Geophysical Research Abstracts
Vol. 14, EGU2012-13555, 2012
EGU General Assembly 2012

Feedbacks among Floods, Pioneer Woody Vegetation, and Channel Change in Sand-Bed Rivers: Insights from Field Studies of Controlled Flood Releases and Models

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To investigate feedbacks between flow, geomorphic processes, and pioneer riparian vegetation in sand-bed rivers, we are combining field, hydraulic modeling, and laboratory simulations. Field studies have examined the response of woody riparian seedlings and channel morphology to prescribed dam-released floods that have been designed in part to maintain a native riparian woodland system on the Bill Williams River, Arizona, USA. Through monitoring of floods over a 7-year period, we have observed temporal and spatial variations in channel response. Floods have produced geomorphic and vegetation responses that varied with distance downstream of a dam, with scour and associated seedling mortality closer to the dam and aggradation and burial-induced mortality in a downstream reach with greater sediment supply. We also have observed that as vegetation grows beyond the seedling stage, its stabilizing effect on bars and its drag effect on flow progressively increases, such that floods of similar sizes but at different times may produce markedly different downstream responses as a function of vegetation characteristics. We also observed greater mortality among nonnative Tamarix spp. (tamarisk) seedlings than among native Salix gooddingii (Goodding's willow) seedlings, likely as a result of the greater first-year growth of willow relative to tamarisk. Combining field observations with modeling predictions of local hydraulics for the flood events we have studied is being used to draw linkages between hydraulics, channel change, and plant response at the patch and bar scale. In addition, mechanistic linkages are being examined using a field-scale laboratory stream channel, where seedlings of Tamarix spp. (tamarisk) and Populus fremontii (cottonwood) were planted and subjected to floods with varying sediment feed rate and plant configurations. The floods conveyed by our model channel were generally insufficient to scour the woody seedlings we planted, but changes in bar size and hydraulics were observed as a function of sediment feed and vegetation density and architecture.