Site-conditions map for Portugal based on VS measurements: methodology and final model

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ABSTRACT

In this paper we present a statistically significant site-condition model for Portugal based on shear-wave velocity (VS) data and surface geology. We also evaluate the performance of commonly used Vs30 proxies based on existing data and analysis. The main contributions are the development of these proxies for calculating site amplification in seismic hazard assessment.

The database flat-file includes information on Vs30, surface geology at 1:50.000 and 1:200.000 scales, and the 1:50.000 and 1:200.000 SRTM digital elevation datasets.

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METHODOLOGY

Geology-based VS30 model based on a 3-step iterative procedure

1. Preliminary model
   - Model of geologically derived units based on literature (e.g., Wills and Clahan, 2006), Distributions of log Vs30 for each unit.
   - Statistical tests
     - Automated declustering
     - Merging of the geological units
2. Final geology-based Vs30 model for Portugal
   - The final model consists of three geologically defined units characterized by Vs30 distributions characterized and illustrated in Figure 4.

RESULTS

Testing correlations with topographic slope for refining the model

- Topographic slope has been often correlated with Vs30 in the literature (e.g., Wald and Allen, 2007; Thompson et al., 2014; Novotný et al. 2014).
- The correlation between topographic slope and Vs30 is poor for the full dataset (Figure 3). However, for F1 sites (Holocene formations), there is some evidence of correlation between those variables, in particular for the SRTM DEM.
- A non-parametric test indicates that the differences between log Vs30 distributions of the two Holocene sites are statistically significant at a 5% confidence level.
- The null hypothesis is rejected for p>0.05).

DISCUSSION

Performance of models based on exogenous Vs30 data

- We analyzed the residuals between the Vs30 values measured and those predicted by the topographic-based Vs30 global model of Silva and Wald (2007).
- By the geological analogue model as implemented by Silva et al. (2014), based on the geology-based Vs30 model of Wills and Clahan (2006).
- The residuals (Figure 9) show that:
  - Both methods show fairly unbiased residuals.
  - The topographic-slope model is biased towards lower values of Vs30 for F1 sites and it is biased towards higher values of Vs30 for F3 sites.
  - The residuals distribution shows clear linear trends with the independent variables for the topographic-slope-based model.
  - The geological analogue model is biased towards lower values of Vs30 for the F2 and F3 sites but it is not discernible with choosing a proper geological analogue from a different geographical region.

CONCLUSIONS

- We present a geology-based Vs30 model for Portugal which includes three geological categories: F1 - Mesozoic, metasomatic, and sedimentary rocks; F2 - Neogene and Pliocene formations; and F3 - Holocene formations. The logVS30 distributions pertaining to each geological category are significantly different from each other.
- We discard the correlation between slope and Vs30 as it is not present, even for larger scalar datasets.
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