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Flood risk to society in Italy: a national scale approach

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Floods are a common type of hazard that globally cause significant economic and societal damage. According to the European Environment Agency (2020) Europe has experienced a large number of catastrophic floods in recent decades, with numerous lives lost. In Italy, a country for which detailed information on the number of flood fatalities is available, in the last decade 2011-2020, 150 deaths, 7 missing people and 68 injured persons were recorded. These figures indicate the severity of the risk posed by flood to people in Italy. The risk posed by a hazard on the population is assessed using the societal risk, and is typically sized constructing frequency-consequences curves that relate the frequency of the fatal events to the magnitude of the consequences. The latter is measured by the number of the fatalities (the sum of deaths and missing people). Using the historical catalogue of flood fatalities available for Italy, here we propose an approach, tested for all the Italian country and previously used for other natural hazards, such as landslides and earthquakes, to evaluate the spatial and the temporal distribution of societal flood risk from historical point information. The historical catalogue was divided in different time subsets, respectively used to calibrate and validate the model results. The empirical distributions of the frequency of fatal flood events was modelled adopting the Zipf distribution, defined for a population of finite size. The model variables, can be defined as: (i) the largest number of flood fatalities F, (ii) the number of fatal flood events E, and (iii) the scaling exponent of the Zipf distribution s, which controls the relative proportion of low vs. large magnitude floods. To obtain a homogeneous risk assessment across the Italian territory we partitioned the entire Italian territory in a regular square grid and for each grid cell, we selected from the record of historical fatal floods all the events within a circular kernel of variable radius r, (in km). For each sub-set, selected inside the kernel, the Probability Mass Function (PMF) was computed to estimate the value of the Zipf distribution *s* parameter. Therefore, for each grid cell, the three model variables (F, E, s) are calculated, producing maps to visualize the model results which revealed the complexity of flood risk in Italy for the exposed population.

Despite the difficulty in modelling sparse datasets, the approach provided a coherent representation of societal flood risk in Italy. We therefore expect the approach to be used to model societal flood risk in other geographical areas for which adequate information on flood events and their fatal consequences is available.