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Uncertainty and Sensitivity Analysis of Direct Economic Flood Damages: Application of the FloodRisk FOSS Software in Italy

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The significant increase of flood damages in the past several decades in Europe has shifted attention from protection against floods to managing flood risks. In this context, the expected damage assessment represents an important source of information within the overall flood risk management process. The present paper proposes an open source software, called FloodRisk, that is able to operatively support stakeholders in the decision-making processes with a "what-if" approach by carrying out a rapid assessment of flood consequences, in terms of direct economic damage and loss of human lives. The evaluation of the damage scenarios, through the use of the GIS software proposed here, is essential for cost-benefit or multi-criteria analysis of risk mitigation alternatives. However, considering that quantitative assessment of flood damages scenarios is characterized by intrinsic uncertainty, a scheme has been developed to identify and quantify the role of the input parameters in the total uncertainty of the flood loss model in urban areas with mild terrain and complex topography. Using the concept of parallel models, the contribution of different module and input parameters to the total uncertainty is quantified. The results of the present case study have exhibited a high epistemic uncertainty on the damage estimation module and, in particular, on the type and form of the utilized damage functions, which have been adapted and transferred from different geographic and socio-economic contexts because there are no depth-damage functions that are specifically developed for the proposed case study in Italy. Considering that uncertainty and sensitivity depend considerably on local characteristics, the epistemic uncertainty associated with the risk estimate is reduced by introducing additional information into the risk analysis. To do so, a new site-specific set of curves was developed using the spatial distribution of the damages collected after the historical flooding event of November 5, 1994, in Albenga, Italy, and more detailed information on the type of buildings at risk, associated with a detailed categorization of land-use classes, was assumed to reduce the uncertainty of the results. The final results, obtained by updating additional local data to the pilot application, show that the 90% percentile range of total estimated damage varied from 1.2 times lower or higher than the median, and the variation of the total damage assessments (measured as the interquartile range / median * 100) was reduced to 35%, with respect to the initial simulations (whose value was 143%). The results demonstrate how additional information and local knowledge can lead to a substantial decrease of uncertainty as well as a decrease of the sensitivity of the flood loss estimation to the uncertainty in the depth-damage function input parameter. It can thus be concluded that there is an urgent need to conduct further research into the implementation of methods and models for the assimilation of uncertainties in decision-making processes.