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Estimation of flood inundation probabilities using hydrodynamic indexes with uncertainty analysis

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Identification, assessment and mitigation of flood risk require a rich fund of knowledge and should be based on a thorough uncertainty analysis. Risk-oriented method is the most complete approach that can be used in the fields of flood design and flood risk management and it allows us to evaluate the cost-effectiveness of prevention measures to optimise investments. The usual procedure is to deal with a precipitation-runoff model and to associate to risk the same return period of original rainfall, in accordance with the iso-frequency criterion. Alternatively a flood frequency analysis to a given record of discharge data is applied, but again the same probability is associated to flood discharges and respective risk. This apparently simple approach has a number of pitfalls and uncertainties, due to fact that only the flood discharges cannot give a reliable evaluation of hazard, depending also by the global characteristics of the flood event.

To overcome these problems the application of a new Monte Carlo simulation procedure to deriver flood hazard maps is here presented.

The layout of the procedure can be resumed as follows:

1) stochastic input of flood hydrograph modelled through a direct Monte-Carlo Simulation based on flood recorded data. This choice has been preferred to circumvent the uncertainties related to precipitation-runoff modelling. Generation of flood peaks and flow volumes has been obtained via copulas, which describe and model the correlation

between these two variables independently of the marginal laws involved. The shape of hydrograph has been generated on the basis of a historical significant flood event;

2) modelling of flood propagation using a hyperbolic model based on the DSV equations (Aronica et al., 1998). The conservative mass and momentum equations for two-dimensional shallow-water flow, when the convective inertial terms are neglected, has been solved using a finite element technique with triangular elements;

3) definition of global hazard indexes based on hydrodynamic variables (i.e., flood water depth and flow velocities)

4) Uncertainty analysis using GLUE procedure.

The procedure was tested on a flood prone area located in the southern part of Sicily, Italy.