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## **Maps as risk mitigation tools. Adaptation of the Swiss hazard assessment and mapping methodology to a Moroccan site: Beni Mellal**

### Abstract

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Severe rainfall events are thought to be occurring more frequently in semi-arid areas. In Morocco, flood hazard has become an important topic, notably as rapid economic development and high urbanization rates have increased the exposure of people and assets in hazard-prone areas. The Swiss Agency for Development and Cooperation (SADC) is active in natural hazard mitigation in Morocco. As hazard mapping for urban planning is thought to be a sound tool for vulnerability reduction, the SADC has financed a project aimed at adapting the Swiss approach for hazard assessment and mapping to the case of Morocco. Beni Mellal, capital city of the Tadla-Azilal region was chosen as a case study.

In a knowledge transfer context, the Swiss method was adapted to the semi-arid environment, the specific piedmont morphology and to socio-economic constraints particular to the study site. Following the Swiss guidelines, a hydro-geomorphological map was established, containing all geomorphic elements related to known past floods. Next, rainfall / runoff modelling for reference events and hydraulic routing of the obtained hydrographs were carried out in order to assess hazard quantitatively. Field-collected discharge estimations and flood extent for known floods were used to verify the model results. Flood hazard intensity and probability maps were obtained. Finally, an indicative danger map was calculated using the Swiss hazard matrix that convolves flood intensity with its recurrence probability in order to assign flood danger degrees to the concerned territory.

Danger maps become effective, as risk mitigation tools, when implemented in urban planning. We focus on how local authorities are involved in the risk management process and how knowledge about risk impacts the management. An institutional vulnerability "map" was established based on individual interviews held with the main institutional actors in flood management. Results show that flood hazard management is defined by uneven actions and relationships, it is based on top-down decision-making patterns, and focus is maintained on active mitigation measures. The institutional actors embody sectorial, often disconnected risk knowledge pools, whose relationships are dictated by the institutional hierarchy. Results show that innovation in the risk management process emerges when actors collaborate despite the established hierarchy or when they open to outer knowledge pools (e.g. the academia). Several methodological and institutional recommendations were addressed to risk management stakeholders in view of potential map implementation to planning. Hazard assessment and mapping is essential to an integrated risk management approach: more than a mitigation tool, danger maps represent tools that allow communicating on hazards and establishing a risk culture.