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Flash flood hazard assessment through modelling in small semi-arid watersheds. The example of the Beni Mellal watershed in Morocco

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Flood modelling is essential for flood hazard assessment. Modelling becomes a challenge in small, ungauged watersheds prone to flash floods, like the ones draining the town of Beni Mellal (Morocco). Four temporary streams meet in the urban area of Beni Mellal, producing every year sheet floods, harmful to infrastructure and to people. Here, statistical analysis may not give realistic results, but the study of these repeated real flash flood events may provide a better understanding of watershed specific hydrology. This study integrates a larger cooperation project between Switzerland and Morroco, aimed at knowledge transfer in disaster risk reduction, especially through hazard mapping and land-use planning, related to implementation of hazard maps. Hydrologic and hydraulic modelling was carried out to obtain hazard maps. An important point was to find open source data and methods that could still produce a realistic model for the area concerned, in order to provide easy-to-use, cost-effective tools for risk management in developing countries like Morocco, where routine data collection is largely lacking.

The data used for modelling is the Web available TRMM 3-Hour 0.25 degree rainfall data provided by the Tropical Rainfall Measurement Mission Project (TRMM). Hydrologic modelling for discharge estimation was undertaken using methods available in the HEC-HMS software provided by the US Army Corps of Engineers® (USACE). Several transfer models were used, so as to choose the best-suited method available. As no model calibration was possible for no measured flow data was available, a one-at-the-time sensitivity analysis was performed on the parameters chosen, in order to detect their influence on the results. But the most important verification method remained field observation, through post-flood field campaigns aimed at mapping water surfaces and depths in the flooded areas, as well as river section monitoring, where rough discharge estimates could be obtained using empirical equations. Another information source was local knowledge, as people could give a rough estimation of concentration time by describing flood evolution. Finally, hydraulic modelling of the flooded areas in the urban perimeter was performed using the USACE HEC-RAS® software capabilities. A specific challenge at this stage was field morphology, as the flooded areas form large alluvial fans, with very different flood behaviour compared to flood plains. Model “calibration” at this stage was undertaken using the mapped water surfaces and depths. Great care was taken for field geometry design, where field observations, measured cross sections and field images were used to improve the existing DTM data. The model included protection dikes already built by local authorities in their flood-fight effort. Because of flash-flood specific behaviour, only maximal flooded surfaces and flow velocities were simulated through steady flow analysis in HEC-RAS. The discharge estimates obtained for the chosen event were comparable to 10-year return periods as estimated by the watershed authorities. Times of concentration correspond to this previous estimation and to local people descriptions. The modelled water surfaces reflect field reality.

Flash-flood modelling demands extensive knowledge of the studied field in order to compensate data scarcity. However, more precise data, like radar rainfall estimates available in Morocco, would definitely improve outputs. In this perspective, better data access at the local level and good use of the available methods could benefit the disaster risk reduction effort as a whole.