Geophysical Research Abstracts, Vol. 8, 10442, 2006
SRef-ID: 1607-7962/gra/EGU06-A-10442

Pattern, process and function: elements of a new theory of hydrology at the catchment scale

M. Sivapalan (1)

(1) Departments of Geography and Civil and Environmental Engineering, University of Illinois, Urbana, Illinois 61801, USA (sivapala@uiuc.edu)

Catchment hydrology is presently operating under an essentially reductionist paradigm, dominated by small-scale process theories. Yet, hydrology is full of examples of highly complex behavior, including strong nonlinearities and thresholds, and paradoxes that defy causal explanation through these small-scale process theories. There are strong interactions and feedbacks between processes, leading to apparent simplicities in the overall catchment response, yet the laws governing these feedbacks are not well understood. Routine measurements and specialized field experiments have been valuable for observing catchment responses and understanding the underlying process controls, but there has been little progress in extrapolating the local knowledge and understanding gained from these well studied (or gauged) catchments to ungauged catchments. Efforts at generalization are hampered by the lack of an appropriate quantitative framework, e.g., a classification system, to help identify interesting and useful patterns in the observations. There are many theories governing different elements of catchment hydrology, but not a unified theory that connects these seemingly disparate elements. In this presentation I will discuss the broad outlines of an emerging new, unified theory of hydrology at the catchment scale, and the approaches being used to develop it. The new theory embraces multi-scale heterogeneities as a natural and intrinsic part of catchment hydrology. Instead of relying solely on current process theories, it seeks to discover new catchment scale process theories that embed within them the effects of natural heterogeneities. Instead of attempting to prescribe in detail the actual patterns of heterogeneity in every catchment, it will seek to understand the geomorphic or landforming processes that may have generated them in the first place, and their ecological, pedological and geomorphological function. Instead of using the meagre observations to calibrate complex models that are based on small-scale the-

ories, it will emphasize the use of patterns in the observations to formulate and test alternative hypotheses about the underlying process controls. Instead of using field measurements to learn more and more about individual catchments, it will seek to find connections between observations in different catchments, to identify broad-scale or general patterns. The defining feature of the new theory of catchment hydrology will be a sharp focus on the inter-connection and feedbacks between pattern and process, over a range of scales, and their interpretation in terms of their overall “function”. The renewed focus on pattern, process and function will revolutionize hydrology, elevate its place within the earth system sciences, and advance the scientific foundations of its practice.