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Evaluating the ecosystem resilience of irrigated drylands using a critical zone approach in western Texas

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One of the Drylands Critical Zone Thematic Cluster sites is an irrigated pecan orchard in Tornillo, Texas, where soils are developed on floodplain sediments and have been frequently irrigated. Geophysics, geochemistry, isotopes, remote sensing, and sensors are combined to examine how soil texture, as the master variable, has controlled the observed spatial changes in soil moisture dynamics, redox conditions, salt buildup, tree size, crop yields, calcite accumulation and CO_2 emission. Soils with finer particles are associated with smaller pecan tree sizes, due to higher soil salinity exceeding the pecan trees' tolerance levels, periodic anoxic conditions, and physical/chemical barriers that limit root development. The CO_2 effluxes from soil to atmosphere, however, showed no obvious correlation with soil texture or tree sizes; they are influenced by both soil respiration rates (releasing biotic CO_2) and pedogenic carbonate accumulation rates (releasing abiotic CO_2). Agricultural productivity is affected by many factors, and the critical zone approach allowed us to single out the fluvial geomorphic processes that created the young parent sediments of the entisols at this orchard. This led to soil textural differences, which cascaded into an assemblage of features that culminate in differences in tree growth. The irrigated drylands face even more challenges in the future due to climate variability and human activities, and a better understanding of the interconnected processes in irrigated dryland agriculture allows us to invest in projects that would increase the resilience of this anthropogenically impacted Critical Zone and seek sustainable solutions.