Geomorphology
Volumes 139–140, 15 February 2012, Pages 1-15

Review

Enhanced sediment delivery in a changing climate in semi-arid mountain basins: Implications for water resource management and aquatic habitat in the northern Rocky Mountains

Jaime R.Goode Charles H.Luce John M.Buffington

https://doi.org/10.1016/j.geomorph.2011.06.021

Abstract

The delivery and transport of sediment through mountain rivers affects aquatic habitat and water resource infrastructure. While climate change is widely expected to produce significant changes in hydrology and stream temperature, the effects of climate change on sediment yield have received less attention. In the northern Rocky Mountains, we expect climate change to increase sediment yield primarily through changes in temperature and hydrology that promote vegetation disturbances (i.e., wildfire, insect/pathogen outbreak, drought-related die off). Here, we synthesize existing data from central Idaho to explore (1) how sediment yields are likely to respond to climate change in semi-arid basins influenced by wildfire, (2) the potential consequences for aquatic habitat and water resource infrastructure, and (3) prospects for mitigating sediment yields in forest basins. Recent climate-driven increases in the severity and extent of wildfire suggest that basin-scale sediment yields within the next few years to decades could be greater than the long-term average rate of 146 T km^{-2} $year^{-1}$ observed for central Idaho. These elevated sediment yields will likely impact downstream reservoirs, which were designed under conditions of historically lower sediment yield. Episodic erosional events (massive debris flows) that

dominate post-fire sediment yields are impractical to mitigate, leaving road restoration as the most viable management opportunity for offsetting climate-related increases in sediment yield. However, short-term sediment yields from experimental basins with roads are three orders of magnitude smaller than those from individual fire-related events (on the order of 10^{1} T km^{-2} year^{-1} compared to 10^{4} T km^{-2} year^{-1}, respectively, for similar contributing areas), suggesting that road restoration would provide a relatively minor reduction in sediment loads at the basin-scale. Nevertheless, the ecologically damaging effects of fine sediment (material < 6 mm) chronically produced from roads will require continued management efforts.

Highlights

► In response to changing climate, we expect sediment yields to increase. ► Increased vegetation disturbances, such as wildfire, are the expected mechanism. ► Elevated sediment yields in central Idaho will likely impact downstream reservoirs. ► Post-fire erosional events dominate sediment yields but are impractical to mitigate. ► Road restoration can provide limited reduction in sediment loads at the basin-scale.