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A Devastating Disaster: A Case Study of Nepal Earthquake and Its Impact on Human Beings

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Abstract: *Earthquake is one of the deadly natural disasters we have regularly experienced. Nepal and its adjacent areas are vulnerable to very high magnitude of earthquake. The Himalayan belt, Bihar- Nepal border, Assam and North Bengal especially Darjeeling, Jalpaiguri, Alipurduar and Cooch Behar districts fall in this seismic zone. On the basis of investigation it has been found that recent earthquakes had destructed many human lives and their properties in Nepal and north India. The earthquake was considered to be the main cause for avalanches, landslides, slumps, many creaks and fissures in the adjacent area of Nepal. The present study endeavours to examine the nature, extent, causes and consequences of the tremor of quakes and suggests suitable recommendations for its revival. The specified objectives have been fulfilled by the utilization of maps of Indian Meteorological Department (IMD) and Google images. Necessary maps, diagrams and tables have been prepared for exposition of these problems.*

Keywords: *Objectives, Causes of earthquake, consequences and Recommendations.*

I. Introduction

Earthquake is a violent tremor in the earth crust, sending out a series of shock and aftershock waves (L waves) in all direction from its focus. Earthquakes constitute one of the most terrible natural hazards which often turn into disaster causing extensive devastation and loss of human lives and their properties. A deadly earthquake shook Nepal and sent tremors through Indian subcontinent. On 25th April and 12th May 2015, Nepal and its surrounding area were hit by earthquakes which are considered to be the most devastating in the living memory of the inhabitants of these affected areas. The 7.9 magnitude quake was the strongest to hit Nepal for 81 years. It was the most horrible natural disaster to hit Nepal since the 1934 Nepal–Bihar border earthquake. The quake measuring 7.9 on the Richter scale, which was followed by 97 aftershocks of magnitudes 3.0-6.9 on Richter scale, caused heavy casualties in Kathmandu and injured thousand others. The earthquakes had its epicentre at Lumjung, around 80 km north-west of Kathmandu. It had its impact in several areas in Nepal and India. It was also felt in northern and north-eastern part of India, China, Tibet, Bangladesh and as far as Pakistan. Continued aftershocks occurred throughout Nepal and its adjacent area at 15–20 minutes intervals, with one shock reaching a magnitude of 6.9 on 26 April at 12:42 IST. It was a major earthquake similar in intensity to the 1934 Munghyr and the 2001 Gujarat Earthquakes.

A second major earthquake occurred on 12 May 2015 at 12:35 IST with a magnitude of 7.3 on Richter scale. The epicentre was near the China border between Kathmandu and Mt. Everest, at Kodari around 113 kms east of Kathmandu. It struck at the depth of 18.5 km. This earthquake occurred along the same fault as the original earthquake of 25 April 2015. As such, it is considered to be an aftershock of the 25 April quake. Tremors were also felt in Bihar, Uttar Pradesh, West Bengal and other North-east Indian States.

II. Problems

On the basis of investigation it has been found that the earthquake and its effects are major problem in study area. In study area, the region of convergence of Indian plate and Eurasian plate is more vulnerable to earthquakes. The problem under study is to assess the nature of earthquakes and to determine specifically the extent of this type of disaster, in details through data generated from Indian Meteorological Department (IMD) and Geological Survey of India. The other main problem is to construct unscientific and non-seismically engineered multi storied buildings which had easily collapsed by the tremor, disrupting civic life in Nepal. This research work will deal particularly with one of the current issues of consequence of earthquakes as well as different problem of human beings related with massive damages.

III. Study Area

The Nepal and some districts of north India along the India-Nepal border have been selected for this study. The study area is bounded by 21°33′07.04′′ N to 30°21′02.53′′ N Latitudes and 77°06′33.77′′ E to 95°56′31.16′′ E Longitude in Nepal and the states of India, namely West Bengal, Bihar, Uttar Pradesh, Assam and Sikkim (Figure 1). This area represents a zone of transition between the Kunlun range of China and the

peninsular plateau of India, and displays the typical characteristics of the Himalayan range and its foothills. It is covering an area of 6, 56,558 sq. km.

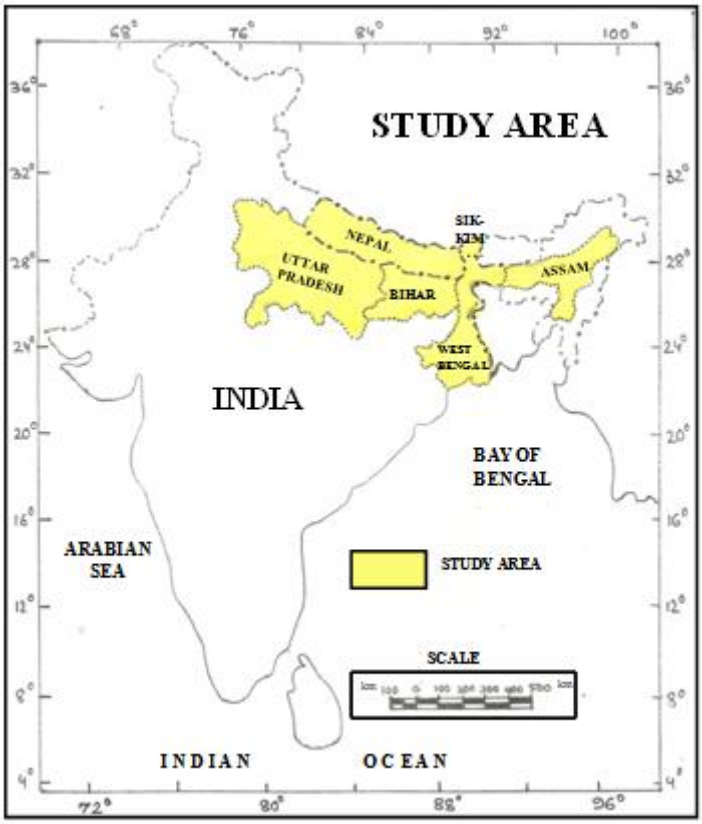

Figure: 1. Study area.

IV. Methodology

This research work is based on the empirical study of consequences of earthquakes. A systematic methodological principle was followed in this study work. The whole work can be represented into three broad categories which are noted below-

4.1 Pre field study

At the beginning intensive literature review from related books, journals, articles, government publication, etc. has been done to specify the research problem and selecting the study area and topic of this research work.

4.2 Field study

The spatial information collected from Indian Meteorological Department (IMD) and Geological Survey of India was also taken into consideration. Primary and secondary data has been obtained through internet and current News Papers. Photographic records of the related features have also been collected from different sources.

4.3 Post field study

The study of empirical observation has been done very carefully through measurement and analysis process to know the causes and consequences of quakes. Data and other information available and generated on the field were compiled using appropriate modern techniques on computer and satellite images, atlas and different maps. The collected data have been quantified, analyzed and synthesized by using standard statistical and cartographic methods.

V. Objectives

Severe, precise and rational objectives have been chosen for the scientific study of the above mentioned problem of the study area, which are noted below:-

1. To highlight the problem of earthquakes in Nepal and its adjacent area.
2. To examine the nature and extent of this.

3. To emphasize the causes and consequences of the tremor of recent quakes.
4. To suggest suitable prevention measures.

VI. Literature Review

After independence some famous scientists and geographers published too many research papers on the nature and mapping of the Earthquake hazards. Hemmady, A.K.R. published a classic book –'Earthquakes' (1996), Bolt, B.A. published 'Earthquakes' (1993). Another popular article was published by Dakshinaranjan Nandy (2007) 'Mapping Earthquake Hazards'. About Earthquake hazard predictable, the authentic article was published in 2007, popularly known as 'Observation of pre-seismic signals through Geochemical Monitoring' by the senior Scientist and research scholar of Department of Science and Technology and Department of Atomic Energy, Hirok Chaudhuri, Nisits K. Das, Rakesh K. Bhandari, Debasis Ghose, Prasanta Sen and Bikash Sinha. Other well-known books are 'Earthquake: Forecasting and Mitigation' (2004) of H.N. Srivastava; "Earthquake Prediction" (1975) of F. Press and 'Earthquake Prediction Techniques' (1982) of Asada, T.

VII. Causes Of Earthquake

Earthquake of Nepal and India along the Himalayan belt were caused mainly due to collision of Indian plate and Eurasian plate. Deep focus and high magnitudes of earthquakes are caused along the convergent plate boundaries because of collision of two convergent plates, namely Eurasian and Indian convergent plates. The subduction of Indian plate below Eurasian plate caused Nepal earthquake at the belt of Himalaya. April 25 and May 12, 2015 earthquakes had occurred on the northern boundary of the Indian plate which is under thrusting the Eurasian plate. The main cause of Nepal earthquakes is attributed to the northward movement of Indian plate. The Indian plate is moving toward north- northeast ward direction at an average rate of about 4.5-5 cm per annum, which causes a stress. On 25th April 2015, the stress built up as the Indian and Eurasian plates slide under one other causing earthquake. The epicentre of these two earthquakes has lay on the boundary of these two plates. The earth quake was caused at the depth of 10 kilometres. The 188 aftershocks measuring around 3.0-6.9 magnitudes in Richter scale were at the depths of 10-50 kilometres. After the major earthquake, the earth's plates lost their equilibrium. The aftershocks are basically nature's way to help earth get back its equilibrium.

VIII. Consequences Of Earthquakes

The hazardous effect of Nepal earthquakes depends not only on their magnitude of Richter scale or intensity alone, but also on so many factors, such as geology of the earth crust (lithology, elasticity, soil condition, permissible stress, rock structure, etc.), design of buildings, quality of construction, population pressure, etc. Several villages, towns, human constructions and their properties, lives were completely damaged. The urban area of Kathmandu, the capital of Nepal, was completely destroyed by April earthquake which hit Nepal. Several buildings collapsed like a pack of cards as if they were mud huts.

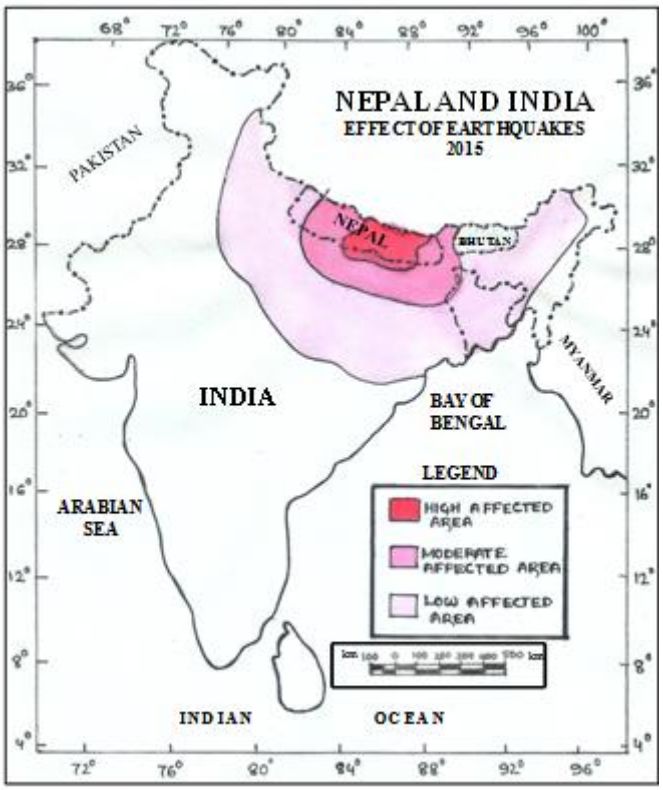

Figure: 2. Affected area of Nepal earthquake.

Several buildings, most of them old, collapsed in the densely populated Kathmandu valley. Kathmandu's Darbar square, a UNESCO world heritage site, was totally damaged in the quake. Harsh damage took place to the parts of the palace complex in Vasanthapura Square. The site of palaces and temples of the city were warren of narrow lanes and historic structure. Kathmandu residents ran onto the streets and other open spaces, throwing up clouds of dust and wide creaks opened on paved streets and the building's wall.

Figure: 3. Effect of Nepal earthquake.

Earthquakes are often followed by landslides and rock avalanches and glacier avalanches in Himalayan hilly areas. The quake caused avalanches on Mount Everest, making the climbers running for cover and killing at least 18 people at the start of the main climbing season. At least 1000 climbers had been at the base camp of the Everest when the earthquake struck. The base camp had been severely damaged and the teams were trapped.

Because of poor phone network coverage the government of India and Nepal were struggling to assess the damage on the Everest.

At Langtang valley in Rasuwa district, a major tourist destination in Nepal, also famous for trekking, it is said that over 100 people were killed and 120 people were injured or missing following the massive avalanche which swept away the entire village in the wake of the powerful quake that hit Rasuwa district. . Over 329 people were reported missing after an avalanche struck Ghodatabela and the Langtang villages. The avalanche was estimated to be 3 kilometres wide.

Continuous aftershocks caused a landslide on the Koshi Highway which blocked the section of the road between Bhedetar and Mulghat. Many smaller landslides occurred in the Trishuli River Valley with reports of significant damage at Mailung, Simle, and Archale areas. As a result of landslide the transport system mainly highways was completely damaged or blocked, which may stop various activities needed for earthquake relief and rescue. Landslides also blocked the river channels, sewage and other communication system in Nepal and now in India specially in Darjeeling district.

Bihar, West Bengal and Uttar Pradesh were the worst affected parts of India. The tremors were felt the strongest in the districts along the Indo-Nepal border, which lie in the seismic zone V (very high seismic zone). Mud wall, buildings and boundary walls in different locations of Siliguri and Jalpaiguri had collapsed because of the tremors. At least 52 people were killed and 237 were injured in India in a powerful earthquake, with epicentre in Nepal, which destroyed or damaged several houses and buildings in Bihar, Uttar Pradesh, West Bengal and surrounding area. According to Union Home Ministry, 38 people died in Bihar, 11 in Uttar Pradesh and 3 in West Bengal, where 43 school children were injured. The majority of the deaths were reported from the northern districts bordering Nepal. According to Bihar Disaster Management Department report, 8 people died in East Champaran district, 6 in Sitamarchi and other 24 death had been reported from Darbhanga, Supual, Saran, Lakhisarai, Madhubani, West Champaran, Araria and Sheohar districts. Huge damage was caused to the property and the lives of the people in north India.

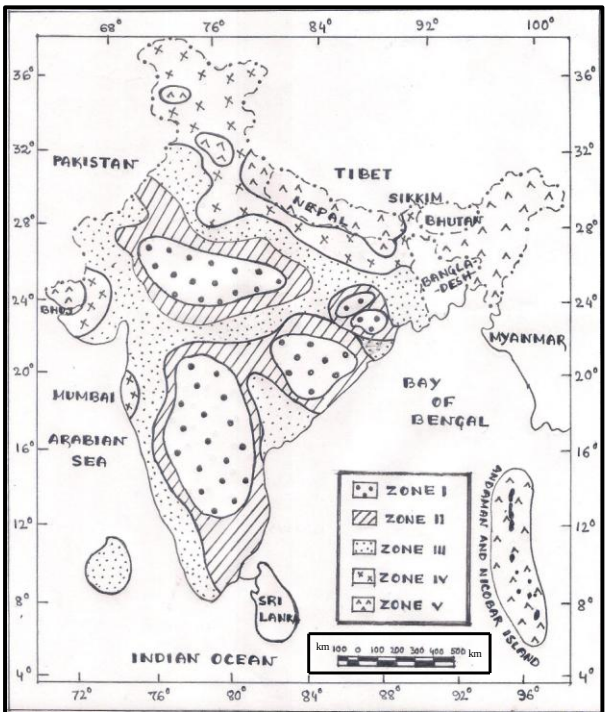

Figure: 4. Seismic zones of India and Nepal.

April 25 quake left 8,699 people dead, 22,220 people injured and flattened thousands of buildings besides destroying whole villages in affected area. In Nepal, Over 5, 00,000 houses were destroyed and 2, 69,000 were damaged by the earthquakes and hundreds of thousands of people were still staying in temporary shelters. More than 8, 64,000 affected people, who lived in remote mountainous area, have lost their relatives and houses. (UN report)

Table: 1 Nepal Earthquakes And Aftershocks (APRIL 25, 2015 ONWORDS)

Date	Latitude	Longitude	Depth (in km)	Magnitude on Richter Scale	Region
25/04/2015	28°6´ N	84°36´ E	10	7.9	Nepal
25/04/2015	28°0´ N	85°42´ E	10	5.5	Nepal
25/04/2015	28°6´ N	84°48´ E	10	6.6	Nepal
25/04/2015	28°0´ N	85°42´ E	10	5.7	Nepal
25/04/2015	27°48´ N	85°36´ E	10	5.0	Nepal
25/04/2015	27°24´ N	85°36´ E	10	4.2	Nepal
25/04/2015	27°18´ N	85°6´ E	10	5.7	Nepal
25/04/2015	28°18´ N	87°18´ E	10	5.8	China-Nepal border
25/04/2015	27°42´ N	84°54´ E	10	5.6	Nepal
26/04/2015	27°36´ N	85°54´ E	10	6.9	Nepal
26/04/2015	27°42´ N	85°48´ E	10	5.0	Nepal
26/04/2015	27°42´ N	85°54´ E	06	4.0	Nepal
26/04/201	27°48´ N	86°0´ E	14	4.6	Nepal
27/04/2015	28°6´ N	84°54´ E	05	3.5	Nepal
27/04/2015	26°42´ N	88°6´ E	10	5.1	Nepal- India (West Bengal) border region
30/04/2015	27°48´ N	85°48´ E	49	3.0	Nepal
12/05/2015	27°42´ N	86°0´ E	18.5	7.3	Nepal
29/05/2015	27°36´ N	86°6´ E	10	6.2	Nepal
16/05/2015	27°36´ N	86°0´ E	28	3.6	Nepal
07/06/2015	27°36´ N	85°54´ E	10	3.5	Nepal
28/06/2015	26°30´ N	90°6´ E	10	5.6	Kokrajhar, Assam

Source: Indian Meteorological Department (IMD)

At least 117 people died in Nepal and 17 people in India as a result of the earthquake of 12 May and about 2,500 people were injured. This earthquake created cracks on a pillar on the top floor of 'Writers' Buildings and a pillar inside the Shaheed Minar in Kolkata. At Colleges of North Bengal University, over 1100 students had to write their examination paper on college ground after the second quake.

A number of old temples, pagodas and churches in the Kathmandu valley were razed. Several temples including Manakamana Temple at Gorkha, Janaki Mandir at Janakpur; Kasthamandap, Panchtale temple, Basantapur Durbar, the Dasa Avtar temple and the Shiva Parvati temple were demolished. The Kumari Temple and the Taleju Bhawani Temple partially collapsed. Some portion of the Jaya Bageshwari Temple at Gaushala, Pashupatinath Temple, Swyambhunath, Boudhanath Stupa, Ratna Mandir and Rani Pokhari had been destroyed. The Char Narayan Mandir, the statue of Yog Narendra Malla, the Taleju Temple, the Hari Shankar, Uma Maheshwar Temple and the Machhindranath Temple in Bungamati were destroyed. In Tripureshwar, the Kal Mochan Ghat, a temple inspired by Mughal architecture, was completely destroyed and the nearby Tripura Sundari also suffered significant damage. In Bhaktapur, several monuments and Temples were totally destroyed. The poor communities of Nepal were most affected, who lost their houses and properties. The key reason for the very high Nepalese casualties was the construction of non-seismically engineered buildings.

The U.S. Geological Survey initially estimated economic losses from this quake at 9 percent to 50 percent of gross domestic product, with an estimate of 35 percent.

Table: 2 Major Earthquakes In Indian Sub-Continent Till June, 2015

Date	Time	Place/ Area	Latitude	Longitude	Magnitude on Richter Scale	Death Toll
June 16 ,1819	18:45 IST	Bhuj (kachchh)	23° N	71° E	8.0	2000
June 12, 1897	15:30 IST	Shillong	26° N	91° E	8.7	1542
March 4, 1905	01:19 IST	Kangra(Himachal Pradesh)	32°0´36´´ N	76°1´48´´ E	8.5	19,500
January 15, 1934	14:13 IST	Bihar- Nepal boarder	26°36´ N	86°48´ E	8.4	10,700
August 15, 1950	19:22 IST	Arunachal Pradesh- Assam border	28°30´ N	97°42´ E	8.7	1526
January 26, 2001	08:50 IST	Bhuj(Gujarat)	23°24´ N	70°16´48´´ E	7.8	30,000
September 18, 2011	18:10 IST	Sikkim	27°43´22´´ N	88°3´50´´ E	6.8	118
April 25,2015	11:41 IST	Lumjung, Nepal	28°6´ N	84°36´ E	7.9	>8900
May 12, 2015	12:35 IST	Kodari, Nepal	27°42´ N	86°0´ E	7.3	>121
June 28, 2015	06:35 IST	Assam	26°30´ N	90°6´ E	5.6	0

Source: Indian Meteorological Department (IMD)

IX. Rccomendations

1. During earthquake, you should run towards safe place like an open area away from buildings, electricity wires, flammable inputs, etc.
2. If you are in a moving car during earthquake, you should stop the car as quickly as possible.
3. If you are staying indoors, you should take shelter under a heavy and hard furniture namely desk, table, bench, etc.
4. You should not run through or near the buildings; always stay in open space until the tremor stop.
5. You should construct seismically engineered (earthquake resistant design) buildings or light weight buildings with lighter roofs in highly earthquake prone areas.

X. Findings

From the above comprehensive study I have assembled several important aspects, which are noted below-

1. Loss of many human and cattle lives.
2. Damage and destruction of many human constructions, namely buildings, roads or highways, bridges, temples, UNESCO world heritage sites, towns and villages.
3. Earthquake creates landslides which may block the highways, river channels, etc.
4. Earthquake crates different types of avalanches which may kill hundreds of climbers, trekkers and Nepali guides at the Everest base camp in Nepal.
5. Earthquakes and continuous aftershocks destroyed the civil structures killing thousands of people and injured over twenty-two thousand people in Nepal and northern India.

XI. Conclusions

An earthquake cannot be prevented or accurately predicted, but there are some forewarning sign of a coming tremor, and there are various system being developed and in use to reduce the damage from this disaster. However, no perfect techniques have been developed to predict the tremor till date. Making exact prediction about the occurrence of a tremor in an area and time is still a tricky proposition. The seismologists are more and more concentrating on the aspect of earthquake forecasting. When we would be able to predict of earthquakes accurately on the basis of animal behavior or other unusual phenomena, it would save many lives and property damages.

Acknowledgement

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