Ecological Restoration Institute

***Fact Sheet**: Sediment Yield After Severe Wildfire*

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Sediment Yield After Severe Wildfire

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INTRODUCTION

Wildfires throughout the western U.S. have increased in size and severity as a result of 20th century land use practices including fire suppression, which has elevated risks to communities bordering and downstream of forested watersheds. High-severity wildfire (i.e., where most trees are killed) in the arid and semi-arid Southwest changes watershed response to precipitation, mainly by increasing runoff. This results in a high risk of flooding, sediment transport, and erosion, particularly on steep slopes (DeBano et al. 1998). Forest floor materials such as organic matter and dead leaves normally absorb most precipitation and limit runoff, but severe fire eliminates this forest floor cushion, leaving a slick, sometimes water resistant surface that deflects a significant amount of rain, or runoff. Slope stability is compromised by loss of herbaceous cover. The increased runoff combined with the reduced slope stability creates an optimal environment for sediment mobilization from hillslopes (also known as hillsides) and channels, erosion, and flooding.

This fact sheet summarizes significant findings on sediment transport and erosion on burned landscapes in semi-arid systems with ponderosa pine and mixed conifer type vegetation.

RESEARCH FINDINGS

- Peak flows can increase from 500% to 9,600% following wildfire in the Southwest.
- Higher peak flows increase the runoff's capacity to carry sediment (Figure 1).
- Sediment flux on hillslopes is the greatest source of increased erosion post-fire (Canfield et al. 2005), but about 75% of the sediment sources are in channels (Moody and Martin 2009).
- Burned hillslopes are prone to rill and gully formation during precipitation, increasing runoff transport to channels.
- Water sources can be contaminated by ash-laden post-fire runoff, reducing potability.
- The 2012 Sunflower Fire burned 17,618 acres of Tonto National Forest (NF), and ash-laden runoff caused water turbidity to spike. Production was reduced and treatments were increased to make water safe for consumption in Phoenix. Murky water was noted up to 45 miles away in a Mesa water treatment plant the following winter.

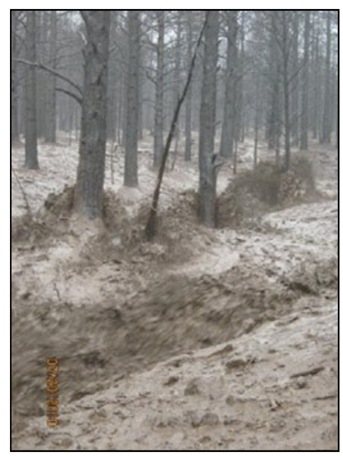

Figure 1. An ash- and sediment-laden flood flows during a July 20, 2010 storm on the Schultz Fire burn area.

- Sediment transport in ephemeral channels is unsteady, meaning sediment response to changing flow conditions lag, and sediments are transported in pulses (Hummel et al. 2012).
- Regional geological studies indicate that sediments have been accumulating for ~6,000 years.

Figure 2. A municipal waterline is exposed from a 12-foot incision of a main drainage gully post-Schultz Fire.

Schultz Fire — Coconino NF, Arizona

- The Schultz Fire was a high-severity wildfire that burned 15,051 acres north of Flagstaff in June 2010. Post-Schultz Fire monsoon storms caused some channels to erode dozens of feet down to bedrock. These channels more rapidly transport runoff and sediment than sediment-lined channels (Figure 2).
- Post-fire flood flows were estimated to be two orders of magnitude larger than pre-fire flows, although lack of pre-fire rain gages limited accurate estimates (Carroll 2011).
- Maximum increases in erosion were projected for one to two years after wildfire, but high-severity burn areas could produce abnormal sediment loads for 14 years.
- Some Burn Area Emergency Response (BAER) erosion mitigation treatments contributed to damage due to limited understanding of watershed's geomorphology and potential responses to post-fire flooding.

Management Implications

- Post-wildfire sediment transport, erosion, and flooding can result in costly damages to property and municipal and utility infrastructure.
- Predicting the location and magnitude of sediment transport and flooding is complicated due to spatial complexity of burn severities and precipitation.
- Prior knowledge of sediment sources and rainfall/runoff/sediment relationships could increase effectiveness of post-fire emergency erosion mitigation.
- Sediment monitoring, rain and flow gage installation, and mapping of geomorphic units can lead to more accurate and precise modeled predictions of post-wildfire runoff and sediment transport magnitudes and locations.

References

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