Geophysical Research Abstracts
Vol. 16, EGU2014-15705, 2014
EGU General Assembly 2014

Stream responses as the sum of flow component responses

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Catchment flows are often treated as continuums of hydrological processes from low flow to peak flow and back to low flow again, when analysing streamflow by methods like recession analysis or flow duration curve analysis. Such a conception of catchment response could not be further from the truth, catchment drainage instead is the sum of various flow components deriving from different parts of the catchment, as is well-understood by modellers. Why then have we traditionally applied the analysis methods to streamflow rather than to the separated components? (Apart, that is, for practical reasons.) Applying recession analyses to separated components turns out to give surprising results, and removes confusion arising from the mixture of components in streamflow (Stewart, 2014).

The simplest separation of components is into quickflow and baseflow, which have very different sources and behaviours as shown in particular by tracer measurements. Quickflow is direct runoff from runoff events and often drops to zero between events, while baseflow is sourced from groundwater aquifers and continues as long as the stream flows. As an example, recession analysis using recession plots (i.e. plots of Q (flow) versus $-dQ/dt$) for quickflow and baseflow was applied to data from Glendhu GH1, New Zealand, a schist catchment of 2.2 km^2. Whereas the streamflow points were fitted by power law slopes of up to 4 (i.e. $dQ/dt = -0.09Q^4$) which proved to be artifacts due to the mixing of components noted above, the quickflow and baseflow points fitted power law slopes of 1.5 revealing the actual quadratic nature of storage reservoirs in the catchment. Other catchments have given similar results although a wider selection may show differences, nevertheless the message remains: In order to understand catchment and hillslope responses we need to be analysing separated components, not just streamflow.

Stewart, M.K. 2014: New base flow separation and recession analysis methods for streamflow. Submitted to *Water Resources Research*, 8 Oct. 2013.