5

SOLID EARTH MODELLING PROGRAMME

Research focus of SEMP is integration of computational seismology, geology, tectonics, GPS for natural hazard assessment (earthquakes, landslides, extreme rainfall events) in Indian subcontinent (Himalayas, Northeast India, rigid Indian plate). During 2017-18, SEMP had one Scientific Reports (Nature Publication) and several high Impact SCI publications and about 240 citations for the year 2017-18. We provided Peak Ground motion database for Northwest Himalaya for better design of buildings and assessed the seismic hazard and risk of 13 urban agglomerations of India with high population density. Neo-Deterministic seismic hazard scenarios for India are given for disaster mitigation. We defined Indian reference frame using two decades of continuous GPS data. We gave an estimate of 15 m slip accumulation since 1100-1250 A.D in Darjiling Sikkim Himalaya pointing towards a real great earthquake threat in this region. Existing eleven empirical models for water vapor estimation are evaluated for high altitude Hanle GPS site. Moist parameters at the Hanle site are examined using observed and model data. Broadband seismic network in Dharwar Craton (DC) of Indian peninsula indicates transition zone between east and west DC starting west of Closepet granite to the east of Chitradurga Schist Belt (CSB), which shows diffused Moho with a thickness of 40–44 km.

Inside

- Peak ground motion estimation in NW Himalaya using a stochastic finite-fault method
- Active crustal deformation and landslide studies in Garhwal Himalayas
- Establishment, operation and maintenance of continuous mode Global Navigation Satellite System (CGNSS) stations

5.1 Peak ground motion estimation in NW Himalaya using a stochastic finite-fault method

A stochastic finite-fault method based on dynamic corner frequency has been used to estimate peak ground motion at bedrock level for NW Himalayas with particular emphasis on Kashmir Himalaya. Instrumental and pre-instrumental earthquakes of magnitude $M_w \geq 5$ were used as seismic sources in simulating the synthetic seismograms at a regular grid of 0.2◦× 0.2◦. Acceleration time series thus generated were further integrated to obtain velocity and displacement time series. Peak Ground values of Acceleration (PGA), Velocity (PGV) and Displacement (PGD) have been extracted from simulated time histories and mapped on a regular grid over the region. Expected PGA value for Kashmir Basin and Muzaffarabad is about 0.3-0.5g and ~0.35g for epicentral region of 1905 Kangra event. The values computed here are in agreement with other studies in the region, whilst PGA expected in general is larger than official hazard map of India produced by Bureau of Indian Standards. To validate our findings, the intensities generated from PGA were compared with observed intensities. Major events in Kashmir Himalayas like recent 2005 are simulated separately and corresponding PGA map is shown in Figure 5.1. Pseudo-Acceleration and Velocity response spectra (PAS, PVS) for three sites (plotted as triangles on Figure 5.1) near 2005 Kashmir earthquake are compared with observed spectra which validated our results providing available site conditions. This study provides ground motion database for better design of buildings and other infrastructure in the region.

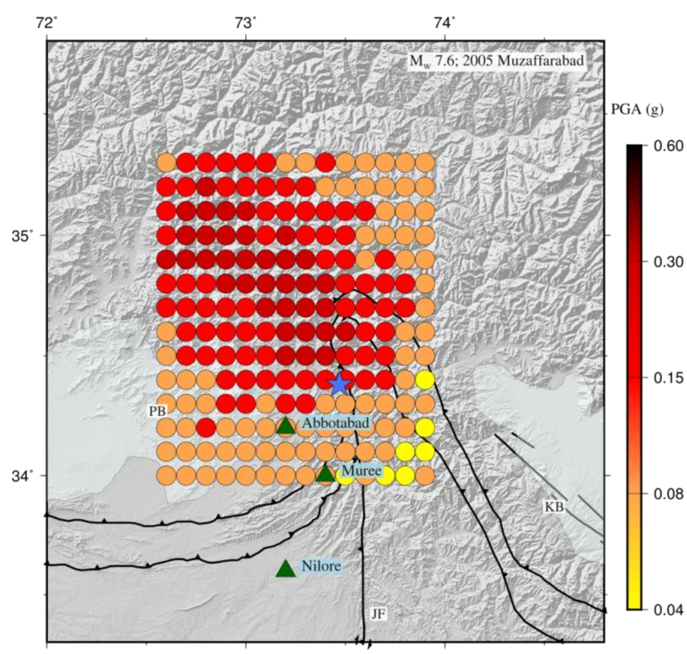

Figure 5.1 Peak ground acceleration map for 2005 Kashmir earthquake at 0.1°×0.1°. The strike angle of 330°, causing a strong directivity effect in NW direction and dip of 40° was used. Stars represent the sites where strong motion records for this event are available. The computation was done at bedrock level. KB and PB are the Basins of Kashmir and Peshawar

5.2 Active crustal deformation and landslide studies in Garhwal Himalayas

Garhwal Himalayas located in Uttarakhand is one of the most seismically active regions in the northwestern Himalayas. GPS re-measurements (Figure 5.2) were carried out in 2017 for GPS sites in Garhwal Himalayas to estimate the present day active deformation in this region. CSIR-Central Building Research Institute (CBRI) in collaboration with CSIR-4PI has selected two landslides in Jalgwar village of Chamoli district for monitoring. GPS re-measurements (Figure 5.3) were carried out for both the reference and control points in 2017. Operation and maintenance of Continuous mode Global Navigation Satellite System (CGNSS) station co-located with meteorological sensor in CBRI, Roorkee is carried out.

Figure 5.2 Campaign mode GPS survey set-up at Tungnath, Uttarakhand

Figure 5.3 GPS survey set-up at Landslide near Jalgwar Village, Pipalkoti, Uttarakhand

5.3 Establishment, operation and maintenance of continuous mode Global Navigation Satellite System (CGNSS) stations

CGNSS stations were established in Bhimbat and Kargil (Figures 5.4 and 5.5), Jammu and Kashmir. Operation and maintenance of twelve stations in Kashmir valley, Leh, Chennai was carried out in 2017-2018. Meteorological sensor (Figure 5.6) was established in Udupi CGNSS station. Srinagar station is remotely accessible and data is streamed in near real time to CSIR-4PI server.

Figure 5.4 CGNSS station established in Bhimbat, J &K

Figure 5.5 CGNSS station established in Kargil, J&K

Figure 5.6 CGNSS station with meteorological sensor established in Udupi, Karnataka