Geophysical Research Abstracts
Vol. 15, EGU2013-10488, 2013
EGU General Assembly 2013

Quantifying subsurface mixing of groundwater from lowland stream perspective.

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The distribution of time it takes water from the moment of precipitation to reach the catchment outlet is widely used as a characteristic for catchment discharge behaviour, catchment vulnerability to pollution spreading and pollutant loads from catchments to downstream waters. However, this distribution tends to vary in time driven by variability in precipitation and evapotranspiration. Subsurface mixing controls to what extent dynamics in rainfall and evpotranspiration are translated into dynamics of travel time distributions. This insight in hydrologic functioning of catchments requires new definitions and concepts that link dynamics of catchment travel time distributions to the degree of subsurface mixing.

In this presentation we propose the concept of STorage Outflow Probability (STOP) functions, that quantify the probability of water parcels stored in a catchment, to leave this catchment by discharge or evapotranspiration. We will show how STOPs relate to the topography and subsurface and how they can be used for deriving time varying travel time distributions of a catchment. The presented analyses will combine a unique dataset of high-frequent discharge and nitrate concentration measurements with results of a spatially distributed groundwater model and conceptual models of water flow and solute transport. Remarkable findings are the large contrasts in discharge behaviour expressed in travel time between lowland and sloping catchments and the strong relationship between evapotranspiration and stream water nutrient concentration dynamics.