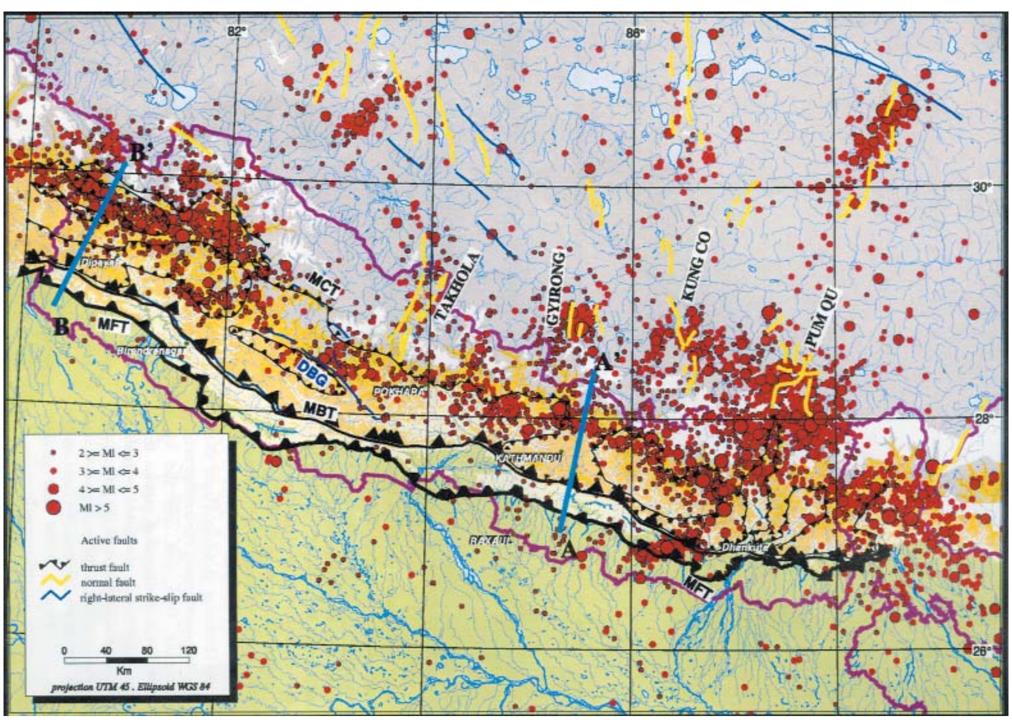
7

Natural Disaster Preparedness

Earthquakes and landslides are the most serious natural disasters occurring in the Kathmandu Valley. As far as earthquakes are concerned, the valley can also be affected when the event takes place in other parts of the country.

Many devastating earthquakes have occurred in Nepal, resulting in great economic loss and social disruption. Such events bring about radical environmental changes and hamper development.

The lithosphere (100-km thick upper surface of the earth) is broken into many pieces called plates. During the process of plate deformation an immense amount of energy is gradually accumulated and ultimately released when the rock body no longer can hold the stored energy. Deformed rock ultimately breaks along a fracture and moving in the opposite direction to it causes an earthquake. The intense seismic activity in Asia, and in particular along the Himalayan Arc, is related to this ongoing process. The large-scale thrusts developed from north to south in the last 25 million years are the Main Central Thrust (MCT), which separates the Lesser from the Higher Himalaya; Main Boundary Thrust (MBT), which separates the Lesser Himalaya from the Siwaliks (Churia Range); and the Main Frontal Thrust (MFT) which separates the Churia Range from the Indo-Gangetic plain. The MCT, MBT, and MFT all join a decollement (a weak contact boundary) rooted in Southern Tibet which is called the Main Himalayan Thrust (MHT). This is the source of big earthquakes (Figures 38 and 39). Four great earthquakes with magnitudes greater than 8.0 have occurred in the Himalayan Arc over the last 100 years, and the great



Source: Pandey et al. 1999

Figure 38: Distribution of epicentres between May 1994 and January 1998 showing two sections. Lines and their geological cross sections are shown in Figure 39 with MCT, MBT, and MFT

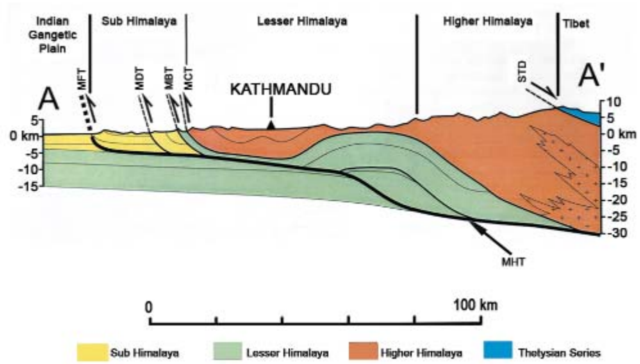


Figure 39: Geological cross section showing MFT, MBT, MCT, and MHT

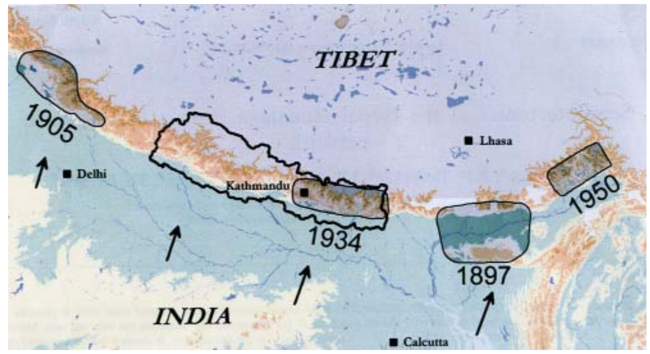


Figure 40: Distribution of probable rupture zone of the 1897, 1905, 1934, and 1950 earthquakes along the Himalayan Arc

earthquake of 1934 (Nepal – Bihar earthquake) is one of them (Figure 40) There was no big earthquake between 1905 and 1934, creating a seismic gap (Figure 40).

Kathmandu Valley is an Intramontane Basin filled by thick lacustrine (lake sediment) and fluvial deposits (deposited by rivers) and is more than 550m thick. The Kathmandu sedimentary basin was formed in the early Pliocene (Yoshida and Igarashi 1984) and from the Late Pleistocene to Holocene (1,000,000-10,000) age (Yoshida and Gautam 1988). The basin is in the middle of the Lesser Himalayas and bounded by the Phulchowki and Chandragiri hills in the south and Shivapuri hills in the north. The engineering and environmental geological map of Kathmandu Valley (Figure 41) gives a broader perspective of the engineering properties of valley sediment and also gives some information about hazardous areas and potential sources for groundwater; landslide prone areas; and sites for industrial areas, hospitals, and new settlements. This map can be used for town /urban development planning, infrastructural development, land-use planning, and potential areas for natural resources.

Historical records show that the Kathmandu Valley was hit by an earthquake of intensity X on the Modified Mercalli Intensity (MMI) scale (a measurement for earthquakes graded from I to XII) in 1255. This earthquake took the lives of one third to one fourth of the total population in the Kathmandu Valley. King Abhaya Malla also died in that event.

Most of the buildings in Kathmandu Valley are vulnerable to even moderate earthquakes, and loss of life in earthquakes can often be attributed to inadequate buildings. More than 4,000 buildings are constructed every year by builders or owners, most without any knowledge of engineering. Hence, vulnerability to earthquakes is increasing due to urbanisation.

Like earthquakes, landslides destroy not only life and domestic dwellings but also major installations such as dams, roads, and bridges. They commonly occur in connection with other major natural disasters such as earthquakes, volcanoes, wildfires, and floods. Growth of urban areas and expanded land use elsewhere have increased the probability of landslide disasters.

Similarly, although land subsidence is a slow process, it causes damage to infrastructure and other buildings. Land subsidence is being reported within Kathmandu Valley in the Shantibasti area, Hyumat tole, and in Imadol, but detailed studies have not been carried out. Until now there has been no record of large areas of subsidence in Kathmandu Valley. This may be because the recharge of groundwater to the aquifer is adequate. This does not mean that subsidence will not occur in future, as in Mexico City which has similar geological conditions.

Kathmandu Valley's geological condition is unstable because of the presence of fluvial-lacustrine deposits such as clay, silt, and fine sand. There has been extensive extraction of groundwater for drinking as well as industrial purposes. The supply of water from underground sources has met more than 50% of the total demand of Kathmandu Valley. The sea of concrete buildings constructed in the valley reduces the percolation of surface water, increasing the demand for water and causing a fall in the water level each year. This renders the valley prone to land subsidence.

The following paragraphs analyse the status of natural disaster preparedness using the DPSIR framework.

Figure 41 Map on this page

Figure 41: Engineering and environmental geological map of Kathmandu Valley

Drivers

Kathmandu Valley has a long history of destructive earthquakes caused by its location in the seismic zone. There is little public awareness about earthquakes, rendering people vulnerable. The tendency for disaster is increased by poverty, lack of education, political instability, lack of planning, inefficiency of policy-makers and decision-makers, lack of social commitment, lack of coordination, and lack of political commitment. There is no central department of disaster management, although there are many organisations working in disaster management. The population of the valley is increasing annually at a rate of more than four per cent. The main driving force is the centralised development of Kathmandu Valley.

The main driving forces causing landslides are geological, morphological, and physical and human intervention. The geological conditions include tectonic uplift, erosion of slope toes, erosion of lateral margins, and deposition of loads on slopes or crests and removal of vegetation. Morphological conditions include weak material, sensitive material, weathered material, sheared material, jointed or fissured material, adversely-oriented mass discontinuity (bedding, schistocity, etc), and adversely-oriented structural discontinuity (fault, unconformity, etc). Morphological conditions include contrast in permeability and contrast in stiffness (stiff, dense material over plastic material) and physical conditions include intense rainfall, prolonged exceptional precipitation, and occurrence of earthquakes. Human interventions include excavation of a slope or its toe, deposition of a load on the slope or

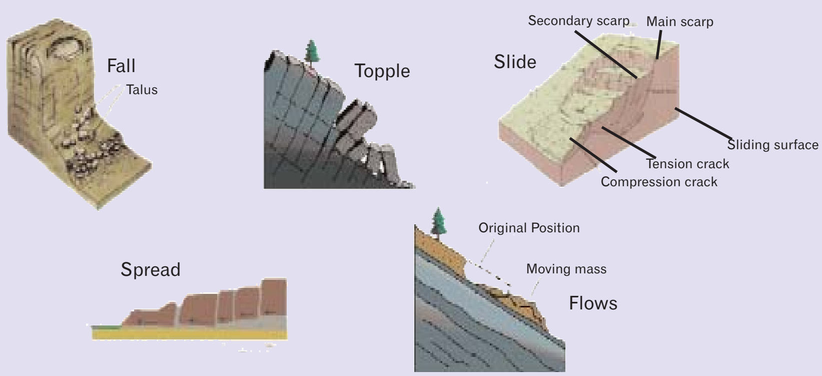
Box 6: Different types of landslide

Varnes (1978) classified slope movement mainly into five categories, based mainly on morphology mechanism, type of material and rate of movement as shown in the Table 7.1 and Figure 42. The complex type of slope movement includes a combination of two or more of the other types of movement.

Table 7.1: **Varnes classification of mass movement**

Type of movement		Type of Material		
		Bed rock	**Debris predominantly coarse**	**Soil predominantly fine**
Falls		Rock fall	Debis fall	Earth fall
Topples		Rock topple	Debris topple	Earth topple
	Rotational		Debris slump	Earth slump
Slides		Rock block slide	Debris block slide	Earth block slide
	Translational	Rock slide	Debris slide	Earth slide
Spreads		Rock spread	Debris spread	Earth spread
Flows		Rock flow	Debris flow	Earth flow
		Deep creep		Soil creep
Complex		Combination of two or more principle types of movement		

Source: Deoja et al. 1991



Source: Varnes 1978

Figure 42: Different types of landslide

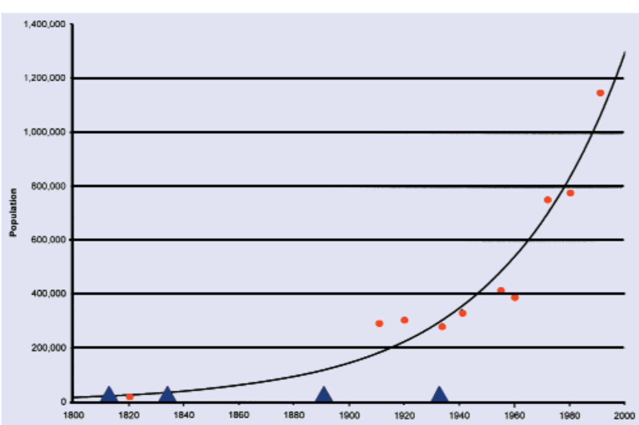
its crest, deforestation, irrigation, mining, and water leaking from utilities. Lack of awareness and poverty can indirectly lead to landslides in hilly regions. The construction of roads without proper geological knowledge of an area also increases the probability of landslides.

Pressure

Infrastructural development in the valley facilitates the concentration of population from other parts of the country. Encroachment on land, haphazard construction of buildings, and rapid urbanisation lead to rapid population growth No building codes are implemented athough they were introduced in 1994; although Lalitpur Sub-Metropolitan City has implemented a Nepal National Building Codes since 16th January, 2003 to make city dwellers aware of the risk of earthquakes. Sky scrapers are being built without taking sub-surface geology into account. Although this is more prevalent in Kathmandu, Lalitpur and Bhaktapur are beginning to follow suit. Population growth trends are shown in Figure 43. The red triangles indicate the occurrence of major earthquakes. According to the figure, the population increased thrice in 50 years.

According to Pandey and Molnar (1988), the population and number of houses in Kathmandu Valley in 1920 were 306,909 and 66,440 respectively. According to the 1991 census the population of Kathmandu Valley was 1,105,379 and according to that of 2001 it was 1,653,951. This means the population has increased five times since 1920. Similarly, the urban area of Kathmandu Valley has increased extensively from 1920, as can be seen in the two images of Lalitpur (IKONOS-2001 and CORONA-1967) (shown in plates a and b on page 91).

This is a situation that could lead to disaster if, in future, there is another big earthquake in the valley. Rapid



Source: Piya 2004

Figure 43: Population trend

urbanisation and uncontrolled population growth means that river corridors are encroached upon, open lands are being captured and haphazard construction practices are being used. All these are factors that have increased vulnerability.

Another aspect of population growth is the need for land. People cut down trees for settlements and for cultivation, leading to deforestation. Global climatic change causes imbalance and irregular precipitation in the region. Exorbitant oil and fuel prices lead to dependance on dwindling forests for firewood.

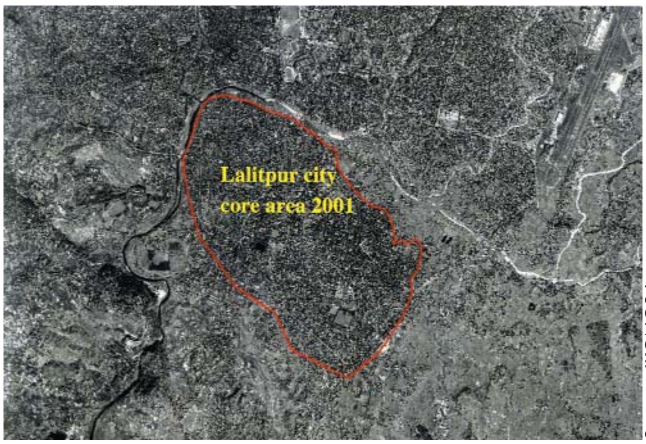
State

The loose fluvio-lacustrine sediment in the Kathmandu Valley plays a key role in amplifying ground vibrations during earthquakes. It is estimated that the amplification factor is six to ten times greater in loose sediment than in bed rock inside the valley. Maximum shakability is confined to Chhauni, Imadol, Sanogaon, and Lubhu. The valley lies between the MCT and MBT, and there are also numerous active faults existing in and around it , e.g., the Chandragiri and Chobhar faults in the southwest and the Kalphu Khola faults in the northeast. Earthquake models were prepared by JICA and the Home Ministry in 2002 for 'The Study of Earthquake Disaster Mitigation in the Kathmandu Valley'; and were based on seismic, seismotectonic, and geological conditions in and around the valley. Earthquake models are of Mid Nepal (West of Nepal), North Bagmati (around Rasuwa), and KV Local (around Kathmandu City). Peak ground acceleration (PGA values), intensity, magnitude, and liquefaction potentials have been estimated based on these models (Table 7.2). Estimated casualties and probable damage to residential buildings are shown in Tables 7.3 and 7.4.

According to JICA and MoHA (2002) report, there are 47 hospitals in Kathmandu and most of them are in municipalities. Quite a number of hospitals are of three or four storeys, built of brick with cement mortar or reinforcement which is less vulnerable to earthquakes than other types of material. According to JICA and MoHA (2002), there are 1,588 doctors and 1,998 nurses looking after 5,390 beds in total. Hospitals and beds are insufficient to deal with the injuries estimated for an earthquake in Mid Nepal. Also of concern is the fact that there are only five fire brigades with a total staff of 48 in the valley as a whole. Considering the size of the population and the fact that, in the event of a Mid Nepal earthquake, their services would have to extend outside

Source: Corona image

a) The settlement area of Lalitpur in 1967



Source: IKONOS image

b) The settlement area of Lalitpur in 2001

the valley, the present strength is deplorable. There is a special fire brigade for the airport, but this would make a negligible difference in the event of an earthquake disaster.

The following types of building are found in the Kathmandu Valley.

- Adobe (AD): These buildings are mainly made of sun-dried brick with mud mortar. They are found mostly in rural areas and some can still be found in old urban and suburban areas on elevated ground
- Stone with mud mortar (ST): These buildings are found mainly in rural areas. The houses are constructed either with river boulders or dressed, squared stone.
- Brick with mud mortar (BM): This type of building is found in the suburban areas where floors and roofs are constructed with timber. Some houses have front walls built of fired brick.
- Brick with cement mortar (BC): This is the most common type of building in the valley. A distinctive feature is the lack of or insufficient number of reinforced concrete (RC) columns. Cement and sand are used as mortar. Such buildings were constructed 30-40 years ago. Although the resistance of houses of this type could be observed in the Udayapur earthquake of 21st July 1988, those in the Kathmandu Valley had to endure the same degree of earth movement.
- Reinforced concrete frame with masonry (RC): This is the most common building type at present in the urban area.

Table 7.2: **PGA value, intensity/magnitude and liquefaction potential based on earthquake models**

Earthquake Model	PGA value	Intensity/magnitude	Liquefaction potential
Mid Nepal	Most parts 200 gal (Some areas >300 gal)	VIII/8.0	Moderate potential
North Bagmati	<200 gal	VI-VII/6.0	No liquefaction
KV local	>300 gal,	IX/5.7 along fault, VII-VIII in most parts	High close to fault, moderate along some parts of the Bagmati River
1934 Eq	>200gal, > 300 gal (Bhaktapur), > 400 (In some areas)	VIII/8.4 in most parts, IX in some areas in eastern parts	Moderate potential but in some areas higher potential

Table 7.3: **Estimated casualties based on different earthquake models**

Earthquake model	Deaths	Injured	
		Seriously	Moderate
Mid Nepal	17,695 (1.3%)	53,241 (3.8%)	93,633 (6.7%)
North Bagmati	2,616 (0.2%)	7,204 (0.5%)	14,709 (1.1%)
KV local	14,333 (1.4%)	42,667 (3.1%)	76,344 (5.5%)
1934 Eq in Present	19,523 (1.4%)	58,728 (4.2%)	103,313 (7.4%)
1934 Eq in 1934	3,814 (1.3%)	10,635 (3.6%)	21,263 (7.2%)

Table 7.4: **Estimated number of damaged residential buildings**

Earthquake model	Heavily	Partly	Total
Mid Nepal	53,465 (20.9%)	74,941 (29.25%)	128,406 (50.1%)
North Bagmati	14,796 (5.8%)	28,345 (11.1%)	43,141 (16.8%)
KV local	46,596 (18.2%)	68,820 (26.9%)	115,416 (45.05%)
1934 eq in present	58,701 (22.9%)	77,773 (30.45%)	136,474 (53.3%)
1934 eq in 1934	19,395 (36.2%)	16,197 (30.25%)	35,592 (66.3%)

Key: eq= earthquake; gal = 1 cm/sec^2
Source: JICA, MoHA 2002

The old durbars (palaces) are based on Gothic (Italian) architecture and have walls very thick at the base and thinner on the upper floors. The binding material is lime with surki. Some houses are built with four walls having 22-inch, 18-inch, 14-inch, and 9-inch brick walls in mud or cement mortar. The general assumption for constructing the houses regarding the foundation is foot/stories. It means that for four-storied houses the foundation should be four feet deep. Nowadays people make pillar houses which rest on pillars. DPC (damp proof cement concrete) is applied after the foundation on the ground floor for most of the houses in Kathmandu. Most of the pillar houses are made either with 9-inch or 4-inch walls (Chitrakar 1998)

Mostly, the AD, ST, and BM buildings are most vulnerable to earthquakes even of moderate size (magnitude Ms 6.5) while BC buildings will suffer little damage with a magnitude of Ms 6.5. BC buildings can be found in the vicinity of the core area of Kathmandu Valley. Most BM buildings are two to three storeys high, while BC buildings are of three to four storeys. The majority of these buildings were constructed 40 years back and some old BM buildings in the core area have been replaced by BC buildings. At present, most of the buildings are RC types in urban areas and some are in the vicinity of the core area. These were constructed 20 to 25 years ago and their storeys range from three to five. Most people think that such buildings are safe and strong enough to withstand moderate to strong earthquakes. People in the valley have started to construct RC buildings that are very high. Some RC buildings have eight storeys located in the heart of the city; and houses 2.5 metres in width at the front have six to seven storeys. RC buildings constructed by owners who know nothing about architecture or engineering, supervised by unskilled craftsmen/masons, will not be strong enough to withstand even moderate earthquakes.

Box 7: Difference between magnitude and intensity of earthquakes

Magnitude requires instrumentally-recorded signals whereas Intensity requires the type of building and its damage pattern. Magnitude is used to measure the quantity of energy released by an earthquake. The most famous scale is the Richter scale, which ranges from 1 to 9, was devised by U.S. Seismologist Charles F. Richter in 1935 A.D. Increase of one unit in magnitude is equivalent to a 10-fold increase in amplitude and ground shaking and a 30 times increase in energy. Nowadays the Moment magnitude scale is used which has no upper limit. Intensity varies from place to place and decreases with increasing distance from the epicentre (generally maximum intensity). However, in some cases, maximum intensity is determined by local site conditions. Intensity is measured on Modified Mercalli Scale which ranges from I-XII. It was originally introduced by Italian Seismologist, Mercalli, in 1902 and modified by Wood H.O and Neumann in 1931.

Implementing a building code for the valley would be a step forward towards building constructions that reduce earthquake vulnerability. RC buildings incorporating such a code can be considered safe, but vulnerability largely depends on whether the area is free from liquefaction possibilities or not. There are some very weak old buildings in the core area, and they need to be demolished or retrofitted. Any structure built on soft soil is much more vulnerable than one built on hard rocks. Hard rocks are exposed in places like Kirtipur, Swayambhunath, Chobhar, Pashupatinath, and Panauti, and these will be safer in an earthquake event than places without hard rock. It is estimated that the centre of Kathmandu will shake six to ten times harder than the surrounding hills.

There are altogether 54 bridges in the Valley; 33 in Kathmandu district, 10 in Lalitpur district, and 11 in Bhaktapur district. The design standard is not uniform, and there is excessive scouring around the foundation of the pier in most of the bridges connecting the ring road and other linked roads due to lowering of the river bed. The bridges upstream from Bagmati, Bishnumati, and Dhobi Khola are badly scoured. Most of them could collapse during a big earthquake. Hence the cities of the valley will be cut off from each other.

The National Seismological Centre (NSC) has been monitoring earthquakes since 1978 in cooperation with the Laboratoire de Géophysique (LDG), France. Altogether 20 seismic stations have been installed and have been running since 1998 in cooperation with the Département Analyse Surveillance Environnement (DASE) (Figure 44).

The monitoring network can detect events as low as magnitude Ml 2.0 occurring inside the network. In the case of threshold events (Ml 4.0 or greater) or technical failure, the network automatically contacts the duty in-charge.Good maintenance is an important feature of the network, and the data gathered are valuable for designing building codes for earthquake-resistant buildings. The NSC of the Department of Mines and

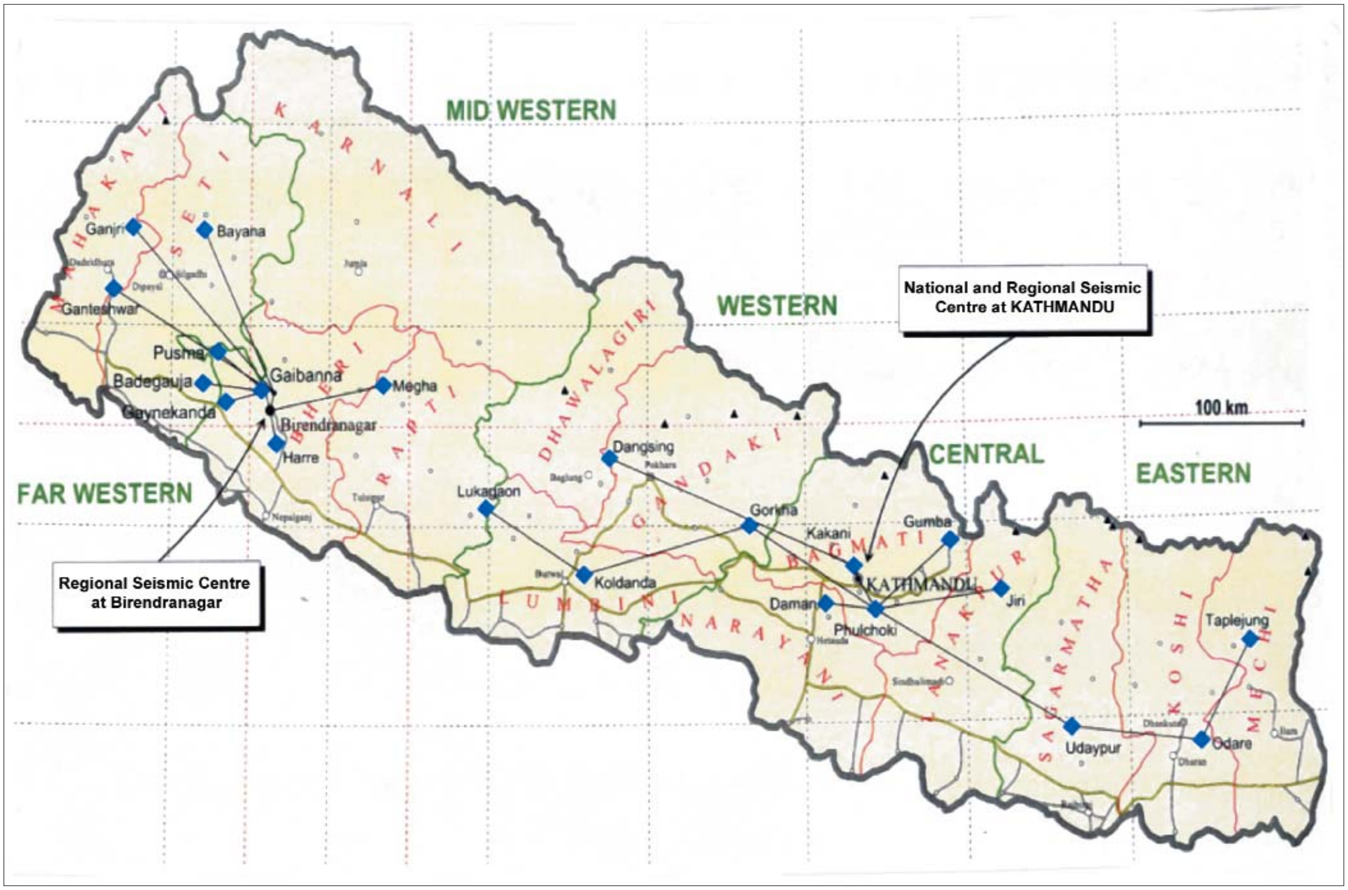


Figure 44: Location map of the national seismological network

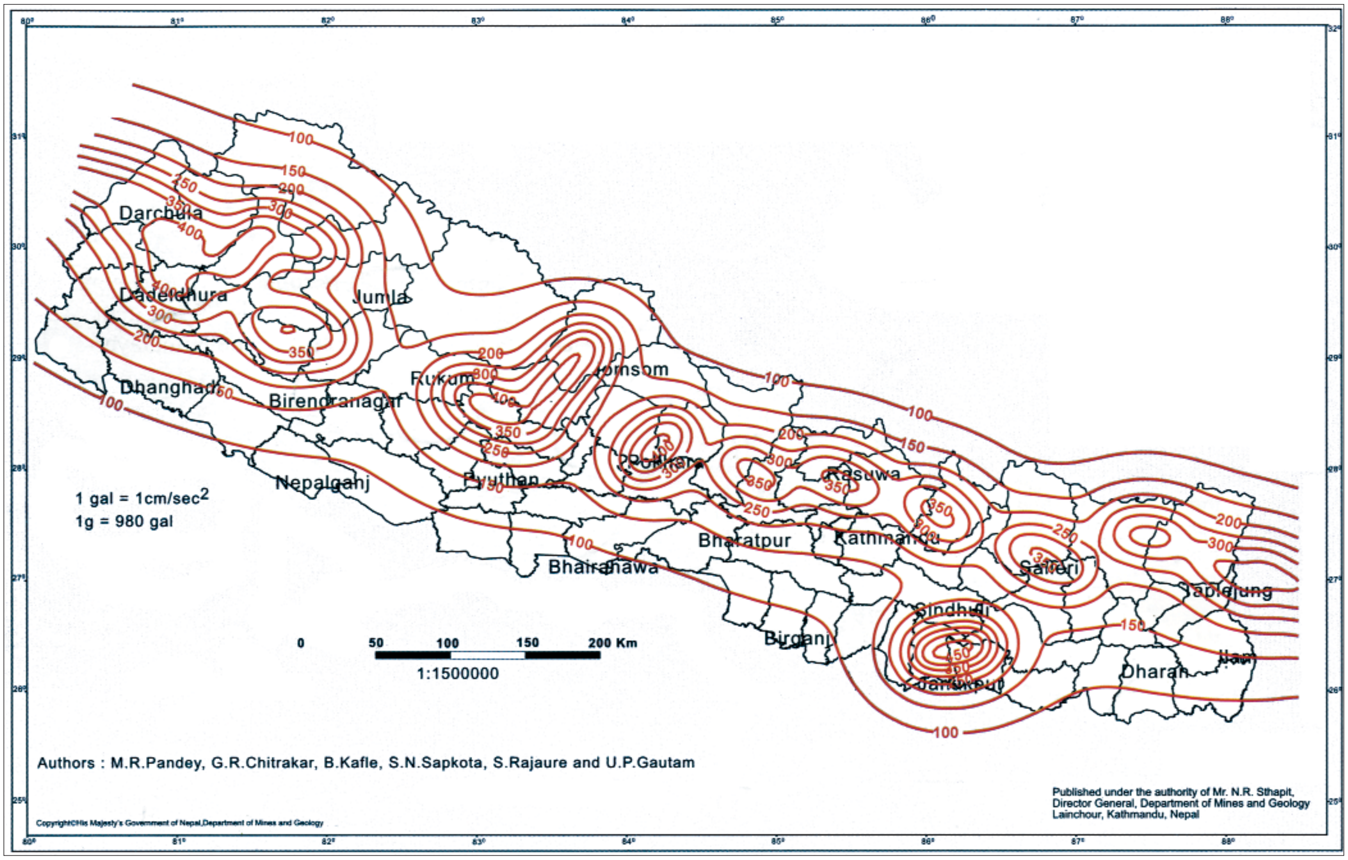
Source: DMG

Geology (DMG) has prepared a Hazard Map of Nepal which shows the peak ground horizontal acceleration in bedrock for a return period of five hundred years corresponding to a 10% chance to exceed in fifty years. According to this map, Kathmandu Valley lies within a PGA area of 200 – 250 gal (Figure 45).

The Department of Mines and Geology (DMG) also monitors crustal deformation through 13 global positioning system (GPS) networks in collaboration with DASE and the California Institute of Technology (CALTECH). DMG is also planning to install 10 more GPS stations in Far-west Nepal to cover the entire country. A slow motion of a millimetre in scale can be detected by a GPS. It will greatly contribute to our knowledge of earthquake precursors; and the characteristics of faults and their activities will help us assess seismic hazards.

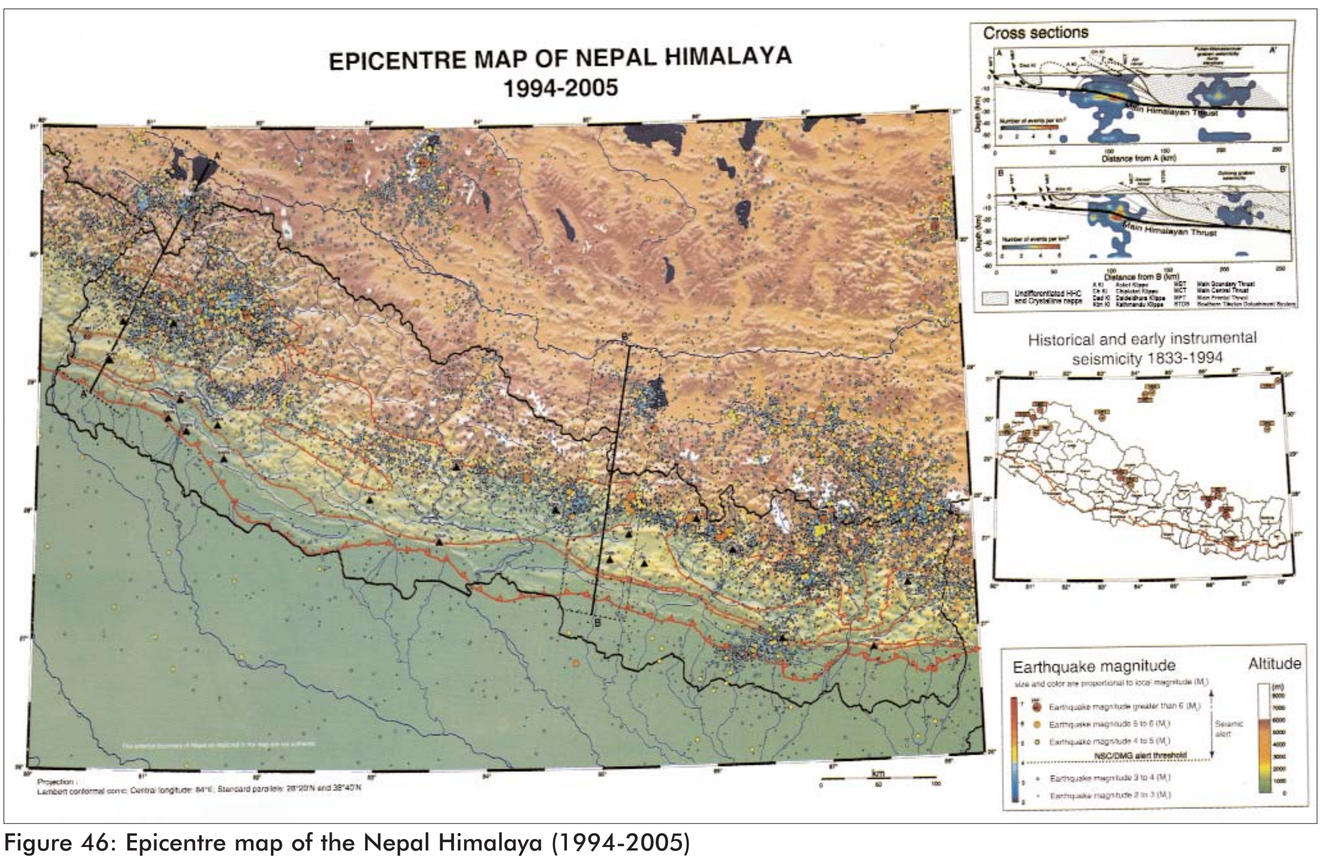
The new epicentre map of Nepal shows the distribution of earthquakes in the foothills of the Higher Himalaya (Figure 46). The Nepal Himalayan area has high seismicity judging by historical data, bulletins of the International Seismological Centre (ISC), and seismic data obtained from the National Seismological Network. The epicentres are clustered around the ramp (top right corner coloured blue in the geological cross-section) and the ramp beneath the Higher Himalaya behaves as an asperity focusing the build up of stress during interseismic periods. The modelling of levelling and GPS data (Jackson and Bilham 1994; Bilham et. al. 1997) indicate that the flat and ramp must be locked in the interseismic period. The continuous creep at depth beneath the Higher Himalaya is at a rate of 21 +/- 3mm/yr, and this is close to the long-term slip rate on the MFT of 21.5+/-2mm/yr (Lave and Avouac1999). Only during a big earthquake, will the the ramp and flat be activated and transfer all interseismic deformation to the most frontal structure (Lavé et al. 1995; Lavé and Avouac 2000).

The distribution of earthquake epicentres clearly shows segmentation of the Himalayan Arc. Most of the epicentres are distributed between the MCT and MBT in plan and depths lie between 10 and 30 km. The average convergence rate between the Indian Plate and Southern Tibet is considered to be 20 mm per year. A liquefaction susceptibility map of Kathmandu Valley prepared by Piya (2004) is shown in Figure 47.



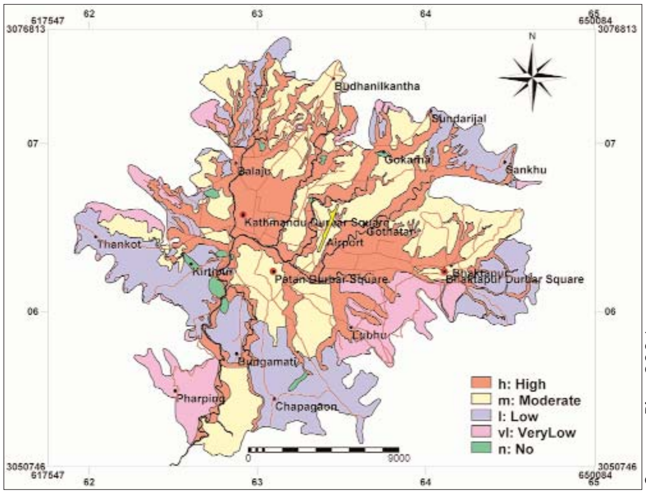
Source: DMG 2002

Figure 45: Seismic hazard map of Nepal showing bedrock peak ground horizontal acceleration contour in gals (1 gal = 1cm/sec^2)



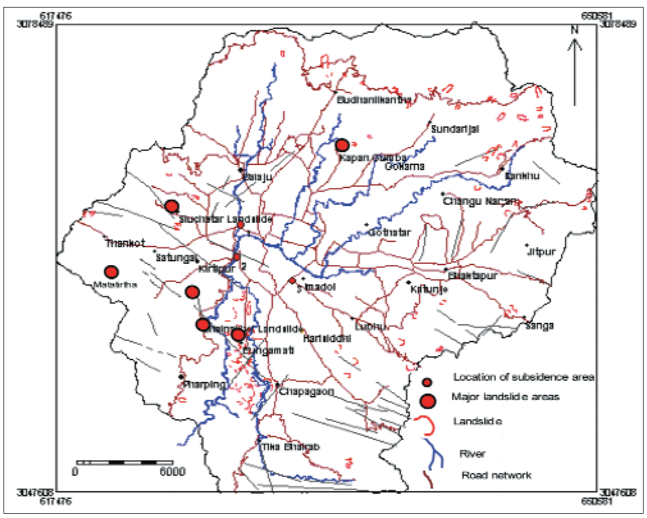
Source: DMG 2006

Figure 46: Epicentre map of the Nepal Himalaya (1994-2005)



Source: Piya 2004

Figure 47: Liquefaction susceptibility map of Kathmandu Valley



Adpated by G.R.Chitrakar and B. Piya

Figure 48: Location of landslides in the Kathmandu Valley

No great earthquake has been reported between the longitude of Kathmandu and Dehradun for 300 years, and that could be a potential area for a big earthquake in future. This location lies between two great earthquake locations (the Nepal-Bihar earthquake of 1934 and the Kangra earthquake of 1905).

Geological faults, fragile geological conditions, high intensity rainfall during monsoon, unplanned land use and insufficient fuel leading to deforestation are the forerunners to landslide occurrences. Figure 48 gives the location of landslides in the Kathmandu subsidence.

Impact

The impact of an earthquake is governed by the magnitude of the earthquake. Loss of life and property will be determined by the location of the epicentre. Epicentres in urban areas with greater magnitude will have a greater impact on the environment with greater loss of lives and property and social disruption than earthquakes in a sparsely populated area. It is said that 'earthquakes do not kill people, buildings do'. Buildings constructed without complying with the building code will suffer the most damage. Figures 49a and b show Bhaktapur Durbar Square before and after the Great Nepal-Bihar earthquake of 1934. The devastation is clear from these figures. Figure 50 is an intensity map of the valley during the 1934 Nepal-Bihar earthquake.Table 7.5 lists the earthquake disasters since 1255 to date that affected Kathmandu Valley.

In a big earthquake, a building can be destroyed by ground vibrations accelerated by resonance affects (amplification of ground vibration to a similar frequency as the earthquake because of the soft soils). There may be liquefaction in some parts of the valley in lowland areas near river banks, buildings may tilt. Infrastructure may be damaged. Similarly sewerage pipes, drinking water pipes, electricity cables, and transport and communication may be greatly affected. Secondary disasters such as ground failure, liquefaction, ground fissuring, ground subsidence, fire, and epidemics and famine also happen during big earthquakes.

Source: Rana 1935

Figure 49a: Bhaktapur Durbar Square before the earthquake of 1934

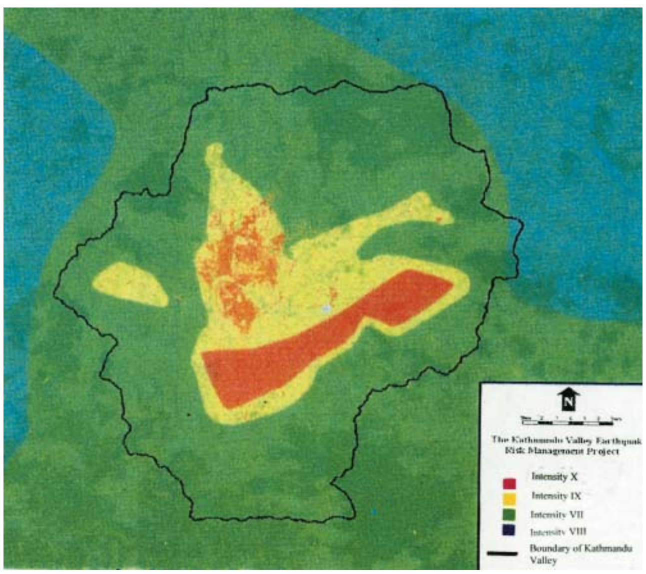
Source: Rana 1935

Figure 49b: Bhaktapur Durbar Square after the earthquake of 1934

Table 7.5: **Earthquakes since 1255 which have affected Kathmandu Valley**

Year	Magnitude/ intensity (MMI)	Epicentre	Human		Temples collapsed	Houses	
			Deaths	Injuries		Collapsed	Destroyed
1255	7.0 X (MMI)	NA	1/3rd to 1/4rth pop. of the Valley	NA	Many	Many	Many
1408	7.0 X (MMI)	NA	NA	NA	Many	NA	NA
1681	7.0 IX (MMI)	NA	NA	NA	N/A	Many	Many
1810	IX (MMI)	NA	NA	NA	N/A	NA	Some
1833	7.6 VII to X (MMI)	50 km north-east of Kathmandu	414	172	More than 6	Many	4,040
1934	8.3 IX to X (MMI)	Lat 27.45N Lon 87.0E	4,296	NA	19	12,397	43,342
1988*	6.6 V (MMI)	Lat 26.77N Lon 86.60E	8	71		650	1,814

Key: NA = not available; MMI = modified Mercalli intensity
Source: MoHA 1989; Pandey and Molnar 1988; Bilham and Bodin 1995; Chitrakar and Pandey 1986



Source: NSET Nepal 1999

Figure 50: Intensity map of Kathmandu Valley during the 1934 Nepal-Bihar earthquake

The environmental impact of the natural disaster in 1993 was beyond description and caused the deaths of more than 1,200 people, great economic loss, and social disruption for more than a month. The total financial loss was Rs. 71.9 billion.

Damage to important infrastructure such as roads, dams, canals, bridges, underground pipelines, sewerage system, slow collapse of buildings into sink holes, loss of valuable crops, and disruption of socioeconomic conditions are among the most severe impacts of landslides. The landslide and debris flows of 1993 blocked the transportation of important commodities from outside the valley for more than one month. This caused loss of life and property and created havoc. Sixteen people died in Matatirtha in a landslide in 2002. Similarly, many houses in Chalnakhel, Chobhar, Kapan, and Siuchatar have been destroyed by landslides. The photographs show the impact of the Chalnakhel and Matatirtha landslides. Table 7.6 gives information about landslides that have occurred in the Kathmandu Valley.

Main scarp of landslide (Chalnakhel)

Source: Prakash Dhakal

Tilted electric pole (Chalnakhel)

Source: Prakash Dhakal

Table 7.6: **Information about landslides occurring in the Kathmandu Valley**

Name	Location	Causes	Formation	Impact	Response
Chalnakhel	Situated about 11.5 km south west of Kathmandu along the Kathmandu - Pharping road	High intensity rainfall, soil creeping r eactivated from July 2001. Two concrete houses collapsed and the road connecting Kathmandu - Pharping passes just above this.	Lukundol Formation overlay by thin layer of mountain wash deposits	First appeared in 1999. In July 2001 subsidence and flow occurr ed causing damage to two houses. Every year it subsided almost one metre. Occasionally reactivated each year during monsoon. It is a rotational landslide.	DWIDP ran a detailed study under the Kathmandu model site project.
Matatirtha Landslide occurred on 23 July 2002	600 m south of Matatirtha temple	Very heavy precipitation 207mm/day caused the Matatirtha landslide. It was slope failure.	Alluvial fan deposits and Tistung Formation	18 people were killed, 8 houses were buried under the debris. A school and cultivated land. were also damaged .	Mr. Ranjan Kumar Dahal and Kumud Raj Kafle have studied this landslide in terms of its velocity and volume of material.
Dahachowk	10 km west of Kathmandu in the Dahachowk VDC.	Steep topography, rugged surface, fragi le geological condition, soft and thin soil cover, high intensity rainfall in a short period, over grazing, unscientific and unplanned development of infrastructure	Kalimati Formation	There are many houses situated downstream and it may attack the se houses at any time during landslides in the upper parts.	DWIDP is monitoring these landslide areas by implementing the Disaster Mitigation Support Programme (DMSP) Project in cooperation with JICA. DWIDP has developed this area as Dahachowk Sabo Model.Site

Source: DWIDP 2003/04

Source: DWIDP

Source: DWIDP

Impact of landslide (debris flow) in Matatirtha area on the 23 July 2002

Response

Key stakeholders

Several agencies within the government and several other stakeholders are involved in disaster management. They provide cash, kind, and technical assistance for rescue and relief operations for disaster victims from time to time. Some of the key agencies involved are as follows.

Government Agencies. The Ministry of Home Affairs; Ministry of Industry, Commerce, and Supplies; Ministry of Environment, Science, and Technology; Ministry of Water Resources; Ministry of Physical Planning and Construction; Ministry of Forest and Soil Conservation; Ministry of Health and Population; Ministry of Finance; Ministry of Defense; Ministry of Information and Communication; Ministry of Foreign Affairs; Ministry of Agriculture and Cooperatives; Ministry of Children, Women, and Social Welfare; The National Planning Commission; Royal Nepal Army; Nepal Police Force; Nepal Armed Police Force; Nepal Scouts; Department of Mines and Geology; Department of Water Induced Disaster Prevention; Department of Hydrology and Meteorology; and the Department of Watershed Management are the key players.

The Central Disaster Relief Committee under the Home Ministry plays an important role in disaster management. The Home Ministry carried out a very important project 'Kathmandu Valley Earthquake Disaster Mitigation' with the support of JICA in 2001 and 2002. The project produced a valuable database containing information on important infrastructure as well as the socioeconomic circumstances of valley inhabitants.

Municipalities. Kathmandu Metropolitan City plays an important role in disaster management. It has a Disaster Management Section under the Department of Social Welfare and disaster management committees in different wards. Several activities have taken place at school level in disaster preparedness, mitigation, vulnerability assessment of different wards, assessment of emergency services, capacity building of KMC personnel for disaster management by participating in national and international training programmes, working together with them, implementation of a National Building Code, and identification and protection of open spaces and public open lands. Future plans include developing emergency plans and evacuation routes; establishing a network among the five municipalities; coordinating to create open spaces, and identifying recreational parks on vacant public land. All these activities lead to disaster preparedness in the event of an earthquake or other natural calamity.

Lalitpur Sub-metropolitan city has introduced a building code to reduce the impact of earthquakes on buildings. Together with the Department of Urban Development and Building Construction (DUDBC) and the National Society for Earthquake Technology (NSET), it made training available on earthquake resistant construction of buildings for masons working in Lalitpur. Other municipalities have also established disaster management committees.

The media. The media have an important role to play during natural disasters. Rescue and relief operations can be carried out more efficiently if there is sufficient and correct information. Radio Sagarmatha broadcasts important news about earthquakes and holds interviews to increase public awareness.

Initiatives from non-government organisations. The Nepal Red Cross Society, National Society for Earthquake Technology (NSET-Nepal), Nepal Scouts, Nepal Geological Society, Nepal Landslide Society, Disaster Preparedness Network, Caritas Nepal, Nepal Engineering College, Institute of Engineering, Khoppa Engineering College, Society of Nepalese Architects, Society of Consulting Architectural and Engineering Firms, Nepal Centre for Disaster Management, Nepal Disaster Reduction Centre, Centre for Disaster Studies, Nepal Disaster Management Forum, Department of Geology, Trichandra Campus, Central Department of Geology, and T.U are the main players.

The Kathmandu Valley Earthquake Risk Management Action Plan, which is a product of the Kathmandu Valley Earthquake Risk Management project contains valuable information about earthquake preparedness. NSET has been playing an instrumental role in issues related to general and specific safety requirements for owner-built buildings. It is supporting training programmes at community level to increase public awareness. It is also promoting integration of seismic resistance into new construction, improving the seismic performance of existing buildings, and vulnerability assessments. Structural and non-structural methods are used to reduce earthquake vulnerability. The Programme for

Box 8: Can we predict earthquakes?

Generally small earthquakes occur before the main shock nd are very close to the main shock in time and space.These are known as foreshocks or pre-shocks. They do not occur always. Similarly, numbers of small earthquakes, known as aftershocks, follow the main shock. Aftershock magnitude is less than the magnitude of the main shock. The most difficult task is to recognise foreshocks. Most events have foreshocks. In the case of the 1934 earthquake, two foreshocks were reported, bringing people outside their homes, eventually preventing a number of deaths.

In the Haicheng earthquake (M=7.4) on February 4, 1975, Chinese Seismologists recognised the foreshocks and gave orders to evacuate the city of Haichang. A series of small events occurred immediately prior to the main shock. Many people were outside during the main shock and very few lives were lost. They claimed this prediction was one of the greatest achievements of the Chinese earthquake prediction programme.Unfortunately, however, on July 27, 1976, Tangshan city was struck by a powerful earthquake (Ms = 7.8) that killed 242,000 people. This earthquake was not predicted.

Animal behaviour and other precursors do not always follow the same patterns, which makes prediction a difficult task Earthquake prediction is a challenge for seismologists worldwide.

Enhancement of Emergency Response (PEER) a training-based programme was introduced in 1998 by the U.S. Agency for International Development's Office of U.S. Foreign Disaster Assistance (USAID/OFDA) to improve disaster response in four Asian countries: India, Indonesia, Nepal, and the Philippines. The second phase was managed by NSET (2003-2008). PEER training includes Medical First Responder (MFR), Collapsed Structure Search and Rescue (CSSR), Hospital Preparedness for Emergency (HOPE), and Training for Instructors (TFR). PEER plays a vital role in earthquake disaster preparedness and earthquake mitigation.

The Disaster Preparedness Network plays an important role in disaster management. It has provided information about natural disasters and held seminars to create awareness about them.

International organisations. The Government of Japan, Japan International Cooperation Agency (JICA), United Nations Development Programme (UNDP), Technical Cooperation of the Federal Republic of Germany (GTZ), United States Agency for International Development (USAID), United Mission to Nepal (UMN), International Centre for Mountain Development (ICIMOD), Lutheran World Service (LWS), OXFAM, Save the Children Fund (SCF), Cooperation for American Relief Everywhere (CARE), World Food Programme (WFP), International Red Cross Society (IRCS),

Federal Emergency Management Agency (FEMA), Asian Disaster Preparedness Centre (ADPC), and Asian Disaster Reduction Centre (ADRC) are the main organisations in this category.

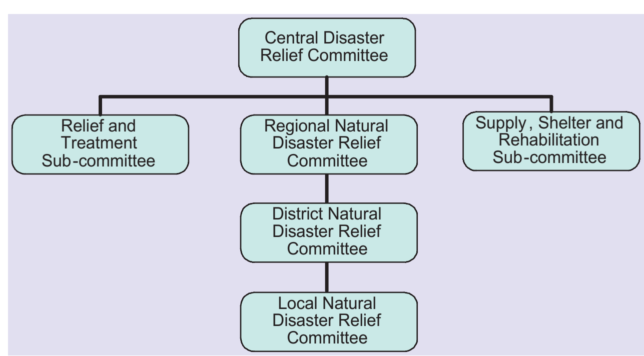
In 1991, UN agencies launched an inter-agency emergency planning process involving all UN agencies represented in Nepal and their respective staff. UN Nepal's inter-agency, Disaster Response, Preparedness Plan, Part 1 consists of Hazard Analysis and Response Guidelines prepared by the United Nations' Disaster Management Team (2001) and covers a wide range of topics regarding natural hazards such as earthquakes and landslides, response and emergency management, and coordination to reduce the loss of life and property in addition to physical damage.

Institutional framework

The Ministry of Home Affairs is acting as the national focal agency for disaster management in Nepal. All activities in disaster management are guided and directed by the Central Disaster Relief Committee chaired by the Home Minister in accordance with the Disaster (Relief) Act 1982.

Nepal observed the International Decade for Natural Disaster Reduction (IDNDR) through a national committee established under the chairmanship of the Home Minister for the decade from 1990 to 2000. Every year, IDNDR Day is observed by holding seminars, workshops, and other activities related to natural disasters to bring different disciplines on to a single platform and make disaster management more effective. Currently Nepal observes 'International Strategy for Disaster Reduction (ISDR) Day', an undertaking of the UN, with an annual seminar to foster awareness of the global framework for action. Similarly Earthquake Safety Day (second week of January or 2nd Magh of B.S.) is observed every year at central and district levels in coordination with various agencies working in disaster management.

Any earthquake occurring with a magnitude greater than 5.5 (Mb) is recorded at the NSC of DMG and an earthquake with a local magnitude greater than 4.0 occurring inside the kingdom will be processed immediately for location and magnitude and reported to the authorities (Home Ministry) and the media within half an hour of the event. The immediate reporting of location and magnitude helps mobilise rescue teams because the earthquake parameters indicate the severity of the earthquake as well as the actual site of maximum destruction. The NSC is well equipped with a 24-hour power supply with a back-up system. The loss of a few seconds' data could greatly impede response. The events are placed on the website www.seismonepal.gov.np. Thus, the National Seismological Centre is acting as a watchdog. Figure 51 shows the organisational chart for disaster management and Figure 52 shows the dissemination of earthquake information and disaster management to reduce loss of life and property.



Source: Home Ministry

Figure 51: Organisational chart for disaster management

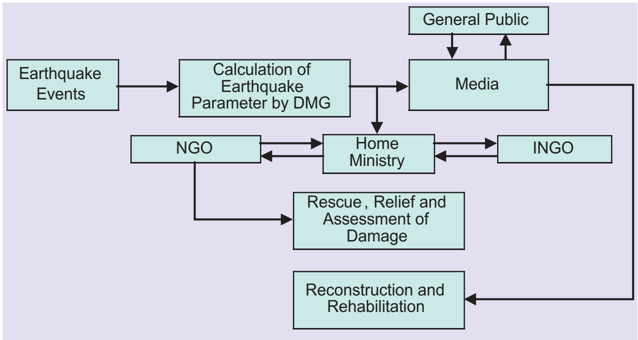


Figure 52 Flow chart showing dissemination of earthquake information and disaster management to reduce loss of life and property

Policy and legal framework for disaster management

The National Action Plan Matrix for Disaster Management was formulated in 1996. The plan depicts in matrix form the priority item groups and activities together with the executing agency and cooperating agency responsible for national hazard assessment, disaster reduction policy, awareness raising, information systems, training, land-use planning, regional and sub-regional cooperation between and among countries, and establishment of a documentation centre for natural disasters.

The plan was reviewed widely and submitted to the World Conference on Disaster Reduction (WCDR-II) 2005 in Kobe, Japan. The outcome of the WCDR has proved to be a milestone in the field of disaster reduction. The revised national action plan has included different national priorities on disaster risk management such as emergency response, strengthening policy, effective reconstruction and rehabilitation, institutional reform, and human resource development. An action plan has been prepared for disaster response, disaster preparedness, disaster mitigation, disaster reduction, and rehabilitation. The Government of Nepal has established a Steering Committee and a Working Committee to draft 'National Strategies on Disaster Management'.

Legal provision. The Natural Disaster Relief Act 1982 is the legal instrument for coping with disaster nationally. Before the promulgation of this Act, disaster management was ad hoc. The Act provides for the establishment of Disaster Relief Committees at central, regional, district, and local levels. This Act is applicable to natural disasters such as earthquakes, fires, storms, floods, landslides, heavy precipitation, drought, famine, and epidemics.

The Cabinet approved a National Building Code (NBC) in 2060 BS. After the approval of the NBC, the Department of Urban Development and Building Construction (DUDBC) has been attempting to enforce this code in all government buildings as well as in private buildings through the municipalities. Lalitpur Sub-Metropolitan City implemented the code first in 2003 (UN 2001).