Design and Implementation of a Flood Forecast and Alert System in an urban area

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Abstract

Floods are one of the natural disasters not preventable, to which society is exposed, affecting people and causing great damage to economic activities and infrastructures. Fluvial floods occur when rivers burst their banks, and Águeda municipality, located in the Centre Region of Portugal, has been identified by the Portuguese Environment Agency as a critical zone with significant potential risk of fluvial flooding in Continental Portugal.

The flood Forecast and Alert System (FFAS – http://ffas.web.ua.pt/) endeavors at improving flood prevention, minimizing loss of life and reducing economic losses within the critical zones. The system was developed based on the combination of meteorological, hydrological and hydraulic models, processing data of weather forecast (precipitations at every 15 minutes) and hydrometric data, to produce deterministic and probabilistic flood hazard forecast maps. The analysis and classification of these maps are performed automatically, comparing water levels with predefined limits of flood risk classes. If the forecast indicates the existence of flood hazard, alert levels are generated and disseminated to the authorities and to the community through a web and mobile applications.

The design and implementation of the system was established according to four phases: preparation, forecasting, alert and dissemination. Numerical weather forecasting models furnish quantitative precipitation forecasting for the next three days. The validation of these forecasts is performed based on the national meteorological network observations. These forecasts are inputs to the calibrated HEC-HMS hydrological model that runs automatically to produce the flood hydrographs used as input to the calibrated HEC-RAS flood model (1D/2D). The system outputs (water levels and flow velocity) are posteriorly compared with those of the monitoring network installed in the flood-prone areas and, if their differences exceed an established threshold, the model will again be calibrated.

The geometric representation of the surface of flood-prone terrain and of the obstacles (vegetation and infrastructures) is one of the critical factors in the hydraulic modeling of floods, because, as an input data for the hydraulic model, influences the peak flow and the flood extension. A Digital Surface Runoff Model (DSRM) was produced resulting from the integration

of LiDAR data, image data and data from large-scale maps. The LiDAR data and images were collected with an Unmanned Aerial Vehicle (UAV).

The FFAS allows a real-time analysis of emergencies in the flood prone areas, predicting the flood hazard for three days, updated every six hours. This system is a decision support tool, useful for the civil protection and water authorities with responsibilities in assessing and managing the flood risk. The flood hazard maps can be also used by others, as insurances companies in the evaluation of the risk.