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The Comparison of the 2020 European and the Finnish Seismic Hazard Models at Two Nuclear Power Plant Sites in Finland

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Finland, which is characterized by very low seismicity, does not have a national seismic hazard map. However, site specific Probabilistic Seismic Hazard Assessments (PSHAs) for critical infrastructure, including nuclear power plants (NPPs), have been conducted. The sophisticated 2020 European Seismic Hazard Model (ESHM20) offers several advancements that could influence seismic hazard work in stable continental regions like Finland. As part of the SEISMIC RISK collaborative project involving the University of Helsinki, VTT Technical Research Centre of Finland, and the Geological Survey of Finland, a national PSHA model has been developed. The model is based on a Fennoscandian earthquake catalogue – FENCAT, compiled from Nordic national catalogues based on the observations from the national seismic networks. This allows for calculation of the recurrence parameters with lower magnitudes than the ESHM20. Although a preliminary comparison reveals only minor local differences at hazard levels, a more detailed examination at critical infrastructure sites is necessary.

We have compared the regional hazard results obtained within the SEISMIC RISK project and hazard values of the ESHM20 at two NPP sites in Finland. Four criteria from the literature, compiled by Douglas et al. (2023), were employed for assessing the differences between the seismic hazard models. To this end, the mean, median, and 16th and 84th fractiles for the ESHM20 were obtained from the European Facilities for Earthquake Hazard and Risk (EFEHR) database hosted by EPOS–Seismology.

A visual inspection of the hazard curves initially indicated consistently higher mean hazards from the Finnish model at the NPP sites compared to ESHM20. The lognormal distributions of the hazard models were estimated, and the differences were assessed for the return periods of 10^6, 10^4, 5000, 2475, and 475 years using the four criteria. The distributions revealed a significantly smaller standard deviation for the Finnish model than for the ESHM20. When comparing the two models, the mean Annual Frequency of Exceedance (AFE) changed by over 25% for the ground-motions corresponding to AEFs ≤ 10^{-4} and by more than 35% for ground-motions corresponding to 10^{-6} AFE. These findings underline the significant differences between the models.

In summary, a minimum of two out of the four criteria are met at one of the NPP sites, and at the

other NPP site, three out of four criteria are satisfied. This further highlights the significance of the differences between the ESHM20 and the Finnish hazard model. Nevertheless, while the observed change in hazard between the Finnish hazard model and the ESHM20 can be deemed substantial, it does not justify the use of the Finnish hazard model for the longer return periods. Further investigations, such as site-specific hazard assessments, are necessary for the return periods relevant to NPPs.

Douglas, J., Crowley, H., Silva, V., Marzocchi, W., Danciu, L., & Pinho, R. (2023). Methods for evaluating the significance and importance of differences amongst probabilistic seismic hazard results for engineering and risk analyses: A review and insights. EGUsphere [preprint], https://doi.org/10.5194/egusphere-2023-991