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A data-driven statistical approach for flood hazard zoning at national scale

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The delimitation of flood-prone areas is an important non-structural measure that proves to be effective in the long term in reducing food risk.

In Italy, more than 20 basin's Units of Management (UoMs) were in charge to delineate the flood hazard zoning (FHZ) for three different flood return periods. Mostly, FHZ was prepared using physically based models i.e., considering the rainfall-runoff transformation and simulating the flood discharge through the river network. Physically-based models require many inputs and boundary conditions including: hydro-meteorological data, detailed characterization of the geometry of the riverbeds, roughness, infiltration parameters and also real hydrometric measurements in order to be calibrated. Physically based modelling is therefore a long, time consuming and resource intensive process that should be frequently updated to take into account the river channel changes. As a consequence, the Italian FHZ suffers from an underlying lack of homogeneity across the different UoMs, resulting in significant differences on the percentage of the river network for which the flood-prone areas were delineated.

As alternatives to physically based models, in recent years many authors have produced maps of flood susceptibility or hazard using expert (e.g. Analytic Hierarchy Process) or data-driven (e.g. multivariate statistics or machine learning) approaches. Such methods were mostly used in ungauged territories where hydro-meteorological data is not available.

Here we present a procedure, named Flood-SHE (Flood - Statistical Hazard Evaluation), which is aimed at the delineation of flood-prone areas and the corresponding expected water depth, using a multivariate statistical classification model. Flood-SHE was applied to the entire Italian territory with the aim to integrate the UOMs FHZ where it is not available or incomplete. The classification model was trained exploiting the existing UoMs FHZ and using, as independent variables, a set of geomorphometric layers (derived at 10x10 meters ground resolution) which includes the distance and height to the closest rivers and to the basins outlets, the local DEM slope, a stream order classification criterion and the DEM local roughness. Random training and validation areas were used for the classification model in order to obtain an estimation of the uncertainty of the values

of the predictive performance indexes. Results highlight (i) the significance of the the variables distance and height to the closest rivers, roughness and stream order in predicting the flood-prone areas, (ii) the impact of the UoMs morphology and the quality of UoMs FHZ on the reliability of the statistically modeled flood-prone areas.