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On the monitoring of antecedent wetness conditions across different scales

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The importance of soil moisture for hydrological applications is widely recognized. In recent scientific literature many examples show that soil moisture is one of the most important state variable to predict the rainfall-infiltration-runoff partitioning with reduced uncertainty. Therefore, for stakeholders involved in flood management aiming at flood risk prevention and mitigation, an accurate estimation of the initial state of the catchment wetness is of great importance.

Several approaches are available to assess the wetness conditions in a catchment. They range from simple approaches based on indicators of antecedent precipitation or initial discharge to the ones more sophisticated using soil water balance models. Recently, soil moisture and water level observations derived from ground networks have been employed for this purpose. Additionally, soil moisture estimates derived from sensors operating on satellite platforms can also be used. In this context, the main scientific and operational issues can be summarized as follows. i) Which are the most reliable indices or observations to be employed for the estimation of catchment wetness conditions? ii) Which spatial and temporal resolution is required? iii) What is the added value of the selected indices runoff prediction? This study attempts to address the above questions by using rainfall-runoff data along with soil moisture and groundwater level observations for several catchments located in the Alzette River Basin (Grand-Duchy of Luxemburg). The individual catchment sizes range from 11 km^2 to 425 km^2. In particular, since 2005, soil moisture is monitored with a set of 40 classic ECH_2O DecagonTM soil moisture sensors at a depth ranging between 4 and 7 cm in the small experimental Bibeschbach catchment (10.8 km^2) located in the study area.

Different indicators of soil moisture conditions prior to a storm event are used for setting up the initial condition of different event-based rainfall-runoff models. In particular, simple (e.g. Soil Conservation Service - Curve Number, bucket type model) and physically based (e.g. Green-Ampt, Smith and Parlange) infiltration models are tested in order to have a more general picture of results. The performance of different combinations of models and soil moisture indicators, are evaluated with respect to flood hydrograph simulation at different spatial scales using a large number of rainfall-runoff events occurred in the study area.

For the investigated catchments, the obtained results besides to confirm the significant role of the initial soil moisture conditions for flood simulation at different spatial scales, have allowed to infer guidelines for soil moisture monitoring at catchment scale in order to reduce the predictive uncertainty of rainfall-runoff modelling.