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Detection of subsurface runoff flow with soil water sensor network in an experimental catchment

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Soil water movement across hillslopes plays an important role in agriculture and environmental systems. Part of the flow occurs over the soil surface, while another important fraction moves as subsurface runoff. Nevertheless the latter fraction can often not be measured. We suggest to overcome this limitation by using high frequency readings from soil water sensor networks. The aim of this work was to characterize soil water movement within a small catchment during periods of several years.
Measurements were made in a 6.7-ha experimental catchment in SW Spain, with an average slope of 10% and a shallow bedrock, limiting soil depth. Rainfall and runoff at the outlet of the catchment were measured during the last eight years, while soil profile water content was measured at eleven locations during the last four years. A total of 109 SWC sensors (10HS and 5TE, Decagon Devices, Pullman, WA) were installed and operated with a temporal resolution of 5 min. The influence of antecedent moisture on rainfall-runoff response could be observed. Water balances for individual events using the sensor measurements showed a stable spatial and temporal pattern, with a soil water accumulation higher than rain volumes in areas near the drainage channel. The water balances at different soil depths evidenced the existence of lateral subsurface flow, influenced by the presence of bedrock, and preferential water recharge in the central part of catchment, where the topography changes from a concave to convex shape. The results illustrate that data provided by soil water sensor networks can be used to assess subsurface flow. The method will be further developed and used to improve the field evaluation of soil and water conservation techniques.