Postfire Rehabilitation Treatments: Are We Learning What Works?

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Wildfire is a major ecological process and management issue in the western United States. In recent years, more than 5 million acres of forest and grasslands have burned annually. Major post-fire concerns include increased erosion due to loss of the protective forest floor layer, loss of water storage, and the creation of water-repellent soil conditions. These conditions increase the potential for flooding, debris flows, and sedimentation, which are of special concern when urban areas are in proximity to the burned areas.

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Burned area emergency rehabilitation treatments fall into three categories: hillslope, channel, and road treatments. Of these, hillslope treatments are most common, as they attempt to reduce erosion at its source. A wide range of treatments have been used and new treatments are being developed and adapted for use on burned landscapes. Given the choices (and the expense) of post-fire rehabilitation treatments, information on the effectiveness and limitations of these treatments is important to land management agencies and the public. Scientists are monitoring and evaluating various treatments across the country.

Erosion and Recovery

Forests that have experienced relatively little disturbance have very small erosion rates, but these rates can increase dramatically after wildfire events. Sediment yields after wildfires range from very low, in flat terrain and in the absence of major rainfall events, to extreme, in steep terrain affected by high-intensity thunderstorms. First-year sediment yields of 1 to 150 tons per acre have been reported for burned mixed coniferous forests in the western United States. Consequently, postfire rehabilitation treatments that have an impact the first year can be important in minimizing downstream effects and watershed resources.

Erosion on burned areas typically declines in subsequent years as the site stabilizes, but the rate depends on burn severity and vegetation recovery. Erosion rates from high-severity burned sites in the Colorado Buffalo Creek Fire declined to background levels within three years. However, another study found that after a wildfire in ponderosa pine forest, sediment yield from a low-severity fire recovered to normal levels after three years, but moderately and severely burned watersheds took seven and 14 years, respectively.

Treatment Effectiveness

Hillslope treatments such as mulches, contour-felled logs (log erosion barriers), and seeding aim to reduce surface runoff and keep soil in place. These treatments are regarded as a first line of defense against post-fire erosion and unwanted sediment deposition. Rainfall intensity is a key factor in treatment success, however. Recent studies suggest that some treatments may help reduce erosion for some but not all rain events. A paired-watershed investigation at the catchment scale (five to 10 acres) under natural rainfall demonstrated that some erosion reduction from contour-felled logs and straw mulches occurred for low rainfall intensity storms, but not for high-intensity storms.

Broadcast seeding has been used for decades and is widely considered the most cost-effective method to promote rapid infiltration of water and keep soil on hillslopes and out of channels and downstream areas. However, studies are showing that grass seeding alone does not ensure increased ground cover during the first critical year after fire. In fact,

Aerial application of wheat straw at about 1 ton per acre after the Hayman Fire, Colorado (above). Cleaning sediment out of the research catchment sediment trap after a summer thunderstorm, Hayman Fire, Colorado (banner).

given the influence of rainfall amounts and intensities on the effectiveness of any hillslope treatment, especially during the first year, treatments that provide immediate ground cover are proving more effective than seeding alone. Immediate protection of the soil from overland flow and raindrop impact is essential in reducing first post-fire year erosion rates. Recent results indicate that a threshold of 70 percent ground cover is needed to impact erosion. For example, 70 percent cover with brown conifer needles that commonly fall to the ground following low- and moderate-severity burns reduced rill erosion by 30 to 40 percent and interrill erosion by 50 to 70 percent. Seeding can be combined with ground cover treatments, but re-establishing native vegetation may be preferable and as effective as planting annual grasses and legumes to establish plant cover in subsequent years.

Using low-intensity rainfall simulation and concentrated flow (rill) techniques, erosion from several postfire areas that had various rehabilitation treatments were compared to nontreated areas. Straw mulch, straw wattles, and contour-felled logs reduced erosion by 70 percent for small rain events. However, during intense summer thunderstorms (10-minute maximum intensity of 1.6 inches per hour) differences between treated and nontreated areas were smaller. Other treatments such as scarification and hand trenching were not effective.

Research in the Colorado Front Range

In a paired-watershed study installed on the Hayman Fire area (Colorado, 2002), first-year data showed that six rain events produced sediment in catchment sediment traps. The mean total sediment yield from these events was 10 tons per acre for three untreated control watersheds. Totals from the treated watersheds were 5 tons per acre from contour-felled logs, 3 tons per acre from wheat straw, and 7 tons per acre from hydromulch. The highest sediment yield resulted when the 10-minute maximum rainfall intensity was at least two inches per hour.

In a silt/sediment fence study also on the Hayman Fire area, four summer storms produced sediment in the 32 fences. The mean first-year erosion rates from the treated plots were all lower than for untreated plots, and mulch treatments (wheat straw and engineered wood straw) produced a much greater reduction in erosion rates. In addition, the mean first-year erosion rate for the plots on 20 percent slopes was about half that of the plots on 40 percent slopes.

Measuring ground cover on treated hillslope plots; silt fence in background.

What have we learned from these studies? Based on runoff and peak flows, erosion rates, sediment yields, and ground-cover measurements, aerially applied wheat straw was more effective than contour-felled logs or hydromulch during the first post-fire year. Although some benefits were observed from the aerial hydromulch, it was less effective than either of the other two watershed treatments. In the silt/sediment fence plots, engineered wood straw was most effective at increasing cover and thereby reducing erosion.

Future Post-fire Rehabilitation

As wildfires continue to grow in number, size, and intensity, concurrent growth has occurred in the treatment application and expense of post-fire rehabilitation efforts. Post-fire rehabilitation decisions must take into account the degree of protection warranted by the assets at risks, treatment costs, availability of treatment materials, short- and long-term effects of treatment applications, and the likelihood of treatment success in the area being considered. The choice to rely on natural recovery processes and not implement any rehabilitation treatments is often the preferable alternative.

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