Module 4. SEDIMENT YIELD OF SMALL WATERSHEDS
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A persistent and often contentious debate surrounds evaluating effects of forest harvest activities on streamflow and sediment yield. Despite abundant discussion of peak flow changes following timber harvest in paired-watershed studies in the Andrews Forest and other basins in western Oregon (Jones and Grant, 1996, 2001a, 2001b; Thomas and Megahan, 1998, 2001; Beschta et al., 2000; Jones, 2000), no studies have evaluated the geomorphic response to observed peak flow changes—a question of great interest in interpreting potential downstream consequences of forest management on channels and ecosystems.

Decades of paired-watershed studies at the Andrews Forest have enhanced our understanding about the impacts of forest harvest on sediment transport through small mountain watersheds (Fig. 4.1). Early studies focused on the impacts of forest harvest on suspended sediment and bedload yields from experimental Watersheds 1, 2, and 3 (for example, Fredriksen, 1970; Grant and Wolff, 1991), and hillslope and channel sediment budgets from Watersheds 9 and 10 (Swanson et al., 1982a). Current research is aimed at disentangling the combined effects of hydrologic changes and increased sediment supply have on fluvial sediment transport following clear-cutting (Grant and Hayes, 2000).

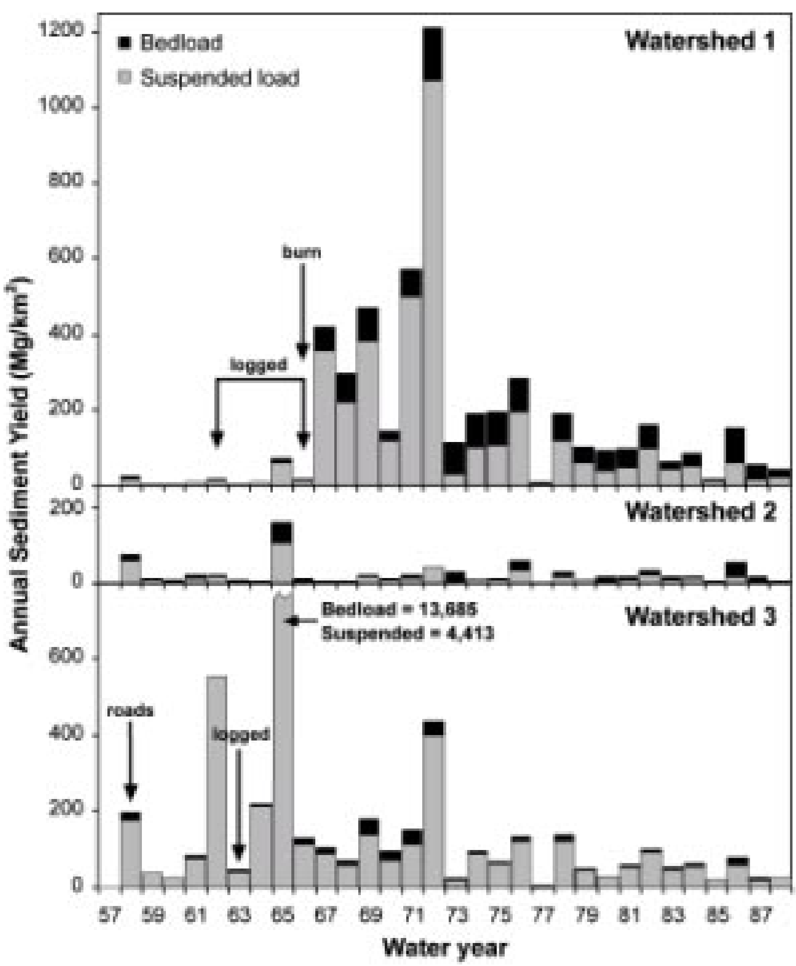

Figure 4.1. Annual sediment yields for Watersheds 1 (100% clear-cut), 2 (control), and 3 (25% clear-cut + roads) for water years 1958-1988 (from Grant and Wolff, 1991).

These studies document significant increases in sediment yields from harvested basins following treatment (Fig. 4.2). Although fluvial transport of sediment increased by at least an order of magnitude following treatment, episodic mass movements dominate long-term sediment output from some small watersheds. In Watershed 3, debris flows during the December 1964 storm transported 88% of the total post-treatment sediment yield through 1988; subsequent debris flows during the February 1996 storm moved comparable large volumes. Debris flows scoured the Watershed 3 channel of available sediment, so transport in intervening years was quite low. In the absence of large mass movements, sediment yields show a roughly exponential decline following treatment, although bedload and suspended sediment transport recover at different rates. Suspended sediment output from Watershed 1, which did not have debris flows, declined to pre-treatment levels within two decades following treatment, but bedload yields exceeded pre-treatment levels as recently as 1999.

The sediment yield histories from this paired-basin study suggest that the timing of land use changes with respect to large storms exerts significant control on magnitude and timing of sediment yield. Watershed 3 was prepared to exhibit a land-use-effects response to the December 1964 and January 1965 floods, but Watershed 1 was not because logging was only partially completed and fallen timber may have stabilized some hillslopes and channels.

Since the relation between sediment transport and discharge typically follows a power law, small increases in discharge can translate into large increases in sediment transport. But timber harvest typically influences both the hydrologic regime and sediment supply of a watershed, making it difficult to isolate the peak flow effect alone. We addressed this problem by using paired-watershed data from Watersheds 1 and 2 to predict streamflow response in the absence of cutting. We combined the predicted hydrology with observed relations between discharge and sediment transport to disentangle the relative effects of changes in hydrology and sediment supply. While peak flow increases alone can account for modest increases in both suspended and bedload transport in Watershed 1, the peak flow effect is dwarfed by the increased supply of sediment following treatment.

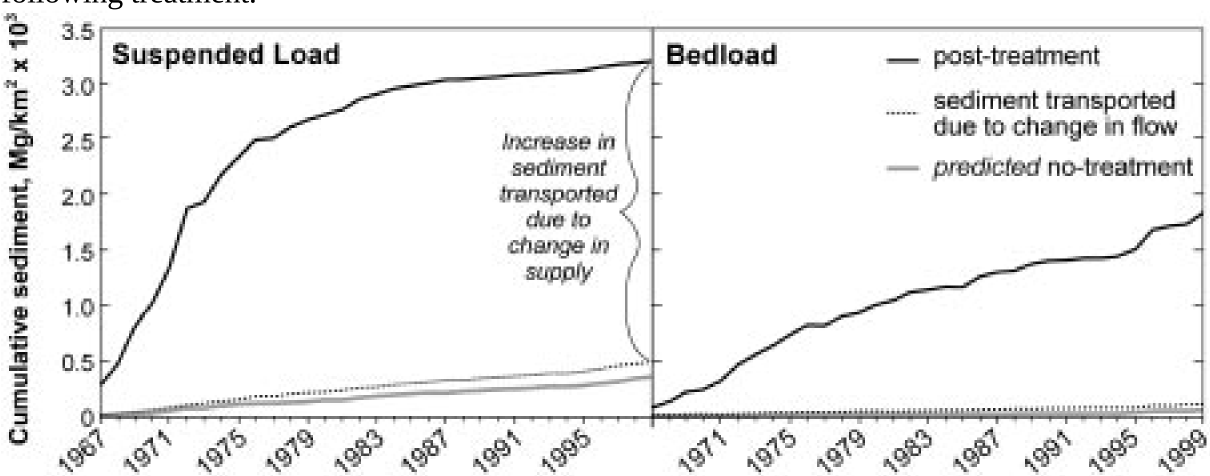

Figure 4.2. Watershed 1 sediment yield after clearcut and prescribed fire for water years 1967-1999.