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A database of the environmental effects associated to the December 29th, 2020 Mw 6.4 Petrinja earthquake (Croatia)

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On December 29th, 2020, a strong Mw 6.4 earthquake hit central Croatia. The epicenter was located approximately 3 km southwest of Petrinja, and the intensity was estimated to VIII-IX EMS. The earthquake led to significant environmental effects related to earthquake magnitude, focal depth, and geological and geotechnical properties of the affected area.

The Croatian Geological Survey (HGI-CGS) conducted extensive geological and geodetic surveys starting a few hours following the main shock to measure the earthquake's effects, including those on infrastructures. Ten geologists from the Department of Geology carried out surveys from December 31st, 2020 to January 7th, 2021 along the potential seismogenic source (inferred from geological maps and InSAR data) and in the wider epicentral area that suffered significant damage (e.g., Glina and Sisak).

During a second phase, researchers from the University of Zagreb (PMF UniZG), Slovenia (GeoZS), Italy (INGV, ISPRA, U. Chieti) and France (CEREGE, IRSN) were mobilized to complete the observations. The collaboration with these geologists allowed to deepen the investigations and to bring further detail to quantify the effects. The surveys were then compiled based on data formats used by the European Community, namely those of the INGV EMERGEO team (Villani et al., 2017; for environmental effects including surface ruptures and liquefaction) and those of the SURE group (Baize et al., 2019 for surface ruptures).

These observations revealed that the earthquake triggered a discontinuous, few km-long surface rupture with a maximum displacement of about 20 cm, which is consistent with the lower average of observations made on similar events (Wells and Coppersmith, 1994). Liquefaction spread over several tens of square kilometers mostly in river plains, the most distant being about 20 km from the epicenter (to be confirmed!). Other observed effects include lateral spreading, landslides, groundwater regime changes, rockfalls, and various infrastructure damage.

The compilation of the acquired dataset into a unified database, consistent with database of other historical and recent events, is essential for establishing reliable empirical relations between geological effects and physical characteristics of earthquakes (magnitude, depth). This forms the basis for seismic hazard assessments, whether for "surface rupture", "liquefaction", or "ground-shaking" potential.