

Storage variability controls seasonal runoff generation in catchments at the threshold between energy and water limitation

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Abstract

Using annual water balance analyses may mask intra-annual variability in runoff generation, which could limit our understanding of the similarities and differences between water- and energy-limited catchments. This may be especially limiting in comparisons between catchments close to the threshold between water- and energy-limitation. For this study, we examined runoff generation as a function of catchment storage in four watersheds, with focus on two that exist close to these thresholds to identify how year-to-year variability in storage resulted in intra-annual variations of runoff generation efficiency. Specifically, we focused on one energy-limited catchment in the humid subtropics and one water-limited in a Mediterranean climate. We used measured and calculated daily water balance components to calculate variations in the relative magnitude of daily storage. We isolated precipitation events to draw connections between storage and runoff generation at intra-annual scales and compared our findings to the same metrics in two intensely energy-limited landscapes. We observed distinct stages in daily storage across water years in watersheds at the threshold, where systems experienced wet-up, plateau, and dry-down stages. During the wet-up, precipitation was partitioned to storage, and runoff ratios (RR) were low. In the plateau, storage was filled, precipitation was partitioned to runoff, causing high RR s. During the dry-down, storage decreased as precipitation was partitioned to evapotranspiration and runoff, causing low RR s. The critical role of evapotranspiration during the growing season resulted in relatively higher RR s during the wet-up than during the dry-down for a given storage value. Thus the same storage amount was partitioned to evapotranspiration or runoff differently throughout the year, depending on the storage stage. Despite their different positions on opposite sides of the threshold, the similarity between the two focus catchments suggests a potential characteristic behavior of systems at the threshold common to both humid and semi-arid landscapes.

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