THE CONSEQUENCES OF DEFORESTATION ON POST EARTHQUAKE DAMAGE

Mridula[1], Deep Gupta[2]
[1]Assistant Professor, Department of Civil Engineering, College of Engineering Roorkee, Roorkee.
[2]Head of the Department, Department of Civil Engineering, College of Engineering Roorkee, Roorkee.

Abstract—Deforestation has major role in slope instability which may lead to landslide. Landslide is one of the major causes of post earthquake damage. Major causalities are due to landslides in hilly areas. A case study of Nepal earthquake of 15th April, 2015 has been presented in this paper. Uttarakhand and Himachal Pradesh being hilly areas, similar consequences can be expected in the Himalayas particularly in Uttarakhand and Himachal Pradesh, since these parts of the states are in seismic gap of the Great kangra earthquake of 1905 and the Bihar-Nepal earthquake of 1934.

Keywords: Earthquake; Landslide; Slope- instability, Deforestation

I. INTRODUCTION

A sudden violent shaking of the ground, as a result of tectonic movements within the earth's crust or due to volcanic action resulting in the generation of seismic waves which can cause great devastation, is known as earthquake [1]. This violent shaking results in fissure, faulting, ground shaking, landslides, tsunamis etc. One of the major damage during an earthquake is caused by landslides [2]. A landslide, also known as a landslip, is a form of mass wasting that includes a wide range of ground movements, such as rock falls, deep failure of slopes, and shallow debris flows [3]. The deforestation can affect the damage after earthquake. It could cause a landslide, since the root systems of trees stabilize the soil.

Slope instability is a massive hazard in mountainous regions around the world. It triggered the major ecological and environmental problems in larger geographically sensitive areas. In Himalayan regions particularly in Uttarakhand region slope movement is an important problem, this movement on hill slopes directly influences the transport and deposit of material in downstream rivers. Due to the climate change extreme weather and unplanned construction activities caused massive floods and landslides. In Uttarakhand, Chamoli, Pithoragarh, Rudraprayag and Uttarkashi areas losses his forest cover due to the development activities. According to a report (MOEF) 44,868 ha of forestland have been diverted to non-forest use in Uttarakhand since 1980. Of this, a maximum of 9,500 ha has been diverted for construction of roads, followed by 5,500 ha for hydel projects and 3,100 ha for transmission lines. Most of the forest diversion (68%) in the state has taken place after the formation of the state in 2000 [4]. These Forests covers come under the category of native Himalayan vegetation. As the deforestation start there is a great loss of top soil. This soil erosion and temperature increase further affect the strength of the nearby forests. This situation again affects the fragile eco-system of Himalaya and makes it more unstable with relation to the balanced ecosystem point of view. Now a day's deforestation has become a major contributor to the greenhouse effect and global warming. Over the past years, the temperature in India (on an average) seems to have become increase day by day. It also resulted in the forest and biodiversity loss particularly in Shivalik Himalayan region. Due to the temperature variation and deforestation some non-native species can be seen very often, which already has changed the specie composition in the region. Non-native species compete for the space and replace native species. These non native species are not as useful as large trees they have no capability to hold the sloppy soil tightly. It triggers the landslide phenomenon. Mountains are particularly vulnerable and sensitive to climate change. Impact of climate change is clearly visible in mountain regions in the form of glaciers shrinkages [5] (Mishra, 2007), changes in species composition, invasion of non-native species and altitudinal movement of ecosystem [6] (IPCC, 2002). A case study for the Nepal earthquake of 25th April, 2015 was done and similar consequences can be interpreted for the Uttarakhand Himalayas.

II. NEPAL EARTHQUAKE OF 25th APRIL, 2015

A major destructive earthquake took place in Nepal on 25th April, 2015, at 11:25 AM (Nepal standard time), which was the worst natural disaster to strike Nepal after the great Bihar- Nepal earthquake of 1934. This earthquake was one the most devastating earthquakes of this decade, with magnitude on Richter scale, 7.8 (USGS, [7]). The epicenter lied between the coordinates 28.15°N, 84.71°E (USGS) and was in east of Gorkha District at Barpak. Its hypocenter was at depth of approximately 8.2 km. It killed nearly 9000 people and over 20,000 people were injured. The earthquake also

triggered an avalanche on Mount Everest, killing 21 [8]. The earthquake triggered another huge avalanche in the Langtang valley, where 250 people were reported missing [8]. Maximum intensity recorded was IX on Modified mercalli scale (MMI) scale.

III. EARTHQUAKE INDUCED LANDSLIDES

The Nepal was once widely forested nation which has gone through extensive deforestation. The Nepal's population is heavily dependent on mountainous region of Nepal and is home to two thirds of Nepali's which led to large demands on the land. Forest resources had decreased by 75%, despite of largely adopted Nepal's forestry programs (Regmi 73). The forests in Nepal are located on top of steep slopes therefore the country is more susceptible to severe damage which will follow after natural disasters. The country's widespread history of deforestation contributed to severe landslides in Nepal after the earthquakes. Along with the environmental effects, poverty among rural Nepali's has led to a complicated relationship between the people and the land. These issues have not only created an ecological imbalance, but have also caused economic hardships for the people of Nepal

IV. DEFORESTATION'S EFFECTS ON THE LANDSCAPE

The negative effects of deforestation are cumulative. Deforestation contributes to flooding because tree roots hold the soil in place, preventing sediment from traveling. Similarly, tree roots absorb more water than grasslands, so the surrounding soil is drier and able to store more water when it rains, thus inhibiting flooding. Without tree roots, eroded soil can end up in river beds, reducing a river's ability to hold water and making them more susceptible to flooding. Deforestation tends to intensify the disastrous consequences of earthquakes, and is a significant causative factor of landslides and flooding. When earthquakes occur when there are steep slopes, which are plentiful in Nepal, the soil slips, and it causes landslides. The earthquakes sparked numerous landslides in Nepal, which were provoked by a long history of deforestation, making their aftermath even more devastating and difficult for aid workers to reach those in need. The great Himalayan region extending from North-West to South-East experiences the large numbers of landslides. The earthquake in Himalayan region also triggers major landslides. The environmental degradation due to deforestation has further classified and generalized the problem of landslides in the hilly region. In recent years deforestation has become the major cause of landslides during rainy season in Himalayas. Sah and Bartarya (2004), [9] have observed some causes for the occurrence of landslides in The Himalayan region. The causes were the dynamic forces (earthquakes, neotectonic activity etc.), an increase of pore space due to high rainfall, and the increment in internal pressure due to chemical and physical alteration (due to deforestation) and unscientific land use, mining and quarrying activities etc. The anthropogenic activities such as the unscientific uses of the slope for construction and deforestation are also responsible for the increase of the vulnerability of landslide in this region [10] (De, 2004). Biswas and Pal (2016), [11] concluded that landslide problem in Darjeeling Himalayas caused by the natural phenomenon but the intensity and magnitude were enhanced by the anthropogenic activities.

In Nepal, about 66 percent of households use wood as the main fuel for cooking, while 13% and 8% use kerosene and LPG, respectively [12] (Pant, 1969). Over 89% of total energy use in Nepal comes from traditional fuels, as electricity and kerosene are only accessible in more urban areas to a small number of people. The cost of fuel causes many impoverished Nepali's to rely on wood from forests to provide food and warmth for their families, leading to additional deforestation. The 2015 earthquakes damaged over 600,000 houses, leaving many Nepali's homeless and in need of wood to help rebuild their houses.

V. INTERPRETATION FOR UTTARAKHAND HIMALAYAS

Uttarakhand Himalayas lies in the seismic gap of the great Kangra earthquake of 1905 and the Bihar –Nepal earthquake of 1934. Which means that no major earthquake took place between this seismic gap. This area of Uttarakhand Himalayas lies in seismic zone V and IV as per Bureau of Indian Standard seismic zoning map of India [13] (IS:1869-2002, Part 2). More over Peak ground acceleration, PGA, computed for this region lies between 0.18-0.25 g, [14] (Mridula et al., 2014). Entire Uttarakhand lies in the most susceptible area, Area A" as per Mridula et. al, 2016, [15], which is an area which may receive earthquakes of magnitude , Mw > 5.5. Moreover, it is very clear in the case of Uttarakhand region. After the development activities like road construction, hydropower plants etc. the total forest cover get reduced from 24,508 Km2 to 24,240 Km2 (-268 Km2) in recent years [16]. For these reasons, if a strong/major earthquake strikes Uttarakhand Himalayas, there is major possibility of landslides and hence loss of human lives.

Development and disaster have a very close and multidimensional relationship. Vegetation cover is very essential for protecting land from devastating activities. According to a report of Uttarakhand forest (till Aug, 31,

2014) 38,814 ha of forest land has been converted into other land for various developmental schemes. Scientific investigations have proved that barren land becomes more sensitive and susceptible to landslides during earthquakes event. Table1 shows the diversion of forest lands for developmental activities in Uttarakhand region.

TABLE 1. CHANGES IN FOREST COVER IN RECENT YEARS. SOURCE= INDIA STATE OF FOREST REPORT

Year	VDF (Km2)	MDF (Km2)	OF (Km2)	Total (Km2)
2013	4,785	14,111	5,612	24,508
2015	4,754	13,602	5,884	24,240
Change in Forest cover	-31	-509	272	-268

VDF= Very dense forest , MDF= Moderately dense Forest, OF= Open Forest

VI. CONCLUSIONS

Since deforestation is one of the major causes of damage during earthquakes, this needs to be prevented. Deforestation can be prevented through proper management and regulated harvesting, as well by reducing the demand for products and services contributing to deforestation, explains Greenpeace. However, this requires the cooperation of industry, governments and citizens to achieve a balance between the available resources and how to sustain them.

ACKNOWLEDGMENT

The authors would like to thank College of Engineering Roorkee, Roorkee for providing academic support to carry out this work.

[1] I.S. Jacobs and C.P. Bean, “Fine particles, thin films and exchange anisotropy,” in Magnetism, vol. III, G.T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271-350.

References

[1] Reiter, Leon, “Earthquake hazard analysis: issues and insights”, in Columbia University Press, 1990, New York, 254.
[2] Keefer, D. K., “Landslides caused by earthquakes”, in Geological Society of America Bulletin, 1984, 95(4), pp.406-421.
[3] Kramer, S.L., “Geotechnical Earthquake Engineering”, in Prentice –Hall Publications, 2009, 626 p.
[4] Shrivastava , K.S., “Maximum devastation occurred in areas of maximum forestland diversion”, in Down to Earth, June, 2013.
[5] Mishra, N.B., “Modeling Glacier Mass Balance by Comparing in Situ Measurements with Remote Sensing Derived Parameters: A Study of Chhota Shigri Glacier, Western Himalaya, India”, 2007, Masters Dissertation, Asian Institute of Technology, Thailand.
[6] IPCC, “Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the IPCC”, 2007, in : Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M. and Miller, H.L. (eds.), Cambridge University Press, Cambridge, UK.
[7] USGS Catalogue: http://earthquake.usgs.gov/earthquakes/eqarchives (United States Geological Survey).
[8] Goda, Katsuichiro, Takashi Kiyota, Rama Mohan Pokhrel, Gabriele Chiaro, Toshihiko Katagiri, Keshab Sharma, and Sean Wilkinson. "The 2015 Gorkha Nepal earthquake: insights from earthquake damage survey." Frontiers in Built Environment 1, 2015: 8.
[9] Sah MP, Bartarya SK, “Landslide Hazards in the Himalaya: Strategy for their Management”, In: Valdiya KS (ed.) Coping with natural hazards: Indian context. Hyderabad: 2004,Orient Longman, pp: 165-179.
[10] De SK, “Causes of Landslide in the Balason Basin of Eastern Himalaya”, In: Singh S, Sharma HS, De SK (eds.) Geomorphology and environment. Kolkata: acb publications, 2004pp: 182-194.
[11] Biswas, S.S and Pal, Raghunath (2016) Causes of Landslides in Darjeeling Himalayas during June-July, 2015. Journal of Geography & Natural Disasters. DOI: 10.4172/2167-0587.1000173
[12] Pant, K.P., 2007 “Valuing Interventions to Reduce Indoor Air Pollution-Fuelwood, Deforestation, and Health in Rural Nepal.” The Pakistan Development Review 46.4 (2007): 1169-187. Print.
[13] Bureau of Indian Standards (2002), BIS-1893 (Part 1): 2002, Indian Standard Criteria for Earthquake Resistant Design of Structures. 5th rev., Bureau of Indian Standards, New Delhi, 40p.
[14] Mridula, Sinvhal, A. and Wason, H. R. (2014), Probabilistic seismic hazard assessment in the vicinity of MBT and MCT in western Himalaya, Research Inventy: International Journal of Engineering and Science, 4(11), 21-34.
[15] Mridula, Sinvhal A and Wason H R (2016), Identification of seismically susceptible areas in the western Himalaya using pattern recognition, Journal of Earth System Science. pp 1-17, DOI 10.1007/s12040-016-0698-6.
[16] Forest Department Govt. of Uttarakhand, 2014. http://forest.uk.gov.in/files/MPR_AUGUST/Summary_Notification.pdf