Paleoseismology of Nepal Himalaya and its implication in Seismic Hazard Assessment

Soma Nath Sapkota[1], Laurent Bollinger[2], and Paul Tapponnier[3]
[1]Deputy Director General, Department of Mines and Geology, Government of Nepal, Nepal
[2]Deapartment Analyse Surveillance Environment DASE, France
[3]Earth Observatory of Singapore

ABSTRACT

Department of Mines and Geology in collaboration with Department Analyse Surveillance Environment (DASE) France and Earth Observatory of Singapore (EOS) is conducting many basics and applied researches to understand the process of earthquake nucleation in Himalaya and return period of great earthquake in this region. Many fundamental question regarding the seismotectonic model, seismic cycle, interseismic slip deficit and behavior of Main Himalayan Thrust is understood as an outcome of this collaboration. Most of the epicenter of the Himalayan earthquake follow a belt of seismicity, at a depth of 10-20 km, follows approximately the front of the higher Himalaya along the 3000-3500m topographical contours. Past earthquake of the Himalayan region were also nucleated and their epicenter were located in this region. This midcrustal seismic cluster is well mapped at the surface by high uplift rate inferred from geodetic measurements and high conductive zone which might be due to fluid circulation at the midcrustal depth. A network of 29 continuous GPS stations within the territory of Nepal Himalaya complement the seismic network since 2002, monitoring the convergence rate between northward moving Indian plate and the Tibetan plateau. Result from this network shows that the Main Himalyan Thrust fault (MHT) is currently locked between the higher Himalaya and the Main Frontal Thrust, 100 km southward, and accumulates a slip deficit in this part of the Himalaya at a rate of approximately 1.8cm/yr, this slip is responsible for nucleation of big earthquake in this region.

Himalayan region has been shocked by 6 great earthquakes in the past century including recent April 25, 2015 Mw 7.8 Gorkha Earthquake: 2005 Muzzafarabad Pakistan (Mw 7.6), 1905 Kangra (Mw 7.8), 1934 Bihar Nepal (Mw 8.4), 1987 Shillong (Mw 8.3) and 1950 Assam (Mw 8.6) earthquakes. The region between 1905 Kangra Earthquake and 1934 Bihar Nepal Earthquake between 78°E and 84°E has not produced any major earthquake since more than four centuries and stands for being a large seismic gap in the Himalayan region. The high seismogenic potential of this locked fault zone exposes the North-Western Himalaya and the densely populated region of nearby Ganges basin in India to a high level of seismic risk. Better understanding the future seismic behavior within this seismic gap is one of the major challenges to be taken up by the scientific community in the region. This paper will focus on the present understanding of the seismicity of the Himalaya and impending seismic hazard of the region.

To Assess the seismic history of the region, we should have complete history of past earthquake this paper will describe the surface ruptures discovered and studied in Nepal. It will try to answer some fundamental questions such as; How complete is the historic record for M>8 earthquake in the region ? What structures generate these very large earthquakes? and do they rupture to the surface or they stopped before reaching the surface as 2015 Gorkha Earthquake? To address these questions will confront the historical records with the results of geomorphic and paleoseismic studies conducted along the MFT in Nepal. The MFT has been chosen as a main target because deformed river terraces show that late Pleistocene and Holocene deformation across the Nepal Himalaya is expressed on the frontal fold above the MFT. The surface trace of the MFT therefore provides an opportunity to document whether large earthquake in the MFT rupture the surface, and if so, to determine there size and recurrence as demonstrated by the first report by Sapkota et al., 2013 of the surface ruptures on the same MFT segment of two of the largest historical earthquakes that occurred in central eastern Nepal (AD 1934 (M8.4) and AD 1255 (M>8)). For the strict purpose of accurate seismic hazard assessment in Nepal, it is also important to know whether great earthquakes produce surface ruptures, because this has strong implications on the kind of regional damage expected. The design or retrofitting of major infrastructures directly depends on such information. Nepal should put its step forward in this direction to find out the return period of great earthquake and segmentation of Himalayan arc in relation to its length and width.