



The Hunt for the explanation of the Double Peak hydrograph

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Double peak hydrographs (also known as bimodal events) are a catchment’s delayed response to precipitation. “Double peaks” have been reported in a dozen or so experimental catchments around the world, including the well-studied Slapton Wood catchment in UK and the Ina watersheds in Japan. Catchments showing double peak behaviour have varied in size, morphology, geology and soils. While first peaks are often coincident with the rainfall event, the second peak generally takes the form of a broader peak that reaches its maximum lagged in time from the initial response. Generally the double peaks response occurs only when catchments are wetted-up. In most cases, saturation-excess overland flow in the near-stream areas controls the initial peak in the double-peaked event while the second peak (i.e. the delayed peak) is controlled by subsurface stormflow. However, clear evidence for the mechanisms explaining these complex hydrological dynamics across diverse catchments is still wanting. Here we investigate the cause(s) of the size and magnitude of the second peak and the hydrological settings leading to its activation in the schistous Weierbach headwater catchment (0.45 km², Luxembourg). We make use of the extensive high-resolution hydrometric time series of rainfall, runoff, soil moisture and depth to groundwater levels to estimate water catchment storage and causal linkages. The catchment was partitioned in three discrete hydrological response units (HRUs) to determine if delayed runoff is controlled by connectivity between discrete landscape units. We found evidence of catchment storage being a dominant control on the second peak activation. A threshold behaviour between catchment storage and the appearance of the second peak was observed. The amount of this storage threshold was temporally consistent over the 3-years period and was observed not only during the wet season, but also in summer when the catchment was exceptionally wet. We did not observe a rainfall amount threshold for activating the double peak response. This work intends to contribute to the advancement of our understanding of thresholds in runoff response and double peak hydrographs.