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An overview of the effects of areal and temporal scale on sediment transfer in fluvial systems

W.R. Osterkamp
U. S. Geological Survey, Tucson, Arizona, USA. wroster@usgs.gov

The hydrologic, biogeomorphic, and biological processes that control the movement and storage of sediment in a fluvial system are highly scale-dependent both areally and temporally. These processes include rainsplash particle entrainment, dispersed overland flow, rill erosion, and bioturbation at small areal scales, and gully and channel erosion, fire, and forest stress at slightly larger areal scales. At a watershed or drainage-basin scale, geomorphic processes are typically dominant controls of sediment delivery to the drainage network. Fluvial sorting of stream-network sediment is important at all areal scales and, interacting with other processes of sediment movement, the storage and subsequent re-entrainment of alluvial-bottomland sediment.
Among the geomorphic processes affecting sediment yield at the watershed and drainage-basin scales are mass movement, jointing and exfoliation owing to pressure release and gravitational gradients, and, to a lesser extent, physical weathering such as wedging by root growth or ice during freeze-thaw cycles, and crystal growth of evaporate minerals. Mass movement, which here includes various forms of slope failure and debris avalanche, debris and earth flow, and creep by solifluction or plastic flow of soil, is an often disregarded but highly significant mechanism by which transfer of sediment from uplands to channels operates at all temporal scales in all latitudes. High-velocity mass movement, such as rock fall and debris avalanche, delivers large amounts of rock and soil to lower slopes very quickly and effectively. Various gravitational processes, generalized as soil creep and controlled by viscous and frictional forces, however, are responsible for the delivery of a large portion of sediment to stream channels. Although these processes operate at very slow time scales, they may be the dominant mechanism of sediment movement in some drainage basins.