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Tipping Points in Texas Rivers

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Anticipating geomorphic tipping points requires that we learn from the past. Major geomorphic changes in coastal plain rivers of Texas resulting in river metamorphosis or regime shifts were identified, and the major driving factors determined. Nine fluvial tipping points were identified from contemporary observations, historical records, and Quaternary reconstructions. Two of the tipping points (between general aggrading and degrading valley states) are associated with reversals in a fundamental system control (sea-level). One (stable or aggrading vs. degrading channels) is associated with an abrupt change in sediment supply due to dam construction, and two others (changes from meandering to anastomosing channel patterns, and different anastomosis styles) are similarly related to changes in sediment supply and/or transport capacity, but with additional elements of historical contingency. Three tipping points are related to avulsions. One, from a regime dominated to reoccupation of former channels to one dominated by progradation into flood basins, is driven by progressive long term filling of incised valleys. Another, nodal avulsions, are driven by disturbances associated with tectonics or listric faults. The third, avulsions and related valley metamorphosis in unfilled incised valleys, is due to fundamental dynamical instabilities within the fluvial system. This synthesis and analysis suggests that geomorphic tipping points are sometimes associated with general extrinsic or intrinsic (to the fluvial system) environmental change, independent of any disturbances or instabilities. Others are associated with natural (e.g., tectonic) or human (dams) disturbances, and still others with intrinsic geomorphic instabilities. This suggests that future tipping points will be equally diverse with respect to their drivers.