



Deciphering the role of autogenic processes on the dynamics of fine particle transport in mountain streams

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Suspended sediment represents a significant fraction of the mass leaving mountain landscapes. This large mass fraction is believed to represent a signal of sediment supply from catchment processes. Suspended particles are a water quality concern for downstream communities, and represent a significant vector for transport of carbon, nutrients, and contaminants. Fine particles are typically considered to pass through streams and rivers with minimal interaction, based on the assumption that their concentration reflects regional sediment supply, catchment processes, and climatic conditions. However, laboratory and field experiments have demonstrated that fine particles interact with the bed through turbulent exchange and advective hyporheic flow, indicating that bed processes may play a larger role in fine particle dynamics than previously believed. Therefore, understanding fine sediment dynamics requires disentangling the signal of suspended sediment transport that results from external and internal mechanisms, i.e. land use, climate, and storm frequency vs. bed storage, resuspension, and bank erosion.

Here we synthesize a variety of climate and rainfall reanalysis products with US Geological Survey suspended sediment records and hydrographs. We explore the relations between high-resolution suspended sediment records, rainfall, and river hydrographs through the use of wavelet analysis, with particular emphasis on understanding covariation in the frequency, intensity, and duration of events. To first order, suspended sediment flux within a river reach follows shear stress as a simple power function. This scaling is evident in rivers varying in size and morphology. By combining local hydraulic variables and grain scale properties, each river's fine particle flux relation can be collapsed onto a single transport curve. This is surprising as the dominant variables are shear stress, bed material size, and the bankfull stress, which represent local properties of the river dependent on reach scale morphology and channel hydraulics. These properties are known to self-organize in mountain rivers, indicating that catchment processes may not be as readily encoded within signals of suspended sediment flux. Indeed, the storage of fine particles in channel structures and river beds indicates a larger role of bed morphodynamics in suspended sediment transport than previously believed. Further, the strong scaling with local variables provides a basis for estimating fine particle transport in ungauged areas. These estimates represent valuable information for identifying river and land management strategies and forecasting water quality.