Using the rainfall-runoff relationship for hypothesis testing

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Here we demonstrate the benefits of using the annual rainfall-runoff relationship for hypothesis testing. The rainfall-runoff relationship is the functional dependency of runoff on rainfall, and it captures a range of expected catchment responses through wet and dry periods. It enables direct comparison of runoff generation rates for any given annual rainfall, thus separating typical and non-typical runoff responses. This relationship can be easily transformed to linear (by normalising runoff data), which makes it applicable for many parametric tests. Additionally, the technique can be extended to use more complex measures of annual climate, such as various humidity, aridity, or drought indices. We refer to examples from our experience where this relationship was used to detect cumulative changes in catchment functioning by comparing catchment responses during an extended dry period and during individual dry years. We argue that analysing changes in, or departures from, the rainfall-runoff relationship is more informative for understanding hydroclimatic changes than analysing time series of individual factors. We compare our approach to related techniques such as runoff ratios, elasticity of rainfall on runoff, Budyko curves, and double-mass curves, highlighting the advantages and shortcomings of each, and discuss their applicability for hypothesis testing.