Agricultural land use doubled sediment yield of western Chinas rivers

Details

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Abstract

Land use changes, such as deforestation and agriculture, increase soil erosion rates on the scale of hillslopes and small drainage basins; however, the effects of these changes on the sediment load in larger rivers is poorly quantified, with a few studies scattered globally, and only 10 data points in the worlds most populous nation, China. At 20 different sites in western China, we compare contemporary (1945-1987) fluvial sediment yield data collected daily over 4 to 26 years (median = 19 years) to long-term measures of erosion (sediment generation) based on new isotopic measurements of in situ 10Be in river sediments. We find that median sediment transport at these sites exceeds background sediment generation rates by a factor of two (from 0.13 to 5.79 times, median 1.85 times) and that contemporary sediment yield is statistically significantly different from long-term sediment yield ($p < 0.05$). Agricultural land use is directly and significantly proportional to the ratio of contemporary sediment yield to long term sediment generation rates (Spearman correlation coefficient rho = 0.52, $p < 0.05$). We support these findings by calculating erosion indices (following Brown et al., 1988), which compare the delivery of meteoric 10Be to each watershed with the export of meteoric 10Be bound to riverine sediment. Erosion indices are also directly and significantly proportional to agricultural land use (rho = 0.58, $p < 0.05$). We measured unsupported 210Pb and 137Cs in 130 detrital samples from throughout the region. We find that only 4 samples (those from high elevation, low relief watersheds) have detectable 137Cs and 31 samples have detectable unsupported 210Pb. The lack of 137Cs in most samples suggests high rates of erosion in the 1950s-1960s when 137Cs would have been delivered to the landscape. Detectable 210Pb in ~25% of the watersheds suggests that in some areas erosion rates have slowed since that time allowing 210Pb to accumulate to measurable levels. Together, these data sets demonstrate that upstream agricultural land use has significantly

increased sediment supply to rivers in western China, likely increasing turbidity and decreasing ecosystem services such as fisheries.

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