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Investigating dominant processes on small poorly gauged catchments: an inter-comparison approach for catchment similarity study

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Small catchment scales appear to be relevant to study and manage agricultural uses and their hydrological impacts. Mediterranean small catchment responses are characterised by short duration surface runoff due to intense rainfall events of short duration. Ephemeral streams are common fluvial systems: they are usually dry for most of the year and become particularly active during flood events. This considerably complicates hydrological analysis. Therefore, estimating and predicting runoff for small ungauged (or poorly gauged) catchments appears to be a significant challenge. It would allow to a better understanding of dominant processes in relation with catchment functions (partition, release, storage). According to many authors, classification and similarity concepts, which can be profitably used when the processes are not fully understood, could be conducted as an alternative to complex modelling.

This study proposes a new methodology for small poorly gauged catchments to (i) estimate surface runoff and associated uncertainty and (ii) identify dominant functions governing hydrological responses. The work focuses on twelve small agricultural catchments, within the French Mediterranean region, with areas ranging between 0,3 and 1 km2. Water depth at the catchment's outlet and rainfall intensities have been collected at a one-minute data step, from September 2008 to September 2009. The analysis has been conducted on 120 flood events.

The first step was to make an inter-catchment comparison based on limited hydrological data considering the associated uncertainty. Estimation of flow velocity for natural ephemeral channel is a difficult task. To assess catchment runoff, flow rate curves were established from water depth using Manning's equation. Innovative field and laboratory experiments have been carried out to estimate Manning's coefficient for typical Mediterranean non-aquatic vegetation types. 72 tests have been realised to analyse the effects of vegetation's density and water depth. Results show that the use of roughness coefficient values presented in the literature often induces overestimation in flow velocities calculation. This could be mainly explained by effective roughness which depends on the relative submergence of vegetation. Hydrological indicators were derived from estimated discharges: runoff coefficient, rising time, lag-time, peak runoff, runoff threshold. In spite of the associated uncertainty, indicators allow to discriminate catchments according to functions of partition, release and storage.

The second step was to evaluate the efficiency of a catchment classification based on similarity assumptions. The classification highlights an obvious spatial hydrological variability on the studied region. This new approach shows the appeal to use a catchment network, even when poorly gauged, to gain understanding of processes driving hydrological responses.