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Morphologic properties of watersheds across an east-west precipitation gradient in Texas

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The morphology of a watershed reflects the balance between tectonic uplift and erosive downwasting. The rate and type of denudation processes occurring are a function of many factors including slope, drainage area, rate of sediment production, rate of fluvial transport, vegetation, soil thickness, climate, and time. This study addressed how watershed geometry relates to climate along a strong east-west precipitation gradient in Texas, a relatively tectonically inactive area. Specifically, the hypsometric curve, drainage density and aspect ratio of nine major watersheds were compared to annual precipitation, average discharge rate, average peak discharge, and runoff ratio. Previous research has shown watershed concavity (as described by the hypsometric curve) and drainage density to be related to climate, but with conflicting results. Some work shows an increase in concavity with higher precipitation while a number of modeling studies have demonstrated the opposite. Additionally, while theoretical models predict that drainage density decreases with higher precipitation rates due to vegetation influences, I expected drainage density to be linked to concavity, as they similarly reflect the balance between diffusion dominated sediment transport on hillslopes and fluvial transport in the channel network. However, results showed that concavity increased, but drainage density and aspect ratio decreased in more arid watersheds, likely because of differences in runoff mechanisms or precipitation variability. The strongest relationships were between geometric parameters and the average discharge rate.

Keywords: hypsometry, drainage density, watershed, precipitation, runoff, sediment transport