Large Scale Flood Damage Mapping: the case study of Romania

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A large-scale flood risk analysis that properly evaluates and quantifies the three components of risk (hazard, exposure and vulnerability) is essential in order to support national and global policies, emergency operations and land use management. For example, governments can use risk information for the prioritisation of investments to implement measures for flood damage reduction, for emergency operations and for land-use policies, while reinsurance companies can improve the estimation of the flood risk-based insurance premiums.

Nevertheless, limits in time and data represent significant limitation this kind of applications: i) the significant amount of data and parameters required for the calibration and validation of traditional model; ii) the moderate/coarse resolution of data available at global scale and the sparse availability of high-resolution data that may affect the accuracy of analysis results; iii) the high cost and computational demand of hydraulic models. However, the growing availability of data from new technologies of Earth observation (EO) and environmental monitoring combined with the advances in newly developed algorithms (e.g. machine learning) have extended the range of possibilities for geoscientists, updating and re-inventing the way highly resource- and data-intensive processes, such as risk management and communication, are carried out.

The present study proposes a cost-efficient method for large-scale analysis and mapping of direct economic flood damage at medium resolution in data-scarce environments. The proposed methodological framework consists of three main stages. The first step concerns the derivation of a water depth map through a Digital Elevation Model (30m resolution)-based geomorphic method that uses supervised linear binary classification. The second step aims to realize an exposure map on the basis of a supervised land use classification through the use of a machine learning technique: the information extracted from Landsat-8 remotely sensed optical images were utilized in combination with the discontinuous (i.e. available for a few large cities in Europe) existing high-resolution Urban-Atlas land use maps in order to obtain a land-use map with a resolution of 30 m. Finally, the flood economic damage mapping was carried out using the results of the two previous
steps in a GIS algorithm, developed by authors, based on the vulnerability (depth-damage) curves method. The proposed integrated framework has been tested in Romania for a 100-years return time event. The resulting map (at 30m resolution) covers the entire Romanian territory including minor order rivers, which are often neglected in large-scale analyses.

The demonstrative application shows how the description of flood risk may particularly benefit from the integrated use of geomorphic methods, machine learning algorithms and EO freely available monitoring data. The ability of the proposed cost-efficient model to carry out high-resolution and large-scale analyses in data-scarce environments allows performing future risk assessments keeping abreast of temporal and spatial changes in terms of hazard, exposure and vulnerability.

Acknowledgement: This work was carried out during the tenure of an ERCIM ‘Alain Bensoussan’ Fellowship Programme.