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The influence of geomorphological and lithological diversity in catchment hydrodynamic behavior. The case of Arunca river catchment, Portugal

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The catchment hydrologic behavior is the result of a complex interaction between its physical characteristics, such as bedrock lithology, superficial geology, soil type and depth, vegetation type, topography, and drainage network. It has been known for a long time that, in addition to climate characteristics, the variations in the geomorphological and lithological features inside the basin originate specifics surface hydrodynamics, particularly in terms of runoff velocity, runoff amount and lag time. Understanding the hydrological functioning of the different sectors in a basin is essential to its spatial planning and management under the present scenario of climate uncertainty.

The Arunca river catchment is situated in the center-west of Portugal and occupies an area of about 550 km^2. One of the main characteristics is its geomorphological and lithological diversity, which is responsible for the existence of two different hydrological dynamics: (i) a karstic hydrodynamic where the cryptoreic drainage is absolutely dominant, and (ii) a fluvial hydrodynamic, characterized totally by surface runoff (exorheic drainage). The overall aim of this empirical study is to investigate and quantify the geomorphological and lithological influence on the hydrological behavior of these areas, which present very different physical characteristics.

Methodologically, we have adopted an empirical approach based on the analysis of spring and river hydrographs for simultaneous hydrometeorological events. Daily and hourly datasets of rainfall and spring and river flow were performed from 2009/2010 to 2014/2015. The data of the outflow from the karst area were collected by a gauge station at the main spring of the Degracias-Sicó karst aquifer. A second gauge station registered the data of river flow at the Arunca river sub-catchment, a non-karstic area, where only surface hydrodynamic is observed. Both gauge stations recorded data with an acquisition time interval of 20 minutes. The rainfall data were registered every 0.2 mm by two rain gauges installed, one in each studied sector of the catchment. An intra-annual period of analysis was established from October to May in order to understand the hydrodynamic functioning under diverse underground hydraulic conditions in different moments along the hydrological year. For every hydrometeorological event in both study areas of the basin, the hydrograph analysis focused on the calculation of the lag time, the time lag between the hydrological response of spring and river. The shape of the rising limb and the recession curve

also was examined.

The results display a similar reaction of both sectors to a rainfall event. However, the lag time is shorter in the river than in spring, and the hydrograph of the river presents a more pronounced peak flow. The main difference stands in the recession curve, particularly in the falling limb, much steeper in the river hydrograph, which shows the return to pre-event conditions only some hours after the peak flow. Basing on the simple analysis of the hydrograph, it is clear the effects of geomorphology and lithology in catchment hydrodynamic behavior.