



Hydrological annual hysteresis: functional signature for assessing the consistency of catchment conceptual models?

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While most hydrological models reproduce the general flow dynamics, they frequently fail to adequately mimic system internal processes. In particular, the relationship between storage and discharge, which often follows annual hysteretic patterns in shallow hard-rock aquifers, is rarely considered in modelling studies. One main reason is that catchment storage is difficult to measure and another one is that objective functions are usually based on individual variables time series (e.g. the discharge). This reduces the ability of classical procedures to assess the relevance of the conceptual hypotheses associated with models.

In this study, the annual hysteric patterns observed between stream flow and water storage is analysed both in the saturated and unsaturated zones of the hillslope and the riparian zone of a headwater catchment in French Brittany (ORE AgrHys). The saturated zone storage was estimated using distributed shallow groundwater levels and the unsaturated zone storage using several moisture profiles. All hysteretic loops were characterized by a hysteresis index. Four conceptual models, previously calibrated and evaluated for the same catchment, were assessed with respect to their ability to reproduce the hysteretic patterns.

The observed relationship between stream flow, saturated, and unsaturated storages led to identify four hydrological periods and emphasized a clearly distinct behaviour between riparian and hillslope groundwaters. Although all the tested models were able to produce an annual hysteresis loop between discharge and both saturated and unsaturated storage, integration of a riparian component led to overall improved hysteretic signatures, even if some misrepresentation remained. Such systems-like approach is likely to improve model selection.