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Ecohydrological implications of changes in rainfall patterns and woody plant encroachment.

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Semi-arid and arid regions in the southwestern United States and Northern Mexico are characterized by pulses of rainfall during the summer growing season and intervening dry periods that frequently are severe enough to limit biotic activity. Changes in the frequency and size of rainfall events will produce differential patterns in the depth and duration of soil wetting, which will affect plant production, carbon and water fluxes. Additionally, the encroachment of deep-rooted woody species into areas formerly dominated by grasses is a pervasive worldwide problem in these systems. A remaining challenge is to partition evapotranspiration (ET) into it components, transpiration (T) and evaporation (E), in order to understand feedbacks between vegetation dynamics and the water cycle. We investigated how changes in the frequency and magnitude of experimentally added precipitation affected carbon and water fluxes at leaf, soil and ecosystem levels. A 46% increase relative to mean summer rainfall was applied at two different frequencies and magnitudes over twelve weeks during the summer growing season to plots containing both mesquite (*Prosopis glandulosa*) and black grama grass (*Bouteloua eriopoda*). Plots received either: ambient precipitation (controls), ambient plus frequent small (5-6 mm) rainfall events applied weekly, and ambient plus infrequent large (20-24 mm) events applied monthly. Stable isotopes were used to partition ET and carbon sources in large static chambers. Mesquite was highly efficient at using water from both small and large events as evidenced by shifts in the hydrogen isotope composition of xylem sap. Net ecosystem exchanges of carbon and water, measured in chambers that included all ecosystem components (soil, grass and mesquite) were similar in July and September across all treatments. In August, carbon and water fluxes were higher in large-magnitude infrequently watered plots. Smaller static chambers that encompassed only soil and grass differed between treatments in net ecosystem exchange of carbon and water flux rates in august and

September. This indicates that changes in the depth and duration of soil wetting may have different implications depending on the degree of woody plant encroachment.