

International Research (Project No.: 29W-03)

Project name: Source and Structural Properties of the 2015 Mw7.8 Nepal earthquake
- Clarifying Seismic Hazards in the Himalaya -

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Name of DPRI collaborative researcher: MORI, James Jiro

Research period: Apr 1, 2017 ~ Mar 31, 2019

Research location: Institute of Tibetan Plateau Research, Chinese Academy of Sciences, Beijing, China
Disaster Prevention Research Institute, Kyoto University

Number of participants in the collaborative research: 4 (DPRI staff: 2, non-DPRI staff: 2)

- Number of graduate students: 2 (Master students: 1, Doctor students: 1)

- Participation role of graduate students [Master student Sanjev Dhakal works on the detection of small events for the 2015 Nepal earthquake sequence to study the source parameters and faulting structures. Doctor student Moklesh Rahman works on the peak ground acceleration of Nepal to study the seismic hazard assessment.]

Implementation status in FY2017

In 2017, we collected more local data from Stanford University to extend our previous analysis (Bai et al., 2016) on accurate earthquake location. We studied the peak ground acceleration to obtain seismic hazard assessment of Nepal. We deployed two broadband seismic stations at the source area. We organized a session in the 2017 JpGU-AGU joint meeting to discuss the cutting-edge progress on the geophysical study of the Himalayan-Tibetan area. Based on these achievements, Prof. James Mori was awarded as ‘CAS President’s International Fellowship for Distinguished Scientists’. Prof. Ling Bai successfully applied a key research project that is jointly supported by the National Natural Science Foundation of China and the International Centre for Integrated Mountain Development.

The details are shown as bellow.

(1) Seismic hazard Assessment

The potential for devastating earthquakes in the Himalayan orogenic belt has long been recognized. The April 25, 2015, Mw=7.8 Nepal earthquake caused about 9000 deaths and destroyed much of the infrastructure in the source area. This earthquake has greatly heightened concern for future large earthquakes along the Himalayan front. Proper seismic hazard assessment is one of the effective ways to reduce the seismic risk. We computed probabilistic seismic hazards using historical and instrumental earthquake catalogues, different type of source models, along with different ground motion prediction equations. The resulting peak ground acceleration revealed significant spatio-temporal variations. This study provided new insights in improving seismic zoning map and consequently refining seismic building design codes for Nepal. These works have been published in the journal Pure and Applied Geophysics and submitted to the journal Earth and Planetary Physics.

(2) The deployment of permanent broadband seismic stations

Since the end of 2014, we have deployed a temporary broadband seismic array at the China-Nepal boundary. The 2015 Nepal great earthquake and many of the aftershocks are located within a distance of 0-300 km from the array, which is the first well recorded large earthquake along the Himalaya orogenic belt. In 2017, we further installed two broadband seismic stations at Kathmandu, Nepal and Higher Himalayan at the China-Nepal border within the integrated observatory, which will enable us to have long-term observations (Figure 1). At that time, Prof. Ling Bai visited Tribhuvan University and give a talk about the source and structural properties of the 2015 Gorkha earthquake.



Figure 1 (left) Broadband seismic station at Kathmandu; (right) Prof. Ling Bai gives a talk at the Tribhuvan University.

- (3) During the 2017 JpGU-AGU joint meeting, we organized a session on May 24, 2017 for ‘Recent earthquakes and deep structure of the Earth in and around Tibetan Plateau’. Researchers from different organizations around the world, such as International Seismological Center (ISC), University of Tokyo, and China Earthquake Administration shares the latest findings. As the director of ISC, Dmitry A. Storchak, pointed out: ‘the evolution of the Himalayan orogenic belt is very complex and it requires extensive participation of scientists from different countries for further studies’.

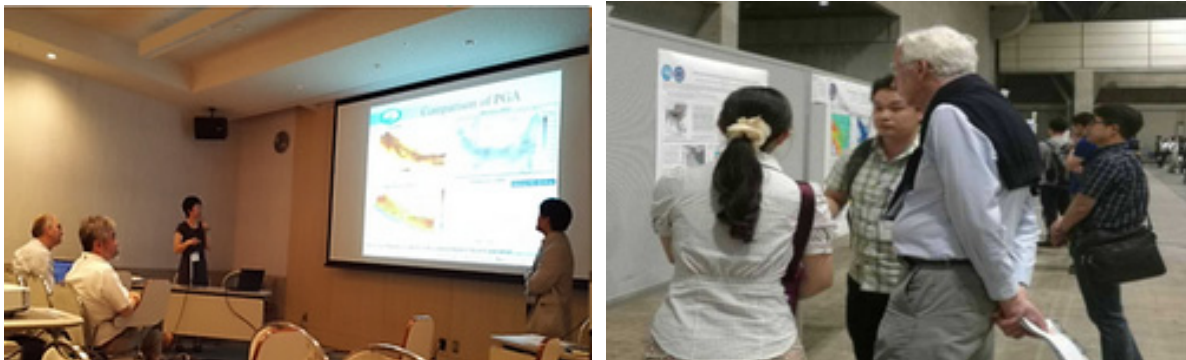


Figure 2 (left) Prof. James Mori preside the session; (right) Poster presentation site of the session.

Implementation plan in FY2018

In 2018, we will focus on our studies on three aspects: the detection of small earthquakes in source area, source parameters of the aftershocks, and the velocity structures for the aftershock zone. We will deploy near-field broadband array in Nepal to study the structure of the source area in more details. We will develop data processing software to analyze the data and discuss the mechanisms of megathrust earthquakes along the continental plate collision zone.

(1) Detection of small earthquakes in the source area

Historically, aftershocks of large Himalayan earthquakes occur on both the subduction-zone thrust (i.e., MHT, the Main Himalayan Thrust) and on the splay faults which are located above the MHT with steeper dip angles. The Mw7.8 Gorkha earthquakes was followed by a large amount of aftershocks. However, due to the limited number of local stations, small earthquakes have not been reported in the standard catalogs. Bases on the waveform correlation technique, we will complete the earthquake catalogue with smaller earthquakes, and analyze the Spatio-temporal variation of the seismicity in the Nepal Himalaya region.

(2) Accurate source parameters of the earthquake sequence

Detailed locations and mechanisms of the present seismicity provide unprecedented subsurface resolution of these faults in the complicated collision zone. Identifying current active faults leads to better

understanding about the dynamic process of the continental collision and potential sites for future large earthquakes. We will relocate aftershock hypocenters and carry out waveform inversions for focal mechanisms. As a Cox visiting professor of Stanford University, prof. Ling Bai has the priority to collect waveform data from local seismic stations, which were deployed by US scientists. This study extends our previous works (Bai et al., 2016) which examined the aftershocks that occurred within one month after the main shock.

(3) Tomography of the source zone

Earthquake rupture zones typically start and end at locations where there are changes in material properties and/or fault plane changes geometry. We will conduct three-dimensional P- and S-wave travel time tomography to image the regional velocity structure in and around the source area. This study will benefit from the combination of local Pg/Sg and regional Pn/Sn signals recorded by the China-Nepal array and the permanent broadband seismic network of Tibet.

Combining the source and faulting information of potential large earthquakes (1 and 2) along with the 3-D structural details of the Himalaya (3) will provide much needed information about future large earthquakes for the region. This information is needed for planning and seismic mitigation efforts of the growing cities and towns that are close to the earthquake prone Himalaya.