Erosion Processes and Prediction in NW U.S. Forests

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Outline of Presentation

- Background
- Forest Erosion Processes
- Predictive Models

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Sediment from Forests is not new!

- In 500 BC, Jewish slaves wept by Babylonian irrigation canals as they dug out sediment from eroding forests
  - “By the rivers of Babylon we sat and wept when we remembered Zion.” Psalm 137
Sediment from Forests is not new!

- In 500 BC, Jewish slaves wept by Babylonian irrigation canals as they dug out sediment from eroding forests on the Anatolian Plateau
  - “By the rivers of Babylon we sat and wept when we remembered Zion.” Psalm 137

- In 2011, the Lower Granite Dam in Idaho will accumulate about 100,000 m³ of sediment that the Corps must manage!
  - They too may sit and weep!
Sources of Sediment

- Surface Erosion
- Mass Wasting
- Stream Channel Erosion
Surface Erosion

- Minimal unless slopes are disturbed
  - Timber Mgt
  - Wildfire
  - Roads
Forest Management Disturbances

- Skid Trails
- Prescribed Fire
Soil Properties

- Sandy soils resist compaction
Soil Properties

- Sandy soils resist compaction
- Silt and Clay soils may become permanently compacted
Following wildfire, soils can become “hydrophobic” or water repellent.

Infiltration is reduced for months to years.
Soil Properties

- Sandy soils are more likely to become repellant
- Silt soils may be naturally repellant, or may resist repellancy
Cover is how we manage erosion

- Decreased litter cover increases erosion
  - Increased raindrop impact on soil particles
  - Increased surface sealing
  - Reduced infiltration
  - Increased runoff
  - Increased rilling
Some Perspective on Cover

- Management disturbance may be minimal, exposing less than 10% mineral soil
- Skid trails can be treated
  - Seeding
  - Mulching
  - Water bars
  - Forested Buffers
- Data often show minimal mgt impact
Erosion and Wildfire

- Wildfire increases runoff
  - Soils may be water repellent
  - Cover is reduced
Erosion and **Wildfire**

- **Wildfire** increases runoff
  - Soils may be water repellent
  - Cover is reduced
- **Wildfire** increases hillslope erosion
  - As much as 1000x forest erosion
  - A natural part of the ecosystem
What about those roads?

- Sediment from roads is only exceeded by sediment from wildfire
Forest Roads serve many purposes

- Timber harvest
- Fire suppression
- Recreation
Frequently roads are removed

- To improve watershed health
- To offset other sources of sediment
Road’s evil twin: The ATV Trail

- The erodibility of ATV trails may be higher than any other soil condition.
- Unmanaged ATV trails frequently cross streams.
- Considerable effort by management agencies to improve trail management.
What about Sediment from Landslides?

- Sediment from landslides may dominate the sediment budget.
- Landslides due to rain-on-snow or heavy rains in the (finer-textured soils).
- Landslides follow wildfire on coarser-textured soils.
Some Landslide Principals

- **Timing**
  - Earthslides may occur 3-5 yrs *after* a vegetation disturbance when roots decompose
  - Debris flows linked to water repellency for 1-2 years following wildfire

- **Storm Type**
  - Earthslides associated with *wet periods* and rain-on-snow events
  - Debris flows driven by *high intensity localized storms*
Sediment Routing

- Sediment from wildfires or landslides may take years to decades to be routed through a stream system.
- Moderate flows move most sediment.
- Overbank flows may result in deposition.
- Stream channel alteration triggers erosion.
Sediment Summary

- Sediment from forests is linked to disturbances
- Forest management generates minimal additional sediment (except for access)
- Fire and weather are biggest factors in sediment generation
- Sediment from recreation sources is increasing
Predictive Models Available

- Project scale models (1-100 acres)
- Subwatershed models (up to 10 sq km)
- New GIS tools
Project Scale Tools

- RMRS Online interfaces to the Water Erosion Prediction Project
Example: WEPP FuME Input
## Example WEPP: FuME Output

### Output summary based on 50 years of possible weather

<table>
<thead>
<tr>
<th>Line</th>
<th>Source of sediment</th>
<th>Sediment delivery in year of disturbance (ton mi(^{-2}))</th>
<th>Return period of disturbance (y)</th>
<th>&quot;Average&quot; annual hillslope sedimentation (ton mi(^{-2}) y(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Undisturbed forest</td>
<td></td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Wildfire</td>
<td>1548.8</td>
<td>40</td>
<td>38.7</td>
</tr>
<tr>
<td>3</td>
<td>Prescribed fire</td>
<td>166.4</td>
<td>20</td>
<td>8.3</td>
</tr>
<tr>
<td>4</td>
<td>Thinning</td>
<td>6.4</td>
<td>20</td>
<td>0.3</td>
</tr>
<tr>
<td>5</td>
<td>Low access roads</td>
<td>1.4 to 10.3</td>
<td>1</td>
<td>1.4 to 10.3</td>
</tr>
<tr>
<td>6</td>
<td>High access roads</td>
<td>3.6 to 12.6</td>
<td>1</td>
<td>3.6 to 12.6</td>
</tr>
</tbody>
</table>

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**Rocky Mountain Research Station**
Example: ERMiT Mitigation Table

<table>
<thead>
<tr>
<th>Probability that sediment yield will be exceeded</th>
<th>Event sediment delivery (ton ac(^{-1}))</th>
<th>Year following fire</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 %</td>
<td></td>
<td>1st year</td>
</tr>
<tr>
<td>Untreated</td>
<td></td>
<td>11.35</td>
</tr>
<tr>
<td>Seeding</td>
<td></td>
<td>11.35</td>
</tr>
<tr>
<td>Mulch (0.5 ton ac(^{-1}))</td>
<td></td>
<td>4.68</td>
</tr>
<tr>
<td>Mulch (1 ton ac(^{-1}))</td>
<td></td>
<td>3.75</td>
</tr>
<tr>
<td>Mulch (1.5 ton ac(^{-1}))</td>
<td></td>
<td>3.69</td>
</tr>
<tr>
<td>Mulch (2 ton ac(^{-1}))</td>
<td></td>
<td>3.6</td>
</tr>
<tr>
<td>Erosion Barriers: Diameter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.15 ft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logs &amp; Wattles</td>
<td></td>
<td>7.74</td>
</tr>
</tbody>
</table>

Note: The data in the table represents the mitigation treatment comparisons for event sediment delivery following a fire in different treated conditions.
GIS Tools

- GeoWEPP for ArcView or ArcGIS 9.x
  - Builds WEPP Watershed scenarios
  - Need to convert to ArcGIS 10.x
  - Can combine subwatershed runs using GIS tools
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- IC Water routes sediment pulses through river systems
GIS Sedimentation Tools on the Horizon

- **Online** GIS interface to WEPP technology
- Enhance hydrology in WEPP technology to include base flow as well as surface and lateral flow
- Improved flood routing and channel process modeling
Landslide Tools

- RMRS LISA single slope stability tool
- Local GIS Regression Tools
- Basin GIS sediment regression tools
- Sediment = f(slope, area, precip, ...)

Rocky M
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Summary

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- Erosion is associated with disturbances
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- Sediment generation depends on topography, climate, geology/soil and vegetation
- Erosion is associated with disturbances
- Erosion can be reduced by reducing frequency or severity of disturbances
  - Fuel management
  - Road improvement or removal
Questions & Comments?