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“Development on the margin”

## Aboveground Net Primary Production and Rain-use Efficiency in Drylands – Results and Insights from a Meta-analytical Perspective

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### Abstract

In drylands above-ground net primary production (ANPP) and rain-use efficiency (RUE) are common ecological indicators for assessing ecosystem's state, including degradation and supply of key ecosystem services. Despite their widespread and frequent use, both indicators have been challenged by strong critique, raising the question whether — and if: to what extent — these parameters can comply what they promised: being easy, fast and relatively cheap indicators and tools for ecosystems assessment and modelling. Both have been criticised as ‘lumped’ parameters, aggregating complex information and rendering clear interpretations impossible. Furthermore, literature still lacks a consensus about the response patterns of ANPP and RUE along precipitation gradients, which makes it difficult or even impossible to extrapolate them in space and time.

Taking advantage of a large body of studies from the last 50 years, we conducted a meta-analytical database for mid- to long-term monitoring and experimental studies from (semi-)arid environments. Data was analysed with meta-analysis and non-standard regression methods in order to render new insights and test assumed generalities. Meta-analysis was used to disentangle the influences of several ecological factors on ANPP and RUE, and enabled us to separate the impact of these factors into significantly distinct, quantitative effect sizes. Linear piecewise quantile regression was used to analyse the response of maximum ANPP and RUE along an arid to semi-arid precipitation gradient.

Meta-analysis shows that ANPP, and therefore RUE, are significantly affected by precipitation, different land use parameters, soil characteristics and biome type. Our results strongly suggest that usability as well as informative value of RUE as tool for ecosystem assessment and land management decisions would strongly increase if biome and soil characteristics would be accounted, rather than assuming general thresholds for this indicator. LPQR revealed that both parameters follow a unimodal trend along arid to semiarid precipitation gradients, peaking at relatively low precipitation values. The unimodal trend holds for different land use regimes and intensities, but varies along these with respect to total magnitude and the post-peak decline. Furthermore our found trend is able to reconcile the partially contradictory response patterns of ANPP and RUE found in literature.

**Keywords:** Drylands, meta-analysis, rain-use efficiency, rangeland ecology