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Sensitivity of streamflows to hydroclimatic fluctuations: resilience and regime shifts

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Landscape and climate alterations foreshadow global-scale shifts of river flow regimes. However, a theory that identifies the range of foreseen impacts on streamflows resulting from inhomogeneous forcings and sensitivity gradients across diverse regimes is lacking. In this contribution, we use a dimensionless index embedding simple climate and landscape attributes (the ratio of the mean interarrival of streamflow-producing rainfall events and the mean catchment response time) to discriminate erratic regimes with enhanced intra-seasonal streamflow variability from persistent regimes endowed with regular flow patterns. The proposed classification is successfully applied to 110 seasonal streamflow distributions observed in 44 catchments of the Alps and the United States, allowing the identification of emerging patterns in space and time. In the same framework, the impact of multi-scale fluctuations of the underlying climatic drivers (temperature, precipitation) on the streamflow distributions can be analyzed. Theoretical and empirical data show that erratic regimes, typical of rivers with low mean discharges, are highly resilient in that they hold a reduced sensitivity to variations in the external forcing. Specific temporal trajectories of streamflow distributions and flow regime shifts driven by land-cover change and rainfall patterns can be also evidenced. The approach developed offers an objective basis for the analysis and prediction of the impact of climate/landscape change on water resources.