Geophysical Research Abstracts,
Vol. 11, EGU2009-12177, 2009
EGU General Assembly 2009

Dimensionless classification of modes of hydrologic behavior based on characteristic rates and timescales of processes and inputs

C.J. Harman (1) and M. Sivapalan (2)

(1) University of Illinois at Urbana-Champaign, Department of Civil and Environmental Engineering, Urbana, IL, United States (charman2@illinois.edu, +1-(0)217-333-0687), (2) University of Illinois at Urbana-Champaign, Departments of Geography and Civil and Environmental Engineering, Urbana, IL, United States (sivapala@illinois.edu, +1-(0)217-244-1785)

A wide variety of responses can be observed in hillslope hydrologic responses. This variety represents not only the variation in the physical properties that make up hillslopes, but also the regimes of temporal and spatial variation in the drivers of the hydrologic processes, and the interaction with surrounding landscape elements, as expressed through boundary conditions. These factors make up the context in which the hydrologic processes operate, and are central to understanding the partitioning of incoming water to the system between the variety of storages and flow paths available.

A significant advance for prediction in ungauged basins would be a classification framework that characterizes the circumstances under which a particular flow path is likely to be dominant, and the effect of that flow path on the transformation (or filtering) of the episodic precipitation inputs into discharge outputs. In this work we develop such a framework for patch and hillslope scales that is "quantitative","process-oriented" and "generalizable". The framework is based on the idea that the relative dominance of different hydrologic functions (the storage, partitioning and release of water) in the soil depends on the relative timescales of variability in the inputs of water and the various processes that carry out these functions "(infiltration, drainage, evapotranspiration, etc)". Dimensionless ratios of these timescales capture the competition between the processes they represent, and produce quantitatively different modes of behavior. The use of similarity parameters to express the relative importance of a particular process is a well established concept in fluid mechanics, but has had only limited application in hydrology thus far.

The classification system is applied to results from a simple "multiple wetting front" model of unsaturated zone fluxes, and a Boussinesq-equation model of lateral saturated flow in hillslopes. The results suggest that the classification system can distinguish quantitatively different modes of discharge behavior from the unsaturated and saturated zones that arise due to the dominance of particular processes, such as evapotranspiration, fast and slow drainage, leakage through the bedrock, and Hortonian overland flow. The classification is also applied to lysimeter data for a range of soil types, revealing a diversity of types of hydrologic variability, even in systems subject to the same climate.