



Assessing catchment hydrological functioning using discharge recession analysis based on the Kirchner's method. A case study in the Ardèche catchment (France)

Marko Adamovic (1), Isabelle Braud (1), Flora Branger (1), and Robert Krier (2)

(1) Irstea, UR HHLy, Hydrology Hydraulics Research Unit, CS70077 69626 Villeurbanne, Cedex 9, France (marko.adamovic@irstea.fr), (2) CRP Gabriel Lippmann, Environnement et Agro-biotechnologies (EVA), Luxembourg

Catchments show a high degree of heterogeneity and variability, both in space and time. In order to deal with spatial heterogeneity and process variability in more efficient and more "natural and realistic" manner, model simplifications are needed. Governing equations such as the Darcy or Richards' equation, which are inherent in many hydrological models, are suitable for local scales. However, their application at much larger scales (e.g. catchment scale) remains problematic. The linear reservoir is a well-known and common approach in many catchment-based hydrological models. However, reality shows that those linear equations might not be representative enough for describing hydrological catchment behavior.

Kirchner (2009), proposed a simple approach representing catchment behavior as a non-linear reservoir model, assuming that discharge at the outlet is only a function of catchment storage. He also proposed a method to determine non-linear reservoir parameters for this simple bucket model.

The objective of this study is to investigate whether this approach is applicable to the Ardèche catchment (2355 km²), located in the southern part of France. The catchment is influenced by a Mediterranean climate with seasonal heavy rainfall events during autumn. The northern and north-western part of the catchment is characterized by steep slopes and igneous and metamorphic rock formations.

A further objective is to relate the estimated parameters of the first-order dynamical system to catchment characteristics, in order to be able to develop a distributed model, adapted to the catchment response variability. The challenge for the Kirchner's method is the high geological and pedological heterogeneity of the Ardèche basin.

We apply the Kirchner's method to 6 sub-catchments of the Ardèche ranging from 3.9 to 200 km² using hourly rainfall and discharge data, in order to identify the discharge sensitivity function. We use the obtained corresponding parameters in a simple bucket model similar to the one proposed by Kirchner (2009). To have more representative potential evapotranspiration data used in the model, we introduce crop coefficient seasonality to better represent the data. Performance measurements with the Nash-Sutcliffe coefficient show performances above 80 %. These results clearly indicate that timing and magnitude of simulated discharge is correctly reproduced by the model. Additionally we assess the impact of the seasonality on the model parameterization yielding similar results in the discharge analysis.

Our work shows that Kirchner's method can be applied successfully in the Ardèche catchment. Eventually, we observe that geology may be highlighted as a predictor that dominates the overall hydrological response in the basin.

Kirchner, J. W. (2009), Catchments as simple dynamical systems: Catchment characterization, rainfall-runoff modeling, and doing hydrology backward, *Water Resour. Res.*, 45, W02429, doi:10.1029/2008WR006912