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A new Matlab tool to assess probabilistic fault displacement hazard

Selina Bonini¹, Oona Scotti², Alessandro Valentini³, Francesco Visini³, Giulia Tartaglia⁴, Riccardo Asti¹, and Gianluca Vignaroli¹

¹University of Bologna, Department of Biological, Geological and Environmental Sciences, Bologna, Italy
(selina.bonini2@unibo.it)

²Autorité de Sûreté Nucléaire et de Radioprotection (ASNR), PSE-ENV/SCAN/BERSSIN, Fontenay-aux-Roses, France

³National Institute of Geophysics and Volcanology (INGV), Pisa, Italy

⁴ITALFERR S.p.A., Gruppo Ferrovie dello Stato Italiane – Architecture, Environment & Territory Department – Geology Division, Roma, Italy

In tectonically active regions, surface faulting and offset of the ground surface caused by capable faults pose significant hazard to urban settlements and critical infrastructures. Given the challenges in fully parametrizing the geometry, kinematics, and activity of a capable fault, Probabilistic Fault Displacement Hazard Analysis (PFDHA) is widely employed. PFDHA is a relatively recent methodology that estimates the probability and magnitude of expected surface displacement at a given site during an earthquake.

Current methods for Fault Displacement Hazard Analysis (FDHA) are commonly tailored to specific kinematic scenarios and often rely on scaling laws that are based on the characteristic earthquake magnitude. These approaches typically distinguish between displacements occurring along the primary fault (PF) and those occurring at distributed off-fault ruptures (DR). However, only a limited number of these methods are associated with computational tools, and their accessibility to users varies widely.

This study introduces a new Matlab-based tool that integrates published scaling laws, surface rupture models, and fault displacement models into a PFDHA framework. The tool supports hazard assessment for both PF and DR displacements and incorporates the concept of floating rupture along faults, a common practice in probabilistic seismic hazard assessment.

The modular design of the code provides users flexibility in generating hazard curves and maps by allowing them to select a variety of kinematic-specific components within the PFDHA. Furthermore, it allows the hazard assessment that considers distinct frequency-magnitude distributions.

Moreover, a novel approach to address co-seismic ruptures that may be shorter than the total length of the main fault is proposed. It involves translating fault segments along the fault trace, with the co-seismic rupture length evaluated over a range of M_w values, such as those derived from a truncated Gutenberg-Richter distribution. The conditional probability of exceedance is then determined by recalculating the x/L points corresponding to the site location (x) in each rupture length (L) translating along the total length of the fault. Contributions from all scenarios are

aggregated to produce the total hazard for distributed ruptures.

This new tool aims to advance the current state of PFDHA by addressing variability among current models, facilitating direct comparisons between published methodologies for both PF and DR.