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Monographic issue

# Disaster profile of Nepal

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# *Letter from the Editors*

The *Emergency and Disaster Reports* is a journal edited by the Unit for Research in Emergency and Disaster of the Department of Medicine of the University of Oviedo aimed to introduce research papers, monographic reviews and technical reports related to the fields of Medicine and Public Health in the contexts of emergency and disaster. Both situations are events that can deeply affect the health, the economy, the environment and the development of the affected populations.

The topics covered by the journal include a wide range of issues related to the different dimensions of the phenomena of emergency and disaster, ranging from the study of the risk factors, patterns of frequency and distribution, characteristics, impacts, prevention, preparedness, mitigation, response, humanitarian aid, standards of intervention, operative research, recovery, rehabilitation, resilience and policies, strategies and actions to address these phenomena from a risk reduction approach. In the last thirty years has been substantial progress in the mentioned areas in part thanks to a better scientific knowledge of the subject. The aim of the journal is to contribute to this progress facilitating the dissemination of the results of research in this field.

This monographic issue is about Nepal and its disaster risk profile. Nepal's fragile geology and steep topography make it the 20th top most disaster prone country in the world. Nepal is a part of the Himalayan-Ganga system with the system extending about 160-200 kilometers from north to south spanning six geological and climatic belts varying in altitude from about 8000 to just about 60 metres above mean sea level in eastern Nepal. About 83 per cent of Nepal lies within the mountainous region of the country, while the remaining 17 per cent falls in the northern part of the Ganga Basin plain.

As a country Nepal is ranked fourth, eleventh and the thirty in terms of relative vulnerability to climate change, earthquake and flood hazards respectively. It is highly prone to high magnitudes of natural hazards such as flood, landslide, earthquake, fire, hailstone, windstorm, thunderbolt, cloudburst, drought, Glacier lake outburst flood (GLOF), avalanches and epidemics.

Nepal ranks the twenty three in terms of total natural hazard related deaths globally for the year 1988-2007 with more than 7000 deaths as a result of natural hazards. 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. Eighty-five percent of Nepal districts are prone to disasters of some type, sixty-five percent of districts are prone to floods and/or landslides and thirty percent to wildfires.

Nepal ranks very high in terms of relative vulnerability to earthquakes and water related disasters respectively. Of the 21 cities around the world that lie in similar seismic hazard zones, the capital, Kathmandu is at the highest risk in terms of impact on people. All the above mentioned facts make this study of Ashma Baruwal an excellent approximation to the global disaster risk profile of Nepal.

*Prof. Pedro Arcos, Prof. Rafael Castro*
*Editors, Emergency and Disaster Reports*

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*Monographic issue*

# Disaster profile of Nepal

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## List of Abbreviations

| | |
|---|---|
| ADPC | Asian Disaster Preparedness Center |
| ADB | Asian Development Bank |
| CSSR | Collapsed Structure Search and Rescue |
| CDO | Chief District Office |
| CDRC | Central Disaster Relief Committee |
| CDRF | Central Disaster Relief Fund |
| CIEC | Center for International Studies and Cooperation |
| DD | Damage Depth |
| DDRC | District Natural Disaster Relief Committee |
| DHO | District Health Office |
| DHM | Department of Hydrology and Meterology |
| DHS | Department of Health Services |
| DoMG | Department of Mines and Geology |
| DoI | Department of Irrigation |
| DP-Net | Disaster Prevention Preparedness Network |
| DDRC | District Natural Disaster Relief Committee |
| DEPROSC | Development Project Service Center |
| DRR | Disaster Risk Reduction |
| DSCWM | Department of Soil Conservation and Watershed Management |
| DWIDP | Department of Water Induced Disaster Prevention |
| EOC | Emergency Operation Center |
| EVRA | Exposure Vulnerability and Risk Assessment |
| INSARAG | International Search and Rescue Advisory Group |
| GoN | Government of Nepal |
| GLoF | Glacial Lake Outburst of Flood |
| GDP | Gross Domestic Product |
| GFDRR | Global Facility for Disaster Reduction and Recovery |
| GPS | Global Positioning System |
| HOPE | Hospital Preparedness for Emergencies ( |
| IASC | Inter Agency Sectoral Committee |
| ICIMOD | Integrated Centre for Integrated Mountain Development |
| IFRC | International Federation for Red Cross |
| JICA | Japan International Cooperating Agency |
| KVERMP | Kathmandu Valley Earthquake Risk Management Project |
| LDRC | Local Natural Disaster Relief Committee |
| LSGA | Local Self Governance Act |

| | |
|---|---|
| MBT | Main Boundary Thrust |
| MF | Main Frontal Thrust |
| MFR | Medical First Responder (MFR |
| MIRA | Multi Cluster Initial Rapid Assessment |
| MOHA | Ministry of Home Affairs |
| MoHP | Ministry of Health and Population |
| MMI | Modified Mercalli Intensity |
| NA | Nepal Army |
| NCRA | Natural Calamity Relief Affect |
| NDMA | National Disaster Management Authority |
| NDMC | National Disaster Management Council |
| NDR | National Disaster Report |
| NEOC | National Emergency Operation Center |
| NGI | Norwegian Geo Technical Institute |
| NRCS | Nepal Red Cross Society |
| NSET-Nepal | National Society for Earthquake Technology- |
| NS | National Scouts |
| NRRC | National Risk Reduction Consortium |
| NSDRM | National Strategy for Disaster Risk Management |
| OFDA | Office for Foreign Disaster Administration |
| OXFAM-GB | Oxfam-Great Britain |
| RDRC | Regional Natural Disaster Relief Committee |
| SWC | Social Welfare Council |
| STDS | South Tibetan Detachment System |
| USACE | United States Army Corps of Engineers |
| USD | United States Dollars |
| UNDMS | UN Disaster Management Secretariat |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UNICEF | United Nations Children's Fund |
| UNOCHA | United Nations Office for the Coordination of Humanitarian Affairs |
| UNDP | United Nations Development Programme |
| UNFPA | United Nations Population Fund |
| UNISDR | United Nations International Strategy for Disaster Reduction |
| USAID | U.S Agency for International Development |
| WFP | World Food Programme |
| WHO | World Health Organization |
| WB | World Bank |

# 1. INTRODUCTION

Nepal is a mountainous landlocked country between China on one side and India on the south east and west. The total area of Nepal is 147,181 square kilometres[1]. It spreads from 145 kilometres in the north to 241 kilometres in the south and 885 kilometres from east to west[2]. The population of Nepal is approximately 27 million with nearly 2 million of migrant population working abroad[1]. Nepal was declared a federal republic in 2008. The country is still in the process of creating a new federal republic constitution and concluding the peace process. Administratively, Nepal is divided into 5 Development Regions, 14 Zones, and 75 Districts. There are 3,913 Village Development Committees and 58 Municipalities.lt is the world's 93rd largest country by land mass and the 41st most populous country. Nepal's gross domestic product (GDP) for 2012 was estimated at over $17.921 billion[2].

## Geography

Nepal's landscape is predominantly composed of hills and mountains covering about 83 % of the total area of the country and the country's small size betrays its geological, topographical and climatic diversities thus resulting in the varied problems that the country and its population faces[4]. Nepal is characterized by rugged topography, variable climatic conditions, complex geological structure with active tectonic process and continued seismic activities.

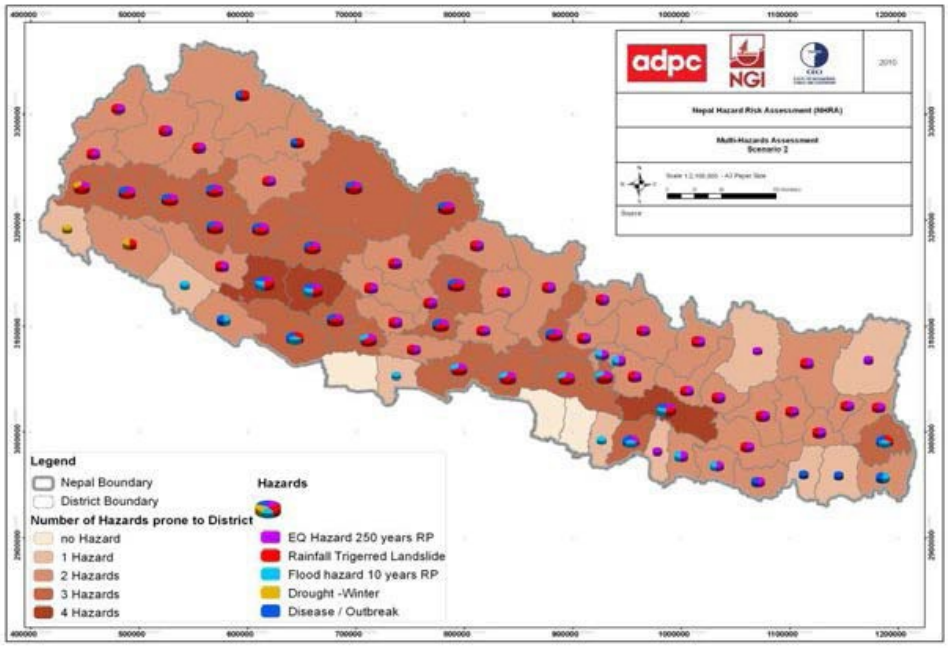
The elevation of the country rises from 70 m. in Terai to 8848 m. within a short horizontal distance of 145 to 241 Kilometres. Such a sharp vertical landscape renders the country highly vulnerable to potential water induced disasters like landslide, slope failure, soil erosion and debris flow[1]. It is divided into three ecological zones, the Mountains, Terai and Hills. The low lying plains of "Terai" borders India and is a part of the northern Indo-Gangetic plains.Three main Himalyan rivers-, the Kosi, the Narayani and the Karnali form part of the region. The outermost range of foothills called Shiwalik or Churia Range cresting at 700 to 1,000 metres (2,297 to 3,281 ft) marks the limit of the Gangetic Plain[36]. The "hills" lie adjacent to the mountains and it varies from 800 to 4,000 metres in altitude.

The Mahabharat range starts from the 1,500 to 3,000 metres at the southern end with subtropical river valleys and hills alternating at the northern end. Population density is high in valleys but notably less above 2,000 metres and further less above 2,500 metres (8,202 ft) as the region occasionally experiences snowfall during winter. The "mountains" situated in the Great Himalayan Range, makes up the northern part of Nepal and contains the highest elevations in the world including the Mount Everest at 8,848 metres. Seven other of the world's eight thousand metre peaks are in Nepal or lie on its border with China[5].

## Hot Bed for Natural Disasters

Nepal's fragile geology and steep topography make it the 20th topmost disaster prone country in the world. Nepal is a part of the Himalayan-Ganga system with the system extending about 160-200 kilometers from north to south spanning six geological and climatic belts varying in altitude from about 8000 to just about 60 metres above mean sea level in eastern Nepal[1]. About 83 per cent of Nepal lies within the mountainous region of the country, while the remaining 17 per cent falls in the northern part of the Ganga Basin plain. Nepal can be divided into eight physiographic units that approximately run from the east to west ,the Terai ,the Chure or Siwalik range,the Dun valleys, the Mahabharat Range, the Midlands, the Fore Himalaya, the Higher Himalaya, and the Inner and trans-himalayan valleys.

Map 1: Areas prone to different hazards




Source: Nepal Hazard Risk Assessment

Nepal is ranked 4th, 11th and 30th in terms of relative vulnerability to climate change, earthquake and flood hazards respectively. It is highly prone to high magnitudes of natural hazards such as flood, landslide, earthquake, fire, hailstone, windstorm, thunderbolt, cloudburst, drought, Glacier lake outburst flood (GLOF), avalanches and epidemics[1]. Nepal ranks 23rd in terms of total natural hazard related deaths globally for the year 1988-2007 with more than 7000 deaths as a result of natural hazards[6]. 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.

An 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[1] as shown in Map 1. Globally Nepal ranks very high in terms of relative vulnerability to earthquakes and water related disasters respectively. Of the 21 cities around the world that lie in similar seismic hazard zones, the capital, Kathmandu is at the highest risk in terms of impact on people[7].

The fact that the country is small in size and also few people live in comparison to other countries that are in the top, the rankings are particularly high for the country and thus undermine the soaring yearly toll on human lives as a result of disasters such as floods, even during "normal"years[8].

## 2. TRENDS AND ANALYSIS

The top 10 natural disasters for the country from 1971-2011 (Table 1) shows that epidemics, landslides and floods are a consistent threat to human life with epidemic being the number one killer in terms of hazards. The casualty rate for these hazards is consistent over the decade. The analysis shows that about 750 people are killed every year due to these hazards[9].

Table 1: Top Ten Disasters from 1971-2004

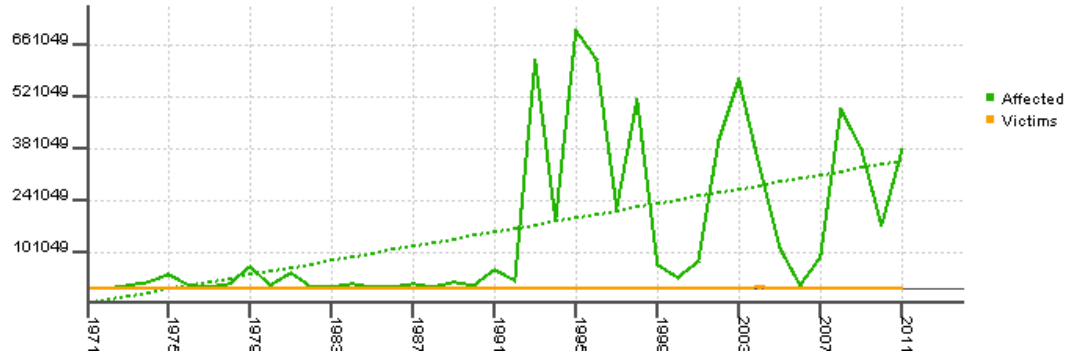
| Hazards | Events (n) | Deaths (n) | Injuried (n) | Affected (n) |
|---|---|---|---|---|
| Epidemic | 3452 | 16566 | 43076 | 514535 |
| Landslides | 2908 | 4476 | 1589 | 574020 |
| Flood | 3520 | 3329 | 523 | 3935933 |
| Fires | 5264 | 1328 | 1200 | 264114 |
| Accident | 1314 | 1280 | 491 | 2509 |
| Thunderstorm | 1175 | 1091 | 2111 | 8447 |
| Earthquake | 212 | 882 | 7024 | 39596 |
| Cold wave | 458 | 595 | 83 | 2393 |
| Structural Collapse | 425 | 414 | 643 | 2671 |
| Boat Capsize | 146 | 284 | 154 | 410 |
| Other | 97 | 77 | 64 | 11982 |
| **Total** | 18971 | 30322 | 56958 | 5356610 |

Source: DesInventar 2011

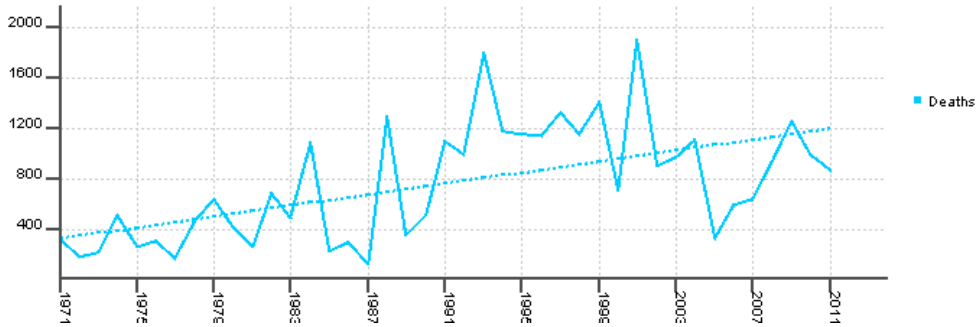
Preliminary analysis shows that epidemics accounts for more than 50% of the deaths occurring due to natural hazards followed by landslides and floods at 14.7 and 10.9 percents respectively. However, fires account for more than 25% of the number of events while flood accounts for more than seventy percent of the affected population[9].

The trend shows that there has been a sharp increase in the number of people affected during the 1990s as shown in the Graph 1. The trend of deaths (Graph 2) in the region is also quite sporadic but dramatically increases in the 90s which could be attributed to the same factor as well as the outbreak of diseases such as malaria[10].

Graph 1: Trend of Affected Population due to Disasters (1971-2011)




Graph 2: Trend of Deaths due to Disasters (1971-2011)



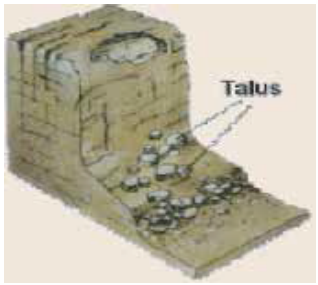

Source: DesInventar 2011

# 3. LANDSLIDES

Unstable steep slopes and fragile geological formation of a young growing mountain range with heavy monsoon rainfall leads to wide range of geological and hydro-meteorological disasters across the country. Varnes system of classification is one of the most commonly used which is based on the nature of the source material involved and the type of involvement involved (Figure 1)[11].

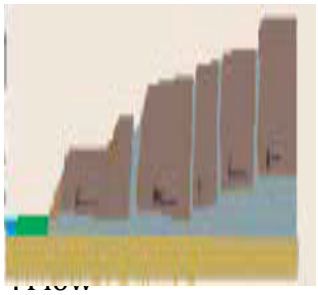
Landslides in Nepal vary in size from massive failures of whole mountains to very minor slope failures. The variation in geological characteristics together with torrential rain during rainy season results in landslides[12]. The weak geo-tectonic characteristics of the Himalaya make it vulnerable to both heavy rainfall and earthquakes[13]. Inundations of large areas are due to overflowing river banks resulting in extensive damage to life and properties. Nepal's hills and mountains covering most of the country are at the highest risk of landslides[14].

a. Fall

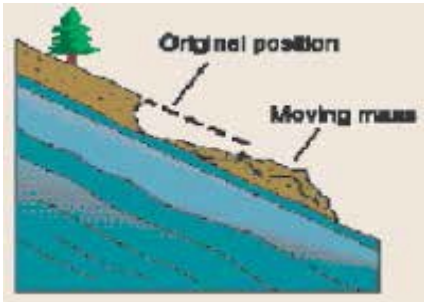



b. Topple

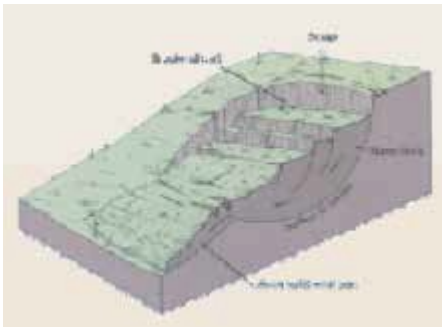
c. Slide



d. Flow




e. Slide



A landslide is the result of slope failure. The factors can be geological, morphological, physical, and/or human (Cruden and Varnes 1996). The Mahabharat and the Higher Himalayan Range are the two units that are mainly responsible for the rainfall and the climate sectors of the country[2].

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 thus resulting in a high rate of natural territorial sedimentation[8].Other natural factors are earthquakes and weathering.

The major anthropogenic factors are inappropriate land use and poor watershed management practices such as deforestation, extension of agriculture on steep slopes, intensive agriculture or unsuitable crops, and overgrazing; poor water management; unplanned settlements; and poorly planned construction of roads, trails, and other infrastructure[14]. Various other social factors also come into play when it comes to the extent of damage post landslides. lack of awareness amongst the population as well as the decision makers could be one of the major anthropogenic activity related indirect cause of landslides. All the above mentioned factors are the underlying causes for the landslides but is usually triggered by two factors namely excess of rainfall and the second one being earthquake, excavation or transitory stress [15].

According to the hazard risk assessment carried out for landslides, hazard maps have been developed for two classes namely, rainfall induced landslide and earthquake induced landslide. The lithology, soil moisture, slope and rainfall are the underlying factors for a landslide which are usually triggered either by landslide or earthquake. Landslide hazard maps have been developed for the whole country[16].

Bhattarai and friends report that roughly 12,000 landslides/slope failures occur every year. Important mountain highways of Nepal, including the Tribhuvan, Prithvi, Arniko, Butwal-Pokhara, and Narayanghat-Mugling highways, regularly experience landslides. The last 2 days of the month of July in 2003 saw landslide and slope failures at more than 70 locations along the Narayanghat-Mugling Highway because of intense 24- hour rainfall. According to the media reports a total of 83 people were killed , 46 were injured and over 4250 families were affected cause of one event[20].

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[8].

## Rainfall induced landslide

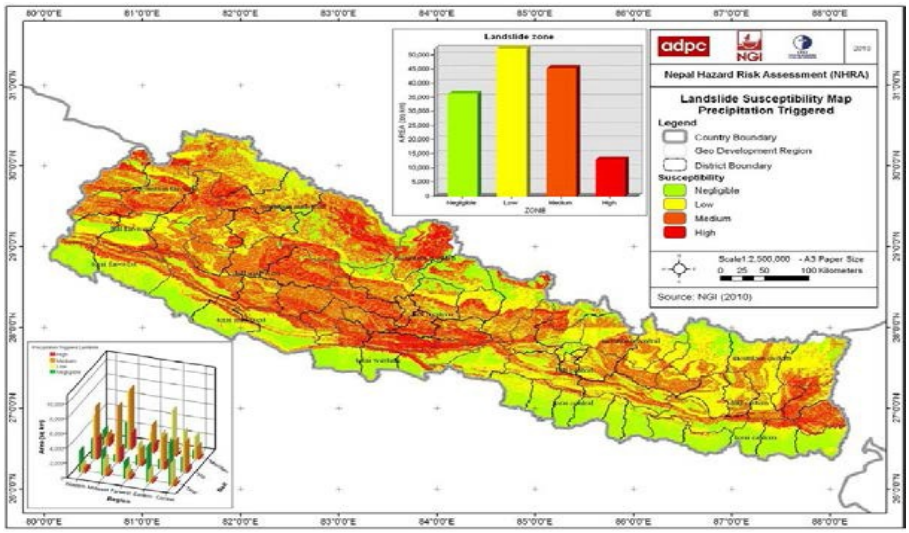
In Nepal, the number of landslide events is at its peak during the monsoon season owing to high rainfall. According to NSET, the whole of the hilly and mountainous region is exposed to landslides during the monsoon period and majority of the landslides occurs during the late monsoon periods. Rainfall during the monsoon season is caused by the influence of both the south-east and south-west Monsoon, characterized by intense rainfall during the four months from June to September, contributing to 80%

of the rainfall. During the monsoon, rivers originating from the Mahabharat range; viz., the Kankai, Kamal, Bangmati, West Rapti and Babai causes greater damage in floodplains of Terai region. Riverine floods from the major perennial rivers generally rise slowly in the southern Terai plains.

The rainfall induced landslide zones are distributed relatively normal (normal distribution) with large area having low and medium severity with the high severity zone is mainly due to the specific lithology condition[16]. Karmacharya[17] studied the relationship between total annual precipitation and the frequency of landslide events in Nepal during a period between 1971 and 1980 through a spatial distribution analysis, and found that the landslide frequency is high in high annual precipitation zones .

The areas in central Nepal, between Okhaldhunga (in east) and Pokhara (in west) has higher amount of rainfall-induced landslides than other parts of country[18]. Based on analysis, more than 20 % of geographical areas of Rukum, Arghakhanchi, Baglung, Ilam, Tanahu, Syangja, Mustang and Palpa are prone to high landslides triggered by high intensity rainfall. More than 10 % of Jajarkot, Rasuwa, Salyan, Baitadi, Terhathum, Surkhet, Bajhang, Bajura, Rolpa, Darchula, Pyuthan, Gulmi, Dolpa, Nawalparasi and Panchthar are prone to high landslide under above stated category[16](Map 2)

Map 2: Areas prone to rainfall induced landslides




Source: Nepal Hazard Risk Assessment

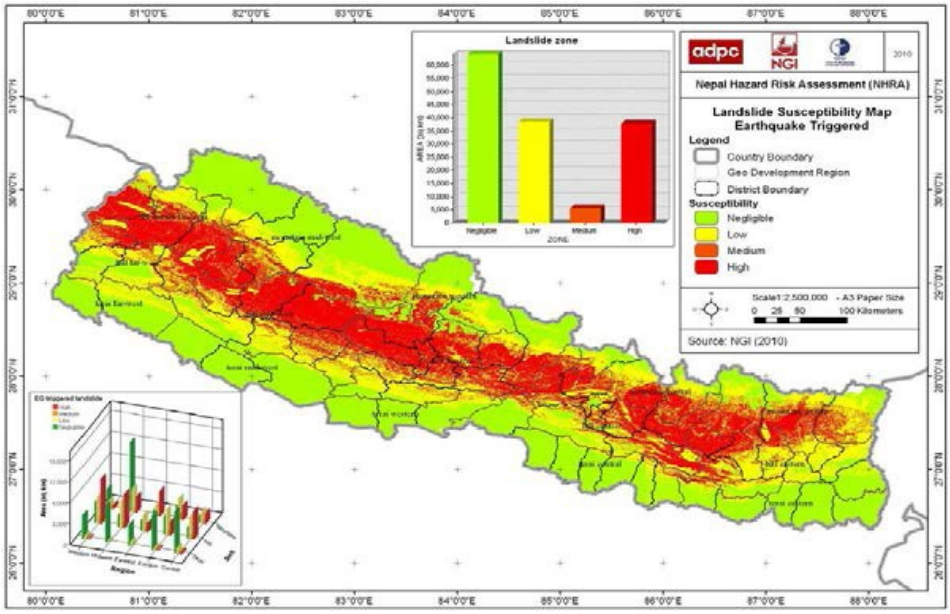
Gabet *et al.* (2004) studied the relationship between landslides and rainfall in Khudi Khola catchments along the Marsyangdi river. River valley, which gets between 3,000 and 5,000 millimetres of rainfall per year. For three consecutive monsoon seasons,from 2000 to 2002, they used a six-station network 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[18]. Another recent study by Dahal and Hasegawa[19] have established an empirical rainfall threshold of landslides for the Nepal Himalaya and found that if daily rainfall exceeds 144 mm, small-scale or shallow-seated landslides, which generally refer to failure of weathered slope material over hard or soft bedrock mass, may occur in the Nepal Himalaya.

## Earthquake Induced Landslides

High susceptibility zone of landslide due to earthquake hazard are distributed in the central region of Nepal. The medium severity zone is situated around the high severity areas and covers smaller percentage of geographical area. Negligible and low zone areas are located in north and southern border of Nepal.

Map 3: Areas Prone to Earthquake induced landslides




Source: Nepal Hazard Risk Assessment Part 1

## Trends

There is a general consensus that the impacts of landslides has been on the rise but there is lack of data in numbers to support the claim. According to a study conducted by David et al[12] from 1978-2005, it has been found that there is a high level of variability in the occurrence of landslides from year to year, but that the overall trend is upward. The analysis of the study shows that the occurrence of landslides fatalities overlaps the cycle of southwest

monsoons in the South Asia. There is an inverse relationship between the monsoon strength and the amount of precipitation in the hilly district areas of Nepal. The reason for the increase in the number of fatalities has been stated as the change in land use, deforestation and unplanned road building. According to the study, it mentions that a major component of the generally upward trend in landslide impact probably results from the rural road-building programme, and its attendant changes to physical and natural systems[12].

## Case Study of Krishnabhir

Krishna Bhir, situated 82.5 kilometers from Kathmandu along the Prithvi highway until 2004 was notorious for disrupting the highway to the capital of the nation. Every year until 2004, the place was a nightmare for thousands of commuters traveling along the highway with the landslide with being people stranded on either side of the highways for hours or even days.Transport of the essential supplies were halted. In 2000, an entire side of the mountain slithered down the Trisuli river during the monsoon blocking the highway for 11 days. Even after the debris was cleaned, it would be blocked again following a slight spell of rain.But then in 2004, Krishnabhir got a total facelift[21].


Source: Areal distribution of large-scale landslides along highway corridors in central Nepal. Georisk: Assessment and Management of Risk for Engineered Systems and Geohazards.2013.

According to Naresh Man Shakya, an engineer at the Department of Roads and the incharge of the project, they used a combination of water and debris management along with bioengineering , the problem was resolved.The team used special grass to trap debris, armoured the surface and anchored the top soil, thus stopping the slide. Culverts, inclined at 15 degrees, were set up underneath the reconstructed highway over the drained

and left over debris. A retaining wall was constructed at the toe of the slide adjacent to the river.Different other structures such as wire bolsters,wire mesh, seeding,rofa boards(German technology) and seedlings were also used. The total project was completed under Rs 40 million unlike as proposed by a Japanese constructor who studied the landslide and proposed to fix it for oer Rs 2 billion. The successful plan was home made and it is one of the 100 major landslide sites that have been stable since2003-2004[22].

# 4. FLOODS

The Mahabharat and the Higher Himalayan Range are the two physiographic units that control the rainfall and the climate zones of the country. Precipitation in Nepal follows the South Asian monsoons path with majority of the locations receiving about 80 per cent of their annual precipitation as rainfall during the months of June to September and the rest 20 percent between November and February. During the summer monsoons, precipitation decreases from east to west while the winter monsoon shows the reverse trend. The amount of precipitation decreases after 3,000 meters[23]. At the same time, south-facing slopes (windward side) receive more rainfall than north-facing (leeward side) slopes, because they fall in the rain-shadow regions.

The Chure and the Mahabharat ranges are the first mountain barriers so the northward-moving monsoon clouds coming from the Bay of Bengal upon encountering these get heavy precipitation. The annual precipitation in the Mahabharat region is around 2,500-3,000 millimetres and rainfall up to 500 millimetres of rain in 24 hours are common. Such cloudbursts, which occur at intervals of about eight to ten years, bring disasters such as floods and result in deaths and damage to property and infrastructure[8].

Flooding occurs when the 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. Most of the Terai faces severe problem of floods. Rivers originating from the Siwaliks are brief and become wild during the monsoon season, thus posing high flood hazards to the Tarai. Extensive inundation in the Tarai plain is due to frequent change in the river courses and erosion in the bank rivers[8]. There are seven river basins in Nepal that are the most prone to flooding: Bagmati, Kankai, Kamala, Rapti, Tinau, Babai and Narayani. The different reasons for floods in Nepal are[24]:

## Rainfall

According to the NDR 2009, 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[8]. The average annual rainfall is 1,627 mm.Torrential rainfall and cloudbursts that

bring over 400 mm rainfall in a single day are common in the Mahabharat Range and often cause heavy floods[25]. Rainfall intensity during a single hour is equally high, with over 40 millimetres common in the lower Mahabharat and Chure ranges[8].

## Topography

The slopes of Nepal's hills and mountains range from steep to very steep from 30 to less than 10 cent in the Terai region. Because of this gradient change, the rivers in the higher areas flow at very high speed and in turn bring sediment along with it. However, on entering Terai region, the speed lessens and all the materials of stones, gravel, sand and silt gets deposited as an alluvial fan. And as such deposition increases, the level of the river bed also rises which increases the probability of flooding even during moderate rainfall.

The natural properties of a watershed, including relief, precipitation type, vegetation cover, and drainage capacity, determine the magnitude of a flood. 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[8].

## Deforestation

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[26].

## Trends

Floods have been reported in Nepal since the early 19$^{th}$ century. The floods in 1978,1980,1985, 1987,1989 are among the major floods recorded in Nepal. The July 1993 flood for two days however was the most overwhelming in terms of the intensity and damage it had on the national economy as a total of forty four districts were affected. Thousands of people were rendered homeless and thousands of hectares of standing crops were also destroyed. Around 1,336 people lost their lives and about 73,000 households were affected. Seven bridges along the national highway were destroyed resulting in the capital being cut off from the rest of the country. The power stations of Kulekhani 1 and 2 were closed down due to the damage to the penstock pipe. Several farmer managed irrigation project along with the irrigation projects of Bagmati, Manusmara and Rapti were washed away due to the heavy downpour. The total loss in terms of infrastructure damage was estimated to be Rs 5 billion[8].

Budhi Gandaki river at Labu Besi was blocked by a huge landslide on August 1 in 1968.The river was blocked for 29 hours and created a 60- metre deep lake. The debris flow and flood washed away most of the houses and

bridges downstream when it breached. Floods and landslides in 1950, 1952, 1957, 1977, 1982, 1985, 1993, 2002 and 2005 have caused more than 1,680 human casualties in every event[27].

Climate anormalies and changes in extreme events have been observed throughout the region with intense rains, floods and droughts reported every year. More gradual year-on-year changes in temperature have also been observed, with a 0.09ºC per year increase in recorded in the Himalayas and 0.04ºC per year increase in the Terai (with higher increases in winter). The most profound impacts of climate change in Nepal will be in agriculture and food security, water resources, water induced disasters, biodiversity changes, and human health[28].

## Risk Assessment and Hazard Analysis

ADPC in collaboration with the GoN, NGI and CIEC carried out a vulnerability and risk assessment study. Seven major river basins that is Kamala, Kanki, Bagmati, Tapti, Tinau, Babai and Narayni rivers were studied as part of the analysis Flood hazard map was developed showing the flood inundation and flood water depth with respect to various return periods. The return periods were 10,25,50, 100 and 500 years. Bigger the return period, worse is the case scenario. It has been found that flood coverage area is directly proportional to the return period.

The hazard maps were developed based on data available with focal departments and established authentic sources. Flood exposure, vulnerability and assessment was carried out for the different return periods with respect to agriculture, housing, population, education and hospitals for the fact that they are the primary affected sectors. However, it has been mentioned that carrying out such study is difficult in under developed countries due to lack of detailed data.

For the agricultural sector, the flood water depth ranges from 0.3 meters to over 2 meters. When looking at 100 year return periods, the percentage of agricultural land affected ranges from 0.02 in the Bagmati river basin to over 10 percent in the Narayani river basins.

The percent of housing exposed to flooding in the river basins ranged from 5% in the Kankai river basin to a maximum of 72% in the Bagmati river basin. Analysis for the educational institutions revealed that schools in the Babai region were the least affected with the schools in the Bagmati river basins being the most affected at over 13%. Similarly 100 percent of the health institutions in the Bagmati river basin is expected to be affected with the health institutions in the Kankai river least affected followed by the Babai river basin. The effect on population with respect to 100 year return periods also depends on the population density of the river basin with more than 500,000 adult population at risk in the Bagmati river basin[24].

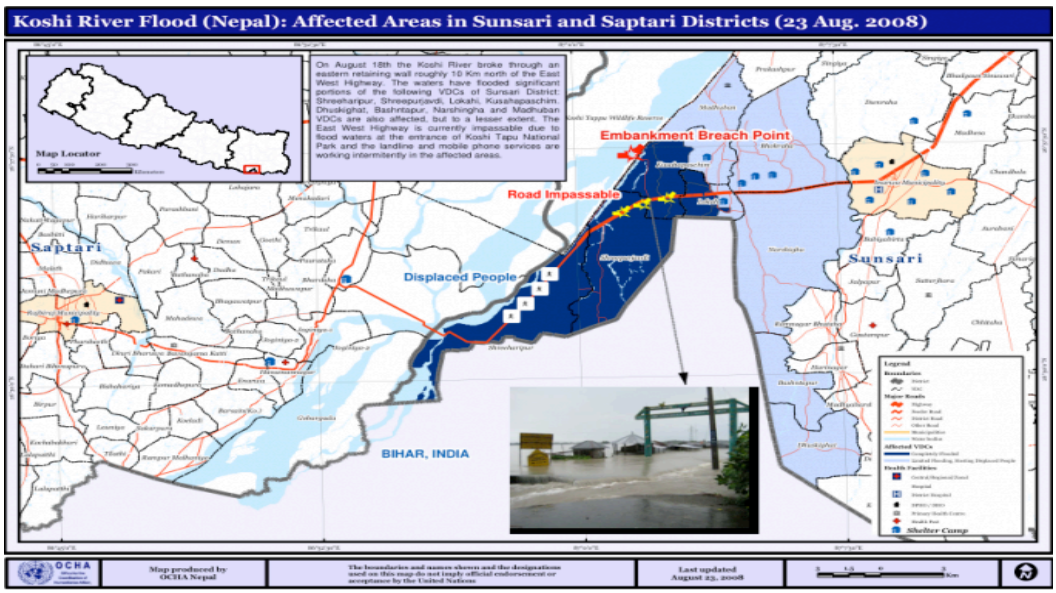
Based on the results, a damage depth(DD) curve was developed after modifying it to suit the conditions of Nepal. The DD curve was built off the

United States Army Corps of Engineers (USACE) and the USACE Institute for Water Resources. The modification of the DD is based on the past performance of buildings during floods. The characteristics and performance of each type of building in floods has been considered when finalizing the DD ratio curve. The DD grades are classified as D1- slight(1-15%);D2-moderate(15-35%); D3-high(30-60%); D4- very high(>61 %) and used to study the effect on different building structures. The analysis revealed that almost all the housing in all the river basins were affected by either D3 or D4 grade[16].

## Case Study: Koshi flood (2008)

Nepal had a devastating flood in 2008 in eastern region due to heavy monsoon rains in Koshi River Basin, one of the largest river basin among the major three river systems in the country. On 18 August, the Koshi River breached an embankment through an eastern retaining wall damaging two dam spurs, roughly 10 Km north of the East West Highway, affecting 8 VDCs - Kusaha, Laukahi, Ghuski, Sreepur, Haripur, Narshimha, Madhuban and Basantapur of Sunsari and Saptari Districts. Additional flooding on 29 August affected further 4 VDCs.

The breach occurred because 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. 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[15].




Source: UNOCHA, 2008.

## Direct loss and Damage

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 the Sunsari District. The Indian nationals from the state of Bihar who were displaced by the flood also sought refuge in Nepal for a few weeks before they were able to return back.[8]

However, the data on loss and damage differs with different sources. According to the field survey conducted by UNESCO a total of 6183 households that is 40% of the households in the 12 VDCs of the flooded areas were affected[30]. While, the source at the CDO Office, Sunsari, put the total number of displaced families at 7584. Almost all the households in the districts of Haripur and Shreepur were affected[15].Majority of the properties in the area including houses, public buildings and temples were swept away and destroyed. In addition to that , 8 rice mills and 23 seller mills were also damaged in the disaster. A total of almost 265 kms were destroyed which included the East West Highway.

The East West Highway is the country's main transport lane and the highway remained impassable for three months hampering movement of agricultural product from the Eastern Terai to other parts of the country. A total of 17 km was damaged of which 1 km was completely washed away at three different points and about 4 km was submerged in flood water[15] .The flood destroyed 12 km of the Mahendra Highway in different parts of the Sunsari district and the transport of goods and foods was halted completely for a nearly four months. Similarly resuming the supply of drinking water and electricity to the normal took nearly 4 months in many of the places[30]. The same was the case with the industries which resulted in huge economic loss. UNESCO estimated the loss at about 3773.6 million rupees. Land value comprised nearly 64% of the total loss, followed by livestock, food, crops and houses[30].

Partial Early Warning System had been established at the flood site and rise in the level of water which had been brought to notice a week prior to the incident. Local radio regularly aired the situation of the river and as the spur cutting began, people were alerted and advised to leave the place which was a day before the catastrophe. This did result in people being evacuated with limited belongings. The responsible agency, DDRC in the area contacted the different local and international agencies requesting rescue and relief materials. As one of its main responsibilities, DDRC assessed the situation while the NRCS carried out damage and needs assessment. Oxfam, Caritas and DEPROSC Nepal completed were involved in the initial rapid assessments of the area. Initial food needs was done by the WFP. MoHP, WHO and UNFPA carried out rapid health assessment. UN OCHA was responsible for carrying out initial assessment of the situation in the district of Saptari and other areas. Child protection and education assessment was done by child related agencies[15]. Initially, ready to eat foods was distributed

by the Government, INGOs, NGOs, UN and local civic organizations. Later on 30,000 were fed up to two weeks by the WFP[31].

The cluster approach was carried out by the government and humanitarian agencies. The Government took the lead role in response operations through DDRCs and CDOs by coordinating between local authorities and the different responsible ministries[8]. A State of Emergency was declared on the 4th of September'2008 in the 10 VDCs of Sunsari and 1 VDC of Saptari which facilitated the CDOs at the district level to make decisions and take actions as required. At the regional level, the Saptakoshi Disaster Management Coordination Cell was established to monitor and direct the DDRCs. The work of the international humanitarian community in both regions was being coordinated through a cluster system formalized on 9 September 2008[15]. Different clusters were established as per the needs such as WHO was responsible for looking into the health sector; nutrition and watsan – UNICEF; food assistance- WFP and education was overseen by the UNICEF and the Save the Children together. UNOCHA was responsible for the protection with UNICEF overlooking the child protection. IOM was responsible for the coordination and management of the camp while the emergency shelter was provided by the IFRC.

The clusters was coordinated by the UNOCHA.Two barges were funded by the World Bank to provide temporary transport across the Koshi River. Immediate response in the districts of Saptari and Sunsari was provided by the NGOs and NRCS which was done in coordination with the UN agencies. NRCS was chiefly responsible for facilitating the distribution of relief materials obtained from the various government agencies and development partners[29].

The Government of India also provided Rs 321 million as part of immediate relief to the affected people as the respective government is responsible for maintaining the Koshi barrage and the embankment under the Koshi Project Agreement.The fact that responsibility was actively shared between the different acting agencies, the initial rescue and relief was met very quickly. However, there were still challenges as there was no pre designated evacuation sites[15]. There was no pre identified land for camp settlement and the vulnerability assessment of public buildings which could be used for evacuations was not done. Appropriate registration system was absent which further delayed the process of carrying out relief efforts.

The government lacked emergency budget which delayed procurement of relief materials for the emergency shelters[8]. Though there was only one fatality as a result of flooding but the number rose to 55, which mostly happened in the shelter camps as reported by the CDO office of Sunsari[8]. The number varies with that of UNESCO which puts the figures at 40, of which 18 were female and 6 were children[30]. Many of them had died due to diarrhea. The response and relief was not adequate as the quality of the relief items and the non food items provided ranged from the lowest to that of the highest. There was gaps in information flow. The disposal of dead animals was a huge problem and the time duration for developing the distribution

mechanism was longer than expected. Management of the camp with respect to SPHERE standard also posed as an issue. Establishment of EOC at the district level was seen as one of the needs during the disaster[29].

## Case Study-Mahakali Flood(2013)

The Mahakali river is a transboundary river between Nepal and India with a catchment area of 14,871 km2. The month of July saw massive flooding in the Mahakali River which disrupted the lives of over 2500 people in the region, namely, Khalanga, the district headquarter of Darchula[32]. Local Administration issued an early warning to the people living along the banks of the river due to the absence of embankments along the area. The flood washed away 14 houses, four temples, three government offices and 17 huts as stated by the Darchula District Police Office.

The District Administration office declared a state of emergency. At least 50 police personnel from District Police Office and 50 Nepal Army personnel have been deployed as part of the relief and rescue efforts. Neighbour India into which a majority of the river flows into opened the gates of Mahakali barrage so as to minimise the risk[32]. The bridge over the Mahakali River was closed and a red flag was placed over it indicating the danger. The Natural Disaster Relief Fund distributed 20 kg of rice, five kg of pulses, one kg of salt and a liter of edible oil to each flood-hit families and Rs. 5,000 to Rs. 20,000 to those who were rendered homeless in the floods. The distribution was done through the Nepal Red Cross Society[32].

# 5. EARTHQUAKE

Le Fort[33] in his report has mentioned that Himalayas are the youngest mountain range on Earth, and were produced as a result of the world's most recent tectonic activity. The process of formation around 50 million years ago when the Indian tectonic plate moving northward first had a collision with the Asian plate after floating near the South Pole for about 70 million years. But the process of movement towards the north continued even after the collision, resulting in slicing, breaking and folding which resulted in the upliftment of the country's front edge. This led to the formation of Himalayas. They were responsible for first bringing the summer rains, to South Asia 17 million years ago and they continue to affect the climatic conditions of the region until today[34]. The Indian plate still continues its movement towards the north at about 20 millimetres a year and converges with the Asian plate below Tibet which further pushes the Himalayas upward. Recent global positioning system (GPS) measurements using satellites have shown that show the central region of the Himalayas of Nepal, northeast of Kathmandu is rising 7±2 mm per year[5].

Himalayas is formed by five thrusts in the upper region of the Indian plate, namely, the Main Central Thrust (MCT); the Main Boundary Thrust (MBT); and the Main Frontal Thrust (MFT), and the South Tibetan Detachment System (STDS) which is also a normal fault. These five thrusts form the floor of the Tethyan sedimentary series of the Himalaya and all the three faults conjoint along the MHT. The energy is stored for a period of time and their sudden release causes earthquakes[8].

Nepal has a long history of earthquakes owing to its location on an active tectonic zone[8]. The country's environmentally hazardous location both climatically as well as the terrain coupled with its low level of development further intensifies the risk and makes the population more vulnerable. According to the NDR 2009 [8],The first major earthquake in Nepal was reported in 1255. Since, then various others have been recorded through the years, 1408, 1681, 1810, 1833 and 1866. But the major one to hit the valley of Kathmandu was in 1934 measuring 8.4 on Richter scale with the epicenter in eastern Nepal. The earthquake had devastating effects both in terms of human casualties as well as infrastructure (NSET-Nepal 1999). The number of human casualties were put at 8,500 along with partial or complete destruction of almost 38,000 buildings. Another one in 1980 measured at 6.5 on Richter scale had its epicenter in Bajhang, far western Nepal. Human casualties were reported to be 178 and about 40,000 houses were damaged. Similarly, the earthquake in 1988 measured at 6.6 on the Richter scale had its epicenter in Udaypur district in eastern Nepal. The event caused a total of 721 human casualties and destroyed infrastructures completely[35].

According to the seismological center of Nepal, medium and small size earthquake event occurs in Nepal frequently. According to Global earthquake Initiatives, Kathmandu is exposed to the greatest earthquake risk per capita

among 21 megacities around the world, and the risk is largely based in terms of poor infrastructure which are likely to collapse, insufficient preparedness and medical care[1].

## Risk Assessment and Hazard analysis

Eathquake was one of the natural hazards studied as part of the Multi hazard risk assessment carried out by the ADPC in collaboration with GoN & CECI. The Department of Mines and Geology (DoMG) has developed Peak Acceleration Map for the whole country and the earthquake hazard maps have been developed on MMI scale. Earthquake exposure assessment was done to identify the social and physical elements at risk and hazard maps has been done for the whole of Nepal with return periods of 50,100,250 and 500 years respectively. Very high map seismic risk has been demarcated by red colors followed by orange, light brown yellow and yellow colors depicting high, medium and low seismic zone respectively[16]. Under 500 years return period, 29 districts of the total 75 fall under the very high risk zone with two third area of the 19 districts falling under high risk zone.

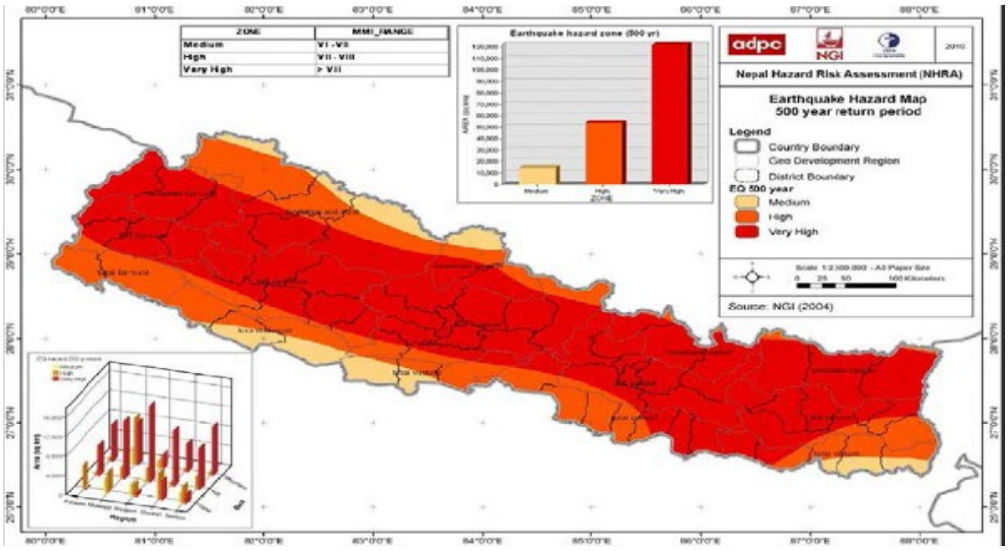
Analysis of the population exposure with respect to age group shows that Kathmandu has the highest population with a high proportion falling in the productive age group (age 15-59 year) along with high proportion of children. Further analysis shows that 10% of the elderly population in more than 60 districts is exposed to very high earthquake hazards. Similarly 60 percent of adults are exposed to very high earthquake hazard zones in 40 districts. Around 40 percent of the children living in 35 districts are prone to a very high earthquake hazard zone. Hazard analysis of the housing sector revealed that as a highly concentrated urban area, Kathmandu has the highest proportion of permanent houses exposed to a very high hazard zone. On an average 35 percent of permanent houses in Nepalese districts are exposed to a very high hazard earthquake zone.

When looking at the risk assessment of the educational institutions, it shows that 84.8% of the schools in Nepal lie very high hazard zone areas. Vulnerability to health sector was also analyzed as part of the study and the result showed that since 41 districts are exposed to high hazard zone areas, a large number of health posts are also exposed. The proportion of health posts found in a high hazard zone area is higher than in a moderate hazard zone area. Hospitals were also analyzed though less in number as compared to health posts. The profile shows that Kathmandu along with two other districts has four hospitals exposed to high risk earthquake. More than 60 districts have over 100 percent of their hospitals located in a very high earthquake hazard zone area.

For a 500 year earthquake return period, in more than 25 districts, the bridges are located in a very high hazard zone area[16].For the 250 year return period, 2 districts fall completely under the high risk zone with 12 districts having more than two thirds of their area in a high risk category. High risk zone has slightly larger area coverage, followed by medium and then by very

high earthquake risk zone. Terai area has large coverage of medium earthquake risk zone[16].

Map 3: Hazard analysis for 500 years return period



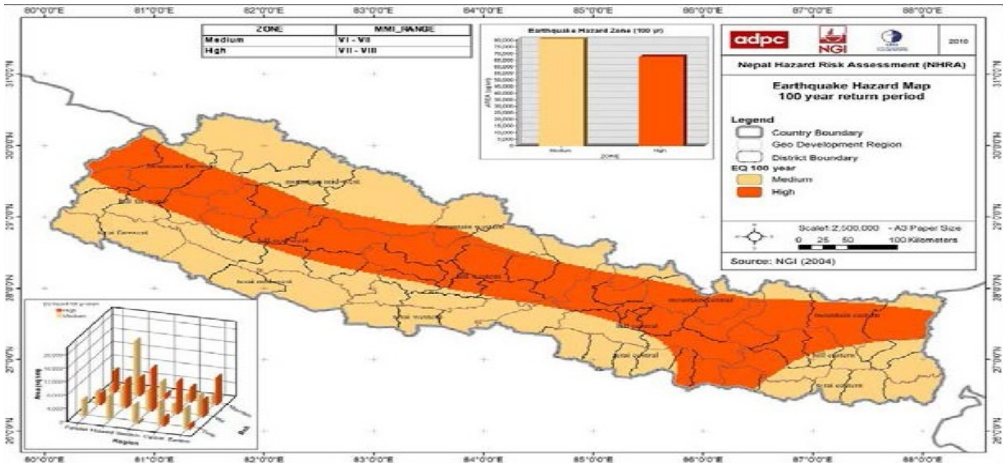

Source: Nepal Hazard Risk Assessment Part 1

100 years return period hazard mapping relatively covers medium and high risk zones. Thirty four districts fall under the high risk zone with eleven districts completely falling under the high risk zone. medium earthquake risk zone has larger area coverage than high risk zone. High risk zone is concentrated in the Hill belt, followed by the Mountain area, and lastly the Terai region.

The analysis reveals that around 10 percent of the elderly people living in more than 55 districts are exposed to a high earthquake hazard. Likewise, 60 percent of adults and 40 percent of children are exposed to high earthquake hazard zone in 28 districts. When it comes to housing, on average 40 percent of permanent housing in all Nepalese districts are exposed to a high hazard earthquake zone with the permanent houses of the capital, Kathmandu being one of most severe hit amongst 5 others. Hazard analysis for the educational institutions showed that in 12 districts the schools are located in a high hazard zone area with around 20 districts schools are falling in a moderate earthquake hazard zone. In 24 districts 100 percent of the bridges are located in a high earthquake hazard zone area[16].

For the 50 year return period, medium earthquake risk has large coverage with the high risk zone concentrated in the hilly region.The hazard mapping shows that 8 districts have more than two thirds of their area in high risk zone. Western region shares a larger distribution of high risk zone as compared to other regions[16].

Map 4: Hazard Analysis for the 100 year return period




Source: Nepal Hazard Risk Assessment Part-1

## Hazard Analysis of Kathmandu

With the impending risk of an imminent earthquake, several loss estimation studies have been carried out among which one was carried out by Kathmandu valley earthquake risk management project (KVERMP) which focused on the impact of earthquakes on building institutions and other infrastructural aspects. The study was administrated by ADPC and implemented by the National Society for Earthquake Technology – Nepal (NSET) and GeoHazards International. Nepalese and international experts were consulted to provide information on earthquake risk in the Kathmandu valley. Different earthquakes that have struck the valley was used as case studies for the project. An iso-seismal map based on the MMI scale was layered over maps depicting the most current infrastructural and demographic data for the area. Impacts were estimated based on the extent of ground-shaking and liquefaction potential. This information was used to help develop a safer Nepalese building code[16].

## Case study: 1934 earthquake (8.4 Richter scale)

The results shows that up to 60 percent of all the buildings in the Kathmandu valley would be damaged heavily, many beyond repair. Almost half of the bridges in the valley would become blocked or impassable, and 10 percent of the paved roads would be moderately damaged with deep cracks or subsidence. In addition, many of the narrowest streets in the valley would be blocked by debris from damaged buildings and approximately 95 percent of the water pipes and 50 percent of the other water system components would be seriously damaged. Almost all of the telephone exchange buildings and 60 percent of the telephone lines would be damaged and it is expected that there would be more than 40,000 deaths and more than 95,000 injuries

reported. Along with an additional 600,000 to 900,000 residents of the Kathmandu valley rendered homeless[37].

Another study was carried out by Japan International Cooperation Agency (JICA) in collaboration with MOHA, Government of Nepal on earthquake disaster mitigationin the Kathmandu valley, Kingdom of Nepal" in 2002.Historic earthquake catalog was used in the study and the current seismological and tectonic activity in and around the Kathmandu valley along with its demographic data and infrastructural development was also taken into consideration. The different case studies used were the 1934 Bihar-Nepal earthquake (magnitude 8.4), the mid-Nepal earthquake (magnitude 8.0), the north Bagmati earthquake (magnitude 6.0) and the Kathmandu valley local earthquake (magnitude 5.7)[38].

According to the study, if an earthquake similar to that of the Bihar-Nepal earthquake is to occur in valley, it is estimated that 59,000 (or 23 percent) of the buildings would be heavily damaged and that the death toll would be 20,000 people (or 1.4 percent of the total population) in the valley. Around 59,000 people would be seriously injured. There are a total 2,497 schools in the valley and if an earthquake similar to that of mid-Nepal earthquake occurred it is estimated that 20 percent of the schools would be heavily damaged and 11 percent would be partially damaged. It is also estimated that 2 percent of the hospitals would be heavily damaged and 9 percent would be partially damaged. For every 15 bridges in the area, 13 are likely to collapse in a major earthquake[38].

# 6. ECONOMIC LOSSES

Disasters whether it be small, medium or a large one result in thousands of lives being lost as well as destruction of infrastructures causing losses worth millions of rupees and hampering the economy and development of the country. The various impacts of disasters has been classified as direct(human lives, infrastructure, livestock), indirect(disruption of goods and earnings loss) and secondary effects such as impact on GDP performance, indebts etc. There are two databases which have looked into the economic losses suffered by Nepal as a result of the natural disasters. One is the Des Inventar database compiled by the NSET in collboration with the UNDP, which looks into the disasters from 1971-2010[40].The other one is by the MOHP in collaboration with DWIDP which looks in to the disasters from 1983-2010. According to the MOHA/DWIDP database[39], a total of 22,302 people have been killed by all types of disasters with an annual average of 797.More than 50% of the human casualties is due to epidemics(Table 2).A total of 82,172 livestock have been lost with an annual average of 2,935.

A total of 417,002 buildings have been damaged with an annual average of 14,900 buildings. Total agricultural land of 117,967 hectares has been affected with an annual average of 4,200 hectares. Infrastructural damage

includes health facilities, government offices and the total number stands at 6,640 with an annual average of 240(Table 3)[39].

As seen from the Table 3, the highest amount of loss was incurred in the year 1988, of around 6 billion Nepali Rupees, the value of which in 2010 was estimated to be Rs 30.83 billion. The economic loss in terms of GDP for the year was around 6.83%.The year 1993 also showed large amount of losses of around Rs 5.2 billion, mainly due to the floods that hit South-Central Nepal, the value of which in the year 2010 was estimated to be Rs 16.2 billion. Significant GDP losses were also seen in the years 1987, 1989 and 1993 with 2.61%, 4.03% and 2.61% respectively[39].

Table 2: List of Disasters from 1983-2010

| Year | Flood & Landslides | Fire | Epidemics | Windstorm Hailstorm & Thunderbolts | Earthquake | Avalanche | Stampede | 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 | 128 | 20 | 2 | 0 | 0 | 318 |
| 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 | 83 | 65 | 951 | 49 | 0 | 12 | 0 | 1160 |
| 1998 | 273 | 54 | 840 | 23 | 0 | 0 | 0 | 1190 |
| 1999 | 193 | 39 | 1207 | 22 | 0 | 5 | 0 | 1466 |
| 2000 | 173 | 37 | 141 | 26 | 0 | 0 | 0 | 377 |
| 2001 | 196 | 26 | 154 | 38 | 1 | 0 | 0 | 415 |
| 2002 | 441 | 11 | 0 | 6 | 0 | 0 | 0 | 458 |
| 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 | 114 | 3 | 0 | 15 | - | - | - | 132 |
| 2007 | 216 | 9 | 3 | 40 | - | 6 | - | 274 |
| 2008 | 134 | 11 | 10 | 16 | - | 0 | - | 171 |
| 2009 | 135 | 35 | 462 | 7 | - | 2 | - | 641 |
| 2010 | 240 | 69 | 36 | 70 | - | - | - | 415 |
| Total | 7,809 | 1,334 | 11,461 | 773 | 727 | 127 | 71 | 22,302 |
| | | | | | | Average of 28 years | | 797 |

Source: MOHP 2004

Table 3: Direct Loss due to Disasters from 1983-2010

| Year | Loss of Livestock (No.) | Houses Destroyed (No.) | Land affected (Ha.) | Damage in Public Infrastructures (No.) | Estimated loss (Million NRs.) | Value of losses in 2010 |
|---|---|---|---|---|---|---|
| 1983 | 248 | 12 | | | 240.00 | 1,974.38 |
| 1984 | 3,547 | 10,597 | 1,242 | 869 | 49.00 | 378.84 |
| 1985 | 3,399 | 7,166 | 1,355 | 436 | 23.00 | 167.49 |
| 1986 | 6,566 | 3,370 | 1,315 | 436 | 23.00 | 147.35 |
| 1987 | 1,852 | 36,220 | 18,858 | 421 | 2,005.00 | 11,363.18 |
| 1988 | 2,788 | 108,801 | | 4,365 | 6,099.00 | 30,833.49 |
| 1989 | 4,240 | 7,648 | | | 4,172.00 | 19,353.44 |
| 1990 | 867 | 6,352 | 1,132 | | 139.00 | 619.56 |
| 1991 | 642 | 5,510 | 283 | 39 | 43.00 | 174.86 |
| 1992 | 1,586 | 13,997 | 135 | 66 | 52.00 | 175.20 |
| 1993 | | 21,911 | | | 5,189.00 | 16,197.44 |
| 1994 | 1,329 | 3,234 | 392 | | 184.00 | 542.90 |
| 1995 | 2,053 | 10,275 | 41,867 | | 1,933.00 | 5,303.58 |
| 1996 | 2,480 | 30,014 | 6,063 | | 1,579.00 | 3,955.40 |
| 1997 | 1,191 | 4,825 | 6,063 | | 410.00 | 947.46 |
| 1998 | 1,179 | 15,082 | 327 | | 1,230.00 | 2,620.03 |
| 1999 | 650 | 4,304 | 182 | | 509.00 | 964.48 |
| 2000 | 1,017 | 6,886 | 889 | | 1,141.50 | 2,092.54 |
| 2001 | 665 | 6,103 | | | 526.55 | 936.13 |
| 2002 | 2,126 | 19,856 | 10,078 | | 525.56 | 907.32 |
| 2003 | 1,125 | 6,819 | 2,360 | | 989.93 | 1,631.43 |
| 2004 | 888 | 4,818 | | | 341.09 | 545.09 |
| 2005 | 955 | 3,169 | | | 387.21 | 592.70 |
| 2006 | 10,098 | 3,765 | 3,397 | | 392.31 | 553.03 |
| 2007 | 21,861 | 37,984 | 514 | | 1,928.55 | 2,555.42 |
| 2008 | 7,066 | 13,864 | 21,315 | | 1,633.28 | 2,008.53 |
| 2009 | 228 | 1,050 | | 5 | 420.25 | 458.40 |
| 2010 | 1,526 | 23,370 | 200 | 3 | 1,398.19 | 1,398.19 |
| Total | 82,172 | 417,002 | 117,967 | 6,640 | 33,563.42 | 109,397.87 |
| | Average Annual Loss during the period (2010 Value) | | | | | 3,907 |

Source: MOHP 2004

Table 4: Direct Losses due to Disasters from 1971-2010

| Hazard | Buildings | | Agricultural Land and Forest (Ha) | Livestock (No.) | Public Infrastructures | | |
|---|---|---|---|---|---|---|---|
| | Destroyed (No.) | Damaged (No.) | | | Roads (affected in meters) | Education centers (No.) | Medical Facilities (No.) |
| 1971 | 131 | 142 | 500 | 1,335 | - | 2 | - |
| 1972 | 771 | 86 | 397 | 340 | - | 1 | - |
| 1973 | 1,957 | 160 | 1,404 | 709 | 500 | - | - |
| 1974 | 2,615 | 859 | 17,347 | 1,431 | 1,045 | 1 | - |
| 1975 | 2,051 | 36 | 1,292 | 723 | - | 4 | - |
| 1976 | 4,957 | 448 | 30,404 | 1,714 | 2,050 | 1 | - |
| 1977 | 1,347 | 462 | 12,877 | 299 | - | - | - |
| 1978 | 3,132 | 75 | 345 | 959 | 3,960 | - | - |
| 1979 | 2,061 | 68 | 778 | 695 | - | - | - |
| 1980 | 14,348 | 13,650 | 16,818 | 10,881 | - | 68 | 1 |
| 1981 | 1,246 | 1,004 | 9,537 | 687 | - | 1 | - |
| 1982 | 1,039 | 37 | 1,614 | 6,894 | - | 1 | - |
| 1983 | 1,384 | 1,207 | 1,448 | 399 | 598 | 20 | - |
| 1984 | 2,568 | 485 | 5,429 | 2,892 | 16,040 | 6 | - |
| 1985 | 1,475 | 63 | - | 1,067 | - | 5 | - |
| 1986 | 1,160 | 21 | 223 | 392 | - | 1 | - |
| 1987 | 1,041 | 6,115 | 2,365 | 804 | - | 6 | - |
| 1988 | 23,202 | 41,182 | 1,003 | 1,446 | 2,000 | 2,388 | - |
| 1989 | 4,813 | 1,377 | 7,898 | 669 | - | 4 | - |
| 1990 | 1,209 | 1,366 | 1,791 | 91 | - | 2 | - |
| 1991 | 1,392 | 202 | 243 | 100 | 350 | 4 | - |
| 1992 | 6,225 | 79 | 77,993 | 442 | 450 | 1 | - |
| 1993 | 21,249 | 21,673 | 90,485 | 25,165 | 25,224 | 2 | 1 |
| 1994 | 3,175 | 517 | 157,688 | 766 | 160,000 | 15 | - |
| 1995 | 9,685 | 15,898 | 23,622 | 2,409 | - | - | - |
| 1996 | 19,638 | 13,923 | 6,849 | 2,995 | - | 6 | - |
| 1997 | 4,549 | 1,046 | 80,668 | 26,414 | 50 | - | - |
| 1998 | 15,978 | 477 | 3,975 | 1,035 | 495 | 6 | - |
| 1999 | 4,046 | 697 | 3,022 | 1,101 | - | 4 | - |
| 2000 | 3,038 | 1,810 | 36,580 | 1,125 | 3,072 | 9 | 3 |
| 2001 | 6,308 | 2,350 | 51,920 | 28,672 | 200 | 12 | - |
| 2002 | 14,059 | 5,479 | 12,561 | 4,593 | 2,780 | 3 | - |
| 2003 | 1,974 | 761 | 72,634 | 2,395 | 271,062 | 27 | 2 |
| 2004 | 1,641 | 3,339 | 37,480 | 101,993 | 141,025 | 26 | 2 |
| 2005 | 1,449 | 539 | 15 | 1,484 | 44,320 | 20 | |
| 2006 | 1,927 | 8,512 | 72,746 | 1,297 | 15 | | |
| 2007 | 9,456 | 1,466 | 5,696 | 499,566 | 80 | 31 | 1 |
| 2008 | 16,029 | 3,293 | 89,568 | 8,853 | 33,420 | 67 | 9 |
| 2009 | 3,761 | 9,125 | 38,902 | 7,782 | 24 | 104 | 4 |
| 2010 | 4,276 | 8,453 | 10,444 | 1,674 | 300 | 33 | 1 |
| Total | 222,362 | 168,482 | 986,560 | 754,288 | 709,060 | 2,881 | 24 |

Source: MOHP 2004

According to the DesInventar Database which has disasters data filed from 1971-2011 shows that the total deaths for the period of fourty years is 30,982 with an annual average death of 775(Table 3). Epidemics accounts for more than 25% of the data followed by floods and landslides. A total of

222,362 houses were completely destroyed of which 168,482 were damaged by the 1980 Bajhang earthquake and 1988 Udayapur earthquake[40].

High infrastructural damage was also seen in the floods of south central Nepal and Koshi flood of 1993 and 2008 respectively. a total of 986,560 hectares of land have been damaged during past 40 years(Table 4) .Nearly 94% of land loss is due to floods(24%) followed by landslides at 2% and other hydro metrological disasters count for 68% of the of the loss. A total of 754,288 numbers of different livestock were lost during the 40 years with an annual average livestock loss of around 19,000. Flood is one of the major (71%) causes of livestock loss.

A total of 710 km of different types of roads have been damaged or washed away by different disasters during the said period with landslides being the major reason. 51% of the road damage is a result of landslides. A total of 2,881 numbers educational facilities, primarily school buildings have been lost during the 40 years period along with 24 n health facilities. The figure mentioned for the health facilities seems to be low because many such buildings are often reported as housing or other building categories[15]. According to the NDR 2011[15], economic values of all damages and loss have been calculated along with year wise loss for the DesInventar Database. The loss values were initially calculated for the 2004 prices of the properties and then they were converted to the prices of the said year using the price index of 2010.Based on the calculations, Nepal has lost almost Rs 937 billion worth of properties as a result of the different disasters in the last 40 years with an average loss of Rs 23,431,217 million every year[15].

Table 5: Top 5 Disasters & Damage to Infrastructures

| Hazard | Buildings | | Agricultural Land and Forest (Ha) | Livestock (No.) | Public Infrastructures | | |
|---|---|---|---|---|---|---|---|
| | Destroyed (No.) | Damaged (No.) | | | Roads (affected in meters) | Education centers (No.) | Medical Facilities (No.) |
| Earthquake | 33,708 | 55,312 | - | 2,215 | - | 2,461 | 1 |
| Flood | 93,807 | 86,504 | 232,095 | 536,369 | 53,358 | 63 | 3 |
| Landslide | 18,249 | 13,690 | 22,288 | 10,486 | 364,937 | 76 | 6 |
| Fire and Forest Fire | 71,930 | 1,834 | 10,789 | 115,532 | 3,025 | 72 | 8 |
| Other Hydro-Meteorological | 3,419 | 10,101 | 669,604 | 9,897 | 275,200 | 195 | 6 |
| Others | 1,249 | 1,041 | 51,785 | 79,789 | 12,540 | 14 | - |
| Total | 222,362 | 168,482 | 986,560 | 754,288 | 709,060 | 2,881 | 24 |

Source: DesInventar 2011

According to the Economic Survey, 2011, the GDP for the year 2010 was Rs.1183 billion and on comparing the estimated loss with the GDP for the year, it has been found that around 2% of the GDP is lost every year due to disasters. The year 1998, 1993 and 2008 shows greater losses owing to the major intensive disasters in those years. Floods are one of the major contributors to the total economic loss with floods accounting for 70% of the total loss followed by droughts at 9% (Table 5)[15].

Table 6: Year wise damage to Infrastructures (1971-2010)

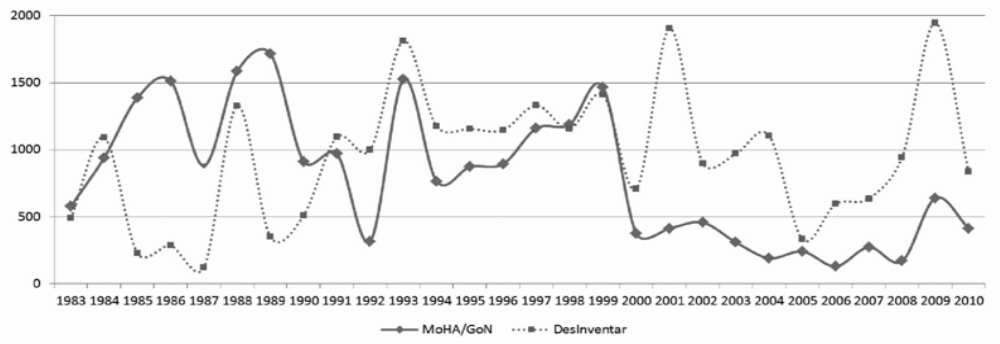
| Hazard | Buildings | | Agricultural Land and Forest (Ha) | Livestock (No.) | Public Infrastructures | | |
|---|---|---|---|---|---|---|---|
| | Destroyed (No.) | Damaged (No.) | | | Roads (affected in meters) | Education centers (No.) | Medical Facilities (No.) |
| 1971 | 131 | 142 | 500 | 1,335 | - | 2 | - |
| 1972 | 771 | 86 | 397 | 340 | - | 1 | - |
| 1973 | 1,957 | 160 | 1,404 | 709 | 500 | - | - |
| 1974 | 2,615 | 859 | 17,347 | 1,431 | 1,045 | 1 | - |
| 1975 | 2,051 | 36 | 1,292 | 723 | - | 4 | - |
| 1976 | 4,957 | 448 | 30,404 | 1,714 | 2,050 | 1 | - |
| 1977 | 1,347 | 462 | 12,877 | 299 | - | - | - |
| 1978 | 3,132 | 75 | 345 | 959 | 3,960 | - | - |
| 1979 | 2,061 | 68 | 778 | 695 | - | - | - |
| 1980 | 14,348 | 13,650 | 16,818 | 10,881 | - | 68 | 1 |
| 1981 | 1,246 | 1,004 | 9,537 | 687 | - | 1 | - |
| 1982 | 1,039 | 37 | 1,614 | 6,894 | - | 1 | - |
| 1983 | 1,384 | 1,207 | 1,448 | 399 | 598 | 20 | - |
| 1984 | 2,568 | 485 | 5,429 | 2,892 | 16,040 | 6 | - |
| 1985 | 1,475 | 63 | - | 1,067 | - | 5 | - |
| 1986 | 1,160 | 21 | 223 | 392 | - | 1 | - |
| 1987 | 1,041 | 6,115 | 2,365 | 804 | - | 6 | - |
| 1988 | 23,202 | 41,182 | 1,003 | 1,446 | 2,000 | 2,388 | - |
| 1989 | 4,813 | 1,377 | 7,898 | 669 | - | 4 | - |
| 1990 | 1,209 | 1,366 | 1,791 | 91 | - | 2 | - |
| 1991 | 1,392 | 202 | 243 | 100 | 350 | 4 | - |
| 1992 | 6,225 | 79 | 77,993 | 442 | 450 | 1 | - |
| 1993 | 21,249 | 21,673 | 90,485 | 25,165 | 25,224 | 2 | 1 |
| 1994 | 3,175 | 517 | 157,688 | 766 | 160,000 | 15 | - |
| 1995 | 9,685 | 15,898 | 23,622 | 2,409 | - | - | - |
| 1996 | 19,638 | 13,923 | 6,849 | 2,995 | - | 6 | - |
| 1997 | 4,549 | 1,046 | 80,668 | 26,414 | 50 | - | - |
| 1998 | 15,978 | 477 | 3,975 | 1,035 | 495 | 6 | - |
| 1999 | 4,046 | 697 | 3,022 | 1,101 | - | 4 | - |
| 2000 | 3,038 | 1,810 | 36,580 | 1,125 | 3,072 | 9 | 3 |
| 2001 | 6,308 | 2,350 | 51,920 | 28,672 | 200 | 12 | - |
| 2002 | 14,059 | 5,479 | 12,561 | 4,593 | 2,780 | 3 | - |
| 2003 | 1,974 | 761 | 72,634 | 2,395 | 271,062 | 27 | 2 |
| 2004 | 1,641 | 3,339 | 37,480 | 101,993 | 141,025 | 26 | 2 |
| 2005 | 1,449 | 539 | 15 | 1,484 | 44,320 | 20 | |
| 2006 | 1,927 | 8,512 | 72,746 | 1,297 | 15 | | |
| 2007 | 9,456 | 1,466 | 5,696 | 499,566 | 80 | 31 | 1 |
| 2008 | 16,029 | 3,293 | 89,568 | 8,853 | 33,420 | 67 | 9 |
| 2009 | 3,761 | 9,125 | 38,902 | 7,782 | 24 | 104 | 4 |
| 2010 | 4,276 | 8,453 | 10,444 | 1,674 | 300 | 33 | 1 |
| Total | 222,362 | 168,482 | 986,560 | 754,288 | 709,060 | 2,881 | 24 |

Source: Des Inventar 2011

On comparing the two databases for the same period, that is 1983-2010, DesInventar under reports the number of people affected and the damage incurred until 1990 but reports higher after 1990(Graph 3).The reason for this could be the increased reporting of the events in the media[15].

The Ex-Ante and Ex Post Investment Estimates in Disaster Risk Reduction was carried out by the NSET with support from the Global Facility for Disaster Reduction and Recovery (GFDRR) of the World Bank which analyzed the investments by the different organizations from the period 1998-2008 with regards to DRR[41]. Ex ante refers to the expenditures done by agencies pre disasters while Ex Post refers to the expenditures post disasters. Mainly four types of organizations were studied, the government agencies, the donor agencies, UN agencies and the few other INGOs[15].

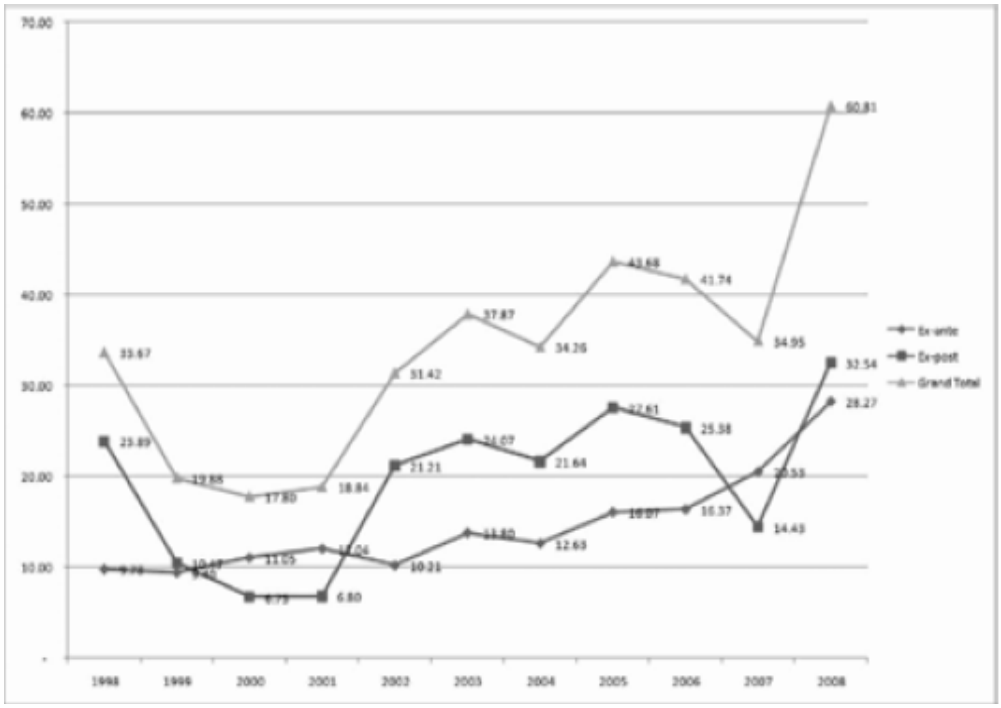
Graph 3: Comparison of losses




Source: MOHA and DesInventar

The study revealed that a total of 1.1 billion USD had spent in the said period of which 60% (681.568 million USD) was a part of direct investments. The different activities carried out as part of the direct investments was preparedness, response, planning and pre-disaster mitigation activities while the remaining 40% (402.785million USD) was spent impromptu in response related activities. Of the total amount invested, almost 50% has been invested in the health sector alone in the event of epidemics. This is followed by landslides and floods with a total amount of 123.747 million USD. A significant amount of around 332.717 million USD has also been spent on preparedness and response to general hazard(Graph 4). It also includes the post event relief for the people, mostly in the form of cash or reconstruction[41].

Graph 4: Comparison of expenditure Ex Ante and Ex Post Disasters




# 7. DISASTER RISK MANAGEMENT FRAMEWORK

## Natural Calamity Relief Act, 1982

Ministry of Home Affairs (MOHA) is the lead agency for preparing national policies and accountable for its implementation. It was under the leadership of MOHA that the National Calamity Relief Act, 1982 was established in Nepal[42].It was the earthquake of 1980 that prompted the formation of National Calamity Relief Act, 1982(NCRA) after concerns poured in from various national and international agencies[15]. According to NCRA 1982, earthquake, fire, storm, flood, landslide, heavy rain, drought, famine, epidemic, and other similar natural disaster were included as part of the term natural disasters and mainly focused on relief and rescue aspects. (Dangal-). However, after amendments were made to the act in 1989 and 1992, the act expanded to include man-made calamities such as industrial accidents. The amendment also included preparedness and rehabilitation components in it[15].

The Central Disaster Relief Committee (CDRC) was also established through the NCRA under the MOHA along with various disaster relief committees as the regional, district and local levels namely, Regional Natural

Disaster Relief Committee (RDRC), District Natural Disaster Relief Committee (DDRC) and Local Natural Disaster Relief Committee (LDRC) of which the CDRC and DDRC are very much functioning but LDRC is yet to function normally[15].Efforts are being made to operate the RDRC which is headed by the regional administrator.

The CDRC is the apex body with Relief and Treatment sub- committee and Supply, Shelter and Rehabilitation sub- committee at the center .CDRC is a committee of 25 representatives with the Minister of Home Affairs as the head of the CDRC along with the Minister of Health, the Minister of Physical Planning & Works, Secretaries of other ministries, representatives from the Nepalese Army(NA) and the Nepal Police(NP), the Director Generals from the Department of Mines & Geology(DoMG) and from the Department of Hydrology & Meteorology(DHM), as well as representatives from the Social Welfare Council(SWC), the Nepal Red Cross Society(NRCS) and the Nepal Scouts(NS). The committee has a Central Disaster Relief Fund (CDRF), which is occasionally supplemented by the Prime Minister's fund.CDRC usually formulates short term directives and ways of dealing with disasters, specifically large disasters. The CDRC meets twice a year that is pre and post monsoon season but can meet as often as required otherwise as well[27].

At the district level, the DDRC has been implemented in all the 75 districts and the Chief District Officer (CDO) is the chairperson of the committee and is responsible for taking disaster related decisions such as rescue and relief. DDRC comprises of the District Health Office (DHO) and other agencies dealing with emergency response (army, police and the district chapter of NRCS), critical facilities and development institutions such as irrigation, road and. DDRC is responsible for assessing the situation and if the disaster is a huge one, then the DDRC seeks recommendation from the RDRC and MOHA for further actions[27].

A National Action Plan for disaster management in Nepal was formulated in 1996 after UN declared the need for disaster reduction efforts in 1994. As part of the new plan, disaster preparedness, response, recovery and mitigation activities were prioritized and the responsibilities of the various organizations were outlined. It also mentions time frames for monitoring and evaluation which, however, have only been negligibly applied[15].Nepal has committed itself to DRR in the world forum, be it the World Conference on Disaster Reduction in Yokohama Japan in 1994 as well as the World Conference on Disaster Reduction in Kobe Japan in 2005[27].

## Local Self Governance Act, 1999

The Local Self Governance Act (LSGA) has given the authority and responsibility to local people and the local governing bodies such as the DDCs, VDCs and the municipalities to undertake activities with respect to DRR. Control of natural calamities, prevention of infectious disease and epidemics, operation and management of fire brigades, developing mitigating and preventive measures against landslide and foods are some of the

assigned task that local bodies can pursue by using the legal authority granted by the LSGA[27].

# 8. POLICIES AND PROGRAMMES

## National Strategy for Disaster Risk Management (NSDRM) 2009

The NSDRM was formed in 2009 and has been built off the Hyogo Framework for Action(HFA) 2005. Various meetings were held between the government, local bodies, international agencies, academic institutions, private sector, UN agencies, INGOs, and civil society organizations during the process. The long term vision of the strategy is to develop Nepal as a disaster-resilient community with a mission to provide supervision and ensure effective disaster management in the country by implementing the disaster cycle concept. The strategy follows the direct principles of disaster risk management that is mainstream DRR concept into the development plan, ensure life safety and social security, lay emphasis to gender and social inclusion, adopt decentralize process of implementation, follow the holistic approach, prioritize the security and safety of staff, follow one-window policy and cluster approach in implementation of DRM and work in the spirit of participation, interaction, and coordination[27].

Different sectoral strategies have been adopted as per the new strategy and these are broadly divided into nine areas, which are agriculture and food security, Health, Education, Shelter, Infrastructure and Physical Planning, Livelihood Protection, Water and Sanitation, Information, Communication, Coordination and Logistics, Search and Rescue and Damage and Need Assessment. The above mentioned approach has been taken into account realizing the fact that disaster management is an integrated multi sectoral responsibility. The strategy has also proposed new institutional arrangement for disaster management which necessitates the formation of a National Disaster Management Council (NDMC) with the Prime Minister as its Chairman. The strategy also envisions National Disaster Management Authority (NDMA) as a Secretariat of the council with other three committees under the council for preparedness, rescue, relief and rehabilitation activities with active participation from all the concerned stakeholders such as the UN agencies, donor community, governmental and non governmental agencies and the different civil societies[27].

An International consortium was formed on May 2009 to support the GoN in developing a long term Disaster Risk Reduction Action Plan built off the NSDRM. Members of the Consortium are the Asian Development Bank (ADB), the International Federation of the Red Cross and Red Crescent Societies (IFRC),

United Nations Development Programme (UNDP), UN Office for the Coordination of Humanitarian Affairs (OCHA), UN International Strategy for

Disaster Reduction (ISDR) and the World Bank (WB). The Consortium also initiated a multi-stakeholder participatory approach with the GoN and various civil society organizations to ascertain short to medium term DRR priorities that are much needed and feasible within the current institutional and policy arrangements of the country. The consortium identified five immediate areas for action namely, making the schools and hospitals structurally and non structurally safe and earthquake resilient, emergency preparedness and response capacity, Flood management in the Koshi river basin, Integrated community based disaster risk reduction/management and policy/institutional support for disaster risk management.

Total budget of the three-year Flagship Programmes is US $131.1 million. On 19 March 2010 the Government formally established the Nepal Risk Reduction Consortium (NRRC) Steering Committee, chaired by the Secretary of Home Affairs. Different Members include the Joint Secretaries of the Ministries of Finance, Education, Irrigation, Local Development, Physical Planning, Health and Population, and the National Planning Commission. Directors and Representatives of the ADB, WB, UNDP, OCHA, IFRC, NRCS, and DP-Net are also members.The Joint Secretary of MoHA is Member Secretary[15 27].

Governmental Agencies Involved in DRR[27]. The following government institutions have a stake in policy formulation and coordination for disaster management:

- National Planning Commission
- Water and Energy Commission
- Ministry of Home Affairs
- Ministry of Water Resources
- Ministry of Forest and Soil Conservation
- Ministry of Environment, Science, and Technology
- Ministry of Health and Population
- Ministry of Local Development

## Ministry of Home Affairs

It is the lead agency for disaster management affairs and is responsible for formulation and implementation of national policies [15]. The above mentioned task is executed through Disaster Management Section and National Emergency Operation Centre under the leadership of Planning and Special Service Division of the Ministry. It also carries out data collection and dissemination and distribution of funds and resources[15].

## Implementing Institutions

## Department of Water-Induced Disaster Prevention

Flood control used to be a section under the Department of Irrigation (DoI). In 2000, this unit became the independent DWIDP. The main targets of DWIDP is to identify potential disaster zones and stock emergency relief

material in all five development regions and establish early warning systems all over the country. The department also plans to have infrastructures for mitigating predictable disasters in place by 2017 so as to reduce the possible losses following a disaster. Their main activity is to prepare and implement a water induced water disaster management policy in place and carry out hazard mapping of the country and strengthen the disaster related system at all levels, be it the awareness, data collection, management and implementation at the community as well as the national level.

DWIDP has seven divisions and five subdivisions throughout the various districts of Nepal[27].

## Department of Irrigation (DoI)

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[1].

## Department of Hydrology and Metrology(DoHM)

Iit was underthe MoWR but was moved to the Ministry of Science and Technology in 1997. It 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[15].

## Department of Soil Conservation and Watershed Management (DSCWM)

This department is one of the main divisions of the Ministry of Forest and Soil Conservation. It works in improving land use and helps increase the productivity of the agricultural land which is usually done through protection, utilization and management of the upper watershed resources.The activity also helps in the community meeting their basic needs. The department incorporates people from all different areas such as the forestry, agriculture, livestock, water and land resources. It ensures community participation and adopts measures to ensure minimum damage to the environment. They help protect irrigation systems and river banks through plantation and other conservation techniques. The department works in expanding and institutionalizing soil conservation and water shed management throughout districts of Nepal.

## Department of Health Services(DoHS)

District health offices dispatch health teams during disasters to provide first aid for the wounded. The DHS acts to control the epidemics that occur after a disaster hits an area[27].

## National and International Agencies

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[27].

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 [15, 27].

# 9. PROGRESS TOWARDS HFA 2005

Nepal has signed the commitment to achieve the HFA goals by 2015. The following progress has been achieved so far:

**Area 1:** The more effective integration of disaster risk considerations into sustainable development policies, planning and programming at all levels, with a special emphasis on disaster prevention, mitigation, preparedness and vulnerability reduction[27 44].

- NSDRM (2009) has been adopted and the 3rd interim plan(2008-2010) calls attention to include DRR as an integral component for sustainable development and has prioritized pre disaster preparedness[43].

- Community participation to be increased for prevention related works at the local level is one of the visions of the plan.

- Sixty seven districts of the seventy five have disaster preparedness plans and four municipalities of the fifty eight have already implemented the safe building construction using the seismic code.

- Multi Hazard Assessment has been carried out for five major disasters.

**Area 2:** The development and strengthening of institutions, mechanisms and capacities at all levels, in particular at the community level, that can systematically contribute to building resilience to hazards [27 44]

- MOHA is the the focal agency for implementing NSDRM in Nepal. It aims to build and develop international coordination with the different stakeholders in the country and work together to augment the institutional capacity in order to execute the DRR activities in the nation.

- The LSGA 1998 promotes decentralization thereby giving more authority to the local bodies and making them more accountable. Disaster Management Committees (DMCs) have been formed at about 44 VDCs (out of 3913 VDCs from 75 districts in the country) of two districts and expansion plans are in progress.

- Inorder to identify gaps in the emergency response and relief,cluster approach has been identified with 13 leading agencies.

**Area 3**: The systematic incorporation of risk reduction approaches into the design and implementation of emergency preparedness, response and recovery programmes in the reconstruction of affected communities[44]. Nepal loses more than 300 lives each year due to water induced and other disasters, which is likely to be increased further owing to climatic change.

- Disaster preparedness and response planning workshop have been conducted at national and regional level through multi-stakeholders involvement. one window policy and cluster approach has been adopted in view of the different disasters in the past[27 44].

- As part of initial damage and loss estimation,Multi Sectoral Rapid Assessment(MIRA) has been put in to action for collection of standard information[27 44].

- 64 evacuation sites have been identified inside the Kathmandu valley to be used during disasters[44].

- At national level, National Emergency Operation Center has been established by the MOHA which acts as a central unit for emergency response capacity, a coordination center among different clusters and as well as during emergency response and relief[27 44].

- Hospital Preparedness for Emergencies (HoPE), Medical First Responder (MFR) and Collapsed Structure Search and Rescue (CSSR) training are being given to Medical officers and security officers[27 44].

- Earthquake Simulation Exercise (INSARAG) was conducted in 2009[44].

- Model agreement between GON and UN to expedite import/export and transit of relief consignments in the event of disasters and emergencies was signed on 31 May, 2007.

- A comprehensive Logistics Capacity Assessment of Nepal has been done by WFP[44].

- Airport Readiness and Surge Capacity assessment of 4 regional and Tribhuvan International Airport has been conducted[44].

## 9. Discussion and Conclusion

Disasters have been a common entity in Nepal since long. The country is geologically young and evolving. Therefore landslides and earthquakes are common and frequent. Given its mountainous topography and the fact that the country comes under the spell of the monsoon every summer, flash floods, regular floods and flood- and earthquake-triggered landslides are also quite common[8]. The immediate effects on any disaster country can be calculated in terms of the toll it has on human lives as well as the burden it has on the national economy. The average annual losses owing to disasters for a resource limited country like Nepal are high and can be debilitating for its progress[15].

The data reveals that Nepal suffers huge amount of human casualties due to disasters and it has been increasing every year. The death toll contributed by epidemics which accounts for more than fifty percent of the deaths occurring due to natural hazards is itself interesting[40]. Nepal needs to invest its economic and human resources for planning and controlling epidemics whether it is by malaria in the 90s or a diarrhea breakout in the 21 st Century[15]. Interestingly, flood accounts for the maximum number of affected population in the last 40 year. Similarly, the trend shows that there has been a sharp increase in the number of people affected during the 1990s. This may be due to increase in the number of events during the period owing to large movement of people from the hills to the Terai regions. Similarly, the trend of deaths in the region is also quite sporadic but dramatically increases in the 90s. This could be attributed to the same factor as well as the outbreak of diseases such as malaria[40].

The economic burden that disasters have on a developing country as Nepal is a limiting factor to its growth and development. Additionally, high level of poverty as of Nepal increases the vulnerability to disasters as the country lacks the basic infrastructure to withstand preventable disasters[13]. The country's economic growth was hampered for the last ten years as it was involved in a maoist insurgency and that the country had to go through a decade long civil war (1996 to 2006)[4]. Disasters as the Koshi flood, 2008 just after the end of civil war was a tough bolt for the nation's economy. It has

been revealed from studies that financial aid for immediate disaster response or post disaster recovery and rehabilitation is mostly done by the government agencies, the donor agencies, UN agencies and the few other INGOs[15]. A significant amount of this fund is used for providing health services during the time of epidemics. Nepal, being a tropical country, the affected population is always at risk of communicable diseases which gets reinforced by the crowded settlement in the rehabilitation centers[15].

A significant amount of around relief fund has also been spent on preparedness and response to general hazard. It also includes the post event relief for the people, mostly in the form of cash or reconstruction[40]. Comparing the different disasters and its impact during the period, the investments made in the disaster risk management have been considerably less and the victims of the disasters have problems of unemployment, housing, health services as the minimal funds are not enough for proper rehabilitation[40]. Additionally, corruption in the government, lack of coordination between government bodies, convoluted bureaucracy, and unreliability of donor and International Non-Governmental Organization contributions are factors that play in the scenario aid integration in Nepal, which could possibly be a challenge to disaster aid implementation[45].

Disaster management is practically divided into “emergency response” (rescue and relief) and “preparedness” with recovery and rehabilitation as well as mitigation and prevention .The central unit responsible for managing/coordinating any kind of emergency response is the Natural Disaster and Floods Division of the Ministry of Home Affairs. “Preparedness” lies in the hands of respective ministries and local authorities, and includes a range of activities such as training, construction (preventive), mitigations, and mobilization of civil society, etc[46].

There are few national institutions that deal with earthquake preparedness, landslides and floods the serious natural disaster threats in Nepal. While there are no reliable statistics on landslide risks including rock fall, the very geological makeup and the topography of the country make landslide a perennial risk to its population. In addition to the fact that Nepal’s population density is low and settlements are scattered over difficult terrain, it's difficult and less cost-effective to undertake large-scale mapping and preventions. Programs to find more cost-effective ways of assessing landslide risks and training of midlevel technicians to undertake site analysis is a dire need. In this way, people can make informed decisions regarding actions to be taken, including relocation of settlements[16 24].

Flood has become such a common feature that many people have learnt to live with it albeit population pressure. The Indo-Nepal agreements on hydropower and water resources, that brings about construction of dams and water irrigation and hydropower plants often plays a substantial role in creating floods in addition to the natural disasters[14]. In addition to political consensus before constructing dams and reviewing inter -country water policies, there are measures that the nation should consider to reduce the flood associated risks. It could involve includes stockpiling of emergency

materials at strategic points all over the country, introducing a gradual shift in land use so that settlements avoid flood plains, building flood haven (a raised platform of earth that people can take shelter from floods),training of local administration, village leaders and teachers in early warning and rescue/relief. Furthermore public information campaigns including working with village schools in flood disaster preparedness should be implemented as a preparatory measure[14].

Earthquakes pose a special threat owing to various reasons in Nepal. Principal cities like Kathmandu, Lalitpur fall under active seismic zones but the cities themselves have been growing rapidly without any definitive planning as a result of uncontrolled urbanization. Nepalese houses are in general heavily built. Earthquake-resistant measures need to be implemented more seriously while building newer housing settlements. Earthquake preparedness should also involve considerable investment in retrofitting lifeline structures and historical buildings (for which the country is famous). The scale of the investment is high and time required to bring results is long. The government and the donors should collaborate in articulating a full blown earthquake preparedness scenario without which donor and government supported initiatives tend to be selective, fragmented and sporadic[47].

## Role of Government of Nepal (GoN)

The GoN has realized the importance of disaster management as a key in order to achieve sustainable development and steps are being made to incorporate it at the national development level rather than an isolated plan. However, there are lot of factors that inhibit its proper implementation and functioning.

Comprehensive and systematic coordination between the various acting agencies is required with the government in the central role. The opening of the National Emergency Operation Centre at the ministry level is expected to support the coordination activities. The National Disaster Reduction Strategies are more concentrated at the central level. District level DRR strategies have been put in place but are not functioning well. There is lack of well defined DRR strategies at local levels as the risk case scenario locally differs from one area to another. There is lack of awareness and information sharing amongst the planners at the local and district level[47].

DRR is relatively a new concept in the country and the governmental and non governmental agencies have yet to understand the concept. Stakeholders' awareness and national commitment is necessary to build on disaster resilient societies. This demands mutually connected strategies and actions between different ministries and sectors for short and long term. Past experiences showed that local governments should take lead in field level implementation of long term strategies and plans supported by national governments. There is a need to identify the relevant functions of the currently assigned departments or institutions and address those gaps in the institutional function. The different international organizations based in

Nepal also do not have a clear idea as to the exact nature of their role when it comes to DRR[47].

There is lack of continuous hazard risk assessment and monitoring process of the different disasters occurring in the country. Early warning systems should be developed for all the major hazards at the local as well as national level. Rigorous data collection and field mapping should be done for the different hazards for better analysis. GIS mapping currently in use should be upgraded and be extended to the most vulnerable urban areas. Hazard maps for the urban and highly populous areas should be made to better plan response activities.

A much improved and well organized database should be in place (Hazard maps-2). The Terai region has vast coverage of alluvium deposit, which is most prone to liquefaction phenomena. It is necessary to develop one such system, so that earthquake isoseismal maps could be plotted in detail after the earthquakes[16 24].Frequent change of government, increasing number of alleged cases of corruptions, and blatant misuses of authority by those in power paved way for widespread dissatisfaction. Bad politics has exacerbated Nepal's limited development endowments. Political commitment is essential in policy planning as well as implementation in the country. The emphasis on good governance should be complemented by action projects covering institutional development and induction of good practices leading into tangible physical changes[1 8 47].

## Role of National and International agencies working/supporting disaster management

Many national agencies as the NSET along with international agencies have laid a good platform for disaster risk evaluation especially for earthquake in Nepal[15]. Disaster risk evaluation studies for impending flood, earthquake should be given a continuation so that there can be coordinated efforts before the disaster to minimize the risks[16]. A number of countries support Nepal's call for emergency assistance: Japan, USA, European Union, India, to name a few. However, there is a dearth of external assistance in "preparedness". Japan has substantial program on soil conservation, which is linked to floods and landslides. It funds a soil conservation institute that deals with some aspects of flood preparedness[14]. Moreover, monitoring and evaluation of the programs in action can be a key to effective implementation of the program.

Nepal needs assistance in moving beyond scenario planning and into actions that actually may reduce vulnerability. New projects are needed to address the issue of retrofitting essential buildings and infrastructure. This should include technical, financial and organizational matters. Comprehensive national guidelines are needed in earthquake resistant construction. This would include training of artisans, municipal engineers and designers and teachers as well as instituting a system of building permit issuance process that allows people to assimilate the guidelines in the

buildings they build. Further impetus on building networks with regional and global earthquake science centers could pave a path for joint and comparative research that would be beneficial for future planning and implementation[8 16 24]

## Role of community

Communities are the first ones to being affected by the disaster and are the first line responders. Community based disaster risk management is a key to achieving a safer Nepal and community DRM should be included in all VDC and district levels. There is a need to establish national network of local volunteers for DRM. The volunteers should be trained and made responsible for detecting early warning signs, carry out preparedness, response, mitigation and response. They could also support the risk assessment carried out in the area[44].The unplanned settlement (an environment unfriendly behavior) is one major issues being faced in the urban areas which needs urgent attention. Public awareness should be promoted at the national level[35].

DRR should be incorporated in the curricula of school and the university education[14]. Training and advocacy regarding DRR should be performed at different levels of the society. Key decision makers and different professional groups should be incorporated into the training module. Though direct losses have been measured, the indirect losses which are long term are yet to be studied. The other forms of direct loss in including agricultural damage, live stock loss, road damage and power cut offs are and under shadowed while calculating human loss and investment in Disaster risk reduction strategies .

Indirect loss which can be measured in the form of business cut down or lack of job opportunities after disaster including the mental havoc is very immense. Thus, monitoring and implementation of disaster risk reduction strategies at the national or international level is important for effective implementation of the available resources[14]. National and international support in disaster risk assessment and planning needs to be promoted for preventing new and managing the inevitable ones. Political support and community involvement should be addressed at the national level while international agencies can cooperate in building manpower, policy making and program implementation for disaster preparedness and response.

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