



Catchments as simple dynamical systems: Rietholzbach, Switzerland

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In spite of all the complexity of water movement in the subsurface, the dynamics of streamflow have been shown to follow that of a simple dynamical system in which streamflow is only related to the total amount of subsurface storage in the catchment. Here we explore this behavior for the Rietholzbach in Switzerland. The small hilly prealpine basin (altitude 682-950 m) has an area of 3.18 km² and receives an average annual precipitation of 1600 mm. Hourly streamflow observations and standard meteorological observations are available for the period 1976-2007. Streamflow observations confirm that there exist a tight connection between the catchment storage and streamflow. As a result, streamflow can be simulated using a first-order non-linear differential equation that only requires catchment-scale estimates of precipitation and actual evapotranspiration. Observed and simulated streamflow are compared both in the time and frequency domain.

The tight relation between streamflow and catchment storage can also be used to infer storage from streamflow. Storage estimates by this method show good correspondence to storage changes in a weighing lysimeter (diameter 2 m, depth 2.5 m) that is installed in catchment. The storage changes are also compared to estimates by two different land surface models (VIC and CLM). The analysis show a potential for diagnosing catchment states from streamflow, but they also reveal that more attention should be paid to the accuracy of streamflow observations at low flows for the method to work under all conditions.