

Stream Sediment and Soil Erosion

Kings River Experimental Watersheds

Why Measure Sediment Load and Soil Erosion in Mountains?

Soil or sediment transported by wind or water is an important part of the environment. Sediment supports plant growth, forms streambanks, moves nutrients, and affects stream invertebrates and fish. Each year an estimated 3 billion tons of sediment is eroded around the world, affecting water quality, fisheries, and ecosystem health. Soil naturally erodes but activities like road construction and timber harvesting can increase erosion. Therefore the Pacific Southwest Research Station is studying erosion in the southern Sierra Nevada, northeast of Fresno, in the Kings River Experimental Watersheds (KREW).

Little research had been done on sediment loads and movement in the southern Sierra Nevada before the KREW study.

KREW's research has documented stream sediment loads and soil erosion in both dry and wet years. Sediment load is the amount of sediment moved within a stream, while erosion is the movement of soil from a hillside. Sediment basins (figure 1) collect the sediment load from a stream while sediment fences (fig. 2) measure erosion from roads and undisturbed hillslope areas in the watersheds. It is important to know how much soil erosion and stream sediment is caused by natural processes as compared to human activity, so that forest managers can design the best forest restoration practices.

Where and How Is the Study Being Conducted?

The KREW scientists measured sediment load and erosion before and after forest management activities in two sites, comprised of 8 watersheds. These watersheds are considered to be overly dense with vegetation due to the lack of any natural wildfires in the past 110 years. Typically, natural wildfires occur in a mixed conifer forest every 12-15 years. The soils at KREW originate from the decomposition of granite bedrock and are coarse, sandy minerals with varying amounts of organic material that release nutrients into the ecosystem as they decompose.

The KREW scientists have constructed basins at the outlet of each watershed to capture sediment moving downstream. The basins range from 15 to 25 ft. (5 to 8 meters) wide by 30 to 50 ft. (9 to 15 m.) long (fig. 1), and are constructed from wooden frames lined with thick rubber. The entire stream flows into a basin, creating a large pool where water slows down. Here fine sediment suspended in the water settles, and larger sediment moving along the stream bed (bedload), stops moving. Water resumes its natural flow when it leaves the basin outlet. Soil erosion is measured by the installation of sediment fences constructed from rebar lined with water permeable fabric to capture the eroded soil. Scientists remove all sediment from the basins and fences at the end of each year to determine the amount of sediment.

What Factors Affect Soil Erosion?

Soil is transported by wind, water, and gravity. Local weather patterns, contour of the landscape, vegetation, and soil type are important natural factors affecting erosion. Precipitation and stream discharge transport soil down steep hills and channels within watersheds. Soil stability after land management activities is affected by the intensity, length, and type of precipitation received. Researchers expect that watersheds experiencing controlled burns and timber harvests could have increased erosion immediately following those activities, but the amount would likely decrease each year and eventually return to values similar to those before disturbance. The KREW study will determine the change and variability in erosion and sediment load for the southern Sierra Nevada before and after management activities.

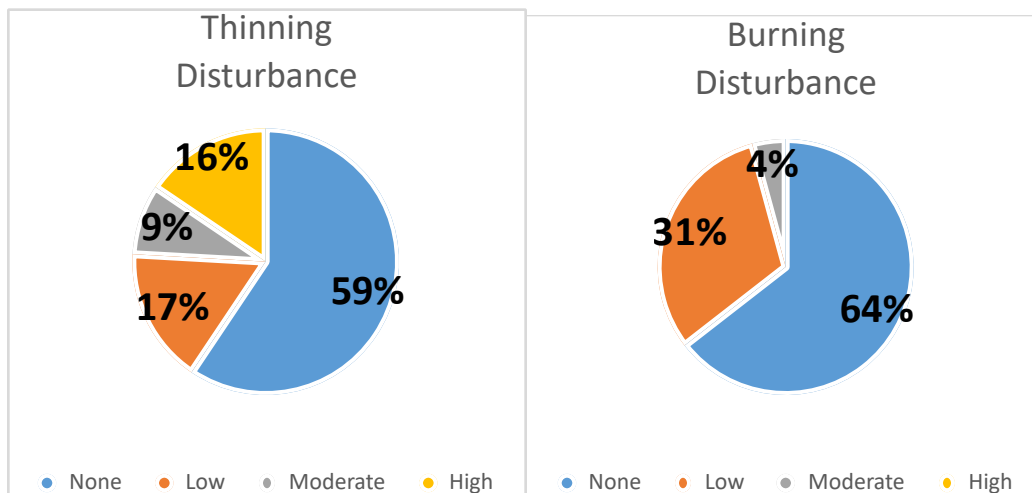


How much Soil Erosion occurs in KREW?

Soil erosion usually increases with human disturbance, i.e. road construction and timber harvesting. Scientists measured soil disturbance using four classes, none, low, moderate, and high. Soil disturbance class none represents no alteration while soil disturbance class high shows significant disturbances (i.e. Thinning-forest floor layers missing/displaced, wheel tracks at a depth greater than 4 inches (10 cm) or Burn-deep ground char with a depth of 4 inches (10 cm) or more.) After the tree thinning and prescribed fire treatments, the soil disturbance was measured. Results showing that majority of the watershed was not disturbed (fig.3 A). Therefore forest restoration activities resulted in acceptable soil disturbance from mechanical treatment and less than 5 percent from prescribed fire.

Although there was little disturbance, there was an effect on soil erosion in the sediment fences. Pretreatment data for sediment fences were collected from 2004-2009 and post treatment data from 2013-2015. During the post treatment period also correlated with the drought. Therefore we compared a drought like year, WY2007, during pretreatment data and found that there was an increase in erosion due to treatment activity (fig.4). If there was normal precipitation years, it would be expected that there would be higher amount of soil erosion seen.

	Bull	Providence
Pretreatment WY07	0 g/m ²	0 g/m ²
Posttreatment WY13-15	0.7 g/m ²	2.4 g/m ²



How Much Sediment Load Occurs in KREW?

The amount of sediment deposited within the basins varies between the two sites due to the type of precipitation that occurs. The Bull Creek site is a snow-dominated area while the Providence Creek site is a rain-dominated site, due to the lower elevation. Figure 3 A



and B show there is a strong relationship between stream sediment and precipitation. The Bull Creek site has eroded a total of 337 pounds per acre (378 kilograms/hectare) for the past 12 years while the Providence Creek site has eroded 725 pounds per acre (811 kg/ha). This difference may be related to the type of precipitation that occurs between the two sites. Snow makes up 24 to 68 percent of the total precipitation at the Bull Creek site and only 16 to 58 percent at the Providence Creek site. Snow events are less erosive than rain events due to the runoff patterns. During intense rain events, the rain is directly impacting the soil and thus causing erosion. However during snow storms, the snow builds upon itself creating snow packs that will melt off slowly during warmer weather. The runoff moves on top of the snow rather than interacting with the soil, therefore there is less erosion. When there is a lack of precipitation, stream sediment reduces. With this knowledge, we found that our results after treatments were altered due to the lack of precipitation. Pretreatment data was found to be higher than posttreatment data (table2). But if we compare WY2007, a drought like year during the pretreatment, results show there was increase in sediment load due to treatment activities. Like the sediment fences, if there was normal wet years following the treatments, sediment loads would be expected to be much higher.

Table 2	Bull	Providence
Pretreatment 03-11	12	24
Posttreatment 12-15	1	2

Table 3	Bull	Providence
Pretreatment 07	0.8	1.3
Posttreatment 12-15	1.0	1.9

