Sediment Production and Delivery From Roads in the Sierra National Forest, California

Lee MacDonald, Allison Stafford, and Abby Korte
Department of Forest, Rangeland, and Watershed Stewardship, Colorado State University, Fort Collins, CO

Abstract. Unpaved roads are often a major source of sediment in forested watersheds, but few areas have data on the magnitude and variability of road sediment production. Over the past four wet seasons we have been measuring road sediment production from 29-40 unpaved road segments in the southern Sierra Nevada of California. These data provide a relatively unique opportunity to quantify the effects of climate, elevation, and other site factors on road sediment production. The study area includes the mid-elevation Providence Creek watersheds(1485-2005 m) and the higher elevation Bull Creek watersheds(2050-2420 m) in the Sierra National Forest. Annual sediment production is being measured with sediment fences placed immediately below road drainage outlets.

The overall mean sediment production for the 71 fence-years of data from native-surface roads is 0.50 kg m^{-2}, but mean annual values have varied from 0.017 kg m^{-2} in a dry year to 1.1 kg m^{-2} in a year when precipitation was 60% above average. Values from individual segments vary from zero to a maximum of 6.6 kg m^{-2} yr^{-1}. Sediment production generally increases with the product of road segment area times segment slope (R^2=0.22; $p<0.0001$) and with the amount of bare soil on the active road surface (R^2=0.14, $p=0.01$). After normalizing by slope, sediment production decreases with increasing elevation (R^2=0.16; $p=0.0005$). This decrease is attributed to the increased proportion of snow relative to rain, as peak snowmelt rates are only about 30% of peak rainfall rates, snowflakes generate no splash erosion, and the more frequent snow cover reduces rainsplash during rain-on-snow events.

We are now extending this project to measure road sediment production and delivery rates in a lower-elevation (850 m to 1200 m) basin. We hypothesize that sediment production rates will be higher, despite the lower total precipitation, as most of the precipitation should fall as rain. The collection of road erosion data from three elevation zones will allow us to quantify the effect of climate change and the associated shift from rain to snow on road sediment production rates in the southern Sierra.