Updating proxy-based site amplification map in Osaka, Japan with soil borehole data: A Bayesian updating scheme based on Uncertainty Projected Mapping

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Proxy-parameters like engineering geology, Vs30 (the time-averaged shear wave velocity (Vs) to a depth of 30 m), etc. are frequently used for preparing site amplification maps. However, these proxy-based maps do not always reflect the in-situ conditions. During the 2018 Mw 5.6 Northern Osaka earthquake in Japan, damage distribution in Ibaraki and Takatsuki cities of Osaka significantly deviated from the site amplification estimations of proxy-based Japan seismic hazard information system (J-SHIS) map. One possible explanation for the deviation is the difference between proxy-based and in-situ site amplification values. The other reasons could be strong ground motion, source effect, age of buildings, etc. In this study the role of site amplification in the damage distribution is investigated with the evaluations from available in-situ data.A Bayesian updating scheme is proposed for updating the proxy-based J-SHIS map with soil borehole data. The proposed scheme is based on uncertainty projected mapping (UPM), where spatial resolution corresponds to the denseness or sparseness of the available data. The study area is in Ibaraki and Takatsuki cities of Osaka, located close to the epicentre of the earthquake, where dense borehole data from Kansai Geo-informatics Network are available. In-situ site amplification at the borehole locations is evaluated using equivalent linear ground response analysis with non-linear soil modelling. The updated map or the posterior in Bayesian inference is generated with proxy-based J-SHIS values as priors, and evaluated in-situ site amplifications as likelihoods. The updated map with borehole data shows increased spatial granularity of low and high amplification regions. Several regions with relatively low amplification appeared in the previously high-amplification zone of proxy-based J-SHIS map. The appearance of relatively high amplification regions in previously low-amplification zones of proxy-based J-SHIS map might explain a couple of earthquake damage locations. However, the majority of damage locations cannot be explained by the updated map. It may be concluded that site factor alone is not sufficient, and factors like the source effect, age of buildings etc. should be considered for understanding the near-source damage distribution.

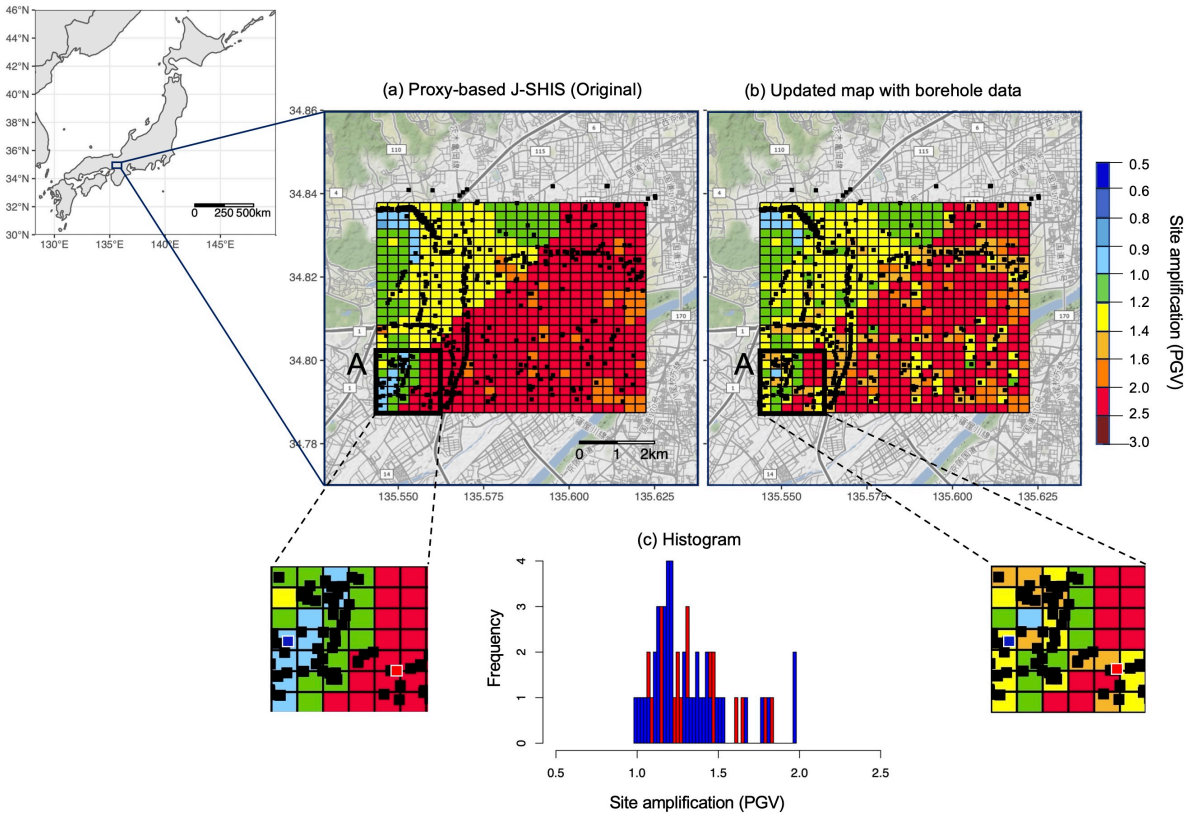

Figure 1. Comparison of site amplification in Osaka, Japan shown by (a) Proxy-based J-SHIS map and (b) Updated map with soil borehole data. (c) Histogram plot confirms the statistical significance of updated (higher spatial granularity) map resolutions in zone A