Rethinking Earthquake Resilience: Uncovering the Multidimensional Factors Shaping Physical Outcomes

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Motivation

Figure 1: Before and after Nepal 2015 earthquake (Calamur, 2015).

- A massive ***7.8 magnitude earthquake killed hundreds*** of people on 25 April 2015 as it ripped through large parts of Nepal, toppling office blocks and towers in Kathmandu and triggering an avalanche that hit Everest base camp (ADRC, 2015).
- ***Traditional earthquake engineering risk assessments*** tend to focus on understanding the seismic hazard, an integration of the socio-economic factors for a complete understanding of earthquake hazard is needed.

Objectives

- Develop a risk assessment model that integrates seismic hazard data with socio-economic factors to provide a holistic understanding of earthquake impacts.
- Examine the influence of socio-economic vulnerabilities, such as poverty rates and land use policies, on earthquake outcomes using the 2015 Nepal earthquake as a case study.

Study Event and Site

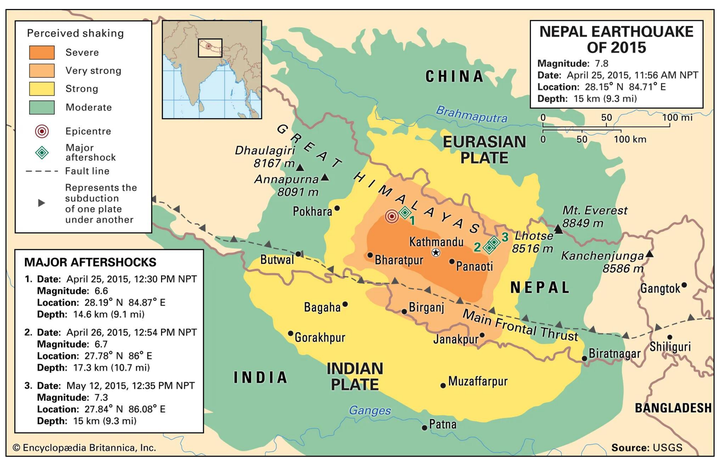
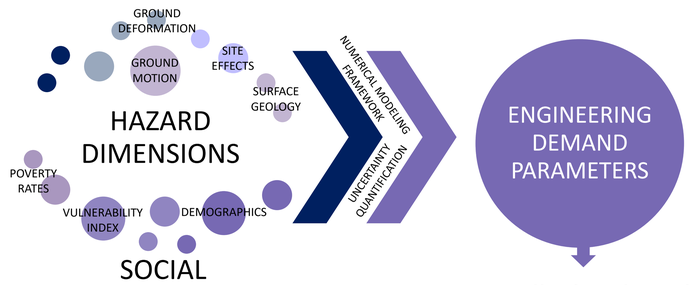


Figure 2. Nepal 2015 earthquake and surrounding region (Chmielewski, 2015).

- Over 8,800 deaths
- Economic loss of 10 billion US dollars
- 602,257 houses fully damaged
- More than 16,000 injured

Proposed Methodology



Spatially distributed: building damage, economic loss, population loss.

Shear wave velocity

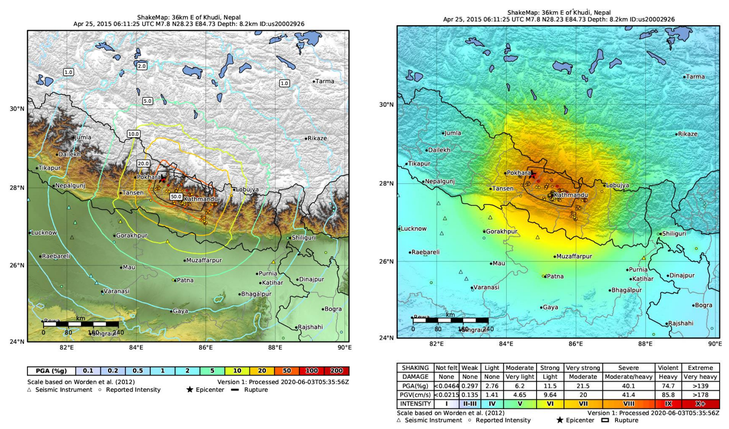
Input Parameters								
Hazard Dimension					Social Dimension			
Ground Motion Data	Ground Deformation Data	Geophysical Data	Geotechnical Data	Geological Data	Socioeconomic Status	Poverty Data	Social Vulnerability Index	Census Data

Landslides, liquefaction triggering, induced settlement, lateral spreading

Soil profiles, mechanical properties of subsurface materials

Input Data

➢ Hazard Dimension



(a) (b)

Figure 3: Spatial distribution of ground motion data: (a) Peak ground acceleration; (b) Modified Mercalli Intensity (USGS, 2024).

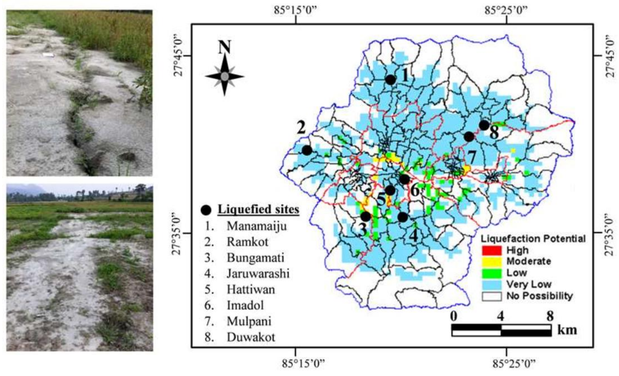
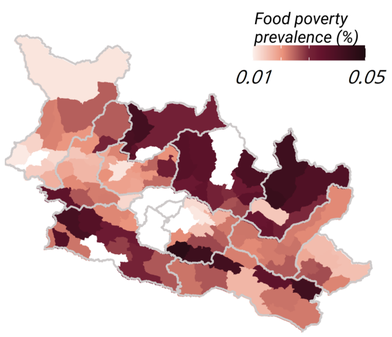


Figure 4: Soil liquefaction in Kathmandu valley due to 2015 earthquake in Nepal (Subedi et al.,2017).

➢ Social Dimension

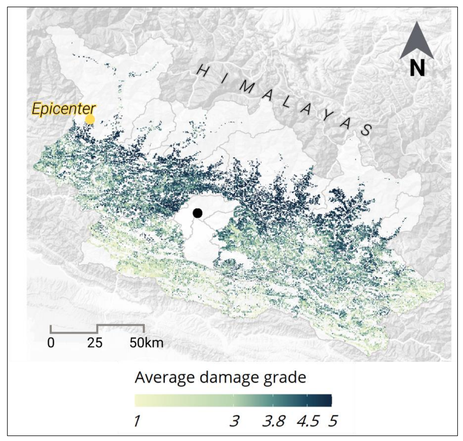


Additional social data to be considered:

- SVI
- Socioeconomic status
- Access to transportation
- Land use

Figure 5: Pre-existing food poverty in Nepal, 2015 (Loos et al.,2023).

Event Outcome



Damage was largely concentrated in the north, near the Himalayas

Representation of the distribution of economic loos and population displacement

Figure 6: Spatial distribution of building damage (Loos et al., 2023)

Expected Outcomes

The relationship between seismic hazards and social variables demonstrates an intersectional dynamic, wherein:

hazard impacts on communities are heavily influenced by **pre-existing vulnerabilities**,

it is necessary to **incorporate multi-dimensional** data into seismic hazard assessments,

research studies focused on **community engagement and education** are much needed.

References

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3. Loos, S., Lallemant, D., Khan, F. et al. (2023). A data-driven approach to rapidly estimate recovery potential to go beyond building damage after disasters. *Commun Earth Environ* **4**, 40. https://doi.org/10.1038/s43247-023-00699-4
4. Subedi, M., Acharya, I.P. (2022). Liquefaction hazard assessment and ground failure probability analysis in the Kathmandu Valley of Nepal. *Geoenviron Disasters* **9**, 1. https://doi.org/10.1186/s40677-021-00203-0