Abstract

Wide-spread wildfires in the Klamath Mountains and Coast Ranges of northwestern California burned tens of thousands of acres across the Klamath, Shasta-Trinity, Six Rivers, and Mendocino National Forests in 2006 and 2008. Much of the area burned was underlain by older dormant, deeply-seated landslides. Numerical analyses were activated after the widespread wildfires of the summers of 2006–2008 and 2010–2011, with several years post-event.

Pre-event debris flows associated with shallow landslides and mobilization of shallow hill slope material and channel bed deposits are well-demonstrated in California (Iverson 2000). These responses are kinematic but not necessarily catastrophic. They were found to be fed by pre-event soaks in bedrock infiltration and are not caused by runoff. In contrast, activation of deep-seated landslides of all types and styles has been observed more recently after the fire, in response to post-event rainfall events. Although delayed, increased yields of soil are often seen. Fire-related shallow landslides are visibly better before the burning event. The 2010–2011 post-fire years were characterized by severe drought, which may explain the cause of these fires. Post-event deep-seated landslide triggering and monitoring could yield better understanding of these processes across a broad range of geomorphic terranes. Such monitoring could mirror the success of fire exclusion in wildfire severities.

Nine landslides which occurred after 2008 are examined and compared with observations made after widespread wildfires in Major 1987 (Iverson 2000). Activation of such landslides can have far-reaching effects on sediment yield and delivery, soil permeability, loss of ground cover and organic material, and loss of fine root support. In contrast, many shallow landslides may generate debris flows. In many cases, landslide debris can be found. For these reasons, it is essential to identify dormant landslides within burned areas and that their burn severity is related to better understand how they react in response to previous events. Newer landslides which occurred after 2008 are examined and compared with observations made after widespread wildfires in 1987. Post-fire activity, including rain gage data, monitored snow packs, soil core analysis, and tree core analysis, were used to further characterize field monitoring data. This study identified several new processes of importance to landslide activity and future monitoring.

1. Why did most of the deep slides react in 2010–2011, which damaged roads and resulted in extensive post-motorway treatment occurring on a broad scale? 2. How far does this go with regards to known landslide activity patterns? 3. How do these new processes compare with other areas of the world? 4. What tools might improve our understanding of these processes? 5. Why did most of the deep slides react in 2010-2011, which damaged roads and resulted in extensive post-motorway treatment occurring on a broad scale?

Summary of Landslide Activity

1. Nine landslides. 2. Eight landslides were identified as dormant and reactivated in 2010–2011. 3. Nine landslides which occurred after 2008 are examined and compared with observations made after widespread wildfires in Major 1987 (Iverson 2000). 4. Activation of such landslides can have far-reaching effects on sediment yield and delivery, soil permeability, loss of ground cover and organic material, and loss of fine root support. In contrast, many shallow landslides may generate debris flows. In many cases, landslide debris can be found. For these reasons, it is essential to identify dormant landslides within burned areas and their burn severity is related to better understand how they react in response to previous events. Newer landslides which occurred after 2008 are examined and compared with observations made after widespread wildfires in 1987. Post-fire activity, including rain gage data, monitored snow packs, soil core analysis, and tree core analysis, were used to further characterize field monitoring data. This study identified several new processes of importance to landslide activity and future monitoring.

Discussion

Fire Response: The high concentrations of recently activated deep landslides within the study area were unexpected. Fire 1987: Fires occurred in 1987 burned about 300,000 acres and many burned on dormant landslides, many of which were reactivated in the subsequent 5 years. These generally caused movement after a few years, but these, plus many other recent wildfires were actually in association with wind-fires. 1987: Post-fires were intense, post-burn response was significant. 2008: Seismic Activity, Landslide Detection, and Monitoring with ALOS/PALSAR Imagery: Imagery was taken from ALOS/PALSAR on December 2009 and February 2010 which was used in this project.

Methodology

- Why did most of the deep slides react in 2010–2011, which damaged roads and resulted in extensive post-motorway treatment occurring on a broad scale? 2. How far does this go with regards to known landslide activity patterns? 3. How do these new processes compare with other areas of the world? 4. What tools might improve our understanding of these processes? 5. Why did most of the deep slides react in 2010-2011, which damaged roads and resulted in extensive post-motorway treatment occurring on a broad scale?

Field Cross Section of Slide 22

Map 2: Dormant Landslide and Fire Perimeters with Forest Boundaries and Geomorphic Provinces

Map 3 Siskiyou Fire: Slide #1 (10 acres) & #2 (2 acres) #3, #4, #5, #6, #7, #8, #9, #10

Map 4 Panther Fire: Slide #1 (15 acres) & #6 (15 acres) #7, #8, #9, #10, #11, #12

Map 5 Trough Fire: #6 (15 acres) & #7 (15 acres) & #8 (15 acres) #9, #10, #11, #12

Map 6 Iron Basin Fire: Slide #8 (15 acres) & #9 (15 acres) & #10 (15 acres) #11, #12

Table 1: Landslide Attributes

<table>
<thead>
<tr>
<th>Area (Ac.)</th>
<th>Area (Ac.)</th>
<th>Fire Severity</th>
<th>Rock Slide Elev.</th>
<th>Failure Date</th>
<th>Debris</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron Basin</td>
<td>3,290.75</td>
<td>315 N 010.25</td>
<td>315 N 010.25</td>
<td>42.50</td>
<td>45.28</td>
</tr>
<tr>
<td>Trough</td>
<td>2011</td>
<td>513 N 035.70</td>
<td>513 N 035.70</td>
<td>42.50</td>
<td>45.28</td>
</tr>
<tr>
<td>Iron Basin</td>
<td>2011</td>
<td>727 N 021.10</td>
<td>727 N 021.10</td>
<td>42.50</td>
<td>45.28</td>
</tr>
</tbody>
</table>

Note: The Siskiyou Fire was not included in this analysis.

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