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Flash-Flood hydrological simulations at regional scale. Scale signature on road flooding vulnerability

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This work contributes to the evaluation of the dynamics of the human exposure during flash-flood events in the Mediterranean region. Understanding why and how the commuters modify their daily mobility in the Cévennes - Vivarais area (France) is the long-term objective of the study. To reach this objective, the methodology relies on three steps: i) evaluation of daily travel patterns, ii) reconstitution of road flooding events in the region based on hydrological simulation at regional scale in order to capture the time evolution and the intensity of flood and iii) identification of the daily fluctuation of the exposition according to road flooding scenarios and the time evolution of mobility patterns. This work deals with the second step.

To do that, the physically based and non-calibrated hydrological model CVN (Vannier, 2013) is implemented to retrieve the hydrological signature of past flash-flood events in Southern France. Four past events are analyzed (September 2002; September 2005 (split in 2 different events); October 2008). Since the regional scale is investigated, the scales of the studied catchments range from few km2 to few hundreds of km2 where many catchments are ungauged.
The evaluation is based on a multi-scale approach using complementary observations coming from post-flood experiments (for small and/or ungaugged catchments) and operational hydrological network (for larger catchments). The scales of risk (time and location of the road flooding) are also compared to observed data of road cuts.
The discussion aims at improving our understanding on the hydrological processes associated with road flooding vulnerability. We specifically analyze runoff coefficient and the ratio between surface and groundwater flows at regional scale. The results show that on the overall, the three regional simulations provide good scores for the probability of detection and false alarms concerning road flooding (1600 points are analyzed for the whole region). Our evaluation procedure provides new insights on the active hydrological processes at small scales (catchments area < 10 km^2) since these small scales, distributed over the whole region, are analyzed through road cuts data and post-flood field investigations. As shown in Vannier (2013), the signature of the altered geological layer is significant on the simulated discharges. For catchments under schisty geology, the simulated discharge, whatever the catchment size, is usually overestimated.

Vannier, O, 2013, Apport de la modélisation hydrologique régionale à la compréhension des processus de crue en zone méditerranéenne, PhD-Thesis (in French), Grenoble University.