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Sediment Transport-Storage Functions for Alluvial Reservoirs

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In a drainage network, sediment is routed through a linked series of channel/valley segments (alluvial reservoirs) that are distinguished from their neighbors by their capacity to store and transport sediment. We propose that sediment transport capacity of each reservoir is a unique positive function of storage volume that is determined by variations in bed-surface texture, gradient, and availability of floodplain sediments to migrating channels. Previously observed exponential decreases in sediment storage in alluvial reservoirs following large sediment inputs imply linear relations between transport capacity and storage. We examine such relations in a laboratory experiment with variable input rates of mixed-size bed load. The primary adjustment to decreasing sediment supply was bed-surface armoring. The results suggest that transport-capacity functions are approximately linear and that sediment output from a reservoir is strictly a function of the physical state of the reservoir and is independent of the proportions that originated from sediment eroded from the reservoir or input from the next reservoir upstream. If valid, these concepts could lead to improved sediment-routing models for drainage basins whose component alluvial reservoirs dynamically adjust to varying sediment loads. Moreover, these concepts imply that common classifications of channels as either transport- or supply-limited represent end members of a continuum of transport-capacity functions. In reality, every alluvial reservoir responds to increases in sediment inputs by increasing both storage and transport, the propensity for either depending on reservoir characteristics.