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# Analysis of NDVI-rainfall relationships reveals vegetation structure and ANPP dynamics in a Chihuahuan grassland-shrubland ecotone

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Shrub encroachment is perceived as a symptom of land degradation in the American Southwest, where large areas of grasslands dominated by black and blue grama have transitioned over the last 150 years to shrublands dominated by woody species (mainly creosotebush and mesquite), accompanied by accelerated water and wind erosion. In this study, simulations of plant biomass dynamics indicate that herbaceous and shrub vegetation in drylands have different responses to antecedent precipitation due to functional differences in plant growth and water-use patterns, and therefore shrub encroachment may be reflected in the analysis of landscape-scale vegetation-rainfall relationships. We analyze the structure and dynamics of vegetation at an 18-km2 grassland-shrubland ecotone in the northern edge of the Chihuahuan Desert (Sevilleta National Wildlife Refuge, New Mexico, USA) by investigating the relationship between 2000-13 records of remotely sensed MODIS NDVI and precipitation. Spatial analysis of NDVI-rainfall relationships at the studied ecotone indicates that herbaceous vegetation shows quick growth pulses associated with short-term (previous 2 months) precipitation, while shrubs show a slow response to medium-term (previous 5 months) precipitation. We use these relationships to (a) classify landscape types as a function of the spatial distribution of dominant vegetation, and (b) decompose the NDVI signal into partial primary production components for herbaceous vegetation and shrubs across the study site. We further apply remote-sensed annual net primary production (ANPP) estimations and landscape-type classification to explore the influence of inter-annual variations in seasonal precipitation on the production of herbaceous and shrub vegetation. Our results suggest that changes in the amount and temporal pattern of precipitation comprising reductions in monsoonal summer rainfall and/or increases in winter precipitation may enhance the shrub-encroachment process in the desert grasslands analyzed.