EFFECTS OF POST-FIRE CHANNEL TREATMENTS ON RUNOFF AND SEDIMENT TRANSPORT

Joseph W. Wagenbrenner, US Forest Service, Moscow, ID, jwagenbrenner@fs.fed.us; Peter R. Robichaud US Forest Service, Moscow, ID, probichaud@fs.fed.us; Scott W. Woods, University of Montana, Missoula, MT, scott.woods@umontana.edu

Abstract Wild fires can dramatically affect reduce interception, transpiration, and infiltration, and thereby cause significant increases in runoff and overland flow (DeBano et al. 1998). Fire can also alter soil properties, resulting in decreased levels of soil aggregation and soil structure, which result in increases in erodibility. These changes to watershed properties and processes can increase channel runoff and sediment transport rates by orders of magnitude, thereby transforming stable, low sediment yield streams into streams with high rates of channel incision and/or channel widening and orders-of-magnitude increases in sediment flux rates.

Land managers in the U.S. and elsewhere often attempt to mitigate these effects by applying hillslope or channel treatments (Robichaud et al. 2000). The effectiveness of hillslope treatments has been well documented over the past 15 years (Cerda and Robichaud 2009). Conversely, questions concerning the effectiveness of post-fire channel treatments at reducing channel degradation and sediment transport headwater streams remain largely unanswered. Further, the effects of these treatments on channel processes are not well documented.

Common post-fire channel treatments, intended to reduce sediment transport or increase channel stability, include: check dams made of various materials; sediment detention basins; channel armoring or roughening with rip-rap or felled trees; grade stabilizers constructed of rocks or felled trees; stream bank armoring; and channel deflectors (Napper 2006; Robichaud et al. 2000). Miles et al. (1989) evaluated 1300 straw bale and 14 log or rock check dams installed after the 1987 South Fork Trinity River fires in northern California. The straw bale dams each stored 1.1 m^3 of sediment, while the larger rock or log check dams stored between 1.5 and 95 m^3. About 13% of the straw bale dams failed in the first wet season due to flow under or between bales or by undercutting caused by downstream scour during spillway overflow. None of the rock or log dams failed in the first wet season. Collins and Johnston (1995) found that only 40% of 440 straw bale check dams were functional 5 months after the Oakland Hills fire in California and sediment storage averaged only 0.1 m^3. Fox (2009) evaluated log and brush check dams after a wild fire in southeastern France; the average dam captured 1.3 m^3 of sediment.

A laboratory flume study and a field study are planned to determine the effectiveness of several common post-fire channel treatments and to measure their effects on hydraulic properties. Objectives for the laboratory study will be to determine whether channel treatments are effective at reducing sediment transport and if the treatments alter the hydraulic processes. Objectives for the field study will be to determine if channel shape characteristics in the treated channels are different from those in untreated channel segments. The flume study will evaluate the effects of check dams and grade stabilizers. The field study will assess check dams, grade stabilizers, armoring, and sediment detention basins. This poster will review the state of knowledge concerning post-fire channel treatments and discuss the methodology for the upcoming studies.

The laboratory flume, located at the University of Idaho's Center for Ecohydraulics Research in Boise, Idaho, has dimensions of 20 m long and 2 m wide, a maximum flow depth of 1 m, a maximum slope of 10%, and a maximum sediment load of 2 kg s^{-1}. Burned sediment will be installed on the bed of the flume and will be added to the water supply to control the sediment concentration. Scaling to fit the flume constraints will be conducted using geometric and kinematic scaling techniques (Hughes 1993; Gill and Pugh 2009). The scaling design will require field-measured values for channel shape, bed and sediment particle size distributions, flow depth and rate, sediment concentration, and treatment dimensions. All of these parameters except the treatment dimensions will be obtained from previously reported precipitation, runoff, and sediment yield data from 3 small (3-13 ha) burned watersheds (Robichaud et al. 2008). Measurements in the flume will include sediment yield, runoff velocity profiles, changes in bed shape, and particle size distributions of the bed and sediments.

The field study will begin in summer 2010 in 1 or 2 recently burned areas. Treated channel segments will be paired with untreated controls. Measurements will include channel cross section and longitudinal profile surveys using a total station, bed material particle size distribution, rainfall rate, and maximum flow depth using crest gauges. Baseline measurements will be made at installation and repeated after significant flow events.

The planned laboratory and field studies will provide information at two scales. The flume study will allow us to directly compare treatments and to measure hydraulic properties in a controlled setting. The field component, although coarser in scope than the laboratory experiment, will help determine the effectiveness of the treatments in a typical installation. This aspect will bolster the applicability of the laboratory results and the combined results will provide a better understanding of the effects of post-fire channel treatments.

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