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Continued risk of natural disasters in Nepal

Overview

- The Nepal earthquakes in April and May 2015 invite a reappraisal of earthquake-related hazards in the region.
- The area affected by the earthquake is prone to further hazards (floods, avalanches, and landslides), highlighting the need for a multi-hazard approach to risk assessment.
- The danger of further hazards is amplified as the monsoon season approaches.
- Remote sensing and mapping of risk conditions can support relief efforts by pinpointing the worst affected areas, and help to forecast future earthquake-related hazards.

The April and May earthquakes

Two large earthquakes in Nepal on 25 April and 12 May 2015, of magnitude 7.8 and 7.3, affected the country dramatically, resulting in over 8,500 deaths to date and hundreds of thousands of people being displaced. Nepal is particularly prone to earthquakes due to its location at a critical interface where the Indian plate is moving underneath the Eurasian plate at a rate of about 45 mm/yr. The April earthquake ruptured an area approximately 150 km long and 80 km wide along a shallow region of the plate boundary, northwest of Kathmandu. The May earthquake, a strong aftershock, occurred about 150 km farther to the east, at the eastern termination of the first rupture, covering a fault area of about 40 x 40 km^2.

The high seismic hazard in the Nepal region is well known and documented in the literature, but the shaking of the M 7.8 earthquake in many places was not as high as anticipated from earthquake models. For example, at Kanthi Path in Kathmandu, recorded peak ground acceleration – a widely used measure of the acceleration felt on the ground during an earthquake – was a factor of two lower than predicted from ground-motion models. The specific geologic subsurface conditions in the region, but also the earthquake rupture process itself, may have played a role in reducing peak ground acceleration, affecting the way seismic waves propagate and causing a ground motion

Road damage in Nepal following the April earthquake. (Credit: Krish Dulal)

more complicated than predicted by empirical models.

No surface rupture has been found so far. The main shock caused a relatively small maximum displacement on the fault, inferred to be of the order of 3–5 m. The global database of earthquake models implies fault displacements of 10 m or more for such events. This small displacement may have mitigated earthquake damage at the surface. While the observed damage in the Nepal case was severe, resulting in the deadliest quakes in the country's history, models for loss estimate had predicted far worse. These preliminary observations may provide a new interpretation of the magnitude and dimensions of historical earthquakes, and may require an improvement of earthquake models and re-assessment of the seismic hazard in the region.

While there have been large earthquakes in recent history along the Indian–Eurasian plate boundary, the seismicity in this region indicates that certain areas of the plate boundary have accumulated significant stress over the last few centuries, and hence are prone to large earthquakes in the future. The seismic activity triggered by the April earthquake was mostly localised east of the main shock epicentre, and the possibility remains for strong earthquakes to occur west of it, in a zone devoid of recent seismic activity. However, the timing of future large earthquakes remains unknown.

Risk assessment outlook

The Nepal earthquakes are a clear example of how a specific natural event can trigger a series of chain reactions that substantially increase exposure to other types of hazards. Several events have followed the earthquakes, including an avalanche on Mt Everest and a landslide that buried the Himalayan village of Langtang in April. With the monsoon season approaching, the country is also at risk of further hazards. Heavy rainfall may trigger more landslides on surfaces destabilised by the quakes, or generate debris flows because of the large amount of destabilised sediment on hill slopes and rivers. There is also an increased risk of floods due to the bursting of glacial lakes if their natural dams collapse.

Encouraging news came from the South Asian Climate Outlook Forum, held in Dhaka, Bangladesh just a few days before the April earthquake. There is a strong consensus among the experts that prevailing El Niño conditions in the equatorial Pacific will continue during the monsoon season, leading to below-normal rainfall over parts of South Asia, including Nepal. However, this does not mean that the risk of floods and landslides for the coming monsoon season will be less than that for a 'regular' year, because the earthquakes may have substantially increased the hydrogeological risk. The earthquakes loosened the soil on the steep mountain slopes, and more rainwater could penetrate into it, increasing the risk of landslides.

This complicated hazard environment emphasises the pressing need for an integrated analysis and management of different natural hazards, since single-event analyses do not fully quantify the enhanced risk of these combined events. There is little agreement within the geoscience community on how earthquakes trigger a cascade of related events and how they should be modelled. A multidisciplinary study on the dynamics of the interaction between the different natural processes that produce risk situations is needed.

Hazard mapping and risk reduction

The recent earthquakes in Nepal highlight the difficulties in managing a seismic catastrophe in a remote mountain area. This has revealed the importance of rapid provision of high-quality geoscientific information for decision makers on the ground. At present, teams of geoscientists are using satellite images and data, including high-resolution digital elevation models that provide 3D representations of the terrain, to analyse the effects of the earthquakes in Nepal and map landslide risk. Data available for free includes that captured by Sentinel 1-A, the first satellite for the Copernicus environment-monitoring programme led by the European Commission.

References and further reading

- US Geological Survey information page on the M 7.8 April earthquake: egu.eu/0H6WOT
- US Geological Survey information page on the M 7.3 May earthquake: egu.eu/7XOUW5
- Global Disaster Alert and Coordination System live satellite map of the affected region, United Nations and European Commission: egu.eu/1FDG3H
- SRCMOD: Finite-source rupture model database: egu.eu/4P7NZJ
- Center for Engineering Strong Motion Data: egu.eu/7XSWVK
- Sentinel-1 Scientific Data Hub, European Space Agency and European Commission: egu.eu/85GP7H
- Nepal earthquake on the radar, European Space Agency: egu.eu/5OG5HL
- The 2015 Nepal Earthquake: Crustal Deformation Observed by Synthetic Aperture Radar, GeoSpatial Information Authority of Japan: egu.eu/1GQDEF
- The April 25, 2015 Nepal Earthquake, Earth Observatory of Singapore: egu.eu/9AJO3M
- Mw=7.8 Earthquake Central Nepal (25 April 2015), Cooperative Institute for Research in Environmental Sciences: egu.eu/4JONV8
- The timing of the landslide season in Nepal, The Landslide Blog, American Geophysical Union: egu.eu/6WGV1T
- Monitoring Post-Earthquake Geohazards, ICIMOD: egu.eu/3SCXNE

Credits

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