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# A Model of Stream Channel Incision, Missouri River Tributaries in Nebraska and Iowa

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Stream channel incision has significant implications for aquatic and riparian ecology, as well as river engineering and management. Understanding the geomorphic processes and cause-and-effect linkages at work in a basin experiencing channel incision is essential for effective stream restoration and planning. This applied study focused on the degraded tributaries of the Missouri River from Gavins Point Dam (RM 811.4) to the confluence with Platt River (RM 594.60). In this 280km reach, the Missouri River has degraded its bed by 0 to 4 meters since the closure of the Gavins Point Dam in 1954 resulting in lower stages for equal discharge conditions. Because a river is part of a geomorphic system, human-induced disequilibrium of the trunk river will presumably permeate into the tributaries through the process of upstream progressive degradation. This research empirically tested the hypothesis that point-specific channel incision (on the tributary streams) was positively correlated with the magnitude of base-level reduction (measured at the tributary confluence with the Missouri River).

The loess hills study area was deliberately chosen to conduct this study because it provides the ideal fusion of three components. First, this entire region has been subjected to a base-level drop due to the degradation of the Missouri River (which sets local base level) following the closure of the Gavins Point dam. Second, the region was chosen because the fluvially-eroded loess sediments are easily transported out of the system, thus speeding the total time required for the fluvial system to establish an equilibrium condition and eliminating a common aggradation feedback which is known to occur in other systems. Finally, this area possesses numerous historical cross-sectional data for tributary streams allowing for the quantification of point-specific channel incision above points of measured base level drop.

Tributary stream channel incision was estimated for 52 sites in eastern Nebraska and western Iowa by comparing historic (1953) and recent (2000) bridge cross-sectional measurements. These site-specific tributary incision values were related to: 1) the measured drop in base level, 2) known grade control structures, and 3) watershed characteristics using multiple regression techniques. Base-level reduction was measured

at the outlet of each tributary stream by comparing historic (1953) and recent (2000) Missouri River water-surface elevation profiles for similar discharge conditions (30,000cfs). Tested watershed characteristics were derived from GIS layers and included two measures of flow length, contributing area, land use and land use change, hydrologic soil type and permeability, and surficial geology. Drop in base level, when combined with a flow-length parameter, was found to be most significant variable. The only other variable that was found to be significant included the presence or absence of a grade-control structure. The multivariate model resulted in a adjusted R^2 of 0.72 and a root mean square error of 0.45 meters. Model accuracy was assessed using the PRediction Error Sum of Squares (PRESS) statistic which infers an accuracy of +/- 0.46 meters. The resulting regression equation may be used to estimate the spatial distribution of incision for all tributaries feeding this reach of the Missouri River and could aid in restoration and planning efforts in the region.