DEVELOPMENT OF A WASHINGTON STATE MODEL TO IDENTIFY POTENTIAL DEBRIS FLOWS FROM WILDFIRE BURN AREAS

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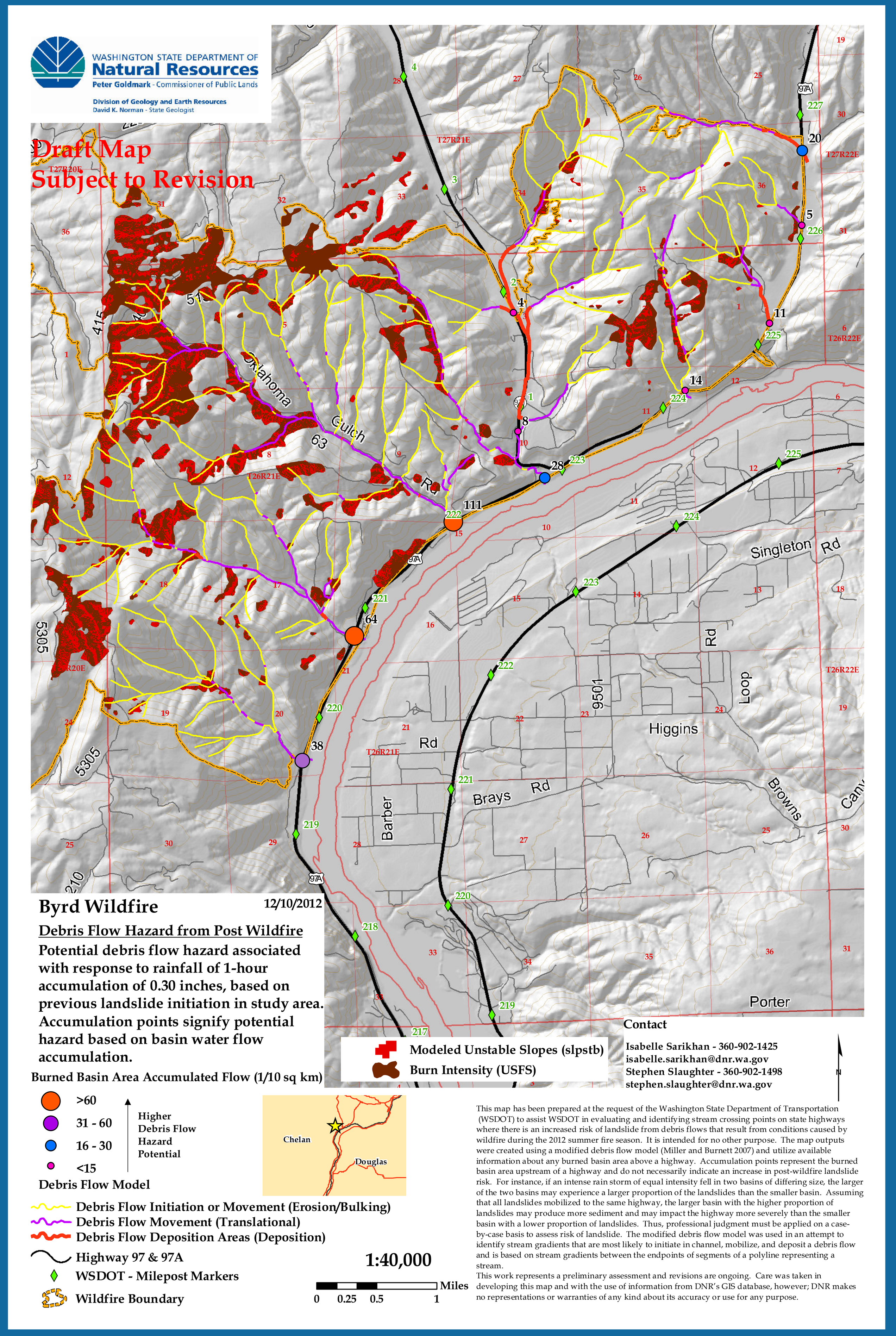
Abstract

Wildfires in Washington State have burned over 1.3 million acres from 1973 to 2011; with over 261,000 additional burned acres in 2012 (Fig. 1). Burn areas are vulnerable to soil erosion and slope instability due to hydrophobic soils and difficult regrowth of vegetation. These conditions lead to the downslope hazard of debris flow mobilization that can adversely impact communities and infrastructure for years following a wildfire. The majority of burn area landslides develop from intense precipitation, usually from thunderstorms or cloudbursts that occur primarily in the spring through early fall. Long term hazards can be exacerbated by the reduction of tree rooting strength (Zeimer, 1981), redevelopment of canopy coverage (Horel, 2006) and rejuvenation of the soils and ground vegetation on a scale of a decade or more. Additionally, debris flows from burned areas can travel long distances, impacting communities and infrastructure, such as highways, miles away from burn areas. An example is the May 2011 Pearrygin Creek debris flow in northeast Washington, which initiated in the burn area of the 2006 Tripod Fire , impacting structures and roads over 5 miles outside of the fire perimeter.

Current landslide prediction tools use multi-regression statistical models with inputs that include modeled burn intensity, slope gradient, soil type, soil erosion potential, and rainfall intensity. Used primarily in the southwest United States, the orographical precipitation, vegetation, and lithology inputs of the current multi-regression statistical models are not calibrated for the Pacific Northwest and a new or recalibrated model must be developed.

The development of a potential model of debris flows initiated from burn areas will include inputs of the models currently in use; however, the addition of spatial time scaling of hazards, calibration of local precipitation thresholds, and a mass-wasting simulator model would increase the usability by local governments and emergency managers to reduce and/or better respond to debris flow impacts to communities and infrastructure. Finally, the addition of a real-time debris flow reporting system would allow for rapid warnings to threatened communities and travelers on nearby highways.



The Byrd fire impacted slopes above Highway 97A, the primary route between Chelan and Entiat with over 4000 vehicles passing below the slopes each day. The fire occurred on very steep and convergent slopes with thin soils and a history of post-wildfire related debris flows. We calculated the Burned Basin Area Accumulated Flow and used the values as a relative indicator for WSDOT personnel to focus maintenance efforts, such as ensuring ditches, culverts, and bridges are clear of debris. Our maps and efforts from WSDOT will likely not prevent damage from a large debris flow and instead is considered a first step in recognizing the hazards and continuing research into identifying slopes susceptible to wildfire-related debris flows.

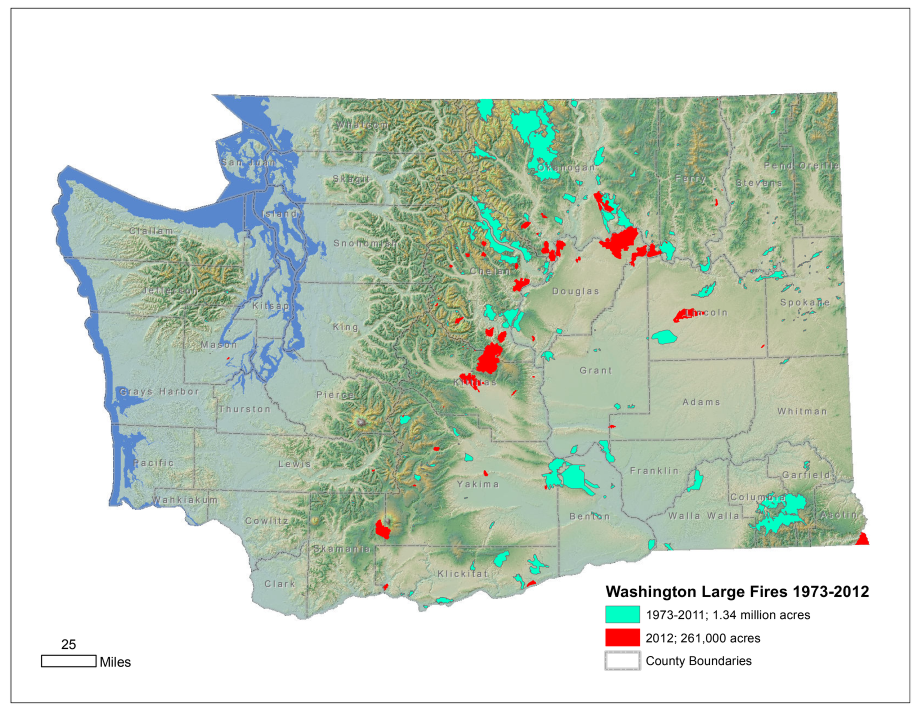


Figure 1. Map of wildfires from 2012 and historic wildfires from 1973 to 2011

On September 8, 2012 a storm front passed over the Cascade Range in central Washington and over 3500 lightning strikes initiated in excess of 450 forest fires. This was the climax to one of the most intense wildfire seasons in state history where 1338 wildfires totaling over 261,000 acres burned. These fires were destructive to forests and property with suppression costs alone for the September 8 wildfires exceeding 70 million dollars.

Post-wildfire debris flows are common in the steep terrain of central and eastern Washington. Late summer thunder storms are the typical driver of many post-wildfire debris flows, especially if a high-intensity storm stalls or moves slowly across the landscape.

Our initial model was prepared at the request of the Wash. St. Dept. of Transportation (WSDOT) to assist in evaluating and identifying post-wildfire landslide hazards at state highways. Due to a short timeline for a product, we opted for a very simplistic tool. We calculated the burned basin accumulated flow value where streams pass under state highways. Where an increased risk of post-wildfire debris flows and flood inundation may be possible.

A partnership between Western Wash. Univ. and Wash. St. Dept. of Natural Resources will continue development of this model and develop additional inputs to potentially improve model outputs to better identify potential hazards.

Citations

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