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Uncertainty in flood risk mapping

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A flood refers to a sharp increase of water level or volume in rivers and seas caused by sudden rainstorms or melting ice due to natural factors. In this paper, the flooding of riverside urban areas caused by sudden rainstorms will be studied. In this context, flooding occurs when the water runs above the level of the minor river bed and enters the major river bed. The level of the major bed determines the magnitude and risk of the flooding. The prediction of the flooding extent is usually deterministic, and corresponds to the expected limit of the flooded area. However, there are many sources of uncertainty in the process of obtaining these limits, which influence the obtained flood maps used for watershed management or as instruments for territorial and emergency planning. In addition, small variations in the delineation of the flooded area can be translated into erroneous risk prediction. Therefore, maps that reflect the uncertainty associated with the flood modeling process have started to be developed, associating a degree of likelihood with the boundaries of the flooded areas.
In this paper an approach is presented that enables the influence of the parameters uncertainty to be evaluated, dependent on the type of Land Cover Map (LCM) and Digital Elevation Model (DEM), on the estimated values of the peak flow and the delineation of flooded areas (different peak flows correspond to different flood areas). The approach requires modeling the DEM uncertainty and its propagation to the catchment delineation. The results obtained in this step enable a catchment with fuzzy geographical extent to be generated, where a degree of possibility of belonging to the basin is assigned to each elementary spatial unit. Since the fuzzy basin may be considered as a fuzzy set, the fuzzy area of the basin may be computed, generating a fuzzy number. The catchment peak flow is then evaluated using fuzzy arithmetic. With this methodology a fuzzy number is obtained for the peak flow, which indicates all possible peak flow values and the possibility of their occurrence. To produce the LCM a supervised soft classifier is used to perform the classification of a satellite image and a possibility distribution is assign to the pixels. These extra data provide additional land cover information at the pixel level and allow the assessment of the classification uncertainty, which is then considered in the identification of the parameters uncertainty used to compute peak flow.
The proposed approach was applied to produce vulnerability and risk maps that integrate uncertainty in the urban area of Leiria, Portugal. A SPOT - 4 satellite image and DEMs of the region were used and the peak flow was computed using the Soil Conservation Service method. HEC-HMS, HEC-RAS, Matlab and ArcGIS software programs were used. The analysis of the results obtained for the presented case study enables the order of magnitude of uncertainty on the watershed peak flow value and the identification of the areas which are more susceptible to flood risk to be identified.