TITLE: The impact of drought on root-zone water storage dynamics in fractured carbonate bedrock of the Edwards Plateau

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ABSTRACT

As climate change is expected to intensify, central Texas may experience more frequent, prolonged, and intense droughts. Droughts lead to strain on water resources, increased wildfire risk, biodiversity loss, wildlife, and vegetation mortality, and economic impacts. In many arid and semi-arid regions, deep rooting into bedrock leads to depletion of root-zone rock moisture storage far below the soil layer, which can prevent incoming rainfall from replenishing streams and groundwater after drought. Here, we quantify deep root-zone rock moisture storage dynamics to identify how the root-zone responds to and emerges from drought in a mixed oak-juniper woodland and oak savanna near Dripping Springs, TX. We monitor and quantify dynamic rock moisture storage in the root-zone before, during, and after exceptional drought by logging deep boreholes using neutron probe and nuclear magnetic resonance. While the majority of moisture dynamics occur in the upper 1.5m of the root-zone, substantial progressive drying occurred to depths > 4m during two consecutive drought years. Precipitation that occurred during drought only replenished moisture stores in the upper 2.5 m, however, trees continued to access deeper water stores. The maximum moisture depletion across 10 boreholes ranged from 89 to 295 mm, suggesting that rainfall totals in excess of that are needed to return to non-drought conditions. While 215 mm of precipitation fell in the first 4 months of the water year 2023, only 23 mm of rock moisture storage was replenished, and did not generate consistent streamflow. Thus, the deep root-zone may limit the transmission of rainfall to runoff far beyond when meteorological conditions have returned to normal.

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