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Hydrological change at the catchment scale: The need to address both velocity and celerity

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Water quantity and quality response to climate- and land use change are difficult to predict. Much of this relates to the complexities of water flow paths and our inability to relate measureable catchment properties to measureable hydrologic response metrics. To date, most work has focused on rainfall-runoff response — that is, the celerity component of change. Here I present new work from 15 headwater catchments, (0.1 to 100 km^2) in the Oregon Cascades and Oregon Coast Range in the USA, aimed at quantifying both celerity and flow velocities (i.e. particle transport through the system). I illustrate this velocity component through stable isotope analysis of runoff components and the mean transit time and residence time analysis of surface water and groundwater, respectively. Results show that despite very similar rainfall-runoff determined celerities, these systems have distinctly different tracer velocities, where transit time of headwater streamflow is 1-3 years in the catchments draining the Western Cascade mountains and 3-11 years in the streams draining the Coast Range mountains. More importantly, the scaling of surface water mean residence time in the Cascades is linked to internal topographic structure of individual sub-catchments whereas Coast Range sites show no evidence of this; and streamwater residence times scale linearly with catchment area. I discuss the implications of these celerity-velocity differences for catchment-scale climate- and landuse change effects in the USA Pacific Northwest and for more general efforts like the IAHS Panta Rhei initiative.

Keywords: Hillslope, Rainfall-runoff, Stable isotope, Climate change, Landuse, Groundwater