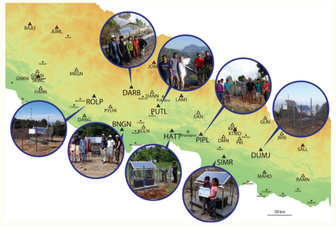
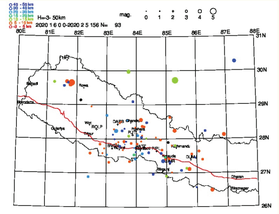
GROUP 4 EARTHQUAKE OBSERVATION SYSTEM

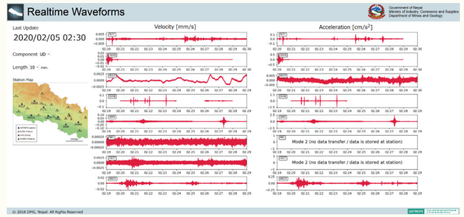
Objective

- To enhance the seismic observation network by newly deploying 8 seismic stations using telemetry and the capacities of data processing and information delivery.



The seismic station includes one accelerometer and one velocity sensor (short-period at 4 sites and broadband at 4 sites) at each station. The installation was finished in 2018 and now the continuous data is transmitted to National Earthquake Monitoring and Research Centre (NEMRC) in Kathmandu by cell modem with 1-2 minutes latency. We also constructed a new system for quasi real-time determination of magnitudes, hypocenters, and shaking intensity distributions, and the results are available on the website.





GROUP 5 EDUCATION AND POLICIES

Microtremor measurement in the field

Objectives

1. Develop a higher education in seismology.
2. Contribute for capacity development.
3. Provide recommendations for seismic design.

Activities

1. Develop the curriculum to build up fundamentals for the higher education of seismology. Provide opportunities for earthquake-related higher education in Japan.
2. Provide opportunities for expert training in Japan to build capacity for seismology and earthquake engineering. The project is accelerated by the capacity built.
3. Based on the earthquake potential evaluation, seismic hazard assessment, etc., recommend seismic design loads and land use plans in Area B.

Several workshops were organized for the collaboration to develop a guidelines and/or technical manuals of the outputs from other groups.

Group3 and Group5 integrated workshop " Earthquake Engineering Issues in Nepal"

COORDINATION OF THE GROUPS

GROUP 1: EARTHQUAKE POTENTIAL EVALUATION
- Crustal deformation monitoring and earthquake-deformation relationship
- Fault activities evaluation by geologic & geomorphologic surveys
- Earthquake potential & earthquake source models

GROUP 2 : GROUND MOTION PREDICTION
- Ground motion monitoring and verification/upgrading of velocity structure model
- Study on scenario earthquakes and ground motion prediction

GROUP 3 : SEISMIC HAZARD ASSESSMENT
- Development of velocity structure and soil structure models
- Upgrade of strong ground motion prediction and seismic hazard assessment
- Reassessment of earthquake disaster risks at high risk areas

GROUP 4 : EARTHQUAKE OBSERVATION SYSTEM
- Enhancement of seismic observation network
- Enhancement of earthquake date processing system

GROUP 5: HIGHER EDUCATION, EXPERT TRAINING, AND POLOCY REXOMMENDATION TO PROVIDE NEPAL WITH OUTCOMES AND HAZARD INFORMATION BY GROUP 1-4
- Foundamentals of higher education of seismology
- Expert training on seismology and earthquake engineering
- Recommendation of polocies for earthquake disaster mitigation

COLLABORATION

Japan

Principal Investigator:
Prof. Dr. Kazuki Koketsu
Professor of
Earthquake Research Institute (ERI),
The University of Tokyo

Nepal

Principal Investigator:
Mr. Ram Prasad Ghimire
Director General
Department of Mines and Geology (DMG),
Ministry of Industry, Commerce and Supplies
Government of Nepal
Mr. Sarbjit Prasad Mahato (Initial Signatory)
Mr. Rajendra Prasad Khanal (16 Apr 2016 to 20 Jul 2018)
Dr. Soma Nath Sapkota (21 Jul 2018 to 16 Feb 2020)

	Japan	Nepal
GROUP 1 EARTHQUAKE POTENTIAL EVALUATION	G1a: Kochi University / Hokkaido University G1b: Hiroshima University / National Institute of Advanced Industrial Science and Technology (AIST)	DMG
GROUP 2 GROUND MOTION PREDICTION	Hokkaido University / Kyusyu University / ERI, The University of Tokyo	DMG / Department of Urban Development and Building Construction (DUDBC), Ministry of Urban Development
GROUP 3 SEISMIC HAZARD ASSESSMENT	OYO Corp. / Building Research Institute	DMG / Central Department of Physics, Tribhuvan University OYO Corp. / Building Research Institute
GROUP 4 EARTHQUAKE OBSERVATION SYSTEM	Home Seismometer Inc. / Kyoto University / ERI, The University of Tokyo / Kochi University	DMG
GROUP 5 EDUCATION AND POLICIES	ERI, The University of Tokyo / Building Research Institute	DMG / DUDBC / Institute of Engineering, Tribhuvan University / Central Department of Physics, Tribhuvan University / National Society for Earthquake Technology (NSET) Nepal

SATREPS Science and Technology Research Partnership for Sustainable Development Program
Japan Science and Technology Agency
JICA Japan International Cooperation Agency
THE UNIVERSITY OF TOKYO

SATREPS Japan-Nepal Joint Research Project

Project for Integrated Research on Great Earthquakes and Disaster Mitigation in Nepal Himalaya

BACKGROUND OF THE PROJECT AND PROJECT INFORMATION

Nepal is an earthquake disaster-prone country because of its tectonic setting. The Indian plate is moving to northward at a rate of 5cm/year. However, its continental lithosphere is too buoyant to subduct, so that it is colliding with the Eurasian plate generating large earthquakes and forming steep mountains in the Himalayan region including Nepal. Urban areas in Nepal are mostly located in a few basins such as Kathmandu Valley. Since basin sediments and steep topography in basins' outskirts can amplify and lengthen seismic ground motions, it is important for hazard estimates and disaster mitigation to explore not only earthquake sources but also the subsurface structures and topographies of the basins. Moreover, the urban areas are highly vulnerable to earthquakes due to almost entirely non-engineered houses with root causes of weak law enforcement of building codes, unplanned settlements. Consequently, Kathmandu valley in Nepal is one of the highest risk cities in the world against earthquakes.

The Gorkha earthquake on 25th April 2015 brought serious damage to Nepal. The Nepal government committed to implement the concept of "Build Back Better" in reconstruction process. Scientific data has important role in earthquake disaster prevention measures to provide justification. It is crucial to provide correct data for reconstruction.

- This project proposes to provide advanced hazard assessment of Kathmandu Valley based on multidisciplinary research.
- Overall goal of this project is to contribute to reduce the future seismic risk in Nepal.
- Project information

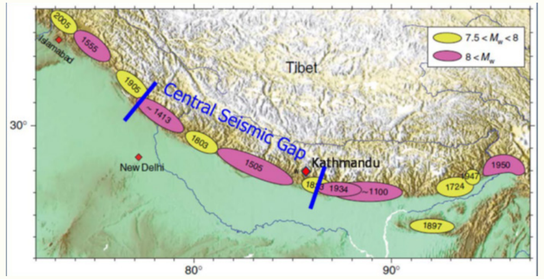
✓ **Project Period:** July 2016- July 2021 (5 years)

✓ **Research Area:**

Area 1: Around the Central Seismic Gap along the Main Frontal Thrust where a great future earthquake is expected, for the source modeling and seismic and geodetic monitoring.

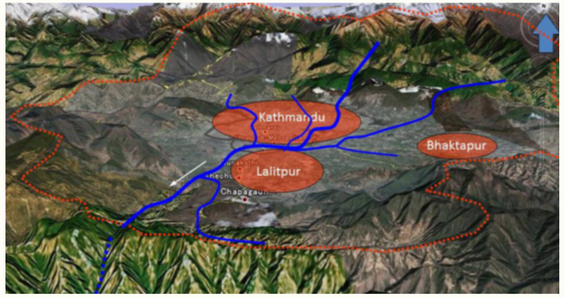
Area 2: Kathmandu Valley and its surrounding areas for the modeling of velocity structures and seismic hazard assessments.

AREA 1



Koketsu et al. Widespread ground motion distribution caused by rupture directivity during the 2015 Gorkha, Nepal earthquake, SCIENTIFIC REPORTS, 2016, pp2. www.nature.com/scientificreports

AREA 2



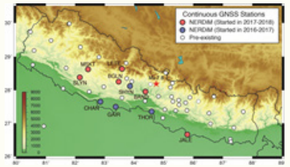
GROUP 1a EARTHQUAKE POTENTIAL EVALUATION (GNSS MONITORING)

Objectives

1) Monitoring of 3-D surface displacements due to plate interaction between the Indian and Eurasian plates at a high precision of a few millimeters per year.
2) Evaluation of earthquake generation potential in central and mid-western Nepal in the near future.

Activities

The group has deployed ten continuous GNSS (Global Navigation Satellite System) stations. In addition, the group is preparing an automated GNSS data processing and archiving system at NEMRC/DMG, Kathmandu. Strain build-up monitored by our system, in conjunction with data from other pre-existing GNSS stations in and around Nepal, will provide very fundamental and important information for evaluating earthquake generation potential in Nepal.

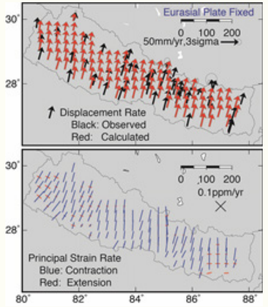


GNSS network in Nepal as of 2019

From near the Indian border (upper) to the mountainous region (lower)

Displacement rate (upper) and principal strain rate (lower) including GNSS stations. North-south contraction is as large as 10-15 mm/yr, equivalent to the strain rate of 0.1 ppm/yr since the network coverage is about 100-150 km in north-south. The Project network clearly improves the spatial coverage especially near the Indian border, that agrees roughly with the plate boundary region.

NERDiM GNSS network contributes to the improvement of detection capability and spatial resolution in the "Central Seismic Gap"

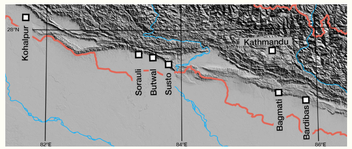


GROUP 1b EARTHQUAKE POTENTIAL EVALUATION (GEOLOGICAL AND GEOMORPHOLOGICAL STUDY ON ACTIVE FAULTS)

The group G1b is conducting detailed geological and geomorphological studies of the active faults in Kathmandu basin and along the Himalayan front in order to reveal the timing and location of past large earthquakes for the evaluation of the potential of destructive earthquakes.

The studies consist of fault mapping and trenching. The fault mapping is conducted with satellite digital terrain models using RTK-GNSS surveys and UAV-SfM mapping to locate the earthquake source faults and identify trench sites. Studies on the Chandragiri fault in southwest Kathmandu basin revealed M 6.9 earthquakes every 5000 years. Trenches around Butwal exposed evidence of the 1344 CE earthquake.

This result constrained the eastern termination of 1505 India-western Nepal earthquake and 1255 eastern Nepal earthquake. Trenches in east and west of Bagmati river crossing of Himalayan front will bring new earthquake history forward.



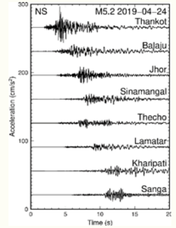
Left: G1b intensive study sites along the Himalayn front and Kathmandu basin.
Right: Trench excavation on the Himalayan Frontal thrust in east of Bagmati river. Two to three faulting events in 1700 years are excavated here.

GROUP 2 GROUND MOTION PREDICTION

Objectives

Installed Stations (2016-2017).

1. Strong motion observation at 10 sites in and around Kathmandu Valley, and 3-dimensional velocity structure model verified and upgraded using obtained data and those of the Gorkha earthquake and aftershocks.
2. Scenario prediction of ground motion in the Kathmandu Valley for more than one earthquake source model in the Central Seismic Gap.



Strong motion records. Explanation in the recorded data for people who concern to the site.

Activities

1. Deploy 10 strong motion seismometers in and around Kathmandu Valley (2016-2017).
2. Collect strong motion records of the Gorkha earthquake, its aftershocks.
3. Using these data, verify and upgrade the velocity structure model in the Kathmandu Valley (G3).
4. Study scenario earthquakes based on the earthquake source models, etc.
5. Conduct scenario predictions in the Kathmandu Valley using velocity structure /soil structure models, etc.
6. Explain the recorded data for people who concern to the site.

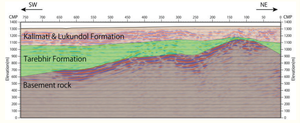
GROUP 3 SEISMIC HAZARD ASSESSMENT

Objective: constructing of Velocity Structure Model (VSM) of the Kathmandu Valley (KTV) for strong ground motion prediction, hazard analysis in KTV when next Mega earthquakes occurred.

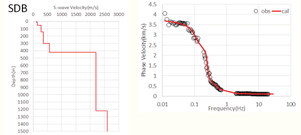
Activities: conducting field survey, analyzing the underground structure and constructing of VSM of 3D.

1. Field surveys in cooperation with Nepal and Japan:
For constructing VSM, we have to get the data of geological structure and physical properties
of the ground, particularly of shear wave velocity, so we have conducted three types of surveys
in KTV: Microtremor surveys, Gravity surveys and Seisimic reflection survey.

2. Training to analyze these survey results for Department of Mines and Geology (DMG) members in Japan:
We conducted exploration data analysis training in Japan for technology transfer. In the next year, training is also planned for construction of VSM.



Geological interpretation of the seismic section at Tribhuvan International Airport.



Phase velocity (right) and Shear wave velocity structure (left) at central part of Kathmandu

Microtremor survey

Seismic reflection survey

Gravity survey

Training at OYO, Japan