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Which resilience of the continental rainfall-runoff chain?

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Processes along the continental rainfall-runoff chain are extremely variable over a wide range of time and space scales. A key societal question is the multiscale resilience of this chain. We argue that the adequate framework to tackle this question can be obtained by combining observations (ranging from minutes to decades) and minimalist concepts: (i) Rainfall exhibits 1/f–spectra if presented as binary events (tropics) and extrema world wide increase with duration according to Jennings' scaling law as simulated by a censored first-order autoregressive process representing vertical moisture fluxes. (ii) Runoff volatility (Yangtze) shows data collapse which, linked to an intra-annual 1/f–spectrum, is represented by a single function (Gumbel) not unlike physical systems at criticality, while short and long return times of extremes are Weibull-distributed. (iii) Soil moisture, interpreted by a biased coinflip Ansatz for rainfall events, provides an equation of state to the surface energy and water flux balances comprising Budyko's framework for quasi-stationary watershed analysis. (iv) Vegetation-greenness (NDVI), included as an active tracer extends Budyko's eco-hydrologic state space analysis, supplements the common geographical presentations, and it may be linked to a minimalist biodiversity concept. (v) Finally, attributions of change to external (or climate) and internal (or anthropogenic) causes are determined by eco-hydrologic state space trajectories using surface flux ratios of energy excess (loss by sensible heat over supply by net radiation) versus water excess (loss by discharge over gain by precipitation). Risk-estimates (by GCM-emulators) and possible policy advice mechanisms enter the outlook.