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How hillslopes and channels impact the water age in catchments

Antonio Zarlenga and Aldo Fiori

University of Roma Tre, Department of Engineering, Rome, Italy (antonio.zarlenga@uniroma3.it)

The water age is a lumped descriptor of the complex dynamics taking place in hillslope and catchments, allowing a synthetic description of mechanisms by which the hillslopes and the channel network transport water and solute at the outlet. Nevertheless, the assessment of the water age is still a challenging problem due to i-technical limitation in the data acquisition and ii-modeling simplification in the data interpretation.

In this study, we present a general physically based framework for the description of the water age in catchments. The water age at the catchment outlet is considered as collection of the different ages of the water particles moving through the outlet at a given time. The water age of each particle results from two main processes: the first one is the transport through the hillslope the second one is the transport thorough the channel. The interplay of those dynamics, which depends on hydrological and geometrical parameters, is of paramount importance in the water age and solute transport study.

Following the previous approach, we develop an analytical framework embedding: i- a Boussinesq model for the description of the flow and the assessment of the water ageing processes in hillslope, and ii- a geomorphological model for the assessment of the water transport and ageing in the channel network. Besides introducing the model, we provide some relevant examples exploring the impacts of the hillslope and channel dynamics on the water age.