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Flood susceptibility assessment based on Analytical Hierarchy Process: application in mainland Portugal

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Although the scientific and computational advances in the hydrological study of flood hazard assessment, a demand still exists concerning more expedite and extensive methods to map flood susceptibility or proneness over large areas. The relevant question is very often to achieve the best equilibrium between the complexity of flood hazard models and the accuracy and quantity of the input data.
The presented study aims to assess flood susceptibility in mainland Portugal through the application of an Analytical Hierarchy Process (AHP), using 17 flood susceptibility conditioning factors related with: i) terrain morphology (elevation, slope angle, slope over area ratio, flow accumulation, topographic position index, landform classification - Jenness); ii) basin morphology (hypsometric integral, Gravelius index, circularity ratio and the orographic coefficient of Fournier); iii) permeability (lithology, , alluvial zones, hydraulic conductivity and ecological zones); iv) rainfall (water balance) and v) hydrography (drainage density and Strahler's fluvial hierarchy). All variables were classified according to empirical knowledge and further defined as raster datasets at the national level with a resolution of 25x25 m cell size.
AHP technique was used to achieve the relative weights based on the Saaty's scale of influence, which ranges between 1 and 9. The weighting of conditioning factors was performed at two levels: initially, between variables and, secondly, between the different classes of each variable. This later process, although consensual regarding most of the variables (e.g., slope angle or flow accumulation) is rather more complex regarding specific variables which require a deeper interpretation of scores (e.g., topographic position index, landform classification and the permeability-related variables).
The study also highlights the challenges posed during the data preparation and integration steps, namely, the integration of data from variables that are represented at the basin level (e.g., those related to basin morphometry and hydrologic behavior) with data represented on a cell-by-cell basis, such as flow accumulation or slope angle.
Future exploration of the results includes the aggregation of the AHP-based flood susceptibility scores – distinguishing progressive floods from flash floods – at the administrative level, achieving a flood susceptibility municipal index in order to verify to each extend disastrous floods have been controlled by natural constrains at the municipal level. Such indexes will be applied later in decision support systems in order to define public civil protection-related resources.

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