Geostructural complexity and passive seismic surveys: a geostatistical analysis in the Kathmandu basin

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- Key objective: mapping soil resonance periods (RP) related to deep seismic reflectors (i.e., transition between sedimentary cover and bedrock)
- Data: 40 RP values acquired via single station passive seismic surveys (HVSR methodology)
- Mapping approach: geostatistical algorithms based on Ordinary Kriging and Kriging with External Drift (using distance from outcropping bedrock as auxiliary variable)
- Results: reliable mapping of RPs, compatible with the geostructural setting of the area and preceding studies based on gravimetric methods. Moreover, high spatial variability of RPs related to deep reflectors, indicating the need to increase the number of data for a more detailed mapping

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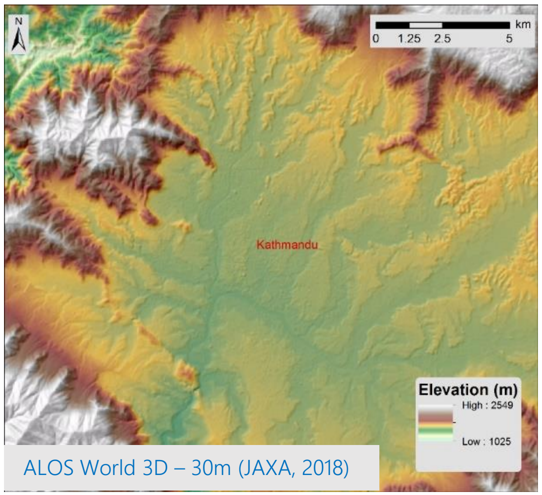
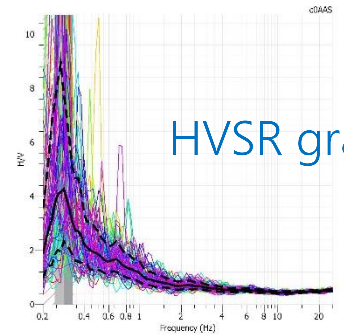
Study Site and HVSR Data

40 RP values acquired via single station seismic noise (Bonnefoy-Claudet et al., 2006) surveys based on HVSR methodology (Nogoshi M., Igarashi T., 1970)

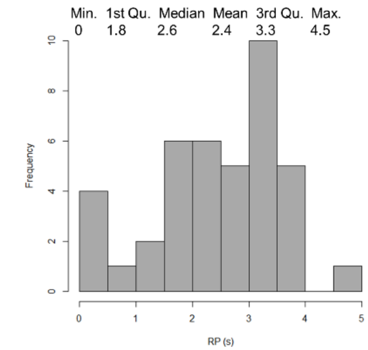


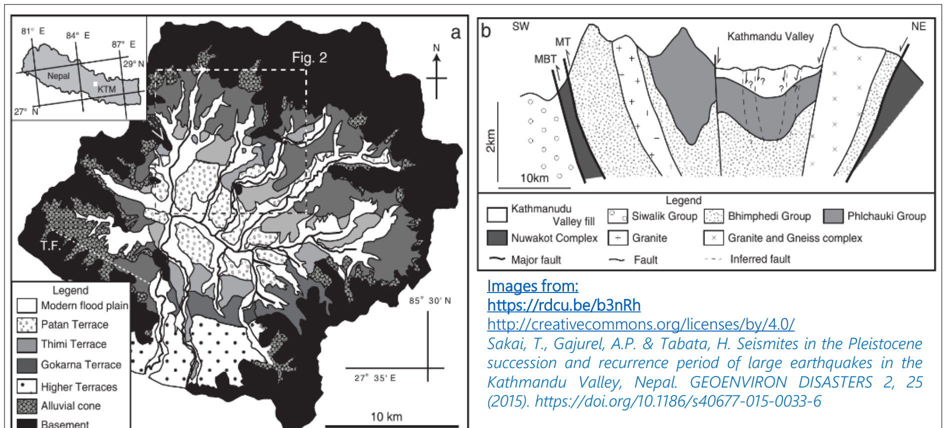
ALOS World 3D – 30m (JAXA, 2018)

Kathmandu basin: geo-structural complexity and heterogeneity of the sedimentary cover (*Sakai, 2015 and 2008; Paudyal 2012)*



HVSR graphs





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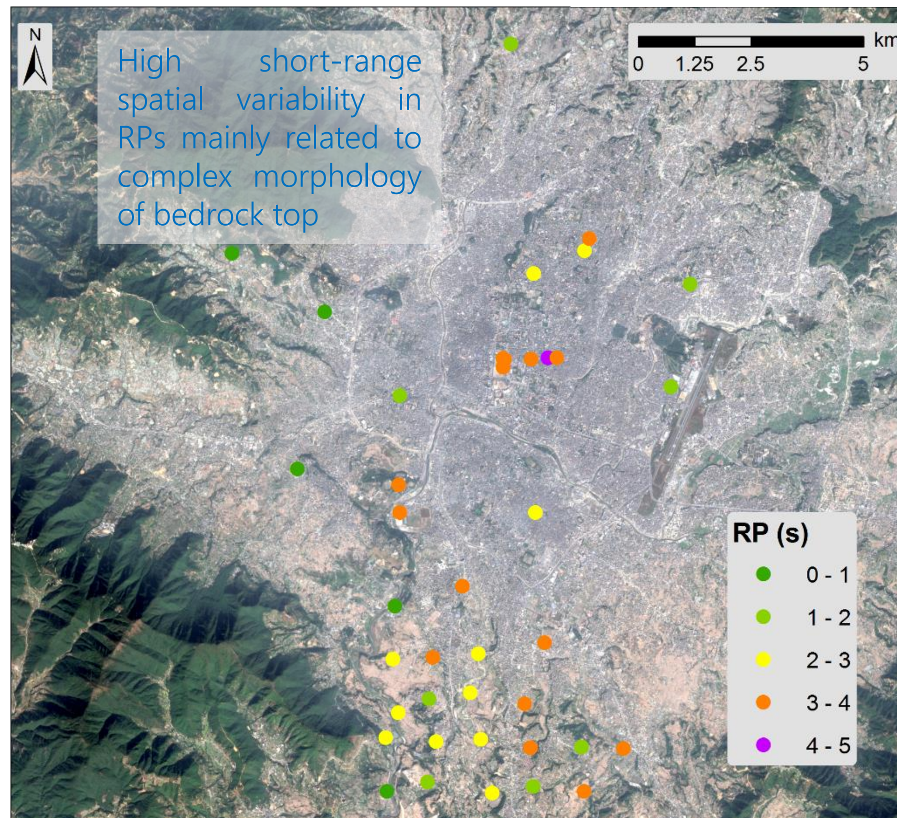
Sakai, T., Gajurel, A.P. & Tabata, H. Seismites in the Pleistocene succession and recurrence period of large earthquakes in the Kathmandu Valley, Nepal. GEOENVIRON DISASTERS 2, 25 (2015). https://doi.org/10.1186/s40677-015-0033-6

High short-range spatial variability in RPs mainly related to complex morphology of bedrock top



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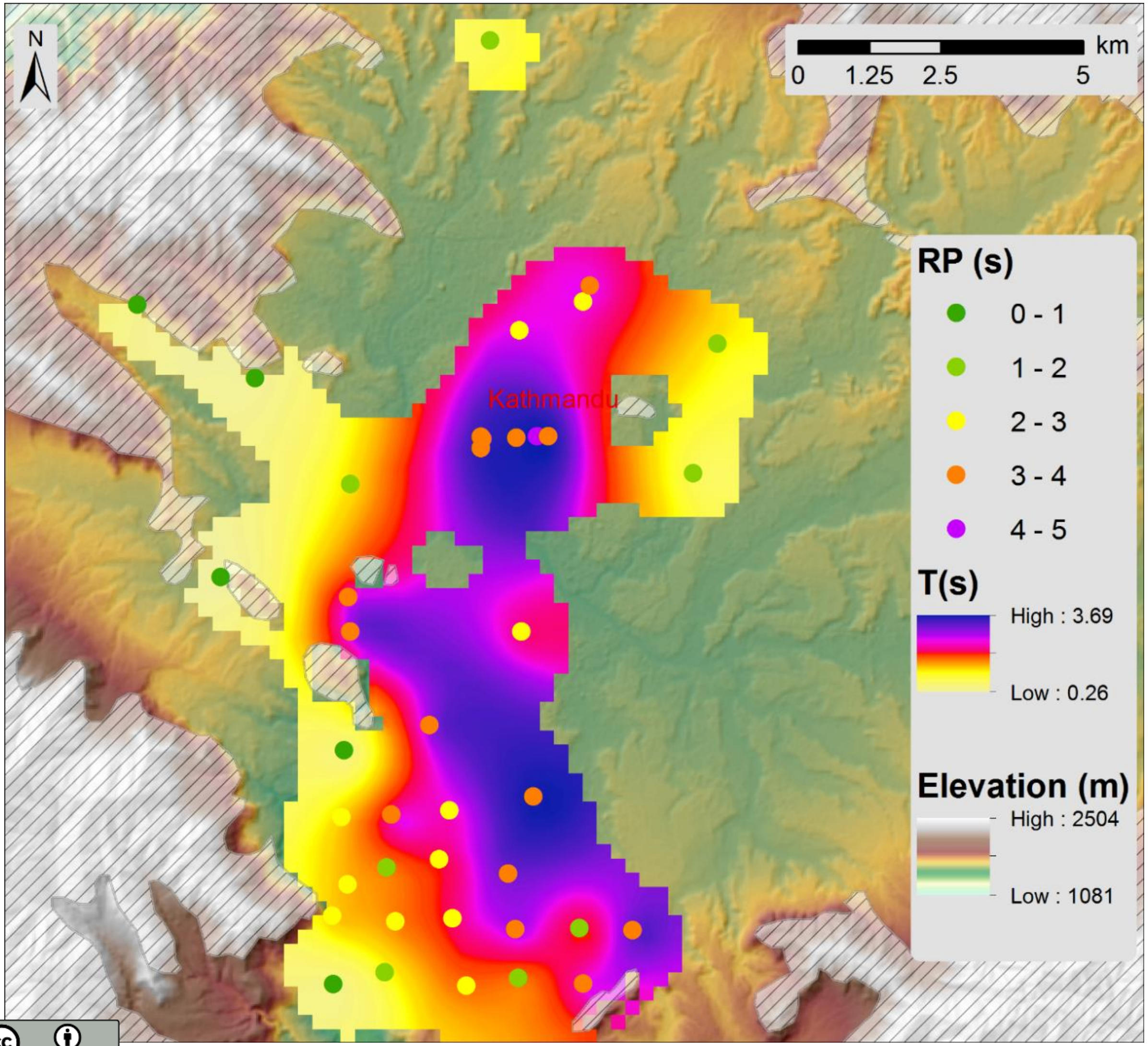
Main Results

Mapping by means of Kriging with External Drift (Goovaerts, 1997) using distance from outcropping bedrock as auxiliary variable (e.g., Trevisani et al., 2017)



The geostatistical analysis has been conducted using the Gstat package in R (Pebesma, 2004) and the "geostatistical analyst" package in ArcMap 10.71 (Esri)

The resulting mapping of RPs is compatible with the geostructural setting (e.g., NW-SE elongated pattern) of Kathmandu basin

The mapping is also congruent with the results from the study of Moribayashi and Maruo (1980) in which bedrock depth has been mapped by means of gravimetric data (112 samples)

The high spatial variability of RPs related to deep reflectors and long period resonances requires a more dense sampling network for accurate mapping

Even seismic local effects related to deep impedance contrast can be characterized by abrupt spatial variations

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