Landslides after Clearcut Logging in a Coast Redwood Forest

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The 473-ha North Fork Caspar Creek watershed, located 10 km south of Fort Bragg, California, was partially clearcut in 1989-1992 during an experiment designed to evaluate the cumulative effects of clearcut logging. Since 1985, new landslides larger than 7.6 m^3 have been mapped and measured along gaged tributary channels after each major storm, and other slides visible from roads or on aerial photographs are mapped throughout the watershed.

Between 1991 and 2006, 65 slides of 7.6 to 380 m^3 were mapped within 15 m of gaged channels, and comparison of sliding rates in logged and forested portions of the watershed shows no significant difference for these slides. Over the same period, 13 slides larger than 98 m^3 occurred in the watershed, not necessarily near gaged channels. Slides larger than 98 m^3 in forested areas displaced about 12 $m^3/km^2/yr$, while rates in logged or roaded areas were one and two orders of magnitude higher, respectively, per unit areas logged or roaded. Moreover, volume rates of sliding from roads in logged areas were at least 3 times greater than those from roads in forested areas.

A major storm in 2006 triggered the largest slide complex (5500 m^3) observed in the North Fork since Caspar Creek studies began in 1962. The slide initiated in a logged (1991) and thinned (2001) swale below a road-drainage outfall and triggered a debris flow that scoured sediment from the downstream channel. Much of the debris remains stored along the channel and may become a long-term sediment source. This slide, in combination with a similar 1995 slide that occurred in an ungaged portion of the watershed that was logged in 1985, accounts for about 3/4 of the sediment displaced by slides in the North Fork watershed between 1985 and 2009.

Landslide volumes in the gaged watersheds were not correlated with sediment yields between 1986 and 1995, showing that small to moderate slides were not a major influence on sediment yield. In contrast, the 2006 slide transported more than 1000 times the mean annual sediment yield measured for the affected tributary before logging.

Logging appears to have influenced landsliding in North Fork Caspar Watershed primarily through an increase in the incidence of large landslides and by destabilization of slopes adjacent to roads. Logging can affect landslide incidence by reducing root strength, though this effect is less important in coast redwood forests because much of the root biomass survives. Logging also reduces transpiration and rainfall interception, increasing average soil moisture and contributing to heightened pore pressures during storms. Interception by Caspar Creek forests removes 21% of the rainfall during large storms, so canopy removal increases rainfall at the ground surface by 27%, effectively increasing the magnitude and frequency of landslide-generating storms.