993) report that the 45 millimetre/hour rainfall on 29 September, 1993 triggered massive landslides and debris flows in South Central Nepal.

b) Topography

The slopes of Nepal's hills and mountains range from steep to very steep (more than 30 per cent), while the Tarai is flat (less than 10 per cent). Because of this gradient change, in the uplands rivers flow at very high velocities and possess a high capacity to transport sediment, but when they enter the Tarai and slow down, all this material—stones, gravel, sand and silt—is deposited as an alluvial fan. Because such deposition increases the level of the river bed, it increases the probability of flooding even during moderate rainfall.

BOX 3.2: Flood forecasting/early warning system

Many localities lack the flood forecasting and early warning mechanisms which could save lives and protect property. National-level efforts to acquire high science also need to make it accessible to local communities and households. Practical Action Nepal has piloted a community-based local flood warning system in the Rapti River basin in Chitwan District. It consists of towers equipped with sirens that the community blows when the river rises above a predetermined level. When people downstream hear the warning of a flood, they can take appropriate measures, including evacuation if necessary.

Some effort is also being made to broadcast locally-collected rainfall data via regular FM news broadcasts. The data is collected daily in schools as part of a science education programme designed to institutionalise civic science-based initiatives and then provided to FM stations in the vicinity. The data is used to generate simple rainfall runoff models useful for forewarning downstream areas about impending floods and enabling local populations to take appropriate measures to save their assets. The aims of the programme are three: to expand the coverage of secondary rain gauge stations across the nation, to help students acquire knowledge about rainfall measurements and to institutionalise locally-based warning systems. Once the mechanism is insitutionalised it can also be used to predict droughts and other likely changes attributable to the complex impacts of climate change.

c) Deforestation/decreasing vegetative cover

Because vegetation intercepts precipitation, it reduces runoff and thereby the possibility of soil erosion. Since farming reduces vegetative cover, it has contributed to the occurrence of local floods. Humans also alter the naturally existing conditions in the watershed through the construction of hydraulic structures, urbanisation, deforestation and quarrying. In comparison with urban watersheds, rural watersheds, exhibit greater interception of rainfall, greater infiltration (because the pervious area is large), less surface runoff, and slower drainage. The many impervious surfaces such as roofs, streets and paved zones in a city channel water and thereby accelerate runoff; they also impede surface drainage and contribute to localised flooding. Upadhaya (2007) attributes the flooding of the Dhobi Khola of Kathmandu to increasing urbanisation because it increases peak flow and surface runoff, but reduces base flow.

The role vegetation plays in flooding must be considered with caution. While urbanisation and deforestation may increase the frequency of floods in small and medium watersheds, these processes have less effect on the scale of a river basin during the mid-monsoon, when the soil has reached its saturation point and can store no more water. In addition, the Theory of Himalayan Degradation (THD) advanced in the 1970s has been disproved. This theory argued that the deforestation in th e mountain slopes of Nepal contributed to the flooding of the plains of Bihar and Bangladesh, but later research in the fields of hydrology, geomorphology, sedimentation, forestry and soil science indicated that flood disaster is the result of many factors. Interdisciplinary studies like those of Thomspson *et al.* (1986) and Ives and Messereli (1989) also suggested that there is no direct link between large-scale downstream flooding and deforestation.

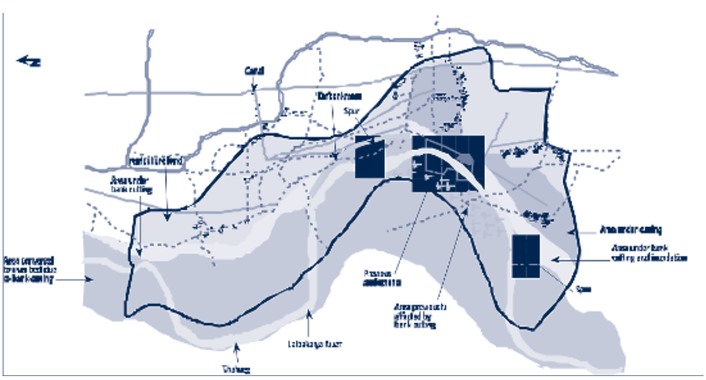
BOX 3.3: Role of local hazard maps in flood disaster mitigation

Disaster is the outcome of the intersection of hazard and vulnerability: a natural event such as a flood only becomes as disaster if it adversely impacts humans and their interests. Improving our responses to natural hazards will require further assessment of this intersection, especially at the local level, where geographic conditions give events like floods, droughts, landslides and earthquakes unique characteristics. In Nepal efforts to assess local hazards include the preparation of village-level hazard maps which both identify the nature of those hazards and link them to the vulnerability of the local population. These maps help design measures to support vulnerable households so that they are better prepared to respond to disasters.

Hazard maps were prepared in consultation with the community in four VDCs Devgaon and Rampur Khadauna of Nawalparasi District and Vasedwa and Bharamapuri of Rautahat District. After hazards were described, villagers used standard social mapping techniques to indicate their threat to nearby settlements. In the third step, a topographical map of the district was used as a point of reference. Villagers took a transect walk along the rivers noting its exact course as well as the existence of three types of local-level hazards: bank-cutting, sand-casting and inundation. These were located on the topographical map, and, after comparing the data with the social map, the social map was modified to increase its accuracy. National-level strategies must be cognizant of the three main local-level hazards and respond appropriately to each.

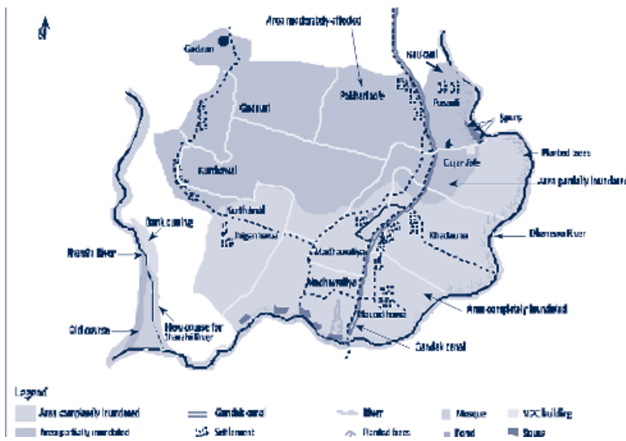
The United Nations Development Programme (UNDP) has also helped Chitwan District Development Committee to prepare a hazard map of the district which identifies areas which are deemed critical from the perspectives of hazard and possible risks to community, infrastructure and lives.

VDC level hazard maps Vasedwa, Rautahat District



Source: Dixit et.al., (2007)

Rampur Khadauna
Nawalparasi District



Source: Dixit et.al., (2007)

Floods in the Bagmati and other rivers, 1993

In July and August of 1993, Central Nepal received heavy rainfall from the Mahabharat range to the Tarai. The Kulekhani River Basin received 540 mm of rainfall in 24 hours. The resulting flooding and landslide killed 1,170, including four Chinese engineers working on the Bagmati Irrigation Project and damaged about 32,765 homes. Major bridges and highways connecting Kathmandu to the rest of the country were washed away. The same year saw major floods in the districts of Sarlahi and Rautahat.

Koshi inundation, 2008

When the eastern embankment of the Sapta Koshi River near Kushaha, Sunsari breached on 18 August, 2008, more than 90 per cent of its discharge began flowing along the river abandoned courses. The result was the devastating inundation of Nepal's Sunsari District and the Indian state of Bihar. About 65,000 Nepalis were affected. One of the many reasons for the breach is that the bed level of the Koshi River had become higher than the surrounding settlements because of the deposition of sediment brought by the Koshi River while the other factors are poor maintenance of the embankment and institutional dysfunctions (Dixit, 2008, and 2009).

Eight village development committees (VDCs)—Kusaha, Laukahi, Ghuski, Sreepur, Haripur, Narshimha, Madhuban, and Basantapur—were affected. Four of them remained under water for an extended period and the East-West Highway was rendered impassable. Telephone lines and electricity pylons were also damaged. Civil society, businesses, national agencies and international partners provided the affected people with support.

Security personnel rescuing children during a flood

According to OCHA's Situation Report, 20,284 Nepalis from 4,186 families were displaced in Saptari District and 43,917 (7,597 households), were displaced in Sunsari District. The Indian nationals (Bihari) displaced by the inundation also took refuge in Nepal. They returned to Bihar after spending a few weeks in the refugee camps that were set up in Nepal. Bihar suffered far more. In Bihar over 2,000 people died and about three million people lost their homes.

Flood in Western Nepal, 2008

On September 19, torrential rainfall triggered floods and landslides in west Nepal claiming 40 human lives. Several others sustained injuries and 47 went missing. According to NRCS- Kailali District Chapter, 15 people were killed and 28 missing in Kailali District. At least 16,000 houses of 39 VDCs and 2 municipalities were affected and 15,019 families were displaced in the district. Tikapur Municipality, Lalbhoji, Pratappur, Naryanpur, Dhansingpur, Amshikarjhala VDCs were the most affected.

Floods and landslides also hit Kanchanpur and Bardiya districts of Far-West Nepal. 10 persons died in Kanchanpur District. The flood along the Mahakali River destroyed 5,500 houses in wards 2,11,12, and 15 of Mahendranagar Municipality. Seventeen VDCs were affected in Kanchanpur District, Mahendranagar Municipality. Rampur, Bilaspur, Parasan, Rautali Bichuwa, Krishnapur, Dhodhara, Dekath Bhuly and Sankarpur VDCs were also affected. In Bardiya District, the flood affected 32 VDCs where 865 houses were completely damaged and 572 were partially damaged. Flood and landslides incidents were also recorded in Dadeldhuara, Dang, Salyan, Doti and Gulmi districts.

Flood damage properties

Recognition of the problem

Floods are recognised as major disasters by the government and by local communities but in the past responses were limited to rescue, relief, and reconstruction. During the Rana regime, flooding of the Koshi River displaced the people of Hanuman Nagar, who were resettled in the newly established town of Rajbiraj. In many rivers local communities have built earthen embankments while the government implemented them in a larger scale. The agreements on the Koshi, Gandak and Mahakali rivers signed by the governments of Nepal and the India mention benefits from implanting flood control measures.

Institutionalised efforts on flood mitigation started after the Department of Irrigation was established in the 1950s. The Water-Induced Disaster Prevention Center (renamed the Department of Water-Induced Disaster Prevention (DWIDP) on 7 February, 2000) was established with support from Japan International Cooperation Agency (JICA) to enhance the country's flood and landslide management capacity. Within its seven divisions and five sub-divisions the DWIDP undertakes river training and slope stabilisation works as well as supervises rehabilitation and management.

The department implements both non-structural and structural measures. Structural measures include the construction of spurs, dykes, embankments and other flood protection works, while non-structural measures include emergency protection and rehabilitation works, Global Information System (GIS) development, the maintenance of linkages with other agencies and dialogue with India on inundation in Nepal's border regions. Non-structural measures also include training, seminars and workshops, education and curricula development and publication. The DWIDP is involved in institution building, research, the provision of insurance, and the development of early warning system. Guided by the National Water Strategy of 2002, the DWIDP is developing water-induced disaster management policies and strategies.

Its long-term strategies include bio-engineering, catchment treatment and watershed management. By seeking to involve local communities in non-engineered structural mitigation measures, the department uses proven local knowledge and local materials. The DWIDP, district development committees and other agencies also distribute gabion wire boxes to communities for local-level flood mitigation. The DWIDP also works with the NRCS, locally based NGOs and other agencies in implementing non-structural aspects of flood mitigation.

The need to provide financial support to flood disaster victims was officially recognised with the enactment of the NCRA in 1982. One of its provisions is that the next of kin of the deceased are compensated NRs. 25,000.

Flood management in Nepal

The DWIDP leads efforts to reduce risk related to water-induced disasters. It regularly conducts research and training programmes, implements preventive measures, assists communities in implementing disaster risk reduction activities, and collects and disseminates information related to water-induced disasters.

Prevention

Flood prevention activities carried out by the DWIDP include constructing spurs, embankments and other flood protection works. Local communities participate in these efforts and also clear natural drainage courses.

Preparedness

The NRCS, local NGOs, the DWIDP and the MoHA address preparedness for flood disasters at both the local and central levels. NGOs work towards improving awareness among locals, while the DWIDP implements structural measures. The NRCS trains volunteers, stores equipments food and medicine, while the MoHA makes sure District Administration Offices (DAOs) and other district-level line agencies remain prepare for post-disaster relief efforts.

Sick person being rescued in a flood situation

The MoHA holds a meeting of the Central Disaster Relief Committee before every disaster season. For floods, this meeting is held every June. District disaster relief committees then hold meetings to alert local-level organisations. At the community level, places to take shelter and local volunteers are identified. In last few years, local FM radio stations also inform people about possible floods and warn them to take preventive measures.

Rescue and relief

Rescue and relief operations are coordinated by the MoHA at the central level and by district administrative offices at the local level. The Nepal Police (NP), the Armed Police Force (APF) and the Nepal Army (NA) work during and after floods to rescue people living in affected areas, but it is the NRCS which takes the leading role by mobilising its volunteers at the local level and drawing on resources from national and international donors.

Relief is provided by the government of Nepal with the help of I/NGO such as the NRCS. After assessing the situation, the NRCS provides both food and non-food items and medical services to the affected. Local and national institutions also provide food and clothes. For its part, the government provides modest compensation to those who lose family members or property or who are injured.

Reconstruction and rehabilitation

In general, rescue and relief activities mark the end of disaster management in Nepal, but there are a few examples of reconstruction and rehabilitation efforts. In July 2003, for example, NRCS Mahottari provided 47 houses worth NRs. 5.8 million to the flood victims of Sundarpur and Shripur VDCs of the district. In the same year, houses worth millions were also provided to flood victims in Rautahat and Sarlahi districts.1 Agencies such as Oxfam GB has provided support to built flood resistant houses in Rampur Khadauna of Nawalparasi District.

Glacier lake outburst floods (GLOF)

Glaciers were formed in the Himalaya between the 15th and 19th century, during the Little Ice Age (Yamada, 1993). A glacier lake originates from a glacier and usually forms at its terminus. According to ICIMOD (2007), the Nepal Himalaya has more than 2,323 glacier lakes with areas larger than 0.03 sq. km. As a glacier melts, melt-water is stored within the lateral and end moraines creating a glacier lake. They can be dammed variously by moraines, glacier ice or ice cores and moraines and will continue to grow as the ice melts. The Imja, for example, "was just a small pond in the 1960s" but in recent, it has radius of 1 km and stores 2.9 million cubic metres of water (Watanabe *et al.* 1994).

BOX 3.4: GLOF mitigation

Glacial lake outburst floods (GLOF) are a common hazard in Nepal's high mountains, at elevations greater than 3,500 masl. The downstream impact of such a breach is catastrophic. The Koshi River Basin, the Gandaki River Basin, the Karnali River Basin and the Mahakali River Basin contain 1,062, 338, 907 and 16 lakes respectively. Dudh Koshi Sub-Basin, the largest basin in Nepal, is also the most densely glaciated region of the country (Bajracharya et al., 2004). It contains twelve of the 27 potentially dangerous glacial lakes identified by ICIMOD and UNEP (UNEP 2001).

The damage associated with GLOF is substantial. In 1984, Dig Tsho ("Tsho" means lake in Tibetan) was breached when a large avalanche slid into it. Two hours afterward, the flood reached a peak of discharge of 1,500 m3/s. The event transported four million cubic metres of sediment down the Dud Koshi River. It destroyed a hydroelectricity project, 14 bridges, 30 houses and farmland worth four million U.S. dollars. Three years earlier, the breach of Zhangzangbo Lake killed four people and damaged the China-Nepal Friendship Bridge on the northern border as well as seven other bridges, a hydropower plant, Arniko Highway and 51 houses. In 1985 a large avalanche triggered GLOF at Dig Tsho. A third devastating GLOF was that of the Tam Pokhari in 1998. Two were killed, six bridges were destroyed and arable land was washed away. Losses were estimated at 150 million rupees.*

In 1997, the Tsho Rolpa in Dolakha District reached a critical stage.** To mitigate the chances of its breaching, a spillway was constructed by Nepal's Department of Hydrology and Meteorology (DHM) with support from the Dutch government. This temporary solution, which involved constructing a trapezoidal channel with a bottom 6.4 m wide and a 14-35 m3/s flow capacity to drain the water, is expected to lower the water level by three meters in two years and thereby reduce the risk of breach of the lake.**

* *Dixit, A. 2003 Basic Water Science. Nepal Water Conservation foundation*

** *Impacts of Climate Change on Himalayan Glaciers and Glacial Lakes "case studies on GLOF and Associated Hazards in Nepal and Bhutan" by ICIMOD and UNEP*

A moraine, which comprises unconsolidated and unsorted material, is easily disturbed by a slight interruption; it can also be over-topped by lake water. Either event can lead to the sudden release of the stored melt-water, resulting in a catastrophic flood called a glacier lake outburst flood (GLOF). GLOFs can devastate the cultivated land, infrastructure, and settlements along the banks of the affected river up to several kilometres downstream of the breach. The surge of water gouges the river bed as well as its banks. The landslides thus triggered result in the loss of agricultural land, threatening livelihoods, and, by transporting massive volumes of sediment downstream, damage downstream infrastructure and, through deposition, farmland.

ICIMOD's 2001 inventory of glaciers, glacial lakes, and GLOFs counted 3,252 glaciers and 2,323 glacial lakes, 20 of which are highly vulnerable to flooding. In the past 30 years, there have been seven major GLOF events in the region: Taraco (1953), Gelhaipoci (1964), Longda (1964), Zhangzangbo (1964), Ayico (1968), Nare Drangka (1977), Phucan (1980), Zhangzangbo

Notes

[12] *Tuladhar, G. B. 2003: Disaster Management in Nepal: Issues and Challenges, Proceedings of one-day international seminar on disaster mitigation in Nepal, Nepal Engineering College in association with Ehime University, Japan.*

(1981), Jinco (1985), Dig Tsho (1985), Kaligandaki (1987), Chubung (1991), and Tam Pokhari (1998).

Nepal's most active glaciers are in the east. Most of the GLOF events we know about occurred in Nepal's Koshi Basin or in China's Pumqu Basin (China). They include the 1964 and 1981 GLOFs in Bhote Koshi-Sun Koshi River, the 1964 GLOF in the Arun River and the 1980 GLOF in the Tamor River (Mool, 1995). On 4 August, 1985, the Dig Tsho moraine-dammed lake in front of the Langmoche glacier over-topped and breached, severely damaging the Namche Small Hydel Project and numerous bridges and trails. Several people were killed and losses estimated at US$ 1.5 million (Ives, 1986; Mool, 1995).

Preparedness

A detailed study of Tsho Rolpa Lake has revealed that a GLOF could cause damage as much as 100 kilometres downstream. The government established a telemetric system consisting of 19 early warning units in 17 villages along the Tama Koshi River in response to the concerns the media expressed in the summer of 1997 (Tuladhar, 2003)[12], but pilfering during the Maoist rebellion has rendered the system dysfunctional.

BOX 3.5: Regional flood issues

In 2000 the International Centre for Integrated Mountain Development (ICIMOD) and the World Meteorological Organization (WMO) jointly initiated a project to promote regional cooperation in flood disaster mitigation with the overall goal of reduction in flood vulnerability in the Hindu Kush Himalaya (HKH) region with specific reference to the Ganga-Brahmaputra-Meghna (GBM) and Indus river basins. The initiative aimed to provide the operational concepts and tools for improving integrated river basin management, specifically by managing floods and thus contributing to minimising the loss of lives and property, reducing poverty, and accelerating economic development in shared river basins affected by recurring floods. The project involved

- Establishing a regional flood information system for the HKH region
- Regional sharing of information to provide warning to potentially affected areas and to save lives

- Regional sharing of technologies, resources, and scientific knowledge to better provide each country with adequate ways and means of collecting and disseminating data and information
- Capacity building of the national collaborating institutions

A series of meetings were held between 2001 and 2005, attended by high level government representatives, directors of national hydrological and meteorological services, technical experts from the region, and representatives of international organisations, in which a framework was developed and agreed for a system for the exchange of information and data to support flood forecasting in the HKH region and associated downstream areas

The preparatory phase of the project culminated in a demonstration and testing phase which was successfully conducted from June to September 2005. Partners shared near real-time data from selected hydro-meteorological stations from 10 June 2005 onwards. Most partners shared data through the web interface available on the project website, while options were also available for submitting data through FTP and email.

A road map has been proposed to establish a regional flood information system. River level/flow, rainfall and related information will be observed at specific sites and transmitted in near real-time using agreed and reliable means of telecommunication to the National Hydrological and Meteorological Services to be used for flood forecasting and information purposes. The successful implementation of the second phase will establish a fully functional data information dissemination system for floods within selected pilot basins within the Ganga-Brahmaputra-Meghna and Indus River basins. Setting up these systems is expected to provide a considerable extension of the lead-time for flood warning in the some selected pilot basins.

For reducing losses people must be provided with sufficient advance warning to be able to take other preparedness and response measures. Timely and accurate flood information based on real-time hydro-meteorological observations across boundaries helps achieve this objective.

Source: Regional Cooperation for Flood Disaster Mitigation in the Hindu Kush-Himalayan Region, ICIMOD

Ways forward

Flood management is a multifaceted task which requires various interventions at different levels and at different times. The entire cycle of management, including prevention, mitigation, preparedness, rescue and relief, rehabilitation and reconstruction should be given due attention at both the local and central levels. To manage floods effectively requires installing early warning measures, opening drainage for flood water to pass. According to Dixit (2009) approaches to flood mitigation that improving drainage, houses on stilts, raising the plinths of houses, etc with other systems (transport, financial, communication, etc) that contribute toward building social resiliency could be an effective strategy for DRR. We must also focus on reducing vulnerability to disasters in general including floods and the robustness of the following systems contribute to risk reduction (Moench and Dixit 2004):

(1) Communications (including the presence of diversified media and accessibility to information about weather in general and hazards in particular);

(2) Transportation (including during extreme events);

(3) Finance (including access to banking, credit and insurance products for risk spreading before, during and following extreme events);

(4) Economic diversification (access to a range of economic and livelihood options);

(5) Education basic language and other skills necessary to understand risks, shift livelihood strategies as necessary, etc);

(6) Organisation and representation (the rights to organise and to have access and voice concerns through diverse public, private and civil society organisations); and

(7) Knowledge generation, planning and learning (the social and scientific basis to learn from experience, proactively identify hazards, analyse risk and develop response strategies that are tailored to local conditions).

Improving public awareness about behavioural changes which reduce risks and build resilience is also necessary. Information can be disseminated through educational institutions, information centres, radio television broadcast and printed media with the support of the Government, civil society networks and local communities. The most vulnerable, including the poor, women, pregnant, the elderly, people with disabilities and children must be specially targeted. The existing flood management policy needs adjusted so that it emphasises preparedness and community-based approaches. A village-level pool of physical and human resources assigned to deal with floods should also be created at the village level. Other preventive strategies to adopt include land-use planning, the diversion of flood water through bypasses, the prevention of construction in flood-prone areas, and the maintenance of drainage systems.

Effective flood disaster reduction also needs to focus on mapping, maintaining databases, develop scenarios and prepare plan for emergencies. Facilitating rescue and relief operation requires training local volunteers and providing safe drinking water facilities and storage facilities for food and medicine. A local-level evacuation plan should be prepared in collaboration with the flood management committee. For rehabilitation and reconstruction, flood funds should be created at the local, district and national levels. Flood-prone VDCs should allocate funds and each household should be asked to contribute proportionate to its economic status. Central and district governments should allocate funds for these tasks in their annual budgets.

Building resilience is the most effective way of reducing the risk associated with floods. The government should help conduct vulnerability analyses in flood-prone areas and prepare hazard maps. The information must be made available to local people so that they know the extent of the threat they face and assess safe areas. It is possible that pooling land by constructing embankments could be a self-financing mechanism, but this concept needs to be tested as embankments can lead to social and environmental externalities. Building low embankments around villages can in some cases provide immediate benefits by protecting valuable assets, including land, homes and livestock. While at the local level bio-engineering works and early warning systems should be installed, non-structural measures like community insurance of crops and cattle initiated, floods are also regional phenomenon that needs regional-level attention.

Chapter-4

Landslides

Landslides are quick mass-wasting processes in which gravity causes variety of slope-forming material, from soils to rock to artificial fill, moves down the slopes. According to Varnes (1978), the term "landslide" is used to denote the "downward and outward movements of slope-forming materials along surfaces of separation," but it is probably the most over-used and loosely-defined term used in slope studies. Several types of landslide exist and different nomenclature is used to classify them. A growing body of scientific opinion is in favour of limiting the use of the term "landslide" to describe situations in which masses of material move down a slope by sliding and to reserve related terms like "mass movements," "mass wasting," "slope movements," and "slope failure" for other phenomena. Landslides may be triggered by natural or anthropogenic factors.

To investigate and understand landscape, it is essential to know its major components (see Figure 4.1).

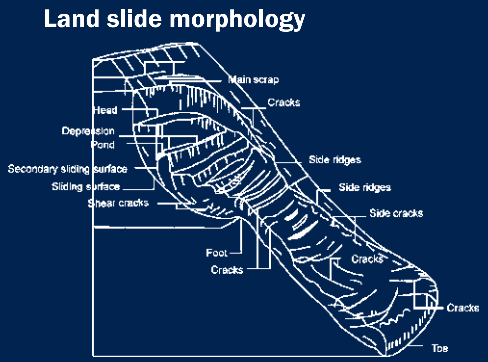


FIGURE 4.1: The components of a landslide morphology

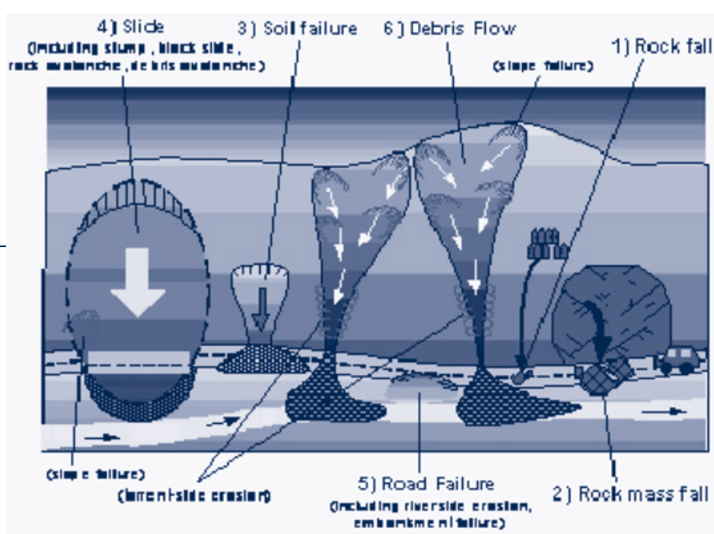
1. *Main scarp – a steep surface of undisturbed ground around the periphery of a landslide*
2. *Head – the upper portion of slide material*
3. *Crown – the highest point seen on the main scarp*
4. *Sliding surface – the surface along which the mass movement takes place*
5. *Cracks – voids created due to mass movement; they are either longitudinal or transverse*
6. *Toe – the line of intersection between the lowest part of the surface of rupture and the original ground*

Varnes classification of landslides (1978) is shown in Table 4.1. The International Association of Engineering Geology (IAEG) (1990) also suggested using the same nomenclature for general use (see Figure 4.2). The different types of movement are divided into five main groups: falls, topples, slides, spreads, and flows. A sixth group, complex slope movements, includes combinations of two or more types of movement. Slide material is divided into two classes—rock and soil—and soil is further subdivided into debris and earth based on the particle size (Varnes, 1978). A short description of various landslide types is given below.

Table 4.1: Classification of landslides (Varnes, 1978)

Type of movement				**Type of material**	
			Bedrock	**Soil**	
				Coarse	Fine
Falls			Rock fall	Debris fall	Earth fall
Topples			Rock topple	Debris topple	Earth topple
Slides	Rotation		Rock slump	Debris slump	Earth slump
	Translation	Few units	Rock block slide	Debris block slide	Earth slide
		Many units	Rock slide	Debris slide	Earth block slide
Lateral spread			Rock spread	Debris Spread	Earth spread
Flows			Rock flow (deep creep)	Debris flow (soil creep)	Earth flow (soil creep)
Complex			A combination of two or more principal types of movement		

FIGURE 4.2: Diagrammatic illustration of all types of Landslides.



The term slide is applied to those mass movement processes in which a distinct surface of rupture or zone of weakness separates the slide material from more stable underlying material. The slide materials can either be broken and deformed or remain fairly cohesive and intact. A cohesive landslide is called a slump. A rotational slide (see Figure 4.3) occurs when the movement is along an axis parallel to the contour of the slope, while a translational slide is a mass movement along a planar surface.

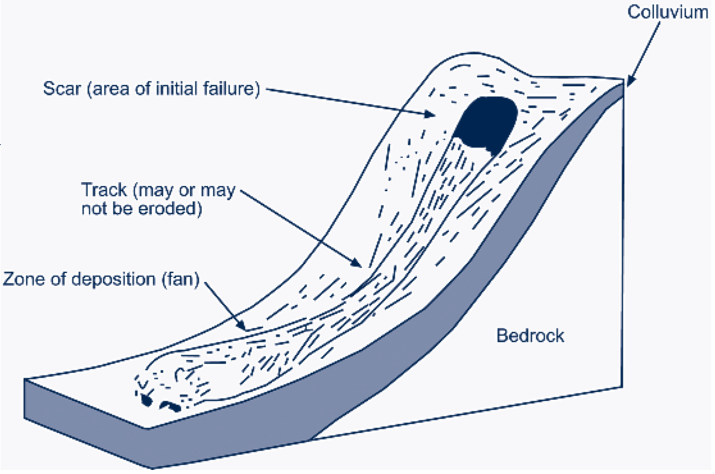
FIGURE 4.3: A rotational slide on the right bank of Bhote Koshi River, Kodari Highway

Spreads are failures caused by liquefaction, the process through which water-saturated sediments are transformed into a liquid state. The movement of a flow resembles that of a viscous fluid; in them, slip surfaces are absent. Flows can take place as one or more lobes that move at different rates depending on the viscosity of the material and the angle of the slope.

A debris flow is one of the most common types of landslide. It is a fast-moving mass of unconsolidated, saturated debris which normally consists of colluvium (a loose, heterogeneous and incoherent mass of poorly sorted mixtures of angular rock fragments and fine-grained materials deposited at the base of gentle slopes or hillsides). Such a flow generally occurs when periods of intense rainfall or rapid snowmelt or a combination of both render unconsolidated material saturated and unstable and cause it to move downhill due to gravity. The consistency of a debris flow ranges from watery and free-flowing to thick and viscous, but as it moves down a slope it becomes thinner as large, heavy components are deposited. Flows carry materials ranging in size from clay particles to boulders and often contain large amounts of woody debris. The speed of debris flows vary: the slowest are two kilometres per hour but in extreme conditions they can reach 40 kilometres per hour. Variables that affect the speed of debris flow include slope and the nature of the loose sediments involved. Debris flows are extremely destructive to life and property.

Debris flow involves two distinct movements: an initial shallow slide is followed by the flow of disturbed earth. A relatively small circular scar is formed where the initial slide occurs and is followed by a long narrow track that delineates the path taken by the liquefied soil and debris. The transported material is deposited in a minor drainage channel at the base of the slope (Turner, 1996, Figure 4.4). When many individual slides carrying large volumes of debris clog such drainage channels, the liquefaction of this deposited material can cause a landslide to remobilise and produce another large, rapidly-moving debris flow that destroys life and property downstream.

FIGURE 4.4: Principal failures of a soil slide-debris flow



The Himalayan terrain, with its steep slopes and high relief, intense monsoon rainfall and frequent cloudbursts provides the ideal conditions for debris flows. Every year, many Nepalis die because of debris flows. Debris flows in Larcha, near Kodari, Sindhupalchock District in 1996; Bagarchap near Chame, Manang District; Phedigaon in the Palung Valley of Makawanpur District in 1993; and in Matatirtha in Kathmandu District in 2000 (see Figure 4.5) are recent debris flows which resulted in the loss of lives and properties.

Causes of landslides

Both natural and anthropogenic factors contribute to landslides. Natural factors may be subdivided into inherent and external factors. Inherent factors include geological formation and structure, slope, aspect, land use, land cover and groundwater conditions. External factors include seismic waves and rainfall. Anthropogenic factors include human interventions like deforestation, improper land use, unplanned construction, and unplanned mining. To assess the risk of landslides requires a careful study of the range of historical and current factors which may be important in triggering the event. Factors which are enduring and inherent in the constituent rock and soil are usually the primary causes of failure. The most basic cause is gravity, but there are several other factors that play crucial roles as well, including rock and soil types; the strength, folding, faulting, jointing, foliation, and bedding of the rock structure (Hoek and Bray, 1981), and soil depth, porosity and permeability. Factors that are either variable or very short-lived are considered secondary causes. These include the presence or absence of gullies, streams, and rivers, seismicity, intensity of precipitation, land use, natural slope conditions, rock and soil weathering conditions, and groundwater conditions. The most common types of mass movements encountered in the Himalaya are slope failure in location in excess of 30 degree slopes rockslides, rocks fall, rock toppling, and failures along the wedge.

Lithology

Rock type: Rock type, or lithology, is a main determinant of landslides. In the Higher and Lesser Himalaya most rocks are granites, gneisses, and schists, while in the Siwalik (Chure) range soft sandstone, mudstone, and conglomerate prevail.

FIGURE 4.5: Debris flow at Matatirtha, Kathmandu Valley

Rock structure: Several major thrusts and faults with weak zones run east to west along the Himalaya. Numerous small and large landslides occur along these linear structures. The orientation of the folds, bedding, foliation, and joints in rocks have a significant role to play in causing landslides. Some of these faults, including the Main Frontal Thrust (MFT) and Main Boundary Thrust (MBT), are active ones characterised by the parallel alignment of many small and large landslides.

Weathering: Mechanical and chemical weathering considerably weakens rocks and soils. It is thought that chemical alterations trigger landslides. Chemical weathering along the discontinuities between rocks may extend tens of metres below the surface, considerably weakening the overall structure. Himalayan rocks, especially in warm-temperate and subtropical climatic zones, are normally deeply weathered.

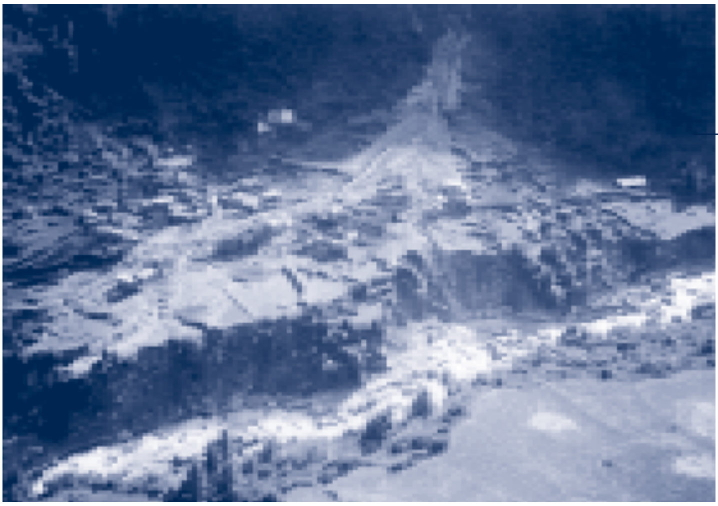


FIGURE 4.6: Debris flow at Bagarchhap, Manang District, Nepal

Geotechnical properties of soil: Soil composition, depth, shear strength (which depends on density, cohesion, plasticity, dilatancy, and angle of internal friction), porosity, permeability, grading, packing, moisture content, and organic material content are some of the important geotechnical features which characterise soil and which, if they are coalesce in a particular fashion, can increase the risk of slope failure.

Genetically, the soils of the Himalaya are classified into colluviums and residual soils on the hill slopes as well as the alluvium found along rivers and stream banks. Because of uplifting, alluvial soil can also be found on hill slopes and river valleys. Such alluvial soils are often silty gravel or, occasionally, clayey silt. Debris slides are often observed in coarse-grained soils with steep (35-45°) slopes, while rotational slides are characteristic of fine-grained and thick soils with gentler slopes (less than 35°).

Groundwater: Flowing groundwater exerts pressure on soil particles, thereby undermining the stability of slopes. Abrupt changes in the water level of a slope can cause pore-water pressure to increase so much that sandy soils are liquefied. Groundwater can also wash out soluble cementing substances and weaken inter-granular bonds; both of these processes reduce the mechanical strength of the ground and make landslides more likely. In soils of fine sand and silt, flowing groundwater flushes out fine particles and reduces slope strength by forming cavities.

Natural slope: A change in slope gradient, whether caused by natural or man-made processes, can cause a landslide. Natural processes include the uplift of mountains by tectonic forces, river undercutting at the toe of the slope, or bank scouring by debris flow. Excavation, blasting, cultivation, and the removal of vegetation are the main ways humans change slope gradients. In the Nepal Himalaya, slope gradients of 30 to 40 degrees are most likely to result in failure (Dixit 1994 a, b; Deoja *et al.* 1991; DPTC/TU 1994 a, b), but landslides can occur on gentler slopes as well.

Vegetation: Vegetation also plays a vital role in determining slope stability and soil erosion processes. While the erosivity of rainfall does increase during the monsoon so does the ability of the vegetation to protect the topsoil; the net result is reduced rates of surface erosion as the monsoon progresses. However, the probability of mass wasting increases during the monsoon because the subsoil becomes saturated with moisture (Galay, 1987). In general vegetation cover increases the strength of soil because the mechanical and biological effects of its root network stabilise slopes. Vegetation dries out slopes by absorbing groundwater. If a landslide occurs deeper than roots penetrate, however, the stabilising effect of vegetation will be rendered moot.

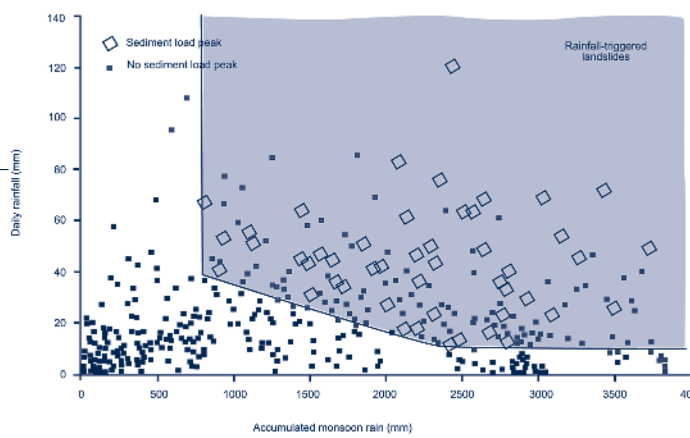
Precipitation: Depending on climatic conditions, topography, the geological characteristics of a slope, porosity, and the permeability of rocks and soils, rainfall can have a considerable impact on the frequency of landslides. Variations in soil depth and the nature and frequency of discontinuities in the rock also play a role. Specifically, rain- and melt-water penetrate joints and produce hydrostatic stress in rocks. In soils, rain increases pore-water pressure and consequently decreases shear resistance. The many authors who have studied the relationship between the amount of rainfall and the frequency of landslide events conclude that recurrent slope movements occur during periods of high rainfall (Záruba and Mencl, 1982).

In Nepal, the number of landslide events peaks in the monsoon season, when they are triggered by high rainfall. According to NSET all parts of the hills and mountains are exposed to landslides during the monsoon period. The weak geo-tectonic characteristics of the Himalaya make it vulnerable to both heavy rainfall and earthquakes (NSET, 2008), which themselves can trigger a landslide. Detailed studies on the relationship between rainfall and landslide events have been conducted in the eastern Himalaya, in Darjeeling, India. Froehlich et al. (1990) observed that in areas devoted to tea plantation, short-distance overland flow and slope wash begins when rainfall exceeds 50 millimetres and falls with an intensity of 0.5 millimetres per minute. Shallow slides or slumps on steep slope segments begin to occur, mainly along undercut sections of roads or rivers, when over 130-150 millimetres fall in 24 hours or when over 200-240 millimetres fall over a three-day period. This example is also applicable in hills of Nepal. While rainfall amount is important to trigger a landslide other climatological factor is the intensity of rainfall. In 1993, cloudburst high intensity rainfall (70 mm/hour) was responsible for widespread slopes failure in the Kulekhani catchment (Dixit, 2003). In Kabilas VDC of Chitwan District many large scale landslide were caused when the intensity reached 80 mm/hour.

Gabet *et al.* (2004) studied the relationship between landslides and rainfall in Khudi Khola catchments along the Marsyangdi

River valley, which gets between 3,000 and 5,000 millimetres of rainfall per year. For three consecutive monsoon seasons, from 2000 to 2002, they used a six-station network of automated rain gauges installed in 1999 to monitor rainfall as well as suspended sediment concentrations and discharge in the Khudi Khola. Their study showed that landslides were triggered only after 860 millimetres of rain had fallen, a result that suggests that the regolith is brought up to field capacity (the level of soil moisture beyond which gravity drainage will ensue) only after sufficient antecedent rainfall has accumulated (accumulated rainfall is a rough proxy for time). It is only at this point, that future rainfall may produce positive pore pressure and trigger landslides. In the Khudi Khola catchment, the daily rainfall threshold decreases as rain accumulates until, at about 2500 millimetres, it reaches a constant minimum of approximately 11 millimetres per day (see Figure 4.7). The shaded area delineates those rainfall values that may trigger landslides (shown by diamonds) and peak sediment load in Khudi Khola (Gabet *et al.*, 2004).

FIGURE 4.7: Rainfall threshold for peak sediment load in Khudi Khola



As time passes and soil moisture increases, progressively smaller amounts of daily rainfall amounts can trigger landslides. Slope angle controls the minimal amount of daily rainfall necessary to destabilise any given hill slope and the water storage capacity of the regolith determines the amount of seasonal rainfall needed to trigger a failure. Measured values of mean annual precipitation in Nepal range from a low of approximately 250 millimetres in stations north of the Himalaya to a high of over 3000 millimetres in stations in the south. According to Alford (1992) the mean annual precipitation for 114 stations is 1,627 millimetres and it is not uncommon for 10 per cent of the total annual precipitation to occur in a single day and for 50 per cent of the total to occur on ten days spanning the entire rainy season. Such uneven distribution plays an important role in triggering landslides.

Using DHM data to plot the 24-hour precipitation equalling or exceeding 100 mm during the period from 1981 to 1990 indicates that there are pockets of intense rainfall in Ilam, in the upper reaches of Arun Valley, in the upper reaches of the Trishuli and Indrawati rivers, and in Pokhara (see Figure 1.9). All those places which recorded 10 to 20 events over the decade studied were located along the east-west axis of the Mahabharat-Chure range (Upreti and Dhital, 1996).

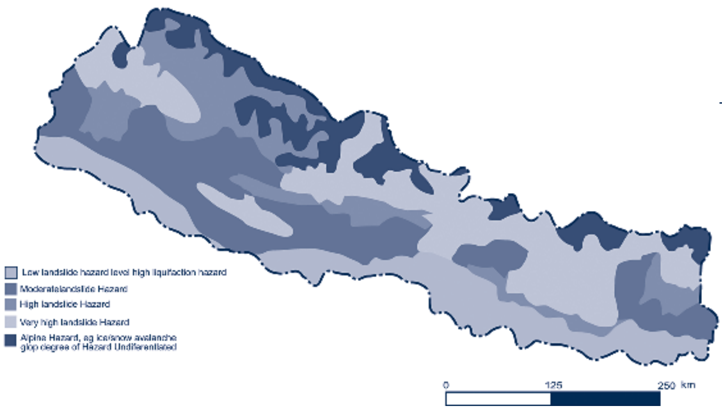
Landslides in Nepal

The 1993 mass movement disaster (a landslide combined with a flood) was a turning point in terms of loss of life and property (it was the second-most devastating natural disaster after the 1934 earthquake) and helped improve public awareness about natural disasters. More than 2000 landslides, ranging in size from a few to a few thousand square metres, were triggered along highways and mountain slopes. Numerous dormant paleo-landslides were reactivated. The cloudburst, landslide and flood disaster affected 42,995 ha of arable land, numerous irrigation systems, highways, bridges and other infrastructure was damaged. The total loss was estimated to be about NRs. 5 billion (Chhetri and Bhattarai, 2001). Altogether 1,170 people died and almost half a million were affected.

The large volumes of soil eroded in at least three major watersheds—the Bagmati in the east, the Trishuli in the north, and the Rapti in the south—generated such huge sediment loads that the beds of many rivers rose. The unprecedented volumes of sediment deposited in the reservoir of the Khulekani plant lowered its economic life significantly. When impoundment began in 1981, the reservoir had a total storage capacity of 83 million cubic metres. Surveys by the Department of Soil Conservation and Watershed Management (DSCWM) and the Nepal Electricity Authority (NEA) showed that from 1981 to 1995, a total of 21.8 million cubic metres of sediment (Sthapit, 1995), which is equivalent to an average of 1.56 million cubic metres annually, were deposited in the reservoir. In fact bulk of this mass came in pulses such as that brought down by the 1993 events and lowered the economic life from 100 years to 30 years (Gyawali and Dixit. 2001 and Dixit, 2003). Yet data on sediment load for many rivers is not available.

The DoMG's inventory of landslides in the Lesser Himalaya between 1985 and 1990 found that most landslides occurred on hill slopes of 21 to 30 degrees and 31 to 40 degrees (Karmacharya *et.al.* 1995). Earlier Dixit (1995) has prepared a landslide hazard map for Nepal which shows the mid hills were more susceptible to landslide (see figure 4.8). According to Brabb's 1984 study (as mentioned in Bhattarai *et.al.* 2002), landslide density in the Nepal Himalaya ranges from 0.2 per linear kilometre on stable land to 2.8 per linear kilometre on susceptible areas fully exposed to human influence. Bhattarai and friends report that roughly 12,000 landslides/slope failures occur every year (Bhattarai *et.al.* 2002). Nepal's geophysical and climatic conditions are responsible for many landslides in the country.

FIGURE 4.8:
Landslide hazard map of Nepal



Source: Dikshit (1990)

Important mountain highways of Nepal, including the Tribhuvan, Prithvi, Arniko, Butwal-Pokhara, and Narayanghat-Mugling highways, regularly experience landslides. On the 30th and 31st of July 2003, for example landslides and slope failures occurred in more than 70 locations along a 36-kilometre of the Narayanghat-Mugling Highway because of intense 24-hour rainfall (364 mm in Narayanghat and 446 in Devghat). Table 4.2 shows the scale of landslides in 2007 considered as a typical year. According to media reports a total of 83 people were killed, 46 were injured and over 4,250 families were affected—all in a single season.

To prevent possible disasters, local people have reported potential landslides to the DWIDP so that mitigative measures can be taken. In 2008, the threat of about fifty such landslides was received by DWIDP. Those expressing concern were local residents, community groups, governmental agencies and security forces.[13] The number of landslide in 2007 reported in the media is listed in table 4.2.

[13] *Personal Communication with K.B. Shrestha of DWIDP*

Table 4.2: Landslides in 2007 and related death and damage

Date of incidence	Location	No. of victims		Property damaged	Other effects
		Deaths	Injured		
08.01.2007	Khahare, Darchula District	3	20	NA	Several missing
27.04.2007	Saptari District	2	-	NA	
01.06.2007	Garagaon VDC, Tanahu, District	2	5	NA	80 families displaced
12.07.2007	Baglung District	24	-	10 houses utterly destroyed; 52 partially damaged	404 people affected
12.07.2007	Bajura District	2	5	NA	
13.07.2007	Khumjung, Solokhumbu District			NA	14 families displaced
03.08.2007	Siddartha Highway			NA	Road damaged
03.08.2007	Belawa-7, Bardia District	1	5	NA	
13.08.2007	Baitadi and Darchula districts	9	-	12 houses	40 families displaced
24.08.2007	Gulmi District	6	-	Many houses	
25.08.2007	Pyuthan District	5	-	Many houses	12 missing
31.08.2007	Gulmi, Argakhanchi and Banke distrtricts	6	5	NA	
04.09.2007	Palpa ands Kalikot districts	5	3	10 houses	
06.09.2007	Makwanpur District	2	3	-	Landslide and flood
06.09.2007	Tribhuvan Highway				Road blocked
09.09.2007	Nawalparasi and Kaski districts	6	-		120 families displaced
09.09.2007	Sindhuli District	6	-	Many houses	100 families displaced
09.09.2007	Sarankot, near Pokhara	4	-	NA	Many houses buried
29.09.2007	Bhairavsthan and Laghuwa, Deurali VDC, Palpa District	4	-	Many houses	Road damaged in places

Source: www.kantipuronline.com (on various dates)

Recognition of the problem

The fact that the inscription on a pillar erected in 613 during the reign of Amsu Verma mentions that a settlement was displaced (Bajracharya, 1997) indicates that reallocation after a landslide was practiced in the past. Years later, prominent geologist Auden (1935) wrote of the landslides triggered by the 1934 earthquake. High magnitude earthquake also trigger landslides falling in and creating several temporarily dammed rivers and, after they breached, engendered devastating floods in the plains.

Every monsoon, Nepal's hills and mountains see the occurrence of thousands of new and reactivated landslides. The majority are not even reported because they are so remote.

When such a dam breaches—and it is only a matter of time—massive floods, called bishyari, occur. Dixit (2006) highlights two such events in Trishuli River in 1962 and 1964 which significantly added to sediment load in the river. On 3 August, 1985 the Trishuli River was blocked near Dhunche for 12 hours reducing total discharge from 350 to 93 cubic meters per second. When the dam broke, discharge reached 2,010 cubic meters per second and caused massive flood damage downstream (Paryawaran 2007).

Since upstream landslides often spawn floods downstream, the two types of disasters are reported together. The effects of floods are more visible than those of landslides which are responsible for high human losses while floods cause high infrastructural losses affecting larger population. As a point of comparison, the devastating Koshi flood of 2008 affected over 65,000 Nepalis though it killed only three, while a landslide in Bajura in Far-Western Nepal in the same year killed 21 people Co Action Nepal, 2008). This dual reportage has created a "flood-landslide disaster reporting culture" in Nepal.

Policy-makers agree on the importance of implementing preventive measures in minimising landslides. Even people who live on mountain slopes are aware that they are vulnerable to landslides during the monsoon. Unfortunately, they have few alternatives to living with the risks they do and are unable to act in ways which reduce their vulnerability.

Mitigation/prevention efforts

Depending on an area's geo-morphological and -tectonic contexts as well as the distribution of rainfall, landslide can be a common hazard, and one that may easily transform into a disaster. Those affected may be hurt or forced to leave their homes. Since its formation in 2000 the DWIDP has undertaken various activities to address the problems associated with landslides. Preventive and mitigative measures began to be implemented soon after the Disaster Prevention Technical Center (DPTC) the former incarnation of DWIDP was established in 1991. The DPTC, in collaboration with JICA, ran the Disaster Mitigation Support Programme (DMSP) until it was phased out in August 2004. Subsequently, DMSP conducted as a regular programme of the department. Initially, the DWIDP focused on landslide prevention, but now it is implementing structural measures designed to train rivers for preventing landslides. Table 4.3 indicates the current status of major landslides for which mitigation measures were undertaken during the DWIDP's DPTC/DMSP phase. While it is difficult to prevent landslides, their impact can be lessened using both structural and non-structural measures (see figures 4.9 and 4.10).

FIGURE 4.9: Structural mitigation measures pursued by DWIDP

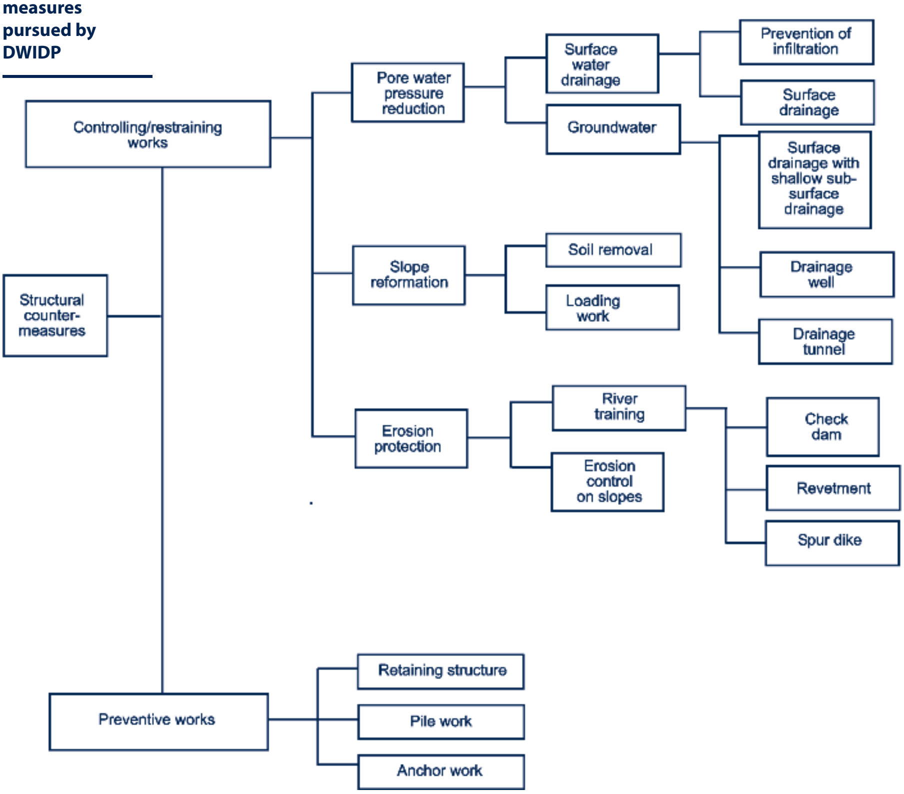
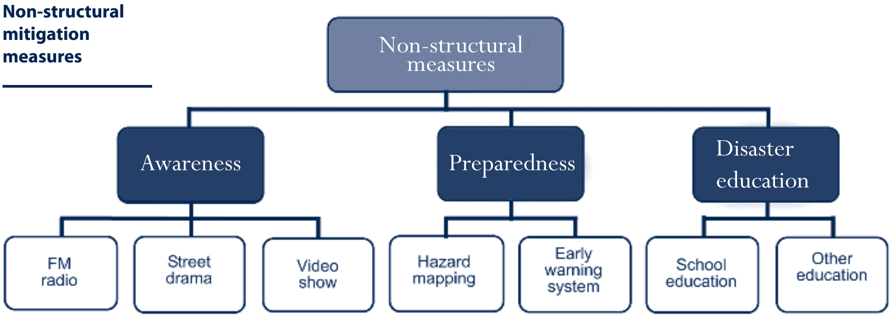


Figure 4.10: Non-structural mitigation measures



DWIDP implements structural measures such as gabion boxes filled with stones to prevent and minimise the impact of a landslide. This practice is also gaining popularity among local communities. In addition, bio-engineering measures are implemented along some sections of roads and national highways. Non-structural measures are relatively less expensive and chosen by NGOs and community group initiatives. However, since non-structural measures are significant from a long-term perspective, it is these measure which most I/NGOs focus on.

Table 4.3: Status of old landslides treated with mitigation measures

Name and Location	Type	Structural mitigation measures	Status	Remarks
Charali-Ilam Road, Ch.62+000km	L	Check dams, toe wall, slope drainage, horizontal drainage boring, bio-engineering	S	Cracks at crown
Kathmandu-Trishuli Road., Ch.19+000km	L	Toe and retaining wall, check dams, H-Drainage Boring, slope drainage	SS	Being monitored
Kathmandu-Trishuli Road. Ch.48+000km	L	Toe wall, check dams, breast wall, slope boring drainage, horizontal drainage	S	
Kathmandu-Naubise Road., Ch.13+000km	S	Breast wall, slope drainage, check dams, bio-engineering	S	
Kathmandu-Naubise Road., Ch15+200km	S	Retaining all, check dams, catch wall, bio-engineering	S	
Kathmandu-Naubise	L	Breast wall, check dams, slope drainage	SS	Being monitored
Bungamati Landslide Model Site, Lalitpur	L	Retaining wall, slope drainage, surface drainage, ground sill	SS	Being monitored
Khandi Chaur Landslide, Sindhupalchowk	S & D	Check dam, retaining walls	SS	Being monitored
Kathmandu-Dakshinkali Road, (Chalnakhel)	L			Under investigation
Shrawan Danda Landslide, Butwal, Rupandehi				Investigation dropped
Syuchatar Landslide, Kathmandu	L			Inspected only

Table 4.3: Status of old landslides treated with mitigation measures cont'd...

Name and Location	Type	Structural mitigation measures	Status	Remarks
Bamti Landslide, Ramechhap	S & D			
Attarpur Landslide, Sindhupalchowk	S	Retaining wall	S	
Tilahar Landslide, Parbat	S	Check dams, retaining wall	S	
Champha Pani Landslide, Syangja	S	Retaining wall, check dams	S	
Bhotang Landslide, Sindhupalchowk	L	Retaining wall, slope drainage	S	
Dahachowk Sabo Model Site Kathmandu	L & D	Check dams, retaining wall, earth works, bio-engineering		
Girubari Sabo Model Site, Nawalparasi	L & D	Check dams, retaining wall, slope drainage, bio-engineering	SS	Being monitored
Matatirtha Rehab Model Site Kathmandu	S & D	Check dams, toe wall, bio-engineering	S	
Pipaltar, Trishuli	SE	Concrete blocks, check dams, bio-engineering		
Narayanghat-Mugling Highway	S,D, & L	Check dams, sabo dams, retaining walls, surface drainage, horizontal drainage boring	S	Needs maintenance

Type: S-slope failure; L-landslide; D-debris flow; SE-soil erosion
Status: S–stabilised; SS–semi-stabilised

The DWIDP has implemented as many structural and some non-structural measures as it has been able to give the institutional and budgetary constraints which handicap it. With JICA, it has implemented structural measures along the Narayanghat-Mugling Highway that have been able to keep the road route open during the monsoon. The department also introduced a road information and early warning system for the inhabitants of Kabilas VDC when it conducted a study on disaster risk management for the same highway in 2008. The study found that the potential frequency of road closure disaster declined 54 per cent and potential annual economic losses declined 66 per cent after these measures were implemented (Unpublished report, DWIDP, 2008). The DWIDP responds to demands made at the district and community levels.

Preparedness

As part of the DMSP, the DWIDP installed a landslide early warning system (EWS) at the Dahachowk Sabo Model Site in the outskirts of Kathmandu Valley a few years ago. A participatory hazard map and evacuation plan was prepared at the same time and a demonstration evacuation drill conducted to demonstrate its usefulness and relevance. The EWS system did not come into operation because undetectable problem in the remote controlled integrated circuit of the equipment.

Rescue and relief

Local communities carry out immediate post-disaster rescue operations when a landslide disaster occurs. Later, a team of members of the NA, the NP and the APF also join the rescue operation. Operations are conducted by the concerned district disaster relief committee under the chairmanship of the chief district officers, who follows the directives of the National Disaster Relief Committee chaired by the Home Minister.

For rescue and relief operations to be successful, post-disaster operations need to be site-specific. Efforts can be hampered by a number of factors including difficulty in accessing the site, poor communication between the site and the sources of relief, and obstacles to moving people, whether volunteers to provide help or the displaced to rehabilitation sites are available. Financial and other resources can be a limitation, as can the fact that the area affected by a landslide is small and there is very little public attention to such localised events. Rescue and relief operations should address the specific needs of the affected people otherwise such initiative will lose credibility (see Box 4.1). Mechanisms must be developed to avoid situation as depicted in Box 4.1.

BOX 4.1: Landslides Relief in Bajura District

On 26 August 2008, a massive landslide killed 25 people of Jugad VDC, Bajura District; it also injured dozens and damaged over 1095 houses. Those affected complained that the rescue and relief operations managed by the chairman of the Bajura District Disaster Relief Committee were far from satisfactory. Some of the problems identified are as follows:

1) 250 of those who received relief were from Jukot VDC which was not affected by the landslide.
2) Other unaffected people were also included as victims.
3) Those who suffer losses in the landslide were not included in the list of relief recipients.

4) The list of the relief recipients was prepared based on a politically- motivated post-disaster assessment of the VDCs of Bajura.
5) The VDC secretary responsible for the affected VDCs did not visit the disaster site; instead he stayed in the district headquarters and offered advice only to those who came to him.
6) The district chairman of the NRCS expressed concern that the real victims of the disaster did not get relief but that non-deserving did.
7) Inhabitants of Jugad VDC, the real sufferers staged a protest outside the district administration office.

Much more needs to be done to improve relief and rescue efforts in the country. Often there are more volunteers than sufferers and their excessive numbers create unnecessary logistical difficulties. Without well thought-out plans, such outpourings of support put undue burden on rescue and relief operations.

Recovery and reconstruction

Post-landslide disaster recovery and reconstruction efforts made by governmental departments are slow for several reasons, including limited time to mobilise resources, the lack of suitable places for rehabilitation, and the difficulty in achieving consensus among different interests. Local communities are helpful and generous during emergencies. For instance, following the Nepane landslide disaster, the local community did a commendable job helping the affected families. Some of the affected families even managed to improve their standard of living after the disaster. Post-landslide disaster recovery and reconstruction in Butwal, in contrast, was unsatisfactory.

Ways forward

Landslide is one of the causes of human toll in Nepal. It also directly affects properties, infrastructure and results in indirect losses as damaged roads and irrigation systems cease to function. In 1990 Dikshit (1990) has suggested two focus areas to reduce landslide hazards in Nepal. The first focus he has suggested related to on acquisition and management of information on landslides. It also involved analysis of both the natural and anthropogenic causes that lead to landslide. The assessment must include the degree of hazards, their mapping, and evaluation of the social, political and technological methods for preventing landslides. Tinchai (1990) makes similar suggestion to meet the need for reducing losses from the landslides:

- Identification of landslide hazard areas; compilation of landslides inventories and landslide mapping.
- Rehabilitation of lands subjected to landslides and development of regulations controlling unstable terrain.
- Specific standards of design and construction of physical control measures in the public and private sectors.
- Formulating land-use regulations in hazardous mountain areas.
- Strong support from research in the context of the mechanics of the landslide process, transport and deposition, mitigation measures, and warning systems.
- Provision of a central clearing-house for collection and distribution of publications and guidelines to professional, agencies, and local governments.
- Development of a national landslide-loss reduction programme and the identification of a central organization for management of the programme.

The second focus area should concentrate on providing the synthesised information to end users to ensure that it is utilised at village, district and regional levels for minimising landslide hazards. The information, for example, can be used in planning and designing infrastructure projects, develop appropriate land use regulations, codes and in formulating management plans for disaster rescue. Initiative on landslides prevention must promote interaction among geologists, hydrologists and those involved in DRR activities for meaningful risk management.

Chapter-5

Drought

Drought is a weather-related disaster that can affect vast regions, even an entire nation, for long periods of time. It diminishes food production, can reduce life expectancy, and hampers economic growth. The Oxford Dictionary defines drought broadly as "dryness, lack of moisture, thirst, continuously dry weather, lack of rain," while the OECD (1994) specifies that the dryness is in comparison to normal levels, claiming that droughts entail a temporary reduction in water or moisture availability to significantly below the normal or expected amount for a specified period. The World Meteorological Organisation (1975, p.13) is more precise in one way but its classification also suggests how much variability exists in defining exactly what constitutes a drought:

(a) rainfall less than 2.5 mm in 48 hours;
(b) rainfall half of normal or less for a week;
(c) 10 days with rainfall not exceeding 5.0 mm;
(d) 15 days with no rain;
(e) 21 days or more with rainfall less than 30 per cent of normal;

Further, complicating matter is the fact that there are also different varieties of drought. Glantz (1987) distinguishes between meteorological, hydrological, agricultural and social drought. Environmental damage may also lead to ecological drought as the productivity of an ecosystem fails as a consequence of low rainfall. A general definition of meteorological drought is 'a reduction in rainfall supply compared with a specified average condition over some specified period' (Hulme, 1995). Agricultural drought is defined as a reduction in moisture availability below the optimum level required by a crop during different stages of its growth cycle, resulting in impaired growth and reduced yields. Because hydrological drought pertains to the impact of a reduction in precipitation on surface or sub-surface water, it may lag behind periods of agricultural or meteorological drought (Wilhite, 1993). Meteorological drought may have an adverse impact on irrigated crops, some forms of non-agricultural production, including hydro-electric power generation, and drinking water supplies for humans. Social drought relates to the direct and indirect impacts of droughts on human activities.

BOX 5.1: Types of drought

Meteorological drought	:	Inadequate or poorly distributed rainfall
Hydrological drought	:	Reduced stream flow and inadequate filling of reservoirs
Soil moisture drought	:	Inadequate soil moisture, particularly in rain-fed areas
Agricultural drought	:	Low soil moisture levels and crop failures
Socio-economic drought	:	Reductions in the availability of food and income
Ecological drought	:	Failure of the productivity of a natural ecosystem

Drought is recognised by its multiple impacts. The key indicators of drought include precipitation, temperature, soil moisture, groundwater levels, snow pack, stream flow, reservoir and lake levels and the condition of vegetation. No one feature is sufficient to signal with certainty that, yes indeed, there is a drought. Instead, we speak of its relative severity, which is best described through multiple indicators and indices.

Unlike other natural disasters, which are immediately obvious in their occurrence, drought is a slow-onset, creeping phenomena. Because its impacts are non-structural and spread over large areas, it is difficult to assess, respond to and mitigate droughts. In addition, the absence of a universally-agreed upon definition can lead to confusion about whether or not there is indeed a drought and, in consequence, to inaction. The fact that its impacts are cumulative—they are amplified when drought-like conditions continue from one season to the next—further complicates our ability to address drought effectively.

Droughts in Nepal

South Asia is a perennially drought-prone region. In fact, Afghanistan, India, Pakistan and Sri Lanka have reported instances of drought at least once in three years in the past five decades, and since the mid-1990s, prolonged and widespread droughts have occurred in consecutive years in Afghanistan, India and Pakistan. The frequency of droughts has also increased in Sri Lanka and Bangladesh—and in Nepal. Most of the country is in the grip of drought from the end of March to when the monsoon arrives in June, but the districts of Mustang and Manang in the Trans-Himalayan region are extremely dry throughout the year and the Tarai and the western hills are more frequently affected than other regions.

BOX 5.2: Recent drought in Nepal

Land tilling

Collecting water from a well

Deficient rainfall in the winter of 2008 resulted in a severe drop in crop production right across the country. Wheat and barley production declined 14 and 17 percent respectively. In some districts of Mid- and Far-Western Nepal which received less than half of average rainfall from November 2008 to February 2009 report that crops yields declined by more than half.

A joint assessment by the Ministry of Agriculture and Cooperatives (MoAC), the UN Food and Agriculture Organization (FAO) and the UN World Food Programme (WFP) suggested that about 2 million people were at high risk of food insecurity as a result of poor harvests and 3.5 million more were vulnerable. Their report estimated that 40 of Nepal's 75 districts were food deficit because of the drought and expressed concern about the nutrition situation throughout Nepal. In these 40 food-deficit districts, half of children under the age of five are stunted, 39 percent of children are underweight and 13 percent are severely malnourished.

According to an article published in Clear Source on 31 May, 2009, WFP declared it would increase its support to NRs. 1.5 million and 2.2 million recipients, an additional 700,000 persons, in the coming weeks. Besides providing food, WFP also helps drought-affected communities build up assets through a variety of projects like Food for Work and Food for Training. FAO plans to help local communities expand irrigation networks and distribute seeds for the next harvest.

People have been coping with the drought by selling their assets, migrating for work and, in some cases, even skipping meals. Farmers depend upon winter crop production to tide them over until the main crop is harvested in September and October.* The situation threatens to continue to be serious, however. Average rainfall in the Far-West in April 2009 was 80% less than normal and temperatures are predicted to increase. Already Nepal's average temperature has increased by 1.8ºC in the last 32 years and is increasing by 0.06 ºC annually.** A second worry is the increasing use of bio-fuel produced from edible crops, a trend which pushes up prices and disproportionately affects the poor.

To reduce the risk of disaster, the capacity of communities to adapt to drought should be enhanced This focus in turn will require a thorough investigation into the nature of drought and its probable immediate impacts as well as its long-term outcomes and people's current coping strategies.

* *www.wfp.org/news/news-release/winter-drought-worsens-food-insecurity-nepal*
** *www.Moac.gov.np/publications/journal/9malla Nepal-World Bank Supports Nepal responses to rising food prices. Retrieved from www.worldbank.org.np Southasia.oneworld.net/todaysheadlines/Nepal-needs-urgent-food-help-says-un*

Drought results in crop failures and famine, both during the monsoon season and during the rest of the year, when winter crops are sown. In fact, Nepal's Ministry of Agriculture and Cooperatives (MoAC) has identified drought as the greatest risk to agriculture (MoAC, 2006), particularly as year-round irrigation facilities supply only 38% of arable land; the rest is rain-fed. Whether or not drought conditions prevail is based on two factors: the amount of rainfall brought by the westerlies during the winter and the timing of the advent of the monsoon. For every day the monsoon is delayed, crops are adversely affected, even if winter precipitation has been good, because soil moisture drops below the minimal level needed for crop maturation. If it is available, irrigation with canals or groundwater can provide a buffer, warding off crop failure. Drinking water supplies are also adversely affected, and many families have to walk long hours or sacrifice hygiene and sanitation.

In Nepal, about 5,000 families living in pockets in the hills and the Tarai (the nation's breadbasket, where 25 per cent of the total 1.2 million acres of arable land are found) are affected by drought each year (LRMP, 1986). When drought conditions prevail, cereal production declines significantly, compounding the country's existing problems with hunger. According to NPC (2007), 39.9 per cent of the populations do not consume minimum daily calories recommended by WHO, whilst UNICEF (2006) depicts 50 per cent of children under five were stunted, of which 20 per cent were severely affected.

The 2009 drought and the rise in world food prices crisis could increase malnutrition levels, forcing the government to increase its supply of emergency food to remote mountainous districts, a challenging task given that there are no roads and food must be transported by porters or by planes, a solution costing several million rupees.

Deaths due to famine are not reported systematically and the MoHA doesn't even maintain such records. In fact, drought is not considered as a disaster in its own right; DesInventar provides data on drought only in conjunction with data on agricultural losses (see Table 5.1).

The UN's World Food Program (WFP) ranks Nepal as the 16th worst country in terms of food shortages and estimates that by mid 2009 the number affected will rise from 1.2 to 2.5 million in at least 31 districts. It warned that more than 300,000 people in the nine hill districts of the Far- and Mid-West (Accham and Bajura in the Far-West and Kalikot, Mugu, Dolpa, Humla, Jajarkot, Dailekh and Rukum in the Mid-West) face a food crisis because of the 2008 drought-inflicted crop failure.[14] Yields in 2009 have been so poor that many will not be able to cope. Most of these districts lack motorable roads and cause difficulty in supply.

Table 5.1: Drought scenario in Nepal

Date	District	Extent of impact
August, 1974 and Saping VDCs	Sindhupalchowk	254 ha of maize in Chakubas, Taragaun,
June, 1983	Ramechaap	80% of paddy and maize crops were damaged
August, 1992	Bara, Dhanusha, Mahottari, Sindhuli, Sarlahi, Saptari,* Morang District ** (VDCs of Bhatigachha, Majhare, Nocha, Kadamaha, Pokhariya, Rangeli, Takuwa, Govindpur, Amardaha, Babiyabirta, Mahadeva, Jhurkiya), Jhapa,*** Siraha, Kailai, Kanchanpur, Banke, Surkhet, Dang, Bardiya, Dailekh, Nawalparasi	*The entire district was affected; about half the paddy and much of the maize was badly affected **About 50-60% of paddy fields couldn't be planted ***4013 ha of paddy fields could not planted

[14] *Nepal initiative on soaring food prices, draft report jointly prepared by Government of Nepal, FAO, WFP, Asian Development Bank and World Bank (July 2008).*

Table 5.1: Drought scenario in Nepal contd...

Date	District	Extent of impact
August, 1994	Parsa, Bara, Rautahat, Sarlahi, Mahottari, Dhanusha, Nuwakot, Panchthar, Terhathum, Khotang, Siraha, Udayapur, Sunsari, Morang, Jhapa, Taplejung, Panchthar, Bhojpur, Saptari, Ilam, Sankhuwasabha, Dhankuta, Achaam, Dadeldhura, Kailali, Kanchanpur, Doti, Kalikot), Bardiya, Rolpa, Dang, Kapilbastu, Nawalparasi, Gulmi, Rupandehi	The VDCS of Rauthat-35, Mahottari-6, Bara-71, Parsa-41, Sarlahi-33, Dhanusha-59, Nuwakot-28, Sindhu-7 Panchthar-47, Terathum-25, Khotang-29, Siraha-112, Udayapur-25, Sunsari-32, Morang-34, Jhapa-51, Taplejung-39, Panchthar-34, Bhojpur-63, Saptari-65, Ilam-42, Sankhuwasabha-15, Dhankuta-27, Acham-75, Dadeldhura-25, Kailai-17, Kanchanpiur-20, Doti-18 Bardiya-19, Rolpa-51, and Dang-14 were affected
2005	Dolakha, Chitawan Taplejung, Jhapa, Sunsari, Siraha, Morang Dadeldhura (Amarghadi Municipality) Banke, Dang, Rupandehi, Gulmi, Syanja, Kaski	In 24 VDCs farmers could not plant millet or paddy. In Choppur, Makha, Top, Khamlung and Phaparbari VDCs, maize could not be planted on 500 ha In Jhapa production was down 10% In Morang, 70% of paddy could not be planted in the VDCS of Bhatigachh, Majhre, Nocha, Pokhariya, Amahibariyati, Sobhag, Bhoudaha, Katahari, Mahadewa, Surkiya, Anpgachi, and Sundarpur In Siraha, only 15,000 of 73,000 ha was planted
2006	Sarlahi, Rautahat (Madhopur, Santapur Motiyon), Ramechaap, Khotang, Bhojpur, Bajhang, Dailekh, Kalikot, Banke, Tanahu, Nawalparasi, Palpa.	In Sarlahi, 8,394 ha of paddy was destroyed and 33,850 ha damaged

TSource: DesInventar

Management of drought

Both the government and INGOs like World Food Programme (WFP) and NRCS have responded to this disaster. While the former provided subsidised food and seeds, the latter supported with free food. The expense can be considerable; to address the 2002-2003 droughts in eastern Tarai, for example, the government allocated about 20 million rupees.

BOX 5.3: Food crisis in the Far-West

The Karnali zone regularly suffers from food deficits and disease, and many of its residents' basic needs remain unfulfilled. It experiences drought, hail and wind storms and frequent snowfall, all extreme weather conditions which decrease crop production. The government has been supplying food to the region since 1972. In 2005 it spent NRs. 152.4 million and the amounts are rising. Maoist insurgency served to compound the extant food security problem. According to a 2007 report by WFP and OCHA, two-thirds of the VDCs of

Karnali zone suffered and the prices of food stuff increased by about 30 percent. An earlier report (Mainali, 2002) on the Far-Western region estimated the number of food-deficit 0.8 million people and gave the reason as a 60 percent reduction in crop production due to poor weather and conflict.

Even after a peace treaty was signed in 2006, the food crisis continued, this time due to drought conditions, which caused declines in crop production of up to 70% in some areas*. Food prices also soared. When the price of pulses increased by up to 35%, many poor families found that they were unable to afford an important source of protein. A household survey conducted by WFP in 2008 in the districts of Jumla, Dolpa and Mugu revealed that half of all households experienced shortages in rice, wheat and millet. Acute malnutrition among children under five is above 26% in some communities. To avert a crisis, in 2006 WFP planned an intervention providing immediate help. However, as is often the case, delivery was complicated by poor road access in western Nepal and the high cost of transportation. In addition, the occasional inappropriate distribution of food created a problem.

The National Food Corporation has committed to supply about 10,000 metric tonnes of food annually to 30 districts (NPC, 2008). For its part, the central government has included the notion of the right to food in the Interim Constitution and the Constituent Assembly will likely adopt the same concept in the new constitution slated to be ratified in May 2010. The government has also developed a special programme in its Interim National Plan (2007/08-2009/10) for the development and socio-economic empowerment of the Karnali region (NPC, 2008).*

** Adhikari, J., 2008: Food crisis in Karnali: A historical and politico-economic perspective.*

In 1997-1998, after a technical team was formed to assess the drought-induced crop losses and recommended distributing 142.5, 16.5 and 52 metric tonnes of wheat, pulses, and maize respectively at a 50 per cent subsidy. Affected families also received 175 kg of vegetable seeds, 611.7 and 2.4 metric tonnes of wheat and pulse seeds respectively with nominal technical assistance. In eleven districts of the Eastern hills a total of 1,166 shallow tube wells and 97 sprinkles were installed and six groundwater sources were renovated. In addition, some INGOs published and distributed materials about the drought through the local bodies. For example, the monthly magazine Paryawaran, which Action Aid Nepal helps distribute to 3,915 VDCs across the country has published articles increasing awareness about drought.

Following strategies help minimise impact of drought.

Land-use: Planned crop rotation can help minimise erosion and enables farmers to plant less water-dependent crops in dry years.

Rainwater harvesting: Rainwater from roofs or other suitable catchments can be collected and stored.

Drought monitoring: Recording rainfall amounts and comparing it with water usage can help prevent man-made drought

Recycled water: Wastewater can be put to use in non-drinking purposes after recycling.

Irrigation: Canals can be built and river water redirected to provide irrigation in drought-prone areas

Water rationing: Water use, particularly outdoor water use, can be regulated by minimising the watering of outdoor plants, the washing of motor vehicles or other outdoor hard surfaces (including roofs and paths), and the filling up swimming pools as well as by installing water conservation devices such as specially-designed shower heads, taps, and dual flush toilets.

Ways forward

In order to effectively reduce the impact of droughts, the government and other stakeholders must address the various factors that exacerbate the situation and adopt a multi-sectoral approach. The following aspects need to be pursued.

BOX 5.4: Enhancing the resilience of the agricultural sector

Many Nepali farmers have almost no access to meteorological forecasting; instead, they rely on traditional knowledge to judge the timing of monsoon rainfall. Recently, however, an initiative to enhance capacity in the agricultural sector to adapt to climate change was launched with funding from the Food and Agricultural Organisation (FAO). A pilot programme including demonstrations of soil conservation techniques and the cultivation of drought-resistant wheat and potato and flood-resistant paddy varieties is being implemented in three VDCs in each of four districts, two in eastern Nepal and two in western. At the district level, the programme aims to improve seed storage systems in flood-prone areas. Other activities include documenting existing local knowledge on climate risk management and enhancing early warning systems in partnership with the DHM by upgrading meteorological stations and improving rainfall forecasts for particular agro-meteorological zones. Another objective is to introduce seasonal agricultural advisories for farmers.

Building institutional capacity: The government should help build drought management capacity of local government. Local governments can play a critical role in drought management, particularly in the mobilisation of local resources. The Department of Agriculture (DoA) should provide the necessary support on drought mitigation. At the same time community groups, the private sector and civil society groups should be involved. A comprehensive drought mitigation plan must be developed along with a system to take action, monitor, and evaluate.

Risk assessment and planning: Decision-makers and administrators should have access to funds and manpower they need to address drought conditions. Those directly affected should be fully informed of the actions they should take and the assistance they can expect in the event of a drought. It is important to make them aware of the financial and other assistance that will be available (or unavailable) to them so that they plan accordingly.

Data collection networks: The government, in collaboration with the MoAC and the DHM, should increase the number of data collection centers which collect data on precipitation, wind speed, and agricultural yields. The government should enlist the help of academic institutions like the Tribhuvan and Kathmandu universities in meeting research needs related to drought monitoring and early warning systems.

Information, communication and public awareness: The public should be kept informed of current and forecast conditions and the required responses by providing accurate and timely information through print and electronic media. Farmers in particular should have access to information regarding on- and off-farm risks. Education on disaster management and training in farm management should also be initiated. Research and awareness programmes should identify those geographic regions and farming communities that are most at risk.

Funding: Since the annual cost of drought reduction programmes is far less than the annual cost of post-disaster recovery and rehabilitation, it is necessary to allocate sufficient funds from the budget to implement drought mitigation plans.

Chapter-6

Earthquakes

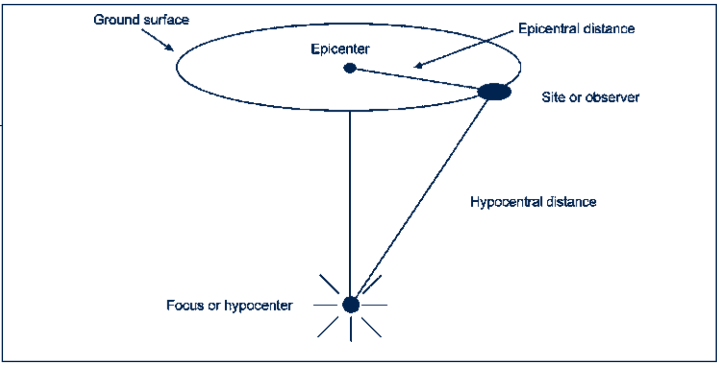
Earthquakes can bring widespread devastation to or even completely paralyse a country or a region for an extended period of time. The violent shaking of the earth's crust which results from the sudden release of tectonic stress along a fault line or volcanic activity can destroy buildings and other infrastructure. It can take years for a country to recover from the damage to its infrastructure and economy. The associated trauma and suffering of survivors may also be enduring.

Iran, Afghanistan, China, Pakistan, India, Nepal, Bhutan, Bangladesh, Burma, Indonesia, the Philippines, Japan and other countries lie in very high risk zones in either the Alpine-Himalayan or Circum-Pacific seismic belts. It is because the Himalaya are still active mountains, with the Indian plate pushing against the Eurasian plate and causing the deformation and uplift of rock, that the Himalayan region is one of the most seismically active parts on Earth.

Causes of an earthquake

The shaking of the earth's crust is caused by the seismic waves that emanate from the earth's interior when, through the constant movement of the earth, deformed rocks under strain release large amounts of potential energy as kinetic energy. Seismologists use the term "earthquake" to refer to the source of the seismic waves, the hypocentre, rather than to the shaking phenomenon, which is actually just an effect of the earthquake and modern geophysicists define earthquakes as sequences of energetic seismic waves. The epicentre of a quake is the point on the surface vertically above the focus (Figure 6.1).

FIGURE 6.1: Details used to describe the location of an earthquake



Most earthquakes, including those which are most disastrous, occur along the boundaries of tectonic plates and are called inter-plate or tectonic earthquakes. The movement between the plates can be both vertical and horizontal (a dip slip) and lateral (a strike slip), but one or the other is usually the dominant cause (Murthy, 2002). When the accumulated energy, the strain created by deformation, exceeds the strength of a rock, it suddenly breaks. The accumulated energy is released as a slip along a pre-existing fault line, or break in the earth's crust. Minor earthquakes occur every few seconds, but severe ones are infrequent. Earthquakes can also be triggered by volcanic eruptions, explosions, avalanches or landslides.

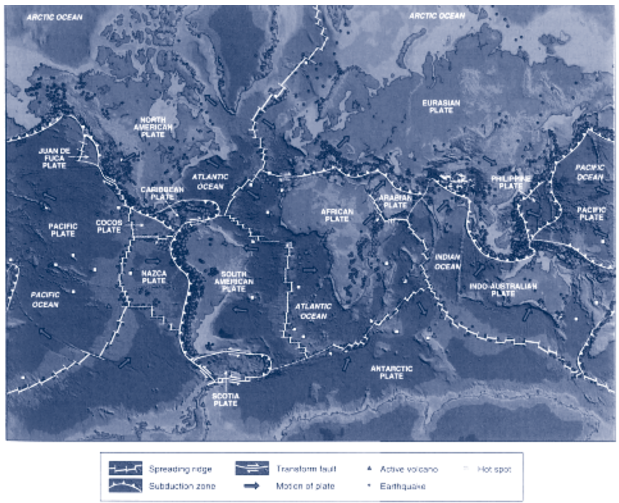


FIGURE 6.2:
Plate boundaries and the global distribution of earthquake zone in the world

Magnitude and Intensity

Earthquakes are measured in terms of their magnitude and intensity. Magnitude is a measure of the amount of energy released by an earthquake, whereas intensity is a measure of the damage or destruction it causes. Magnitude is measured on the Richter scale and ranges from 0 to 8.6. On this logarithmic scale, every increase of one unit means that the amplitude of the seismic waves increases by a factor of ten and that 33 times more energy is released. Intensity is another measure expressed in Roman numerals, from I (the least perceptible) to XII (the most severe). A quake with an intensity of I will cause little to no damage and is hardly felt by humans, whereas a quake with an intensity of XII will have a catastrophic effect and completely destroy buildings and other infrastructure. The two intensity scales most commonly used are the Modified Mercalli Intensity (MMI) Scale and the Medvedev-Sponheuer-Karnik (MSK) Scale (Murthy, 2002). The intensity of an earthquake is highly dependent on the location of its epicentre and area of its impact.

TABLE 6.1 : Frequency of earthquakes and their effects based on the Richter scale

Richter scale magnitude	No. of earthquakes per year	Typical effects of magnitude
<3.1	800,000	Detected only by seismometers
3.5–4.2	30,000	Just about noticeable indoors
4.3–4.8	4,800	Most people notice them, windows rattle
4.0–5.4	1,400	Everyone notices them, dishes may break, open doors swing
5.5–6.1	500	Slight damage to buildings, plaster cracks, bricks fall
6.2–6.9	100	Much damage to buildings, chimneys fall, houses move on foundations
7.0–7.3	15	Serious damage, bridges twist, walls fracture, buildings may collapse
7.4–7.0 >8	4 One every 5–10 years	Great damage, most buildings collapse Total damage, surface waves seen, objects are thrown in the air

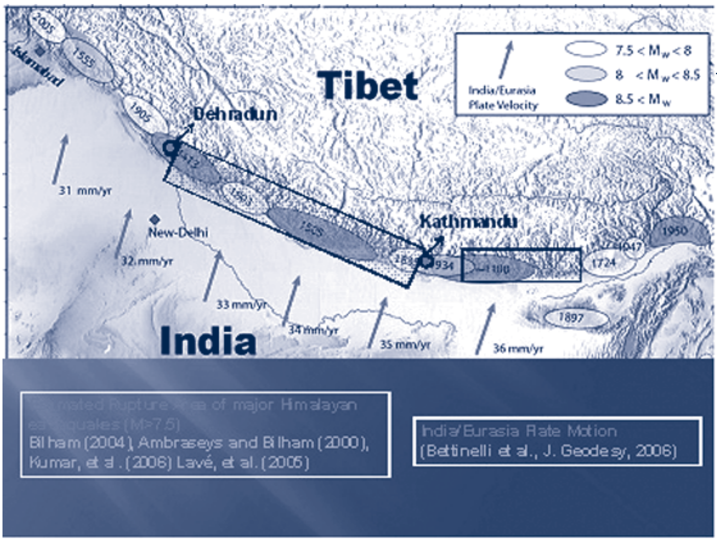
Source: UP Seis – Department of Geological Engineering and Sciences, Michigan Technological University, USA.

Earthquakes in Nepal

In Nepal, over 16 earthquakes have occurred since 1223; the last was in 1988. The most disastrous occurred in 1833 (magnitude 7.7 on Richter scale) and 1934 (magnitude 8.3 on Richter scale). Their epicentres respectively were in Kathmandu Valley and Sankhuwasabha Chainpur Nepal.

Many geologists suggest that the 2400-km-long Himalayan arc can be divided into 200-400-km-long segments which periodically break and separate to produce catastrophic earthquakes. Once an earthquake occurs in a particular spot it will take decades, even centuries before another occurs. From east to west, the earthquakes of Assam, India (1950); Shillong, India (1897); Nepal-Bihar, India (1934); and Kangra, India (1905), each of a magnitude greater than 8, are the largest of the last century in this region. The 8 October 2005 earthquake that occurred in Pakistan's Muzaffarabad is the latest one. The many medium-sized earthquakes that have occurred also caused widespread devastation.

FIGURE 6.3: The seismic gaps in the Himalaya



Note:
That no large earthquake has occurred west of Kathmandu since 1505 or east of Kathmandu since 1100 (modified after Bettinelli *et. al.,* 2006).

Noting that no great earthquake has occurred between Kathmandu in the east and Dehra Dun, India in the west, in what is known as the central Himalayan seismic gap, over the past several centuries (see Figure 6.3), seismologists like Bilham (2002) predict that any part of this segment could experience a major earthquake with a magnitude over 8 in the near future. Over 100 million people in the Himalayan region and the adjacent North Indian plains, the most populous part of India, would be severely affected. This possible mega-earthquake is known as the great central Himalayan earthquake or, if its epicentre is in Nepal, the mid-Nepal earthquake (JICA/MoHA, 2002).

It is estimated that the losses sustained in such a disaster could push Nepal's development decades back and it would take years to recover. Nepal's Himalayan, hill and Tarai belts are home to 7.3, 44.3 and 48.4 per cent of the population respectively. Since heavy construction materials such as stone masonry, are used in the northern two belts, they are particularly vulnerable to earthquakes, especially if they occur at night. Because earthquake-resistant components are not used, buildings in urban Tarai are also vulnerable. Rural Tarai is relatively less vulnerable to damage as most houses are made of light materials such as timber and bamboo and thatched roofs.

Research on active faults in Nepal

Though the Himalaya are one of the most seismically active regions on the planet, historical records of all but the great earthquakes of the last two centuries are few and research on active faults in Nepal began only very recently. The practice of trenching along such faults to understand their history is still in its infancy though a few successful efforts in Nepal and India produced important results which will help build a database for assessing earthquake hazard in this region. The distribution of active faults in Nepal shown in Figure 6.4 clearly shows that most are located along the southern faces of the mountains.

Recent trenching of the main frontal thrust (MFT) in Nepal and India shows that none of the great earthquakes ruptured any surface and that those earthquakes in Nepal (Nakata *et al.*, 1998; Upreti *et al.*, 2000; Yule, *et al.,* 2006) and India (Kumar, *et al.,* 2001; Feldl and Bilham, 2006) which did rupture the surface exhibited very large displacements of the magnitude of 15 to 20 metres along the fault. This evidence indicates that the Himalaya experienced mega-earthquakes in the past with magnitudes even greater than 8.6, the largest in the last two centuries. The earthquake responsible for a 17-metre displacement in Western Nepal can be correlated with the 1505 earthquake and a gap in the east with a 1100 quake. Because these seismic gaps have matured enough to sustain future ruptures and produce new large earthquakes, Nepal is in a very high risk zone. To better understand the nature of that risk and work toward its mitigation, more trenching of active faults is required.

FIGURE 6.4: The distribution of active faults in Nepal (based on the work of Nakata, 1982; Nakata et al., 1984; and Nakata and Kumahara, 2000)

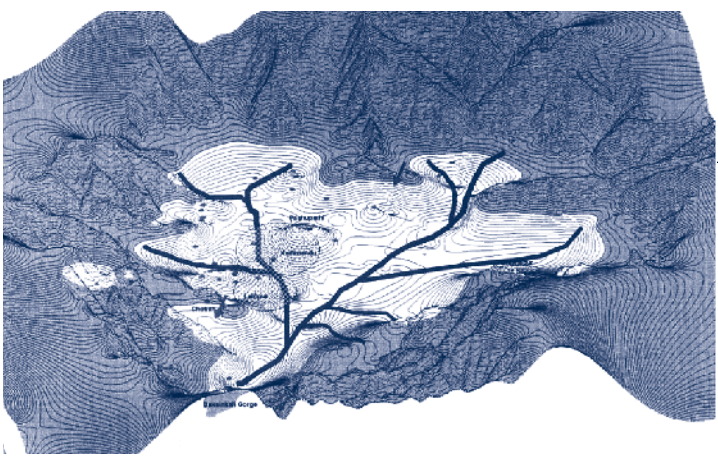


FIGURE 6.5: The lake which once covered Kathmandu Valley (DMG, 2006)

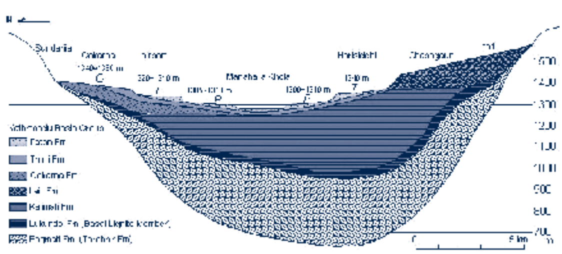
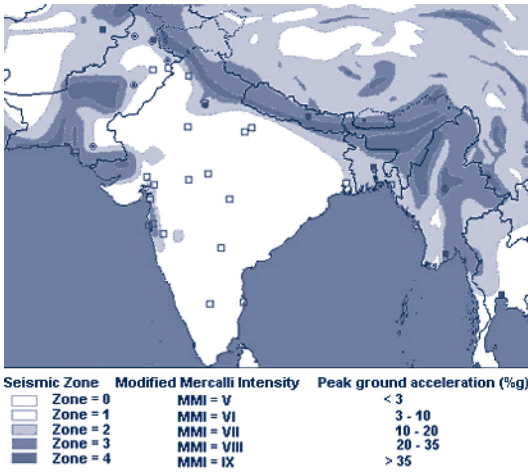


FIGURE 6.6: A north-south geological cross-section of Kathmandu Valley showing the nature of sediment deposits (Sakai 2001)

Box 6.1: Kathmandu Valley earthquake damage scenario

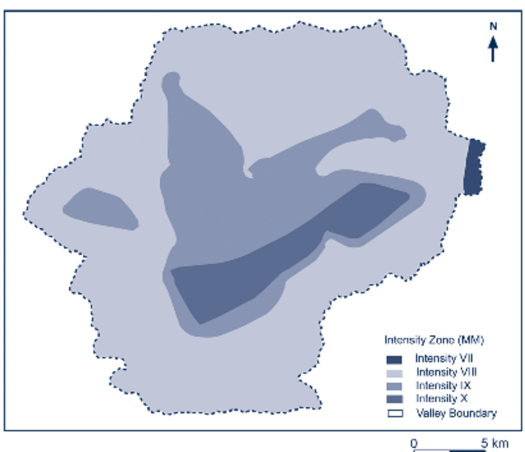
If an earthquake of a high intensity such as that in 1934 were to hit Kathmandu what will be the damage scenario. Such scenarios have been developed by NSET-Nepal and GeoHazards International (GHI) in 1998 and by the Japan International Cooperation Agency (JICA) in 2002. The NSET-GHI study examined the consequences of earthquake shaking on the same scale as that experienced during the 1934 events if Kathmandu Valley experiences an earthquake shaking similar to that during the 1934 earthquake.

The scenario showed that there is likley to be at least 40,000 deaths, 95,000 injured, and serious damage to critical facilities and infrastructure to the extent of reducing their operational capacity by more than fifty percent. The expected number of homeless population in Kathmandu Valley is estimated at 600,000-900,000. The scenario showed that almost half of the bridges impassable, 10% of paved roads will face moderate damage, some 95% of water pipes and 50% of other water system components will face serious damage, almost all telephone exchange buildings and 60% of telephone will be damaged while some 40% of electric lines and all electric substations will be damaged. Poor urban expansion at rate of 5.3% and hazard-in-sensitive landuse, poor construction qualities of buildings, and lack of emergency response system and preparedness capacity were identified as the major causative factors. Very few countries in the world have developed such scenarios. Though one of the developing countries such an exercise has been completed in Nepal and the result of the scenario should be used to highlight the potential losses to life, assets and infrastructure. The next step is in designing and implementing appropriate DRR strategies to minimise losses.



Source: Global Seismic Hazard Assessment Program (GSHAP), http://www.seismo.ethz.ch/GSHAP/

Figure 1: Seismic hazard map of Nepal



Source: UNDP/UNCHS (Habitat), 1994, Seismic Hazard Mapping and Risk Assessment for Nepal

Figure 2 Seismic intensity map of 1934 earthquake in Kathmandu Valley (Modified Mercalli Scale – MMI)

Earthquake Harzard and Risk of Kathmandu Valley

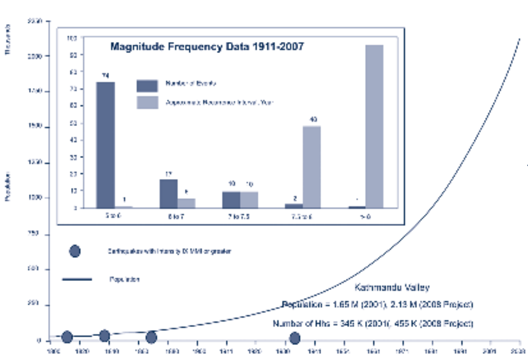


Figure 3: Earthquake hazard and risk of Kathmandu Valley

The 2002 JICA study explored the consequences of a magnitude 8 earthquake, generating somewhat more conservative, but nevertheless severe, loss estimates. The study indicated that 21% of the building stock could be heavily damaged with a potential death toll of 1.3% of the valley's population and a 3.8% rate of serious injury. In the last decade Kathmandu has seen even more haphazard urban growth but these scenarios do not reflect this expansion. When the study was made public in 1998 there was some 'shock' expressed but did not generate desired impact on policy and decision-makers. Such results must be innovatively used to add value to formulating risk reduction polices.

Losses due to earthquakes

The losses incurred due to earthquakes vary with their magnitude. Table 6.2 lists the most devastating earthquakes of the last 25 years.

Earthquakes cannot be prevented, but we do know where potentially hazardous zones lie and we can prepare ourselves to mitigate the risks by utilising the tools available to us. These tools include recent advances in technology and lessons learnt from previous events.

Table 6.2: Major earthquakes of last 25 years

Location	Date	Magnitude
Sichuan Province, China	12 May, 2008	7.9
Java, Indonesia	27 May, 2006	6.3
Muzaffarabad, Pakistan	8 October, 2005	7.6
Indonesia	26 December, 2004	9.3
Gujarat, India	26 January, 2001	7.9
Chamoli India	29 March, 1999	6.8
Chi-Chi, Taiwan	9 September, 1999	7.8
Izmit, Turkey	17 August, 1999	7.6
Duzce Iran	12 November, 1999	7.1
Athens, Greece	7 September, 1999	5.9
Kobe, Japan	17 January, 1995	7.2

The earthquakes that have occurred in the Himalayan region have killed a large number of people. In fact, earthquakes in the Hindukush-Himalaya-Tibet region and its periphery (mainland

China) have killed more people than quakes in any other part of the world because this region includes densely populated countries that house over two billion people, or one-third of the earth's total population.

BOX 6.2: Retrofitting schools to resist earthquakes

Across the world, disasters render schoolchildren vulnerable. The 2005 earthquake in Muzaffarabad, Pakistan, for example, saw the greatest number of casualties among students because school buildings were not earthquake-resistant or poorly built. In the disaster most of the dead were school- and college-going youth in the age group of 5-24 years (Moench and Dixit, 2007). Since the earthquake of 1986, and especially in the 1990s, GoN has made provisions to retrofit school buildings so that they are able to withstand the impacts of earthquakes. Measures implemented include strengthening windows, walls, columns and floors to minimise collapse. Kathmandu-based NEST-N has allocated 200 million rupees to assist in the retrofitting of 30 schools around the Kathmandu Valley and across the country.

The 1934 earthquake in Nepal killed 8,519 people, while the 6.5 magnitude 1988 quake killed 721. The 1998 earthquake resulted in huge infrastructural losses and required eight per cent of the total GDP for rehabilitation (Upreti, 2005). The record of earthquakes in Nepal since 1223 suggests that a large earthquake occurs every seventy-five to hundred years and that moderate ones occur every fifty years. Table 6.3 highlights the losses they incurred.

Table 6.3: Losses from earthquakes

Date	Deaths	Damages
24 December, 1223	Numerous human casualties	Damage to homes and temples
7 June, 1255	One-third of the population of Kathmandu was affected. The many deaths included that of reigning king Abhaya Malla eight days after the quake.	Damages to homes and temples. People lived outside for a fortnight to a month and aftershocks were felt for four months.
1260	Numerous human casualties and a famine afterwards	Massive damage to homes and temples
14 September, 1344	Numerous human casualties, including the death of reigning king Ari Malla in Deopatan one day after the quake	Damage to homes and temples

Table 6.3: Losses from earthquakes contd...

Date	Deaths	Damages
1408	Numerous human casualties	Damage to homes and temples., including Patan's Machendranath temple
1681	Numerous human casualties	Residential buildings damaged
1767	No deaths recorded	No record of damage
4 June, 1808	Several people and animals perished	Houses collapsed
1810	Many lives were lost particularly in Bhaktapur	Buildings and temples were damaged
1823	No deaths recorded	Some damage to houses
1833; magnitude 7.7	414 people died in the vicinity of Kathmandu Valley	Nearly 4,040 houses in Kathmandu, Bhaktapur, Patan and Banepa destroyed and a total of 18,000 buildings damaged throughout the country.
1834	No record available	Many buildings collapsed
1837	No record of death	No damage in Nepal recorded but greatly affected Patna and other parts of Bihar, India.
1869	No record of death	No record available
1897	No record available	No record available
1917/1918)	No record of any deaths	No record of any damage
1934; magnitude 8.3, intensity X; epicentre in Eastern Nepal	8,519 people died, 4,296 in Kathmandu Valley.	Over 200,000 buildings and temples damaged, nearly 81,000 of which were completely destroyed. In Kathmandu alone 55,000 buildings were affected, 12,397 of which were completely destroyed).
1936	No record available	No reliable record available
1954	No record available	No reliable record available
1966	24 people died	1,300 houses collapsed
1980; magnitude 6.5; epicentre in the Far-West	178 people died	40000 houses collapsed
1988; magnitude 6.5; epicentre in the Southeast	721 people died	66,382 buildings collapsed or seriously damaged
1993; epicentre near Jajarkot		40% of buildings were affected

Sources: UNDP/UNCHS, 1993; Pandey and Molnar, 1988; Bilham et al., 1995; Pant, 2002

Management of earthquake disasters

The DoMG studies earthquakes in Nepal and has completed an earthquake hazard mapping exercise for the entire country. It also organises awareness campaigns and trains high school teachers on earthquake safety so that they can pass on this knowledge to the younger generation.

The response to earthquakes in Nepal includes mitigation, prevention, preparedness, rescue and relief, and reconstruction and rehabilitation measures

Mitigation

Mitigation, the implementation of advanced measures to reduce or eliminate the risks of earthquake disasters, includes both structural and non-structural measures and involves both the government and civil society actors. A book written by Brahma Shamsher after the earthquake of 1934 suggests measures to make earthquake safe buildings (Rana, 1934). The book mentions proper site selection, quality materials, proper construction, height of the structure, geometrical configuration or plan form, and lightness of the upper storey as key elements. This suggestion evolved during the post earthquake reconstruction and recovery of 1934 earthquake is useful to develop earthquake safe construction practices in Nepal.

One of the initiatives undertaken to prevent damages from earthquake is the retrofitting of school buildings in Kathmandu Valley, facilitated by NSET-N. Under this initiative, local masons were given trainings and this effort has shown a positive impact on improving awareness. Workshops and art competitions organised in schools have also helped improve awareness regarding earthquake safety. Center for Disaster Studies (CDS) at Institute of Engineering (IoE) has designed and developed techniques for retrofitting of stone masonry buildings in rural Nepal. Successful demonstrations have been conducted in Kathmandu, Sindhuli, Sindhupalchowk, Kaski and Kabhrepalanchowk districts. This method uses locally available materials, like bamboo and timber, and local technology for retrofitting.

Prevention and preparedness

The use of seismic resistant technology is one of the major ways to prevent earthquake disasters. Development and enforcement of building codes and improved community awareness are other approaches that fall under this category. Kathmandu Metropolitan city is the largest municipality among Nepal's 58 municipalities recognises the need of preparedness. Most municipalities that lie in the mid-mountain and Tarai regions of the country still need to recognise the need for better preparedness.

Preventive measures were adopted early in Nepal. Studies reveal that the Newari architecture of Kathmandu took measures to respond to earthquakes and used local technology to reduce vulnerabilities. Traditional buildings in Jumla are designed, developed and constructed to be earthquake resistant. They have horizontal and transverse timber members on the stone masonry walls.

Every February the NSET-N and MoHA organise Earthquake Safety Day to remember the devastation caused by 1934 earthquake. On the occasion, the government and NGOs conduct activities such as earthquake safety exhibitions, drills and seminars. Participants include the MoHA, the Ministry of Physical Planning and Works (MoPPW), and municipalities, as well as professional societies like the Nepal Engineers' Association, the Society of Consulting Architects and Engineering Firms, and the Society of Structural Engineers Nepal. NGOs like NSET-N and the NRCS also highlight the risks of earthquakes. The monthly magazine Paryawaran, which is supported by Action Aid Nepal, includes articles which describe earthquake disasters and the specific measures that can be taken in their aftermath to minimise damages. In coordination with governmental agencies and I/NGOs, NSET-N organises seminars, workshops, and trainings to increase awareness. It also supports the retrofitting of existing buildings. The educational establishments such as the IoE and Nepal Engineering College (NEC) mobilise academic resources in order to improve awareness.

It is necessary to prepare earthquake contingency plan. Using earthquake scenarios, the UN system has trained the IASC clusters in such planning and have response plans updated. There is still more to be done, but a beginning has been made.

BOX 6.3: Vibrating table to demonstrate earthquake resistant and earthquake vulnerable construction

Unless people recognise the advantage of earthquake-resistant over traditional designs, it is difficult to get them to appreciate the need for change. To promote this understanding, NSET-N has devised a vibrating table on which models of both traditional and improved buildings can be placed, an "earthquake" simulated and the impact on both observed. Models which have not been retrofitted collapse much faster than those with safety elements. The demonstration abundantly makes benefits of incorporating earthquake-design elements clear.

The Building Code of Nepal does specify measures for constructing earthquake resistant buildings and some buildings have incorporated such measures. At the same time existing homes have also been retrofitted with earthquake resistant measures. These measures, however, are isolated and many new buildings constructed are not earthquake resilient, on average, than existing structures. This is because building codes are rarely adhered to except perhaps in few public buildings through some municipalities do require that new building incorporate earthquake elements. Overall compliance to building codes is poor.

In the last decade, international agencies, the Ministry of Physical Planning and Works (MoPPW) and local NGOs have also taken initiatives to sensitise people about earthquake hazard. These initiatives include training on earthquake resistant construction techniques, conducted earthquake safety drills and highlight safety. Booklets, posters and pamphlets that highlight safety measures have been printed and distributed.

Existing building retrofitted with external beams and columns

Vibrating table

Similarly, the 1988 earthquake in Udayapur District was a major turning point. Following the earthquake, several initiatives emerged to manage earthquake risks. One of the major initiatives was the implementation of the National Building Code Development Project (1992-1994). This project included (a) an assessment of Seismic Hazard Mapping and Risk (b) the development of a National Building Code, and (c) the development of Alternative Building Materials and Technologies for Nepal (Pokharel, Unpublished). Nepal's National Building Code was enacted in 2002. Lalitpur Sub-metropolitan City was first to follow the code, and today 14 out of 58 municipalities follow the code (Jigyasu, 2002) to approve building construction within their jurisdictions.

Rescue

The DoMG is the central agency, which monitors earthquake in the country. Information on earthquakes exceeding 3 on the Richter scale is related to the MoHA and the Information and Communication Ministry. This information is then broadcast on the state and privately owned radio and television stations. Rescue operations begin immediately after news of damage arrives. The government provides support at national and district levels. In general, the local government (VDCs and Municipalities) is responsible for coordinating rescue operations. Security forces, health workers, fire brigade, NRCS and community-based organisations are also mobilised.

The NRCS is actively involved in rescue operations. It maintains a country-wide network for rescue support and trains volunteers as well. Kathmandu Metropolitan and Lalitpur Sub metropolitan city have also mobilised community based organisations to work for disaster management by establishing community based disaster management committees (DMCs). These committees are the first line of defence. In most cases, such committees lack technical and managerial knowledge to function during a disaster. Building their capacity is a major challenge. The DMC of Ward 17 clustered in the year 2001 is extensively working in the area of community based disaster management. The main partners in this initiative are NSET-N and Rotary Club. The committee has representation from different professional backgrounds: housewives to disaster management experts. Local politicians, ward members, youth volunteers, school children are also members of the committee. Local youth clubs, NRCS, schools, Rotary club, Nepal Scout, Community based committees, local unit of Nepal Police are the institutional members. A community meeting to sensitize and motivate community members to form DMCs. NSET-N is disseminating the knowledge gathered from its experience. The United Nations Centre for Regional Development (UNCRD) also conducts volunteer trainings and supports search and rescue efforts.

In April 2009, International Search and rescue Advisory Group (INSARAG) carried out the largest exercise for search and rescue in South Asia in Nepal. More than 250 participants from 19 countries including SAR teams from several countries in Asia and the pacific participated. Organised jointly by UN OCHA and the MoHA, many NGOs and UN agencies participated in the exercise. Such efforts help build local capacity while helping improve overall understanding of the risk that earthquake entails.

Reconstruction and Recovery

Following the earthquake of 1934, the government carried out rehabilitation and reconstruction efforts in Kathmandu. Guidelines were developed to construct earthquake safe buildings. The government took similar initiatives after the 1988 Udayapur earthquake to recover from the damages in a short time. The victims were provided with financial support to recover from their losses. Agencies such as the World Bank (WB) and Asian Development Bank (ADB) also played key roles in the process. Support was also provided by agencies of United Nation System such as the WFP and the UNDP which assist in during disaster particularly earthquakes.

Ways forward

Losses due to earthquakes are exacerbated by the following factors:

- The use of temporary and/or poor quality building materials
- The fact that earthquake-resistant technologies are not used in masonry buildings or in buildings of rural areas
- The lack of sufficient building codes, by-laws and basic design parameters
- The lack of enforcement of existing laws
- The faulty locations of services such as stairs and corridors in buildings
- The lack of response planning and community mobilisation.

- The lack of awareness at the household and community levels
- Poor implementation of precautions and lack of preparedness measures

To minimise the impact of future earthquakes two things need to be done. First, NGOs and research institutions should conduct awareness programmes including earthquake drills, street plays, concerts, and radio and television programmes in order to improve people's understanding of the consequences of earthquakes. They should be designed to encourage people to change their behaviour during and after an event. The second major step to take is to implement and enforce compliance with building codes as it is estimated that 90 per cent of the buildings in Nepal are poorly designed and built.

New buildings must adhere to strict safety codes and existing buildings need to be retrofitted. Construction practices need to be improved and top-grade construction materials used. Building construction should follow universally agreed upon principles and specify the roles and responsibilities of clients, consultants and contractors. Because local governments play a vital role in enforcing policies, laws and regulations, they must be strengthened through capacity-building exercises and improvements of working procedures. Moreover, settlements should be planned so that emergency vehicles and other support can reach disaster sites without hindrance. The road networks in existing settlements and cities need to be substantially upgraded. An important activity would be the preparation of a comprehensive earthquake response plan for Nepal.

Chapter-7

Fire disasters

Fire is a recurring disaster in Nepal: every year, particularly during the dry season from February to May, a large number of incidents of fire are reported, mostly in the Tarai, where about three-quarters of houses are built with thatched roofs. Historically, fires have even devastated administrative centres. The Licchavi capital of Bishalnagar in Kathmandu was gutted by fire in the seventh century and in 1970 Singha Durbar, the Secretariat of Nepal Government, was engulfed by fire, forcing the then Prime Minister to resign on moral grounds.

Losses due to fire disasters

The DesInventar database has documented losses due to fire since 1970. Although the number of deaths by fire is lower than that of other disasters—just 50 deaths per year on average in the last two decades (1,175 between 1983 and 2003)—the average annual loss of property is high, nearly NRs. 245 million (MoHA, 2006). The average however does obscure the loss in a decade. In the last 10 years from 1993 to 2003, 959 people were reported killed and about 60,243 houses were destroyed. In 2003 alone, 16 people were killed and 23 were injured and 1,162 families were affected by fire. About 233 animals were lost and 1,274 houses and 144 cattle sheds were destroyed. The estimated loss was NRs. 734 million. Two main reasons for the outbreaks of fire are the improper use of fire for cooking and other domestic purposes and the lack of adequate fire safety measures. For the population in the rural areas, living in closely clustered thatched houses, fire is a major hazard.

Thatch roof homes in the Tarai

Every year during the dry season, fires also destroy a considerable amount of Nepal's forest in all major physiographic regions of the country and are a major reason for declines in biological diversity loss of forest products. Negligence is the main cause of forest fires, but sometimes started deliberately to encourage the growth of more succulent grasses for domestic animals and get out of hand. Embers from forest fires occasionally cause fires in nearby villages, especially if roofs are thatched.

Recent fire disasters

The two major fire incidents occurred in the town of Myanglung Terhathum District, in 2002 and Fungling Bazaar—headquarter of Taplejung District in 2003. Another major fire occurred in the Bhutanese Refugee Camp located in Jhapa District in 2008

Myanglung tragedy

When a fire broke out at a private residence in Myanglung, the headquarters of Terhathum District, around 5:45 p.m. on 7 December, 2002, it burned for 12 hours in part because the nearest available fire brigade was in Dharan, 120 kilometres away and rescue efforts were necessarily delayed. In addition, the police and army arrived only four hours after the fire began as the fire was perceived to be an attack by the Maoists rebels. The fire moved northeast and then northwest before a gigantic banyan tree prevented it from spreading north to Putali Bazaar. A large open space stopped it from spreading southward. These natural fire barriers have since disappeared to accommodate the growing population. Approximately 300 families were rendered homeless and the loss was estimated to be NRs. 2 billion.

Fire in Myanglung

Fire in Fungling

A fire which broke out in Fungling Bazaar, the headquarters of Taplejung District, on 28 March, 2003, damaged 59 houses and two temples. Property worth NRs. 18 million turned to ash in a matter of hours.

Fire in Kapilbastu

On 17 February, 2005, anti-Maoist vigilantes deliberately started a fire in Kapilbastu which damaged 3,000 houses in 26 villages, killing 22 and displacing 2,500 families and hundreds of cattle and poultry. Property worth more than NRs. 5 million was destroyed. The arson was a response to the Maoist rebel's abduction of two villagers from Ganeshpur on 16 February.

Fire in Goldhap

A huge fire occurred in Goldhap, a Bhutanese refugee camp in Jhapa District in Eastern Nepal on 1 March, 2008. Though there were no casualties, some 1,700 houses were reduced to ash.

Management of fires Hazard

As is the case with other disasters, the reduction of fires entails prevention, preparedness, mitigation, response, relief and recovery efforts.

Mitigation

Fire mitigation work is carried out by various organisations, including the government, the NRCS and I/NGOs. The MoHA conveys messages by state-owned radio and television stations about precautions needed to avoid the accidental lighting of fires, like keeping matches out of the reach of children. Right across the country, the NRCS distributes fire awareness posters to villages through NGOs, NRCS district chapters, volunteers, youth and CBOs. The monthly magazine Paryawaran also features articles describing the damage fires can cause as well as preventive and rehabilitative measures.

Prevention

Thatched roofs are being replaced with clay tiles and houses built of bricks or concrete rather than bamboo as remittances flow into the country. In Kapilbastu, Nawalparasi, Mahottari, Jhapa and Kathmandu districts the NCDM, in collaboration with the Centre for Disaster Studies, has installed thatching made fire-resistant with mud plaster and Silpauline plastic. In 2006 the Nepal Centre for Disaster Management (NCDM) began organising fire disaster preparedness workshops; the first was held in Nawalparasi District in collaboration with DPNet.

Response

After a fire, both the community and the government step in to help. The government sends a fire brigade, while locals transport water from nearby tube wells and ponds. In some communities, such as Holiya in Banke District, the NRCS has installed deep tube wells and developed plans for their use during a fire.

Testing fire resistant thatch roof

Only a few municipalities have fire brigade and fire engines. Kathmandu's fire station, which was established by Prime Minister Juddha Shamsher in 1935, is located at Kathmandu's New Road. It currently operates under the aegis of the MoHA but its management is in the process of being transferred to the Kathmandu Metropolitan City. Fire fighters are generally junior level staff who lack the training needed to tackle a large fire.

Relief

Both the government and the NRCS provide relief to fire victims. The NRCS provides non-food items after assessing need. INGOs also make donations. For example, Save the Children stores non-food items with NRCS in Dhangadhi, Nepalgunj and other places. The government compensates victims NRs. 25,000 for each death and up to NRs. 10,000 for damage to property after an assessment is carried out. After a fire broke out in Terhathum NRCS provided people with food, shelter and medical assistance and the Central Natural Disaster Relief Committee gave each family NRs. 4,000 for immediate relief.

Recovery

The government carried out a rehabilitation and reconstruction programme in Myanglung following the 2002 fire. It established an office and town development committee to facilitate land pooling. Masons were trained to construct earthquake- and fire-resistant buildings. To demonstrate the techniques at this training, models were designed and built.

In Fungling, guided land development and land-pooling programmes were launched at the cost of NRs. 500,000 in the fiscal year 2005/06. Few people (8.7%) in Fungling were dissatisfied with the arrangements of land distribution because they were relocated at the ends of the settlement, but all the people of Myanglung were satisfied with the construction of a road and drainage system.

In both places, houses were made of reinforced concrete rather than the traditional stone masonry. Prior to the fire, 85 per cent were made of stone; after, the percentage reduced to just five per cent. The proportion of reinforced concrete houses increased from five to 60 per cent. There is not enough open land in the land-pooling area, only about 1.9 per cent because landowners contributed very little to property development.

In Butwal, Caritas recently built houses for landless families whose houses were torched by landlords in 2008.

The following factors increase the risk of fires breaking out.

- Flammable materials like thatch and bamboo used to construct buildings and people have no access to fire-resistant and -retardant materials for roofing;
- Villagers build open fires when camping out and cooking feed for cattle;
- Neither children nor adults take proper precautions when using fire;
- Electrical wiring is often faulty;
- Fire engines often do not have enough room to manoeuvre in cities.

House constructed by Caritas for fire victims in Butwal

The above section discussed fire at household level. Nepal also faces hazard due to forest fire which is discussed below.

Forest fires

Fires are a natural and inherent component of the disturbance regime in most natural forests. Forest fires have both advantages and disadvantages depending on the intensity, timing, and frequency of fire and interactions with other disturbing agents (Burslem, 2004). Forest fires in Nepal frequently occur and cause several damages such as loss of timber, biodiversity, increased soil loss and higher sedimentation every year. Human induced forest fires can also cause losses of livestock and sometime that of human lives. Forest fires can play a vital role in removing dry organic matter present on the soil surface and also diversify the forest ecosystem (Moore, 2008).

The two major anthropogenic causes of forest fires in Nepal are the negligence of livestock herders and the forceful occupation of the forestland for purposes like farming and private ownership. Forest fires closer to human settlement can expand to houses that can have serious adverse implications. Forest fires do have ecological significances as well. One of the serious issues emerging with forest fires is emission of greenhouse gas, CO_2, sequestered in trees contributing in warming of climate.

BOX 7.1: Community-based disaster management

Various INGOs, including Oxfam-GB Nepal, the NRCS, Action Aid Nepal, Practical Action Nepal, CARE Nepal, Mercy Corps and Lutheran World Federation, as well as their local partners, have been involved in community-based DRR interventions in Nepal for well over a decade. These programmes receive support from bilateral donors. Similar input is also provided by UNDP. Their efforts have resulted in the identification of a range of community-level interventions that are effective in responding to flood, drought, landslide, earthquake and fire risks. In flood- and drought-prone areas of the Tarai, the following tasks should be carried out:

- Form community and village disaster management committees,
- Develop community, village and district disaster plans and institutionalise district- and national -level pre-monsoon preparedness and post-monsoon review meetings.
- Develop community preparedness and response plans, conduct related training, and provide equipment.
- Construct or repair flood-resistant shelters,
- Provide access to flood-resistant seed storage facilities,
- Provide access to improved seed varieties that, depending on the prevailing situation, are either drought-resistant or both flood-resistant and early- maturing,
- Carry out community structural mitigation measures, including the construction of protection walls (integrated with the strategic planting of vegetation) and spurs, the improvement of drainage systems and the installation of culverts in roads, and the raising of tube wells and latrines.
- Promote livelihood diversification,
- Develop people-centred early warning systems.
- Promote safe hygiene behaviours and practices.
- Raise awareness about DRR concepts and approaches through schools and at the community level, and
- Develop tools and methodologies for strengthening women's leadership in DRR

Though community based interventions are generally undertaken on a project-basis, and often cover a limited geographical area, they also produce usable knowledge, replicable lessons and practical insights useful for policy advocacy. Efforts in advocacy should draw on the DRR success stories of other countries as well.

Ways forward

To reduce the impact of fire, public awareness programmes need to be developed in both rural and urban areas. Such programmes should be conducted before the start of the fire season in January. The use of flammable building materials like thatch should be discouraged and flame-retardant and – resistant materials used.

In urban areas, building codes, particularly those pertaining to wiring and fire escapes should be strictly followed. Houses should be planned so that they do not impede the movement of people during fire and allow emergency vehicles to reach fire sites without hindrance. Nepal also needs to beef up its fire brigade system.

To prevent forest fires from spreading, fire corridors should be created and cattle grazers should be educated about fire hazards.

Chapter-8

Other disasters

In addition to the natural disasters discussed in previous chapters, Nepal is also struck by human-induced disasters, both technological and health-related. In this chapter we will present road accidents, aircraft accidents and health related disasters.

Road and air accidents

A technological disaster is a sudden and unpredictable event resulting in human injury and possibly death as well as property damage which results from a technological failure. The impact of such a disaster is hard to pinpoint because it affects multiple sectors and the cost of human life cannot be estimated in monetary terms. Death brings emotional pain and may result in the loss of an income earner. Too often, the cost of health care or funeral rites, the loss of a primary breadwinner or income due to disability pushes a family towards poverty. The mental stress associated with such impacts can lead to psychological disorders or depression, which are in themselves costly. Injured and disabled victims can become a burden to family and friends.

Road accidents and air crashes are two types of technological disasters that regularly affect Nepalis. Because we are growing increasingly dependent on cars and two-wheelers in our daily lives, understanding the causes of such disasters so that we can take measures to minimise them is important.

BOX 8.1: Mobile phone hazard during driving

The use of mobile phones while driving, because it distracts drivers, has been responsible for numerous accidents across the world, including in Nepal. There is ample evidence that mobile phone use actually increases the risk of crashes. A study conducted in New Zealand estimates that mobile phones account for 0.5% of all reported accidents.[15] Though the number is small, use of mobile phones during driving can cause loss of human lives and needs to be prevented. To that end regulation must be framed and enforced.

Road accidents

Across the globe, motor vehicle accidents are the most common. In a 2004 report WHO declared that road accidents were the second largest leading cause of death among young people aged 15 to 29 years and the third largest leading cause of death among people aged 30 to 44 years. The same report estimated that road accidents result in the death of an estimated 1.2 million people worldwide each year. Some of the main causes of road accidents include leniency in the issuance of driving licenses; driving while drunk, fatigued, or stressed, competition among drivers, poor maintenance of vehicles and lax vehicle regulation, speeding, overloading of vehicles and negligence. The other causes of accidents are non-compliance with traffic rules, pedestrian carelessness, and reckless motorcycle riding.

[15] *See eJMA: preventing traffic accidents by mobile phones*

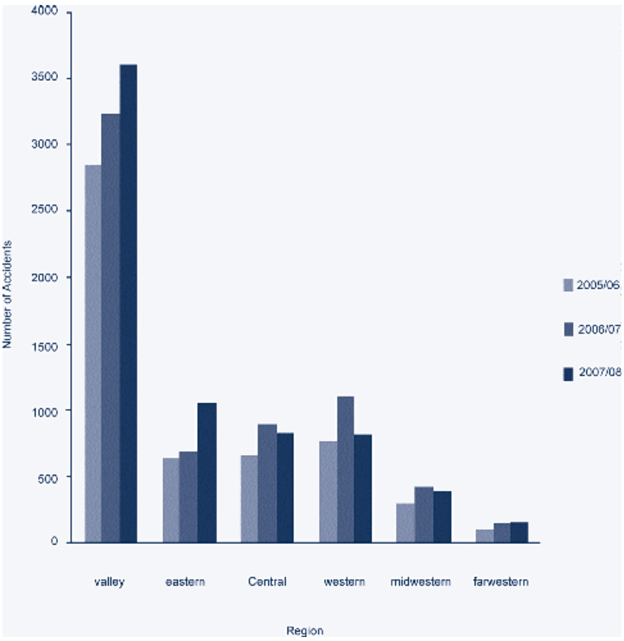


FIGURE 8.1: Accidents by region

Table 8.1: Outcomes of road accidents

year	Outcome		
	Serious injury	Minor injury	Death
2005/06	1,866	3,655	828
2006/07	2,583	5,338	953
2007/08	2,663	5,245	1,131

In Nepal, road accidents are one of the top ten causes of death and with the increase in the number of vehicles and expansion of road networks, road accidents are likely to rise. Data show that motor vehicles accidents increased from 5,269 in the year 2005/06 to 6,821 in 2007/08. Though the number of accidents is the lowest in far-western region, accidents there have increased by 75%, from 85 in the 2005/06 to 149 in 2007/08 (Figure 8.1). The total amount provided as compensation the injured is also increasing.

Box 8.2: Psychological consequences

Mental trauma goes hand in hand with disaster as community life is upset and questions about safety, social organisation and the meaning of life come to the fore. Symptoms of trauma include flashbacks, difficulty remembering, avoidance of stimuli, blunting of responses, high levels of arousal level and obsessive ruminations*. Too often, however, the help provided to the affected overlooks the psychosocial consequences to the individual, the family, and the community. Women, children and the elderly are particularly vulnerable. A study conducted after the 2008 Koshi flood in Nepal demonstrates the need for psychosocial support: people, especially children, women, pregnant women and lactating mothers, are anxious about shelter, food, water, sanitation and their own security and that of their family members. The lack of space in shelters was cause for particular concern. To address these worries, there is a need for counseling and family intervention services, whether they consist of offering emotional support, conducting relaxation exercises, providing psychological education, or various other methods.

Maintaining good health is difficult during floods. Newborn babies suffer from dehydration and malnutrition because of lack of their mothers' breast milk. Young children suffer from purulent conjunctivitis, a communicable disease which often reaches epidemic proportions. Because of the lack of nutritious food, safe water, proper sanitation and overcrowding, disease is rife, particularly cough and cold among older people, malnutrition among lactating and pregnant mothers and mosquito- and water-borne diseases like diarrhea among the general population. Snakebite is also common.** Dead bodies also need to be better handled so that their decomposition does not become a threat.

There is also a need to manage multi-sectoral and multi-level community interventions to address immediate, mid- and long-term needs in a socially and culturally sensitive fashion. The planning for these activities should be based on evidence for their need. After a disaster occurs, the military, health workers, public health service workers including both state and local employees and volunteers should be mobilised to help. The Ministry of Health has, in fact, already devised a health sector emergency and disaster response plan to address the aftermath of disasters and provide the affected with basic needs; unfortunately, it neglects psychosocial relief.***

Another need is to develop policies, plans, and implementation strategies for providing psychosocial support in post-disaster situations. These policies must take cognizance of geographical variations as well as be culturally acceptable, socioeconomically sustainable and politically unaligned.****

** Choudhury,W.A., Quraishi F.A., Haque Z. Mental health and psychosocial aspects of disaster preparedness in Bangladesh 2006: National Institute of Mental Health & Research, Dhaka, Bangladesh. bap@agni.com. Int Rev Psychiatry, 18(6), 529-35.*
*** Choudhury,W.A., Quraishi F.A., Haque Z. Mental health and psychosocial aspects of disaster preparedness in Bangladesh 2006: National Institute of Mental Health & Research, Dhaka, Bangladesh. bap@agni.com. Int Rev Psychiatry, 18(6), 529-35.*
**** Benedek, D.M., Fullerton, C. and Ursano, R.J., 2007: First responders: Mental health consequences of natural and human-made disasters for public health and public safety workers. Annual Review of Public Health. 28, 55-68.*
*****Acharya, L., Upadhya,K.D., Kortmann, F., 2006:.Western Hospital, Pokhara, Nepal. Mental health and psychosocial support aspects in disaster preparedness: Nepal. Int Rev Psychiatry. 18(6), 587-92.*

Minor injury, the most common result of road accidents, increased almost 50% in just three years, from 3,655 in the 2005/06 to 5,245 in the year 2007/08.[16] The incidence of serious injury and death has also increased during the same period, from 1,866 to 2,663 (see Table 8.1). The year 2007/08 saw the greatest number of deaths, 1,131.

Given that Kathmandu Valley has the highest number of two-wheelers and automobiles it is no surprise that it has the most road accidents and that the number has increased since 2005/06. The number of accidents in the first nine months of the 2008/09 ranged from a high of 257 in February/March 2009 to a low of 153 in July/August 2008 (see Table 8.2). In terms of injury and death, however, November/December was the worst month. Altogether the period saw 1,790 cases of minor injury, 516 off serious injury and 107 fatalities (see Table 8.2).[17] Compared to 2007/2008, the number of death in the first nine months of 2008 reached 1,790.

[16] *Data on accidents are recorded as per Nepal's fiscal year which begins in the month of Shrawan and ends on Ashar of the next year. This corresponds to two consecutive Gregorian Calendar years. Therefore the data presented above mention 2005/2006 which is BS 2062.*

[17] *The data is provided by Traffic Headquarters, Naxal*

Table 8.2: Impact of accidents in the last six months of 2008

Month	Deaths	Serious injury	Minor injury
Jul/Aug	10	49	146
Aug/Sep	11	48	190
Sept/Oct	18	62	208
Oct/Nov	11	70	197
Nov/Dec	13	55	308
Dec/Jan	13	63	201
Total	**76**	**374**	**1250**

It is clear that the number of deaths can be reduced by improving traffic management.

Box 8.3: Safety lapses at public gatherings

The dictionary defines "safety" as the condition of being protected against physical, social, occupational, psychological, or other types or consequences of failure, damage, accident, harm or other non-desirable event. The absence of safety results in preventable deaths. In Nepal, the level of safety at public functions is severely compromised and has resulted in many human-induced disasters.

The first recorded major accident caused by compromised safety was in stampede at Kathmandu's Dasarath Stadium in March 1988. A sudden hailstorm during a football match saw a mad rush to the exit gates, all of which were closed and locked. Eighty-seven individuals were crushed to death. The guard with the key was nowhere to be found.

Twenty-one years later, an equally preventable tragedy unfolded. On 30, September 2009, a makeshift three-storey bamboo shelter in Dharan collapsed, killing 23. The shelter was overburdened with 2,000 participants in a religious convention.

Both accidents highlight an inexcusable disregard for safety at public gatherings and both could have easily been prevented with the right safety measures.

Aircraft accidents

Aircraft accidents are incidents that occur during any period in the operation of an aircraft, from takeoff to landing, which may hurt passengers. There are rarely any survivors if the accident is a serious one. Aircraft accidents are more common in hilly terrain and areas with extreme climatic conditions. A global survey of 1,843 accidents (excluding military, private and charter flights), found that 53 per cent occur due to pilot error, 21 per cent due to mechanical error, 11 per cent due to unfavourable weather conditions, and 15 per cent due to error by both air traffic controllers and pilots (See Table 8.3).

Table 8.3: Worldwide aircraft accidents (from 1945 to 20 May, 2007)

Location	No. of accidents	% of accidents
North America	839	25
Europe	753	22
Asia	633	19
South America	557	16
Africa	318	9
Central America	144	4
Australasian	103	3
International waters	68	2
North and South poles	5	0
Total	**3,420**	**100**

Because of the greater number of flights developed continents like North America and Europe see greater number of global air accidents (47 per cent) (see Table 8.3). At 19 per cent, Asia also has a high number of accidents, in part because of poor regulation of flights and extreme weather conditions.[18]

In its half-century-long aviation history, Nepal has witnessed 38 aircraft accidents, the first in 1946, before commercial air services had even begun. In 1958, Royal Nepal Airlines began offering domestic and international flights to a few Indian cities. Today more than half a dozen domestic airlines provide services within Nepal while about 22 international airlines connect Kathmandu to various destinations in Asia and the Middle East.

[18] *Southafrica.to/transport/Airlines/airline-accidents/Africa-air-safety.php5*

The 38 accidents which occurred between 1946 and 2008 (see Table 8.4) in Nepal constitute just one per cent of the total aircraft accidents worldwide. The years 1992 and 1999 saw the most accidents, four each.[19] The main reasons accidents occur in Nepal are its mountainous terrain and extreme weather conditions. Poor judgment on the part of flight crew, failure to adhere to standard instrument departure (SID) procedure and failure of air traffic controllers to warn flight crews are other reasons.

Table 8.4: Aircraft accidents in Nepal

Date	Operator	No. of fatalities	Location
18 October, 2008	Yeti Airlines (DHC-6 Twin otter)	18	Lukla Airport
3 July, 2006	Yeti Airlines (DHC-6 twin otter)	0	Bajura Airport
21 June, 2006	Yeti Airlines (DHC-6Twin otter)	9	Near Jumla Airport
30 June, 2005	Gorkha Airlines (Dornier)	0	Lukla Airport
25 May, 2004	Yeti Airlines (DHC-6Twin otter)	3	Near Lukla
22 August, 2002	Shangri-La Air (DHC-6 Twin Otter)	18	Near Pokhara
17 July, 2002	Skyline Airways (DHC-6 Twin Otter)	4	Near Surkhet
27 July, 2000	Royal Nepal Airlines (DHC-6 Twin Otter)	25	Jarayakhali
25 December, 1999	Skyline Airways (DHC-6 Twin otter)	10	Near Simra
5 September, 1999	Necon Air (British Aerospace BAe-748-501)	15	Ramkot
7 July, 1999	Hinduja (Boeing 727-243F)	5	Near Kathmandu
18 January, 1999	Necon Air (Cessna 208 Caravan 1)	5	Jumla Airport
21 August, 1998	Nepalese (CAA, of, Lumbini)	18	Near Ghorepani
6 November, 1997	Necon Air (Avro 748-106)	0	Pokhara Airport
25 April, 1996	Royal Nepal Airlines (British Aerospace BAe-748-352)	0	Meghauli Airport
17 January, 1995	Royal Nepal Airlines (Twin otter DHC-6)	2	Kathmandu Tribhuvan International Airport
8 November, 1993	Nepal Airways (Harbin Yunshuji Y-12-11)	0	Jomsom Airport
31 July, 1993	Everest Air (Dornier 228-101)	19	Bharatpur
28 September 1992	PIA (Airbus A300B4-203)	167	Near Kathmandu
26 September, 1992	Royal Nepal Airlines(Harbin Yunshuji Y-12-11)	0	Lukla Airport
31 July, 1992	Thai Airways (Airbus A310-304)	113	Near Kathmandu
5 July, 1992	Royal Nepal Airlines ((Twin otter DHC-6)	0	Jumla Airport
9 June, 1991	Royal Nepal Airlines (Twin otter DHC-6)	0	Lukla Airport
30 December, 1985	Nepal Army (Shorts SC.7Skyvan 3-100)	25	Near west Nepal
22 December, 1984	Royal Nepal Airlines ((Twin otter DHC-6)	15	Near Bhojpur
7 April ,1978	Nepal Army (Shorts SC.7Skyvan 3-100)	0	Rumkot
15 October, 1973	Royal Nepal Airlines ((Twin otter DHC-6)	0	Lukla Airport
10 May, 1973	Thai Airways (Douglas DC- 8-33)	1	Kathmandu Tribhuvan International Airport

[19] *Aviation-safety.net/database/country/country.php?id=9*

Table 8.4: Aircraft accidents in Nepal contd...

Date	Operator	No. of fatalities	Location
13 September, 1972	Nepalese AF (Douglas C-47A-45-DL)	31	Paanchkhal
27 February, 1970	Nepalese Royal Flight (DHC-6 Twin otter100)	1	Jomsom
12 July, 1969	Royal Nepal Airlines (Douglas DC-3D)	35	Hetuda
27 August, 1962	Pilatus Porter	5	Porsha Dhuri
1 August, 1962	Royal Nepal Airlines (Douglas C-47-DL)	10	Near Tulachan Dhuri
5 November, 1960	Royal Nepal Airlines (Douglas C-47A-80-DL)	4	Bhairahawa
24 March, 1958	Indian Airlines (Douglas C-47A-85-DL)	20	Near Kathmandu
15 May, 1956	Indian Airlines (Douglas C-47A-20-DK)	15	Kathmandu
30 August, 1955	Kalinga Airlines (Douglas C-47A-25-Dk)	2	Simra
7 May, 1946	RAF (Douglas C-47A-20-DK Dakota C.3)	0	Simra Airport

Key lessons

The reduction of road and aircraft accidents should be considered as a top priority by the both government as they result in a high number of casualties.

Road accidents: The main reason for road accidents is the lack of consideration for safety: vehicle operators do not drive safely, vehicles themselves are unsafe, and roads are dangerously ill-maintained. The traffic police, the Department of Roads (DoR), vehicle owners, drivers and Transport Management Department (Yatayat Byabastha Bhivag) are the main stakeholders who must work together to prevent road accidents. Many easy-to-implement, cost-effective measures can help minimise road accidents. These include organising a traffic safety week once a year, displaying billboards with information on numbers of accidents and fatalities, and conducting frequent checks of licenses and route permit passes. In addition, information about road traffic accidents and traffic rules should be included in school-level curricula. Maintaining traffic discipline, making stringent examinations for driving licenses, conducting routine road and vehicle maintenance, promoting vehicle insurance and restricting the passage of heavy vehicles at specified time within cities are other steps which can curb road accidents.

Aircraft accident: Government must take appropriate measures to control of aircraft accidents. According to ICAO regulations airports should have emergency plans and should conduct simulation exercises regularly including a comprehensive one once every two years. Maintaining air safety and reducing human error during flights are essential to minimise aircraft accidents. Other steps include improving coordination and communication between pilot and air traffic controller, complete departure briefing, avoiding overloading, and performing regular maintenance checks of aircrafts. Improving communication infrastructure is other area of intervention. A closer coordination between MoHA and other disaster management authorities need to be maintained for making effective responses.

Health-related disasters

In Nepal, another anthropogenic cause of disaster is related to health. In fact, epidemics are the number one killer in Nepal, with an average of 519 deaths per year (MoHA, 2004; DWIDP, 2006). Diseases like cholera, gastroenteritis, encephalitis, meningitis, diarrhoea, and pneumonia are common (see Table 8.5 for the morbidity rates of the 10 most prevalent diseases). The average life expectancy at birth is low, just 64 years in 2007. Those most at risk due to disease are children under five, particularly girls, whose mortality rate is 24 per cent higher than that of boys. Women of reproductive age are at risks. According to Nepal Living Standard Survey of 1996, only 41 per cent of Nepali households can walk to a health facility within 30 minutes.

Table 8.5: Disease morbidity in Nepal

Disease	Morbidity
Skin diseases	5.51
Diarrhoeal diseases	3.35
Acute respiratory infection	3.13
Intestinal worms	2.82
Pyrexia of unknown origin	2.02
Gastritis	1.95
Ear infection	1.40
Chronic bronchitis	1.06
Abdominal pain	0.96
Sore eyes and other eye complaints	0.93

Source: MoHA

The other common diseases are scabies dermatitis. Skin and diarrhoeal diseases are common because water is often contaminated or does not suffice for basic hygiene. The other ailment are acute respiratory infections (ARIs) associated with the indoor air pollution due to cooking over open fire herths. Epidemics of contagious diseases have two peaks: during the months of May and June, before the rainy season begins and in August, the height of the monsoon. Unsafe drinking water and poor sanitation are the main causes of water-borne diseases in Nepal. Water-borne diseases continue to take lives in Nepal. In fact, over 80 per cent of all illness is attributed to inadequate access to clean water supplies, poor sanitation and poor hygiene practices. According to the Ministry of Health, diarrhoeal diseases account for a morbidity rate of 3.35 per cent, which is second to morbidity caused by skin diseases (5.51 per cent), another category of illness associated with dirty water, and poor hygiene and sanitation (NCVST, 2009) . About 28,000 children die each year from diarrhoeal diseases in the country. According to official estimates, 89 per cent of the nation's population had access to clean drinking water in 2008 and only 30 per cent to proper sanitation facilities.[20] The unsafe disposal of excreta close to water sources contaminates them through different routes and can cause diarrhoeal outbreaks in communities dependent on them. Many past epidemics can be attributed to contaminated drinking water but such outbreaks result in many deaths because of poor medical infrastructure and inadequate human and financial resources. Nepal's health services, particularly those in rural areas, are inadequate and need to be substantially improved.

More than 70 per cent of Nepalis cook using wood; most use traditional (open-fire) stoves which release large amounts of toxic gases like sulphur dioxide, nitrous oxides and carbon monoxide as well as particulates less than 2.5 millimetres in diameter. Exposure to such harmful contaminants is much greater indoor than it would be outdoors (Godish, 2004) and result in the high prevalence of ARIs among Nepalis,

[20] *An Introduction to Health in Nepal: Nepal Net is an electronic networking for sustainable development in Nepal http://www.panasia.org.sg/nepalnet.health/medicine/health.html)*

especially women who cook and children. According to the 2001 Nepal Demography and Health Survey, 23 per cent of ARIs are found in children younger than five, though they constitute just 12.1 per cent of the total population. Outdoor air pollution caused by emissions from vehicles and industries have caused the incidence of respiratory illnesses to spike in urban centres such as Kathmandu.

Table 8.6: Dermatoses in Bara District

Condition	Description	Incidence (%)
Dermatophyte infections	fungal conditions like ringworm	11.4
Pityriasis versicolor	a yeast rash in which flaky discoloured patches appear on the trunk	8.9
Acne	pimples on the face, neck and back caused by blocked oil glands; common in adolescents	7.7
Melasma	dark patches on the face; common in pregnant women	6.8
Eczema	a persistent rash causing skin to redden, swell, itch, crack, flake and ooze	5.6
Pityriasis alba	dry, fine-scaled pale patches on the face	5.2

Skin diseases are of particular concern in Nepal. People living in rural areas do not have access to good sanitation facilities and lack awareness about the need to maintain good personal hygiene. They are also likely to handle chemicals improperly and suffer from over-exposure to sunlight. Scabies, eczema, and cancers are frequently recorded. Most itchy, as is dermatitis, an itchy inflammation of the skin which can be caused by allergic reactions to chemicals in the environment or by direct contact with such chemicals.

A 2008 study in Bara District (Walker *et al.,* 2008) found that 546 of 878 individuals surveyed, or 62 per cent had identifiable skin abnormalities. The range of dermatoses was wide (see Table 8.6). Most are readily treatable conditions but Walker *et al.* (2008) concluded that if they are not treated, they can develop into severe, even permanent disabilities, and may result in social discrimination. In addition, Nepal has had to deal with outbreaks of bird flu and cases of swine flu. The fact that it has an open border with India increases the risk of pandemics.

Box 8.4: Addressing the needs of persons with disabilities in DRR activities

Though persons with disabilities (PwDs) are often the group most adversely affected by disaster, they often remain unidentified and unregistered and therefore excluded from many emergency response measures. Unless first responders make special provisions for them, including efforts to increase their mobility and their access to aid and assistance, PwDs will continue to be systematically deprived of evacuation, rescue, relief, shelter, water and sanitation and other key services. The absence of channels to communicate messages about the possible impacts of disasters to PwDs serves to increase their vulnerability. In fact, many experience long-term physical and psychological problems because they receive too little help in overcoming the trauma of disaster.

During the 2008 Koshi flood, many PwDs suffered. A few lucky ones lived with host families but most struggled to cope in tented camps that had no specially-designed toilet or bathing facilities. They also found it difficult to access water from tube wells because pumps were too high and the area around them very muddy. The health services available within the camps did not provide special services for PwDs.

To address this pitiable situation and to prevent needless loss, the government and other relief agencies must address the specific needs of PwDs. At heart, this involves two steps: involving PwDs in planning and mainstreaming the concerns of PwDs in all DRR activities, including awareness and training; early warning; immediate response; search, rescue and evacuation; and reconstruction and mitigation. There is no one better than PwDs themselves to assess the risks they face and to propose measures to counter them, and if the groundwork for an effective effort is laid ahead of time, every initiative will meet success.

Awareness and training

Improving awareness among PwDs and sensitising DRR professionals to include PwD's concerns requires special attention. The goals of training include the following:

- Sensitise volunteers and members of DMCs about the specific needs of PwDs

- Train local government and NGOs staff involved in DRR activities to identify the needs of PwDs and the resources that can aid them as well as to include disability issues in DRR planning
- Orient family members and caregivers to the needs of PwDs in DRR efforts
- Train volunteers and local staff to provide primary rehabilitation therapy to PwDs during post-disaster situations.

Early warning

Early warning systems play a critical role in alerting PwDs about impending disasters and help minimise injury and death. Such systems that cater to the needs of the PwDs could incorporate some of the following aspects:

Type of disability	Possible warning system
Visual	- Auditory signals like whistles or sirens - Announcements - Posters written with large characters and bold colour contrasts
Hearing	- Visual signals such as red flags - Pictures - The turning off and on of lights
Intellectual	- Special signals that cannot be mistaken for something else - Simply-phrased announcements
Physical	- Auditory or visual signals - Announcements

Immediate response

Effective response taken immediately after a disaster strikes can significantly reduce the loss of lives and the extent of injury. It begins with the identification of the vulnerable and a rapid assessment of their needs and should give special consideration to PwDs. The preparation and regularly updating of a list of PwDs and the nature of their disabilities and their specific needs is key. Volunteers and professionals involved in DRR efforts will need to make sure that those needs, whether for special foods or medicines; aids to mobility like walkers, crutches, canes or wheelchairs; other aids like glasses or hearing aids; medical supplies like urinary bags; or special arrangements for sleeping or sitting, are available. Even PwDs themselves can serve as volunteers, perhaps working closely with children with disabilities.

Search, rescue and evacuation

Search, rescue and evacuation efforts require the use of special procedures to safely and quickly evacuate PwDs. Doing so requires including PwDs in disaster management committees, where they can inform those who respond to disasters about any special techniques needed to assist them to safety. Plans also need to be made so that no PwD is separated from the enabling equipment or medication he/she relies on. Similarly, it is important that provisions be made to locate a PwD's regular caregiver or family member who appreciates his/her needs. PwDs should be evacuated to a pre-determined location outfitted with PwD-accessible drinking water and sanitation facilities.

Reconstruction and mitigation

Reconstruction and mitigation efforts should focus on creating a PwD-friendly environment. In this endeavour, PwDs can contribute ideas about the design needed to make drinking water and sanitation services, shelters and rehabilitation centres, and health care and hospital services most accessible to them. For their part, DRR institutions and practitioner should work to increase awareness, remove barriers, develop mainstreaming tools, provide support and training, and bring about changes in the functioning and monitoring of their own work.

Involving PwDs in DRR will make them more resilient to disasters as it will ensure that their particular needs are identified and addressed. Since mainstreaming the needs of PwDs into disaster risk management is a process rather than an end goal, learning and sharing experiences are crucial to its success. The more PwDs are involved in the process, the more society will come to change its attitudes toward the abilities and contributions of PwDs.

Ways forward

Treating disease in Nepal effectively is handicapped by geography and poor infrastructure as well as by the poor distribution not only of medicine and medical supplies but also of nutritious food. Because health facilities are inadequate and even manageable diseases acquire epidemic proportion. Promoting health services and creating awareness should be a top priority of the government. However, increasing the number of health service centres alone will not solve the health problems of the country; outreach must also be expanded. Access in rural areas needs to be improved, by providing rural areas with immediate response units, and ensuring the presence of appropriate health staff and where feasible provide ambulance services.

Providing basic measures such as safe drinking water and proper sanitation facilities can help minimise water related diseases, as can promoting good personal hygiene. To reduce deaths due to human-induced factors will require sustained action in these areas. Dealing with health and hygiene related risks effectively requires understanding and appropriately responding to the socio-economic vulnerabilities that exacerbate such risks. Improving public awareness is a critical step in the process.

Chapter-9

Legislation and DRR institutions

Floods, landslides, fires, avalanches and epidemics that kill dozens and destroy property worth billions of rupees have a negative impact on Nepal's development agenda. Numerous factors render Nepal vulnerable to various natural and human-induced disasters, including its rugged yet fragile geophysical terrain, active tectonic processes, high relief and steep slopes and variable climate. Unplanned settlements, increasing populations, poor economic condition and low literacy rate are other factors contributing to exacerbate vulnerability. The ongoing political transition adds a new layer of stress. Disasters are made all the more devastating by the poor governance of government agencies, weak coordination among government agencies and other stakeholders, the ambiguous job descriptions of various agencies, low managerial skills and the lack of financial resources. Poor levels of awareness and the lack of technological skill further exacerbate adversity, as does the low capacity for conducting hazard mapping, vulnerability assessments and risk analysis.

BOX 9.1: Multi-stakeholder forum

DRR is not a problem that can be handled by a single agency or single discipline; on the contrary, DRR requires the efforts of many agencies, a broad interdisciplinary understanding including both science and social science, and the consideration of a wide range of issues, from behaviour to development, society to economy. A stakeholder's platform named Disaster Preparedness Network (DPNet) was established at the premises of the Nepal Red Cross Society in 2003 to address these issues. It has a variety of members, including DRR programme staff, policymakers, INGOs which support local groups in mitigating disasters, and groups involved in disaster research, analysis and advocacy. This network is a forum where different actors and stakeholders come together to discuss the issues and challenges faced by the DRR sector in Nepal.

In the past, Nepal's approach to disaster was reactive, with rescue and relief as its key objective. Over time, however, various government departments, such as irrigation, water and power, as well as local government and I/NGOs have begun including approaches to minimise disaster impacts as a part of their mandates. Still, response to disaster has remained top heavy. These apex agencies have been entrusted with all that is related to disaster management, including the establishment of regional and local disaster management agencies. Unfortunately, their performance at the grassroots level is poor, and communities believe that they are left to fend for themselves. The challenge ahead is for central-level agencies to ensure that mechanisms exist to provide resources to the affected. They also need to change their orientation: though they do recognise certain elements of risk reduction, their thrust is still post-disaster relief. Another challenges is to avoid overlapping distribution of relief materials at local level.

The following sections present the institutional context of disaster management and include a consideration of relevant legislation and institutions.

Natural Calamity Relief Act, 1982

Though the government has made both national- and international-level commitments to reduce the risk of disasters in the country, in actuality disaster management receives attention only after a drastic incident occurs. It was the earthquake of 1980 and the growing concerns of national and international partners that set the stage for the emergence of a legal system to handle disaster management activities. The NCRA of 1982 gave importance to post disaster activities such as rescue and relief. It also provided for the establishment of the Central Disaster Relief Committee (CDRC) under the Ministry of Home Affairs. It was amended in 1989 and again in 1992. The latter change broadened the scope of the act to include man-made calamities such as industrial accidents as well as the preparedness and rehabilitation aspects of disaster management.

It wasn't until almost two decades later that local-level disaster-related responsibilities were assigned through the Local Self Governance Act (LSGA) of 1999. In addition, acts governing the Nepal Army, the Nepal Civil Police and the Armed Police Force assigned their personnel the duty to work closely with the MoHA and other government, non-government partners and local people during a disaster.

In 1994, after the United Nations declared the need for disaster reduction efforts, Nepal drafted the National Action Plan for Disaster Mitigation and established the National Committee for the International Decade for Natural Disaster Reduction (IDNDR) chaired by the home minister. The committee struggled in part because a lack of coordination in implementing the plan and the plan was modified the following year. The government approved the new plan in 1996, renaming it the National Action Plan for Disaster Management in Nepal.

The plan included plans for disaster preparedness, response, reconstruction and rehabilitation arrangement, and mitigation.[21]

[21] *See Rana (1996)*

It prioritised activities, delineated the responsibilities of various agencies, and stipulated time frames for monitoring and evaluation. Because it has no institutional basis, however, monitoring is and knowledge only meagrely applied.

The NCRA can be operationalised before and during a calamity to prevent or mitigate its effect as well as after a disaster to provide relief and rehabilitation. It envisages the formation of a hierarchy of committees for dealing with natural disasters. At the centre is the Natural Calamities Central Relief Committee, which consists of the home, physical planning and health ministers as well as the secretaries of the finance, defence, home, foreign affairs, construction and transport, water resources, communication, forest and environment, labour and social welfare, and supply ministries. The committee also includes the secretary of the National Planning Commission and representatives from the NA, NP and AFP, NRCS, Nepal Scouts, DoMG, DHM, Social Welfare National Co-ordination Council and representatives from affected districts. The central committee's main responsibilities are two: it implements policies and programmes related to disaster relief, prepares specific relief assistance for disaster victims in cash and in kind. It defines its own working procedure and can form relief and treatment and supply, shelter and rehabilitation sub-committees as well as regional, district, and local committees.

Box 9.2: HFA and Nepal

Nepal's signing of the Hyogo Framework for Action in 2005 set the stage for its considering DRR on a holistic basis. This step was necessary as Nepal is vulnerable to the increasingly variable and intense impacts of climate change and likely to see a rise in the incidence of climate-related disasters. The Nepali government has pursued the following activities in DRR.

Milestones in DRR

Year	Activity
1982	Natural Calamity Relief Act (NCRA) promulgated
1984	UNDP study about the threats of disaster and the need for foreign assistance conducted.
1987	Disaster unit under the Ministry of Home Affairs (MoHA) established.
1989	NCRA 1982 amended.
1990	Strategy for Training on Disaster Management prepared.
1990	National committee to celebrate the decade of the 1990s as the Decade of International Disaster Reduction formed.
1991	Comprehensive Disaster Management Plan prepared.
1992	Second amendment of NCRA (1982) ratified.
1993	Training of government officers by the government in collaboration with UNDP/DHA organised.
1993/94	Training on disaster management conducted by USAID and ADPC, Bangkok organized at the request of the MoHA.
1994	Action plan prepared with the help of UNDP.
1996	UNDP's disaster management capacity-building programme begun.
2001	Department of Narcotics Control and Disaster Management established.
2003	Disaster impact assessments of development projects made mandatory in the Tenth National Plan.
2004	Department of Narcotics Control begins operation
2005	Participation in Hyogo Conference.
2007	Drafts of acts, policies and strategies on disaster management in Nepal prepared.

The formation of all these committees was an attempt to make the government's response less ad hoc than it had been by clearly laying out institutional responsibilities. However, committees were formed only at the central, regional and district levels; no local-level committees have been formed. Another weakness is that the act is outdated: ministries that are included in the committees have been changed or split. In addition, the functions, duties and operation procedures of the sub-committees are not specified and their linkages with other committees are not clear.

Local Self-Governance Act, 1999

The LSGA empowers local bodies to govern themselves and recognises that local people and local bodies are the most appropriate points of entry to meet development needs at the district, municipal and village levels. It aims to involve people in local-level activities by according full responsibility and authority to DDCs, municipalities and VDCs. Empowering these institutions is expected to enhance local leadership and its capability to make appropriate decisions about matters affecting the day-to-day needs of local people. Among its provisions is the local management of disaster-related works. Unfortunately, the duties and responsibilities of each of the three local bodies—DDCs, municipalities and VDCs—is, however, stated in only general terms.

Channelling funds

As provisioned for by the NCRA, a Central Disaster Aid Fund (CDAF) was established under the control of the CDRC to provide disaster victims with assistance. Funds come from three main sources

- Cash and kind contributions from the government of Nepal;
- Contributions from the Prime Minister's Disaster Relief Aid Fund (PMAF); and
- Assistance received from foreign countries, agencies and individuals;

In theory, the government should be able to channel disaster relief funds in succession from the regional to the district and finally to the local level, but in fact local-level funding is not operational yet.

To supplement the CDAF's efforts, the PMAF was established in 1993 following the calamitous floods and landslides of that year's monsoon. As the PMAF is larger than the CDAF, this fund is used not just for rescue and relief but also for rehabilitation and reconstruction.

Governmental agencies involved in DRR

Formal governmental organisations work as support and implementing agencies at both the local and national level. Support agencies provide post facto financial, material and technical assistance, while implementing agencies carry out field-based programmes. For the most part, these agencies have worked independently, collecting materials and funds and distributing them directly to affected communities. Actions are ad hoc and efforts to create a panel of institutions have lacked commitment to cooperate and coordinate. The current approach is dominated by the centre and local governments and CBOs have received little attention.

Central-level organisations formulate policy, plan and development; the highest of them is the NPC, whose plans and programmes are approved by the National Development Council (NDC), a body headed by the Prime Minister and represented by all sectors. Since it was created to discuss and secure consensus on national development issues, the council has a political orientation. The NPC's duties include allocating resources, reviewing the progress of its plans, and monitoring and evaluating departmental performance. Though the concept of central planning is being questioned, this hierarchic mode persists.

Ministry of Home Affairs: The MoHA is the central agency for disaster management: it formulates and implements national policies as well as carries out immediate rescue and relief work through the Department of Narcotics Control and Natural Disaster Management and its network. The main function of the department is to carry out disaster management activities in coordination with concerned agencies in an dynamic and efficient manner.

Ministry of Water Resources: The Ministry of Water Resources (MoWR) is the agency responsible for planning, policy-making and implementation related to the country's water resources projects. It receives support and advice from the Water and Energy Commission (WEC) and its secretariat (WECS). The WEC and the WECS were established on 4 January, 1999 to provide better services to the government and have been entrusted with a variety of tasks. The Water

Resource Act (WRA, 1992) accords ownership of all water to the state and prioritises the use of water while at the same time stipulating that the adverse effects of construction and the management of water resources must be minimised.

Water and Energy Commission Secretariat: The WECS is a multidisciplinary institution which is engaged in the coordinated development of water and energy and which supports the government in formulating water-related policy and strategy. It carries out studies, surveys and investigations and offers its opinion on issues relating to the development of the nation's water and energy resources.

Department of Water-Induced Disaster Prevention: Flood control used to be a section under the Department of Irrigation (DoI). With support from JICA, the DoI built gabion boxes and embankments along streams that threatened villages or urban settlements. In 2000, this unit became the independent DWIDP. It has set three targets:

- Identify potential disaster zones and stock emergency relief material in all five development regions by 2007;
- Establish early warning systems all over the country and put in place infrastructure for mitigating predictable disasters by 2017; and
- Reduce social and economic losses to the levels experienced in developed countries.[22]

The DWIDP's main activities are as follows:

- Prepare and implement a water-induced disaster management policy and plan,
- Carry out hazard mapping and zoning,
- Strengthen the disaster networking and information system,
- Establish a disaster rehabilitation system,
- Carry out a disaster-related public awareness programme at the community level,
- Prepare and implement a flood plain action plan,

[22] *National Water Plan (2003)*

- Strengthen institutional set-up and capacity,
- Implement disaster reduction measures and,
- Develop a disaster database, GIS and Disaster Information System (DIS).

Department of Irrigation: The DoI under the MoWR used to be responsible for flood mitigation and river control works but now it deals only with disasters related to government-built irrigation systems. The extent of its current flood control efforts is constructing small dykes to save irrigation systems.

Department of Hydrology and Meteorology: The DHM plays a critical role from the perspective of water resource planning and development by maintaining a network of climatic and river flow gauging stations. The lack of sophisticated instruments for collecting hydro-climatic data and insufficient budget are its main problems. In 1997, it moved from the control of the MoWR to that of the Ministry of Science and Technology. It coordinated the project that lowered the water level of Tsho Rolpa to minimise the likelihood it would breach.

Department of Soil Conservation and Watershed Management: This department is one of the main divisions of the Ministry of Forest and Soil Conservation. By improving land use and increasing agricultural productivity through the conservation, utilisation and management of upper watershed resources, it helps community meet their basic needs. In its effort to manage land and water, it integrates diverse activities related to forestry, agriculture, livestock, water, and land use. Its focus is on mobilising local communities by forming user groups and on raising their awareness.

International agencies

Many donor agencies practice disaster mitigation within sectoral development programmes. In the aftermath of the 1993 cloudburst and floods, the UNDP, or, more precisely, the UN Disaster Management Secretariat (UNDMS), coordinated the distribution of relief materials from international donors to the affected people. In fact it is the UNDMS which is most responsible for coordinating the international response to disasters, including floods. During emergencies, it acts as an information clearing house, receiving and disseminating situation reports, needs assessments, donor pledges, and other pertinent information in order to facilitate a coordinated response. The Japanese government supports the DWIDP and the Office of Foreign Disaster Administration (OFDA), which operates under the aegis of USAID, has supported disaster mitigation activities since 1999. The EU also provides support.

Many INGOs, including Oxfam-GB Nepal, the NRCS, Inter Agency Sectoral Committee (IASC), Action Aid-Nepal, Practical Action Nepal, CARE Nepal, Mercy Corps and Lutheran World Federation and their local partners have been involved in community-based DRR interventions in Nepal for well over a decade. They also help in preparing and implementing cluster plans. Some local organisations are involved in research, training and policy analysis while others study the intersection between DRR and climate change.

Deficiencies in disaster management institutions

The government needs to address the challenges to and gaps in its ability to manage disaster, whether in terms of risk identification, damage assessment, monitoring, early warning, public awareness, preparedness, mitigation, or rehabilitation and reconstruction. Analysis of past disasters and past response provide many lessons and the government must incorporate them into post-disaster recovery and rehabilitation processes and use the opportunities for developing the capacity to reduce disaster risk in the long-term. It must work to reduce risk by sharing knowledge and lessons learned. Action in these two areas will help the government improve its legal instruments and policy frameworks. The country has gained some considerable experience in terms of risk management, vulnerability reduction, and increasing preparedness and response capabilities at the community level but these experiences have not been shared, analysed or used to update policies. The main limitations of Nepal's disaster management system as spelled out in the NCRA follow.

- Because the government has not yet formulated rules and regulations to back up the act, there are no standing orders, procedures or codes for those who respond to disaster.
- The definition of disaster the act had adopted is too narrow: it does not include aircraft crashes, bus accidents, heat waves, or animal attacks.
- The act does not clearly state the roles and responsibilities of disaster management related organisations. The act is focused more on rescue and relief efforts than on preparedness, rehabilitation and reconstruction.
- The Relief and Treatment and Supply, Shelter and Rehabilitation sub-committees are dormant and no local disaster relief committees have been formed.
- The act has no provision for compensation for volunteers and emergency workers in case of serious injury, fatal disease or death.
- The act fails to mention the need for research and development.
- The Tenth Plan (2003-2007) does not adequately address disaster management. The provisions of the LSGA are similarly inadequate: it does not clearly spell out the roles of local bodies in disaster management.

Ways forward

The above sections elaborated the trajectory of institutional development in Nepal with regard to disaster risk management. Most of the disaster-related institutions were emerged in the wake of large events. With each new disaster, one sees a tendency to establish new organisation and propensity toward centralised functioning and funding.

At the same time it was realised that NCRA dealt with the post disaster situation and needed to be replaced with policies that help avert disaster and mitigate their impact. The enunciation of LSGA (1999) did provide for the devolution of the power to plan and formulate policies to local bodies including disaster risk reduction. Past experience in the local governance of irrigation, forest and drinking water system show that effective disaster risk reduction is an achievable goal at the local government level.

Though institutions have been allocated the responsibility for disaster mitigation, there are two main shortcomings in their activities: inadequate policy formulation and poor implementation. There is a need for incorporating DRR measures into post-disaster recovery and rehabilitation processes and for using the recovery phase to develop the capacity to reduce risk. Knowledge and lessons learned need to be shared across the board. At the same time, rules and regulations to back up the disaster management act (NCRA is still in vague) should be formulated. In addition, standing orders, codes, guidelines and manuals should be prepared.

BOX 9.3: Mainstreaming disaster risk reduction into development

Since the late 1990s, both governments and donors have increasingly recognised the need to mainstream DRR into mainstream development process. Earlier, development efforts did not consider reducing vulnerability to natural hazards as an important goal; instead, they often inadvertently created new forms of vulnerability or exacerbated existing ones. Today, in contrast, efforts are being made to incorporate the objective of minimising the risks caused by disaster into plans and legislation and institutional mechanisms to minimise risk. In addition, budgetary allocations are made to plan, design and implement, monitor and evaluate DRR programmes.

To make DRR effective, it is necessary to analyse how a potential hazard could undermine the performance of policies, programmes and projects as well as how these policies themselves could exacerbate vulnerability. Such analysis should lead to the adoption of measures which reduce vulnerability and treat risk reduction as an integral part of the development process, not merely a reactive response. It should also ensure that interventions made to respond to local needs are sustainable.

The impact of climate change must also be taken into account so that DRR interventions constitute a 'no-regrets' minimum level of measures designed to minimise climate-related risks.

In particular, the following issues require attention:

- The government should ensure that DRR becomes both a national and local priority and should provide a strong, multi-sectoral institutional basis for its implementation.
- The dormant Relief and Treatment and Supply, Shelter and Rehabilitation sub-committee should be re-activated and made permanent. Similar committees should be established at the district level.
- A separate, multi-sectoral disaster management agency should be established to facilitate policy coordination and action on DRR.
- Disaster management efforts within each sectoral ministry must be strengthened.
- DRR activities should be effectively integrated into development policies and all levels of planning and programming with a focus on prevention, mitigation, preparedness and vulnerability reduction.
- To promote the effective implementation of disaster reduction policies, awareness of their importance needs to be increased. In this endeavour, the engagement of the media is vital, as are sustained public education campaigns and public consultations. The ultimate objective of such activities is to build community resilience.
- Policies specifying the role of NGOs, local communities, and the private sector should be made.
- Community participation in disaster risk reduction and management should be encouraged and enhanced through the formulation and implementation of specific policies, the promotion of networking, the strategic management

of volunteer resources, the delegation of roles and responsibilities, and the provision of the necessary authority and resources.

- The government should construct warehouses in strategic locations and train concerned officials in warehouse management and the supply of relief materials.
- Emergency relief supplies and rescue equipment should be stockpiled in strategic locations so that they can be mobilised in case of an emergency. Personnel should also be allocated.
- Evacuation plan exercises and other drills should be conducted periodically.
- Indigenous knowledge should be used as it is simple, adaptable, easy to understand and cost effective.
- Good practices and lessons learned must be shared in order to ensure that DRR contributes to the achievement of sustainable development goal and to identify gaps and challenges.
- Disaster management courses should be incorporated at schools and universities.
- Efforts needs to be made to ensure that data on disaster loss are consistent and MoHA must function as the central repository of database on disasters in Nepal.
- Transparency and accountability should be maintained in mobilizing existing funds and materials as key elements of the contingency plan.

Box 9.4: Civil society proposes disaster management policy

In 2006, a nongovernmental initiative has taken on the task of proposing a comprehensive policy to address the challenges of DRR in Nepal by drafting the National Disaster Management Policy (NDMP) and the National Disaster Management Act (NDMA) after conducting extensive national and local consultations with major stakeholders, including communities affected by disasters. Both were submitted to the MoHA and the NPC for consideration in the same year. In 2008, with support from UNDP a National Strategy on DRR has been prepared. This too has been submitted to the MoHA for approval and adoption. All three documents propose tackling DRR using the strategies of preparedness and mitigation as well as effective rescue and relief operations and espouse a livelihood- and rights-based approach.

They recommend that technological innovations be used to address the particular needs of the poor and vulnerable and that DRR be mainstreamed in regular development at all levels of governance. In addition, they emphasise the need for planning, programming and monitoring and link DRR with development, rehabilitation and reconstruction. The allocation of adequate financial resources and the development of human resources and capacity are other major issues these policy instruments address.

The documents propose the establishment of an autonomous central-level disaster management council (DMC) chaired by the Prime Minister and administered by a full-time executive director. The council is to comprise a committee each on preparedness, rescue and relief, and reconstruction and rehabilitation chaired respectively by the ministers of Local Development, Home Affairs and Physical Planning and Public Works. The executive director of the DMC would serve as the member secretary of all three committees as well as of the DMC. At the district level, a similar institutional mechanism with the chief district officer serving as chair has been proposed. The chairs of the proposed municipality- and village-level DMCs are to be city mayors or the chairs of each of Nepal's village development committees. At all levels, representatives of civil society organisations will also be involved in the governance of disaster risk management activities.

In short, to minimise the risk caused by disasters, Nepal should adopt and implement proactive policies rather than pursue a reactive approach. Such initiatives will help create an atmosphere conducive to the rebuilding of livelihoods by the affected and will support the planning of physical and socio-economic reconstruction. This approach will help also build community resilience and reduce vulnerability to future disasters. An integrated policy that encompasses agencies at all levels—central, regional, district and local—as well as other government and non-governmental organisations can provide the uniformity of action needed to minimise disaster risk. Nepal must refine its disaster management approach. Political commitment to prioritising disaster management programmes is essential. Besides remedying these shortcomings, the government needs to develop proactive policies which emphasise disaster preparedness and management and enact laws that focus on preventive measures rather than on curative support.

Box 9.5: National Network of Disaster-Affected Communities (N-DAC)

I/NGOs and NGOs involved in DRR activities recently established the National Network of Disaster-Affected Communities (N-DAC) in Nepal. Its officials are representatives of community-based disaster management committees from across the country. At its first conference, which was held on 10-11 June, 2009, about 100 participants from 30 districts gathered to accomplish the following objectives:

1. Highlight and ensure the rights of disaster-affected people,
2. Begin a programme for raising awareness,
3. Address the issues of disaster victims and ensure their rights in the new constitution,
4. Improve awareness about the link between development and disasters,
5. Integrate disaster management in development programmes,
6. Emphasise preparedness, and
7. Advocate the drafting of a new DRR act.

Effective DRR rests on the principle of democratic governance and recognises the right of the disaster-affected to organise and to engage in the policy process. In Nepal, the users of forests, drinking water, irrigation and community electricity have been organised into federations—the Federation of Forest Users Nepal (FECOFUN), the Federation of Drinking Water and Sanitation (FEDWASAN), the National Federation of Irrigation Water Users Association Nepal (NIFUWAN) and the National Community Electricity Users Nepal (NACEUN)—in order to facilitate their political participation. Now N-DAC joins the ranks of national-level organisations with a voice in policy-making.

Chapter-10

Meeting DRR challenges

Nepal needs more effective strategies to reduce the risks it faces due to natural and human-induced disasters though the nature of disaster itself poses major challenges. Some disasters, like flooding during the monsoon recur regularly, but exhibit both spatial and temporal variations. Other disasters, like earthquakes, occur only intermittently and at long intervals. For this reason, the lessons of one disaster often do not remain in either human or institutional memory. Other challenges Nepal must address have to do with building the institutions and local capacity needed to minimise the impacts of disasters. The mechanisms put in place today to respond to DRR challenges will help build more resilient communities in the future.

For any given DRR activity to be effective, specific risks need to be targeted and emphasised. Success in responses to disasters depend on factors like access to safe drinking water, reliable communication, transport and mobility, access to finances, social support, and risk-minimising strategies. Government agencies at both the national and sub-national levels must coordinate the support they provide; synergies are crucial in helping the affected to rebuild their livelihoods. Equally important is that agencies internalise the learning they derive from their evaluation of the success of specific interventions, especially as climate change threatens to complicate the situation. The government cannot act alone: DRR strategies need to be developed and maintained through private and community-based approaches.

BOX 10.1: Disaster knowledge and education

The growing concern about DRR in Nepal has spawned a few educational initiatives. Since 2003 NEC in Changunarayan, and Ehime University in Kobe Japan have held six conferences to discuss understanding of natural hazards. In addition, NEC and the IoE have a master's-level course that covers DRR in a holistic manner, considering hazards, vulnerability and risk. These initiatives can lead to the emergence of a new corps of professionals who can better respond to the complex issue of DRR as well as generate new knowledge to facilitate effective DRR activities in the country.

Human-induced climate change impacts are likely to increase the severity of flood and drought disasters at both the national and the regional level but their impact will not be uniform. Different sections of Nepali society living in various hydro-ecological regions of the country will face different impacts, and each needs to be addressed separately. As if devising diverse national strategies weren't enough of a challenge, Nepal will also have to work closely with its neighbours. Since important rivers originating in Nepal support the livelihoods and ecosystems of the millions who live downstream in Uttar Pradesh, Bihar, West Bengal and Bangladesh, what we do in Nepal to build resilience can have a trans-boundary impact. In particular, as precipitation patterns become more erratic due to climate change, we can expect alterations in regional hydrology and, as a result, in low, base and higher peak flows as well as increased sedimentation rates. Adapting effectively to these changes requires innovative approaches through tinkering of existing institutions.

The ongoing political transition in Nepal poses a hurdle to effective DRR. The outcome of attempts to transform the centralised state into a federal republic will, depending on how central and federal jurisdiction are defined, have major implications for DRR activities. Complicating that decision is the fact that the government has not been able to provide basic services like drinking water, sanitation, health, education, transportation and energy to the majority of the population. As many studies demonstrate, it is only through access to such basic services that citizens can build their capacity to adapt to climate-related and other disasters. A third challenge is that most DRR activities in Nepal are performed in isolation. Initiatives such as the DPNet platform are needed to bring the many institutions involved into constructive synergy.

BOX 10.2: Disseminating DRR materials in vernacular

In 1998 ECO-Nepal began regularly publishing Paryawaran a monthly magazine that dealt with environment, ecology and development. The magazine also covers issues related with disasters risk reduction. With financial support from Action Aid- Nepal, Oxfam GB Nepal, ICIMOD, Nepal Academy of Science and Technology (NAST), Caritas-Nepal, Lutheran World Federation-Nepal, Paryawaran regularly includes materials on earthquake, landslides and floods and their impacts on ecology, environment and livelihoods. The magazine reaches Nepal's almost all VDCs. In addition, many organisations prepare and distribute brochures, booklets and posters on earthquake prevention. The local print media is a regular source of disaster events. The news of disasters is also carried by visual and audio media. FM radio stations in Nepal offer a practical opportunity to disseminate information related to disasters mitigation in local languages.

This report has discussed the Nepali hazardscape, highlighted the vulnerability of the country as a whole and of its citizens and presented some of Nepal's DRR efforts in a single volume. In doing so, it hopes to provide the foundation needed to produce a comprehensive report on disaster in Nepal in the future. Nepal needs to pursue strategies that strengthen local capacities to respond to disaster risks through multi-sector activities which draw on interdisciplinary approaches.

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