EARTHQUAKE-INDUCED LANDSLIDES IN NEAPL

Ranjan Kumar DAHAL
Assoc. Professor Dr., Tribhuvan University, Department of Geology
Tri-Chandra Campus, Kathmandu, Nepal
rkdahal@gmail.com, ranjan@ranjan.net.np

Keywords: Earthquake-Induced Landslide, Himalaya, Nepal, Large-Scale Landslide

Earthquake-induced slope failures are one of the most damaging natural disasters. Commonly, damage from earthquake-induced slope failures is worse than damage related to the shaking and rupture of the earthquake itself. Nepal is one of the earthquake-prone countries in the world. Earthquake is a major concern of Nepal because of rapid population growth, poor land use planning, precarious settlement patterns, and poorly implemented building code. Earthquakes in Nepal have been reported since 1255 while major earthquakes were recorded in 1408, 1681, 1810, 1833, and 1866, 1934, 1980 and 1988.

A recent earthquake in Nepal on September 18, 2011 measuring 6.9 in Richter scale, killed 6 people and injured 30 people. There were many roadside slope damages near the epicentre area. To assess the roadside slope damages after this earthquake, a field visit was conducted and a landslide inventory map along the roadside slope was prepared for most damaged area.

When earthquake-induced slope failures and landslides in Nepal are concerned, there were many incidents. But, the record on the earthquake-induced slope failures and large-scale landslides are not well documented. Nepal lies in seismically active region and its history is full of devastating earthquakes. After 1934 Bihar-Nepal earthquake in Nepal, seven major earthquakes hit Nepal. The last earthquake was Sikkim/Nepal Border Earthquake of September 18, 2011. In this recent earthquake, 14,544 houses damaged (6,435 completely destroyed), 6 people died and 30 people were injured in Nepal. During this earthquake, USGS and Department of Mines and Geology, Nepal measured the peak ground accelerations in far East Nepal along the major highway (Mechi Highway region) is between 90 gal and 177 gal. As a result, there were many roadside slope damages along the roads (Figure 1a). Many longitudinal as well as transverse cracks were also observed in the ridge part. No large-scale landslides were observed on the area after the earthquake but many transverse cracks on ridges clearly suggested remarkable creeping type of movement during this earthquake.

Interpreting of landslide processes in the Nepal Himalaya needs broad knowledge of both small-scale and large-scale landslides. A trigger is an extrinsic event and for the Nepal Himalaya, an intense rainfall event or an earthquake or rapid stream erosion that causes a near-immediate response in the form of a landslide by rapidly increasing the stresses and reducing the strength of the slope-forming materials. Study shows that for the small-scale landslides, monsoon rainfall is the major triggering agent and for large-scale landslide, mega earthquakes of geological past were major triggering agents (Dahal, 2014a). Comparison of small-scale landslides with triggering factor is quite easy but understanding of triggering factor of large-scale landslide is quite complicated (Dahal, 2014b). When large-scale landslides triggered by earthquakes are concerned for Nepal, scientifically well documented database are not available but many more geomorphological imprints of large-scale landslides are available on the mountain slopes. Inventory map of large-scale landslides was prepared for central Nepal (Timilsina et al., 2014) and their identification guidelines were also developed with a 3-D schematic diagram (Figure 1b). Age, materials, type of movement, rate of movement, and geomorphological features are included in the guidelines. It was understood that a large-scale landslide is a huge mass that slide in the past due to mega earthquake but persists intact in the topography from active to dormant stages. Such landslides were mainly induced in the geological past (during early upliftment of mountains) and their future occurrences may depend upon future mega-earthquake events but the risk of reactivation has been always there. They are widely distributed and dammed the river in the Lesser Himalayan and Fore Himalayan regions (Figure 2) of Nepal. Some studies (Waltham, 1996 and Hasegawa et al., 2009) suggested that the large-scale landslides in the Himalaya occurred within the last few thousand years. The exact age of the landslides is

unknown but their geomorphological attributes indicate that many such landslides are indeed older than human history and triggered by large and mega earthquakes.

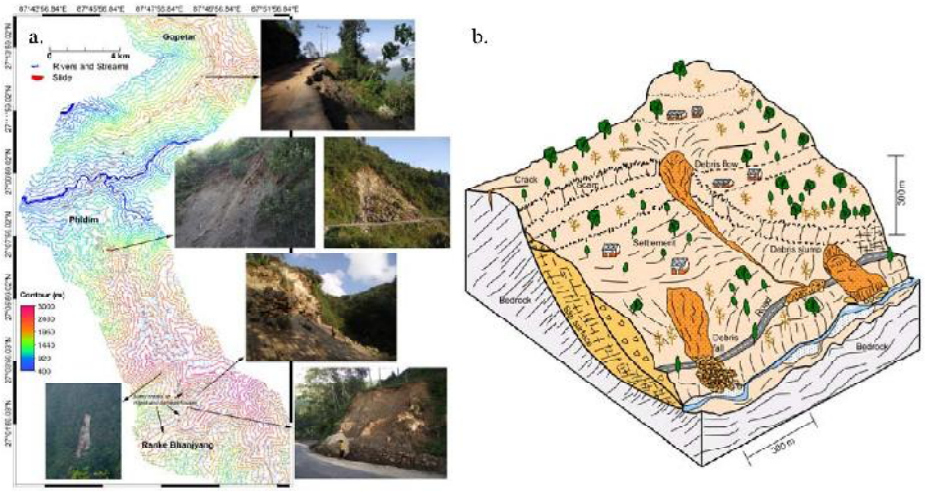

Figure 1. a. Highly damaged road sections of the Mechi Highway after Sikkim/Nepal Border Earthquake of September 18, 2011, and b. 3D scematic model of large-scale landslides in Nepal

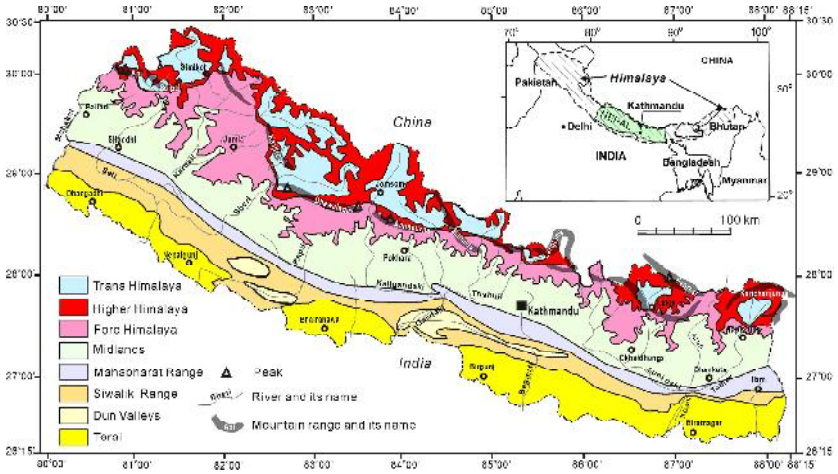

Figure 2. Regional geomorphic map of Nepal

REFERENCES

Dahal RK (2014) Understanding of landslide science in the Nepal Himalaya, Proceedings of 12th IAEG Congress, Turin, Italy

Dahal RK (2014) Regional-scale landslide activity and landslide susceptibility zonation in the Nepal Himalaya, Environmental Earth Sciences,71(12): 5145-5164

Hasegawa S, Dahal RK, Yamanaka M, Bhandary NP, Yatabe R and Inagaki H (2009) Causes of large-scale landslides in the Lesser Himalaya of central Nepal, *Environmental Geology*, 57:1423–1434

Timilsina M, Bhandary NP, Dahal RK and Yatabe R (2014) Distribution probability of large-scale landslides in central Nepal, *Geomorphology*, 226:236–248

Waltham T (1996) Very large landslides in the Himalayas, *Geology Today*, September-October: 181–185