Erosion Processes and Prediction in NW U.S. Forests

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Outline of Presentation

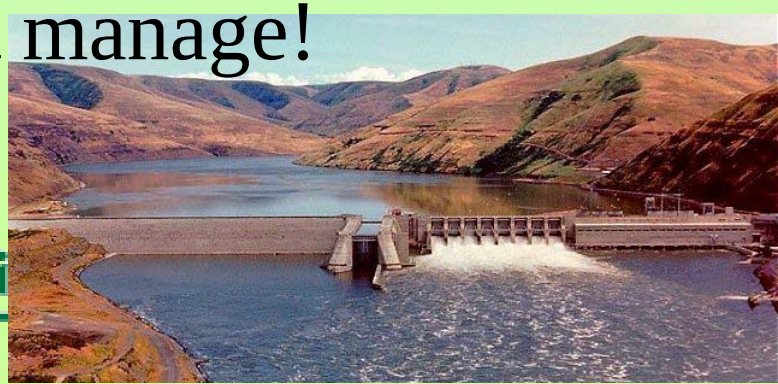
- Background
- Forest Erosion Processes
- Predictive Models

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 m^3 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

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- Silt and Clay soils may become permanently compacted

Fire & Infiltration

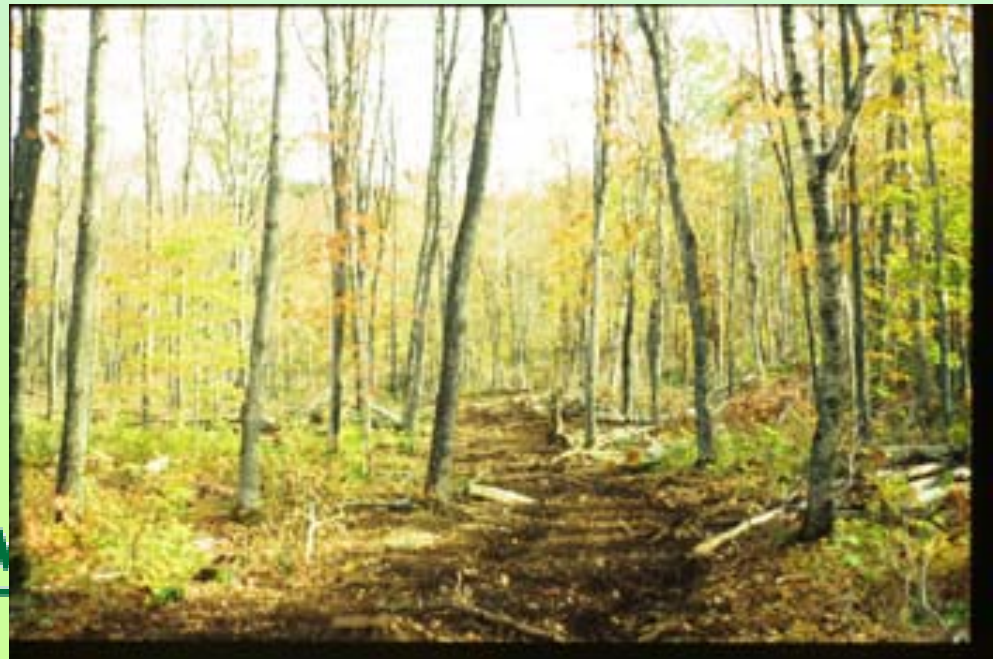
- Following wildfire, soils can become “hydrophobic” or water repellent
- Infiltration is reduced for months to years

Soil Properties

- Sandy soils are more likely to become repellant
- Silt soils may be naturally repellant, or may resist repellancy

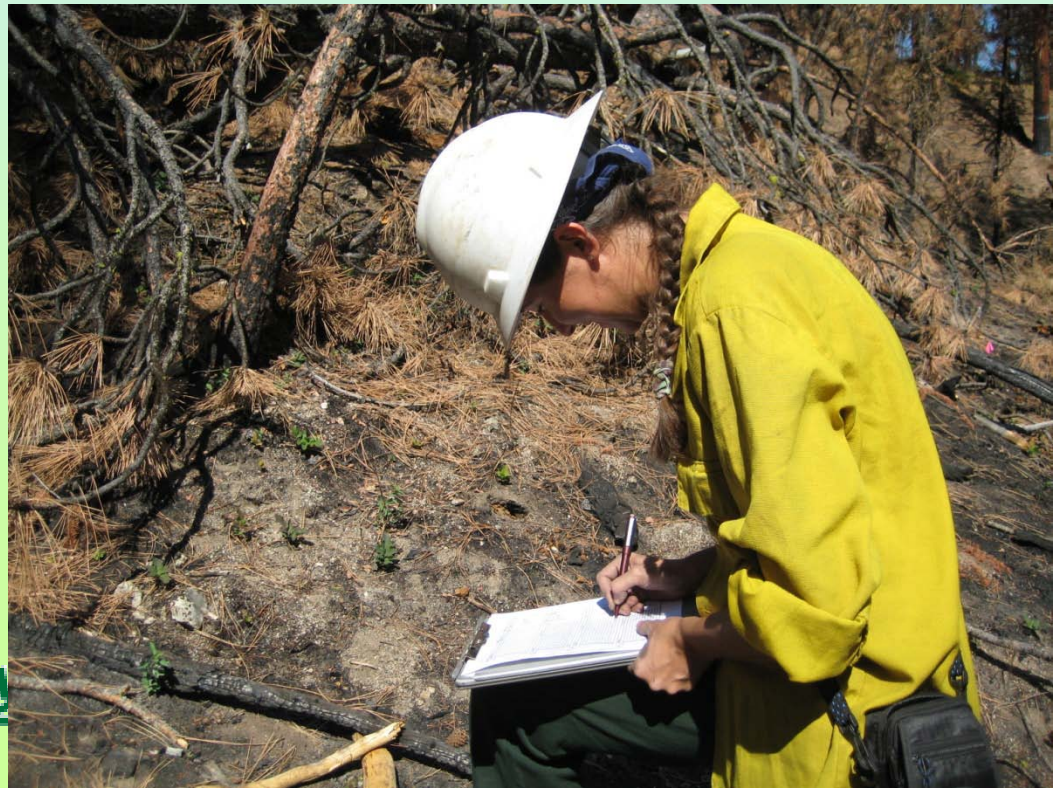
Cover is how we manage erosion

- 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



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Erosion and **Wildfire**

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

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- Wildfire increases runoff
  - Soils may be water repellent
  - Cover is reduced
- Wildfire increase 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

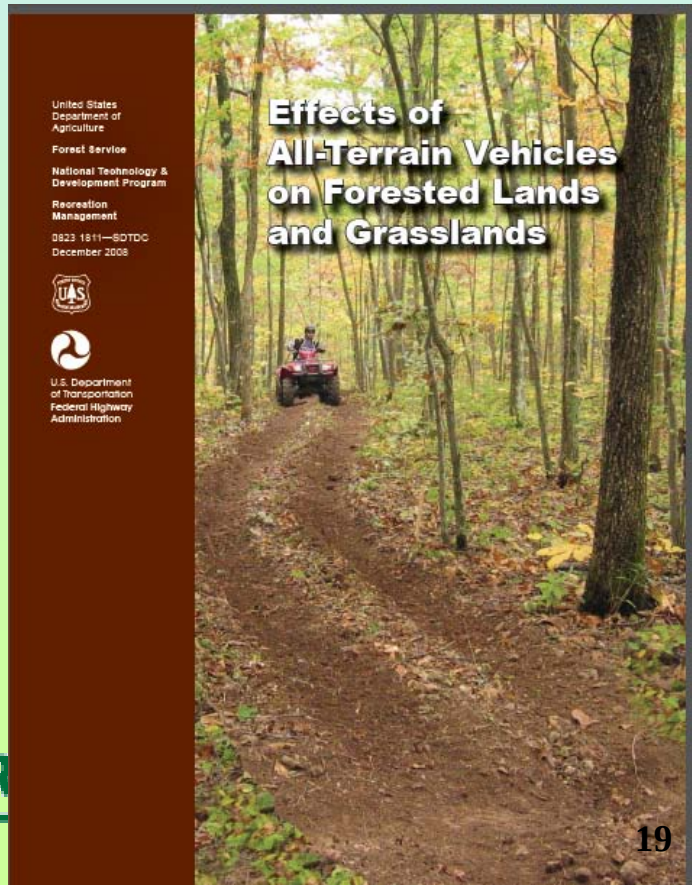
- Timber harvest
- Fire suppression
- Recreation

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

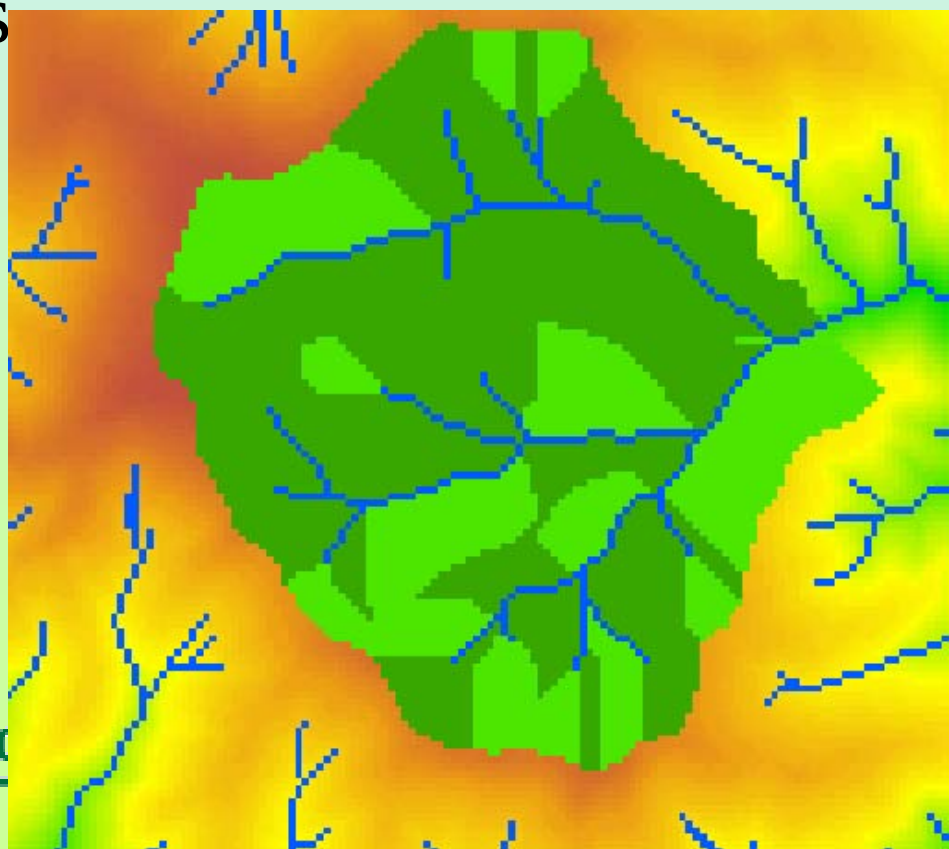
- Sediment from wildfires or landslides may take years to decades to be routed through a stream system
- Moderate flows move most sediment
- Overbank flows may result in deposition
- Stream channel alteration triggers erosion

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

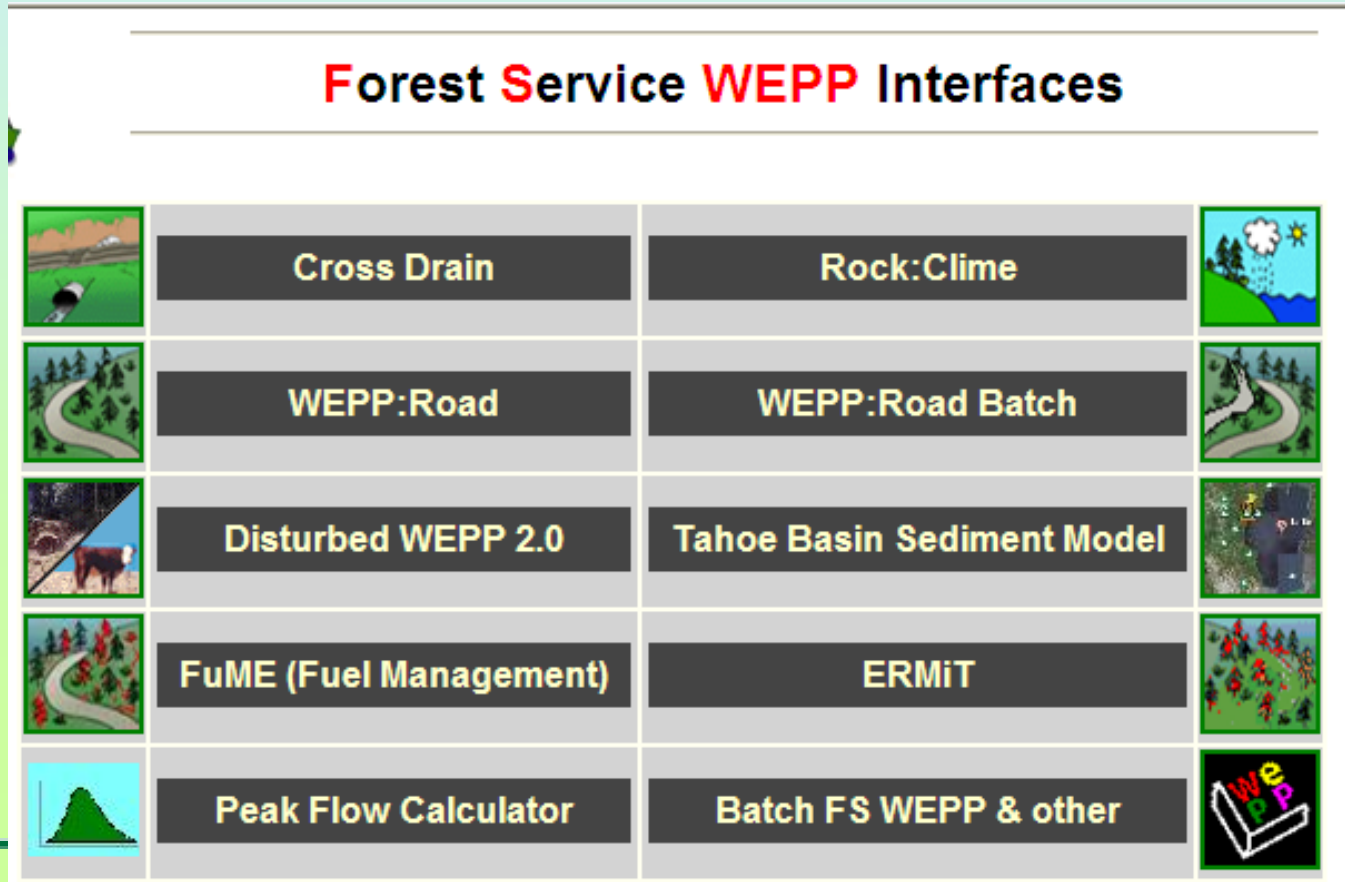
Predictive Models Available

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

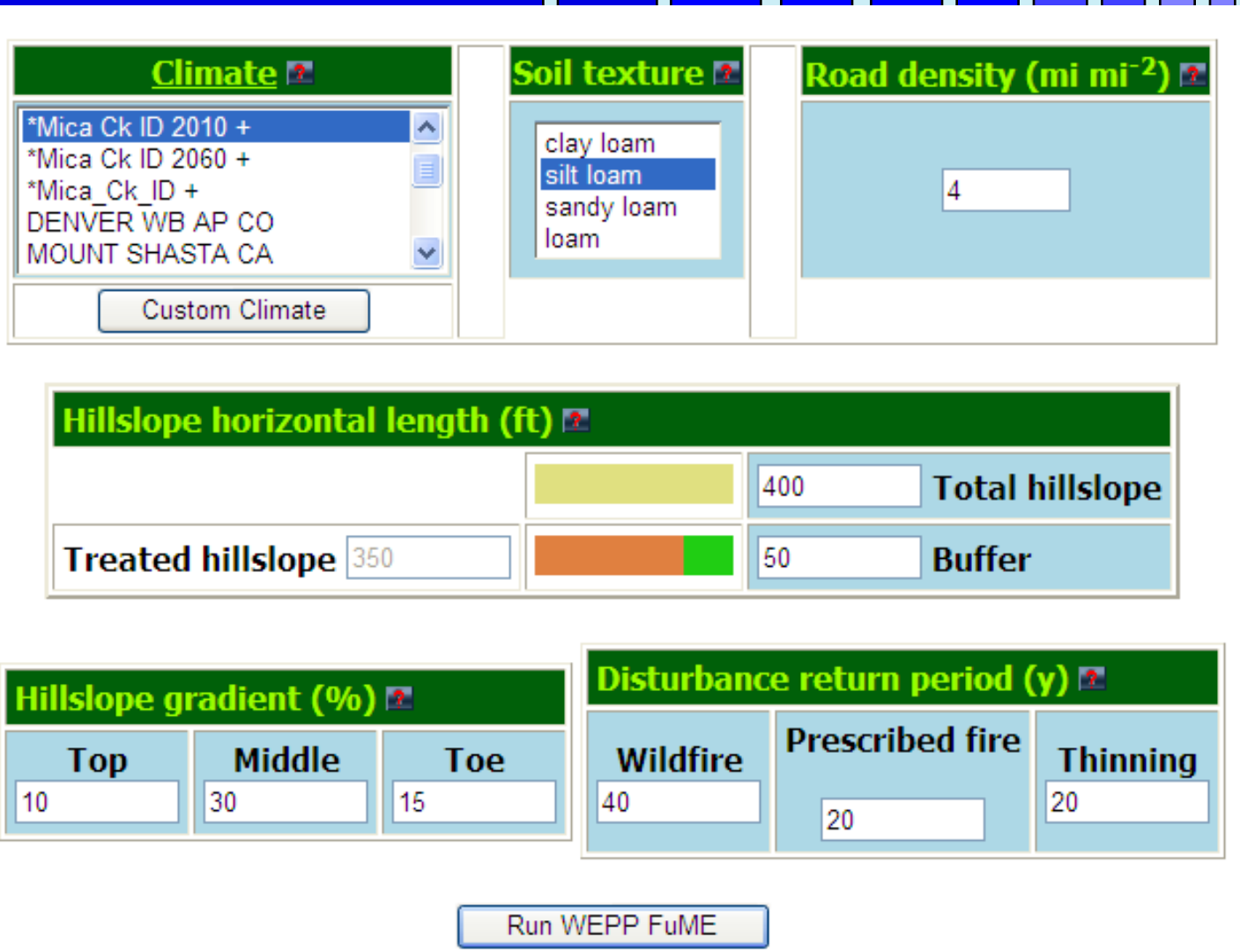


Project Scale Tools

- 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

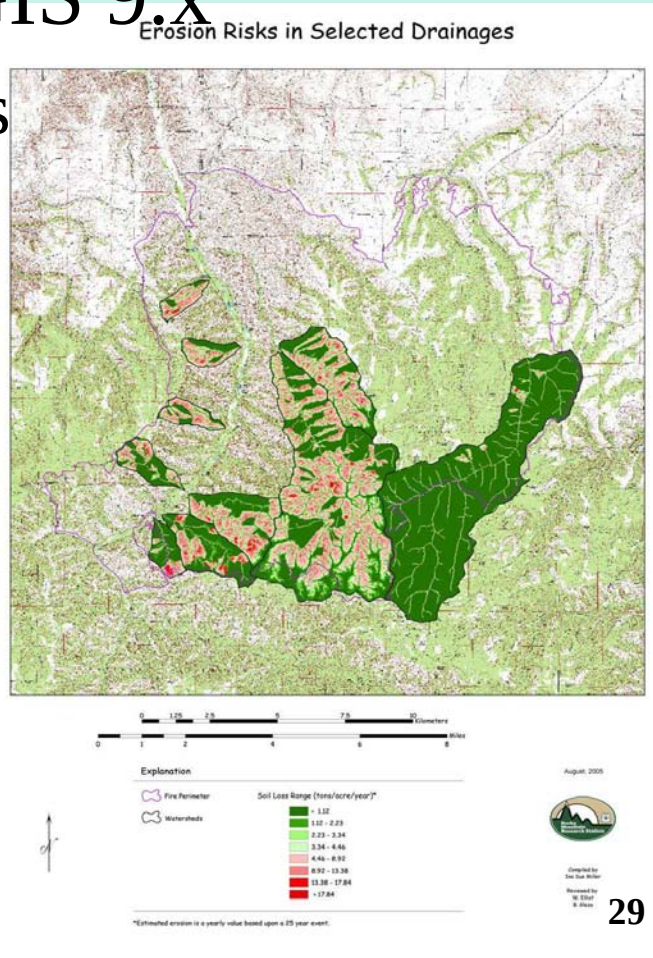
Line	Source of sediment	Sediment delivery in year of disturbance (ton mi^{-2})	Return period of disturbance (y)	"Average" annual hillslope sedimentation (ton mi^{-2} y^{-1})
1	Undisturbed forest		1	0
2	Wildfire	1548.8	40	38.7
3	Prescribed fire	166.4	20	8.3
4	Thinning	6.4	20	0.3
5	Low access roads	1.4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

Example: ERMiT Mitigation Table

Mitigation Treatment Comparisons					
Probability that sediment yield will be exceeded 20 % go	Event sediment delivery (ton ac^{-1})				
	Year following fire				
	1st year	2nd year	3rd year	4th year	5th year
Untreated	11.35	7.07	4.24	2.82	1.2
Seeding	11.35	4.68	3.67	2.26	1.2
Mulch (0.5 ton ac^{-1})	4.68	4.47	4.24	2.82	1.2
Mulch (1 ton ac^{-1})	3.75	3.79	4.24	2.82	1.2
Mulch (1.5 ton ac^{-1})	3.69	3.6	4.24	2.82	1.2
Mulch (2 ton ac^{-1})	3.6	3.54	4.24	2.82	1.2
Erosion Barriers: Diameter 0.15 ft Spacing 50 ft go ?					
Logs & Wattles	7.74	7.07	4.24	2.82	1.2

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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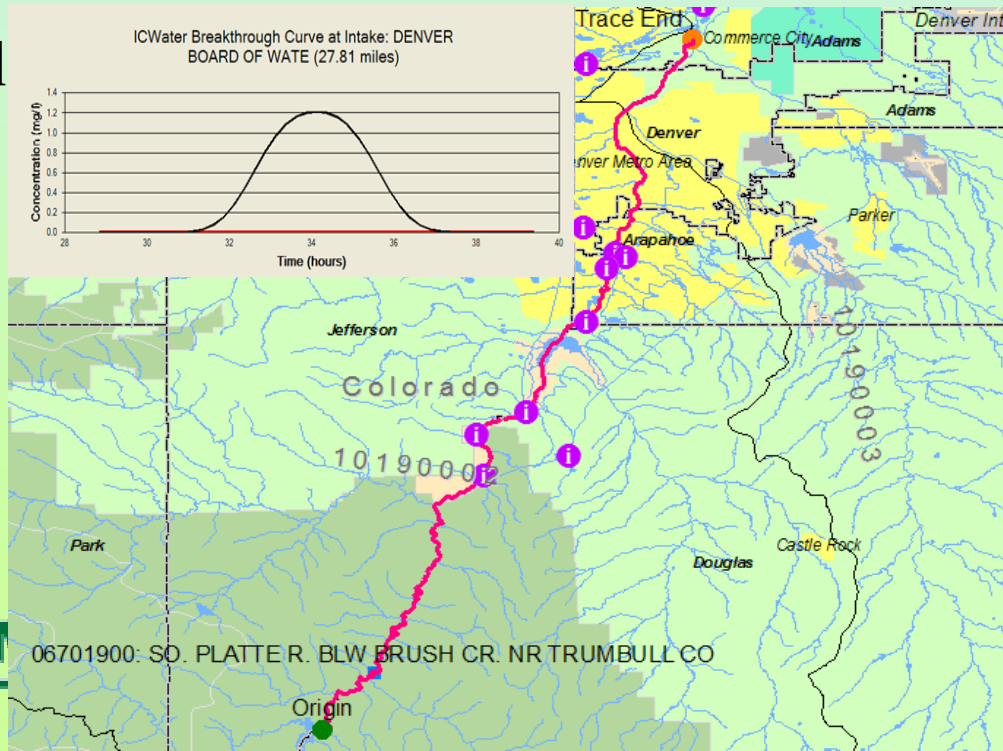
- IC Water routes sediment pulses through river systems

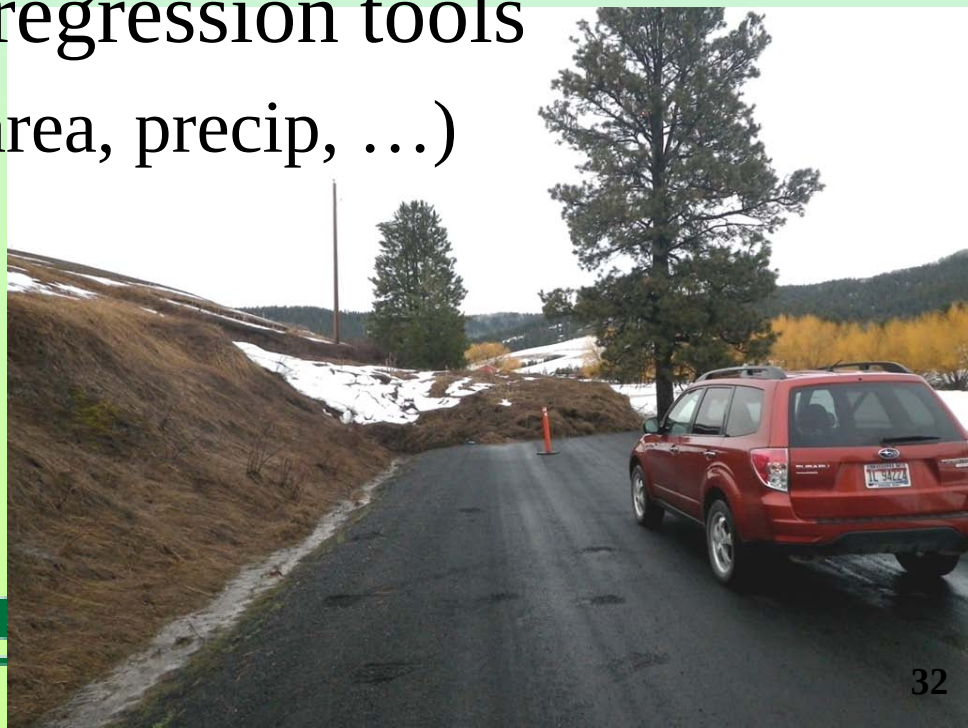


GIS Sedimentation Tools on the Horizon

- **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

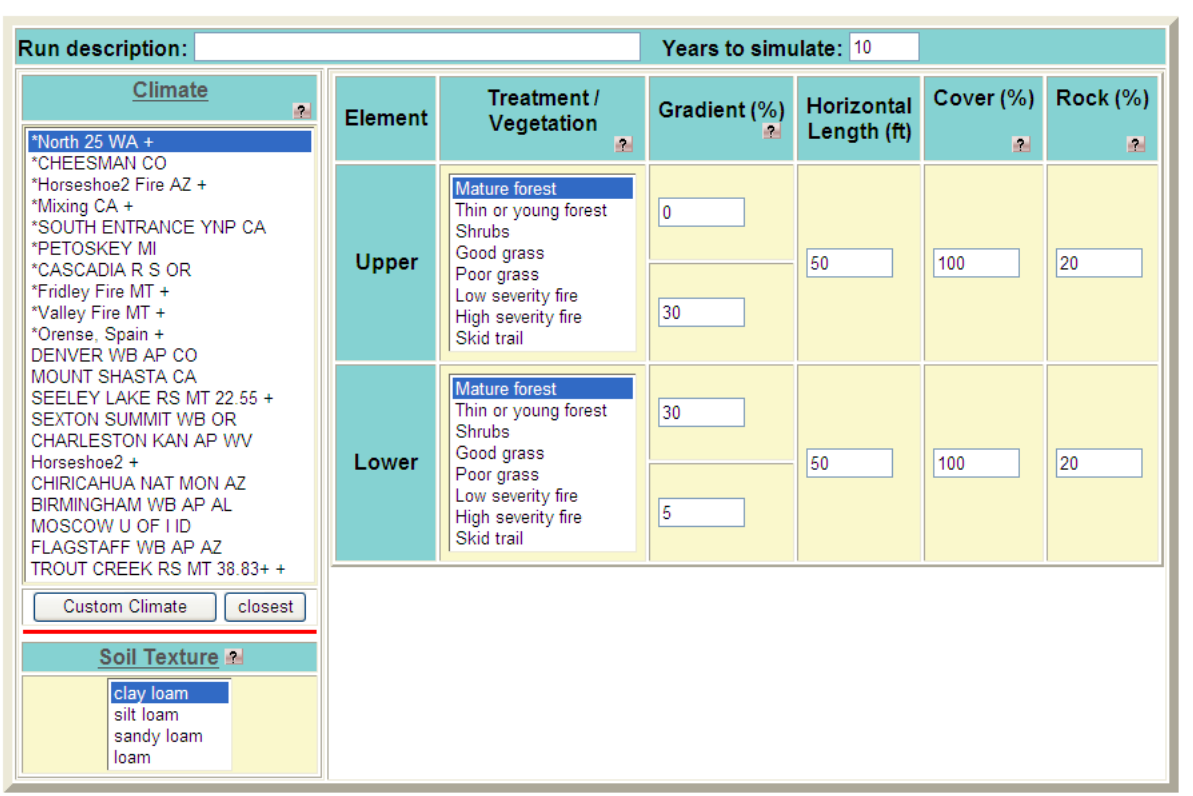
Landslide Tools

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



Summary

- Sediment generation depends on topography, climate, geology/soil and vegetation



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- Erosion is associated with disturbances
- Erosion can be reduced by reducing frequency or severity of disturbances
  - Fuel management
  - Road improvement or removal

Questions & Comments?