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Exhaustive High-Performance Computing utilization in the estimation of the economic impact of tsunamis on Spanish coastlines

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Tsunamis are low-probability phenomena with high-risk potential. Lack of field data emphasizes the need of using simulation software to model the potential devastating effects of a tsunami and use this information to develop safety, sustainable actions and social resilience for the future. These measures may include, among many others, spatial planning; designing of evacuation routes; or the allocation of economic resources through insurance or other instruments to mitigate tsunami impacts. Our work introduces a Monte Carlo-like method for simulating the potential impact of tsunamis on the Spanish coastlines, specifically in the provinces of Huelva and Cádiz for the Atlantic region, and Balearic Islands, Ceuta, Melilla and eastern Iberian coast for the Mediterranean region. The method introduces a pseudo-probabilistic seismic-triggered tsunami simulation approach, by considering a particular selection of active faults with associated probabilistic distributions for some of the source parameters, and a Sobol's sequences-based sampling strategy to generate a synthetic seismic catalogue. All roughly 4000 crafted seismic events are simulated along the areas of interest in high-resolution grids (five meters pixel resolution) using a two-way nested mesh approach, retrieving maximum water height, maximum mass flow and maximum modulus of the velocity at each grid cell. These numerical simulations are computed in a GPU environment, harnessing resources allocated in several high-performance computing (HPC) centres. HPC infrastructures play a crucial role in the computing aspect of the project, as the calculation power required to complete full-fledge high-resolution tsunami simulations in a reasonably time is expensive. The numerical database of retrieved variables generated throughout this study offers an excellent foundation for evaluating various tsunami-related hazards and risks.

The final resulting product focuses on generating frequency distributions for the economic impacts for the Spanish insurance sector (Consorcio de Compensación de Seguros, CCS). The CCS is a public-private entity insuring most natural catastrophic events in Spain. A consistent spatially-distributed economic database regarding insurance building-related values has been constructed and aggregated in conjunction with the numerical tsunami simulations. The proposed procedure allows to associate an economic impact indicator to each source. Further statistical analysis of the economic impact estimators yields to varied conclusions such as an improved definition of worst-case scenario (effect-based rather than worst-triggered), most and least likely economic impact,

highest hazardous fault sources overall and locally and many others.