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# Interactions between Hillslope Hydraulic Response Function, Vegetation Organisation and Catchment Behaviour

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The behaviour of a catchment is sensitive to the pattern and organisation of its components (hillslopes, land cover etc.). Explaining observed organisation and emergence of pattern requires understanding of key organising principles, recognising that albeit similarities, the larger scale behaviour is likely to differ from that of individual components. In other words, the whole does not necessarily behave like the sum of its parts, because the arrangement of the parts matters. For example, hillslopes involve complex and hydrologically interacting elements (rapid flow pathways, depression storage, slope, and variable soil thickness) that shape hillslope hydrologic response in ways that cannot be represented by a collection of pores as implied by standard hydraulic functions. Additionally, inherent spatial and temporal variability of vegetation prohibits detailed and mechanistic parameterisation of root water uptake and evapotranspiration. The interplay of hydrologic hillslope function, climatic forcing and vegetation dynamics translates into complex catchment behaviour at the outlet. Vegetation, one of the most dynamic determinants of catchment behaviour, may interact with its environment by varying different elements such as root system properties, foliage properties and spatial arrangement. These interactions span different temporal scales from minutes (stomatal conductance) to decades (spatial arrangement) all of which may shape evapotranspiration and hence catchment behaviour. Evidence suggests that vegetation adapts to its environment in a self-organised, predictable way, guided by some overarching goal function, such as maximum net carbon profit or maximum entropy production. Appropriate optimality considerations under prevailing constraints enabled predictions of spatial heterogeneity of vegetation cover, or temporal dynamics of root distribution, canopy properties and water use. The hydrologic hillslope behaviour (e.g., surface and subsurface water fluxes and storage) is a powerful ingredient that defines boundary conditions for vegetation self-organisation. To systematically evaluate the role of this element, we propose a Hillslope Hydraulic Response Function (HHRF) a standardised parameterisation framework based on simplified and analytical representation of a prototypic hillslope. The HHRF uses a few geometrical parameters and intrinsic parameters to represent hillslope response in terms of fluxes and storage dynamics. Such an approach has been instrumental in deducing hydrologic response of watersheds (Kirchner, 2009, WRR) but has not been used for systematic parameterisation of HHRF. Here we separate out the biotic and abiotic components of catchment behaviour and test the sensitivity of vegetation and the catchment water balance to different hypothetical parameterisations of the HHRF.