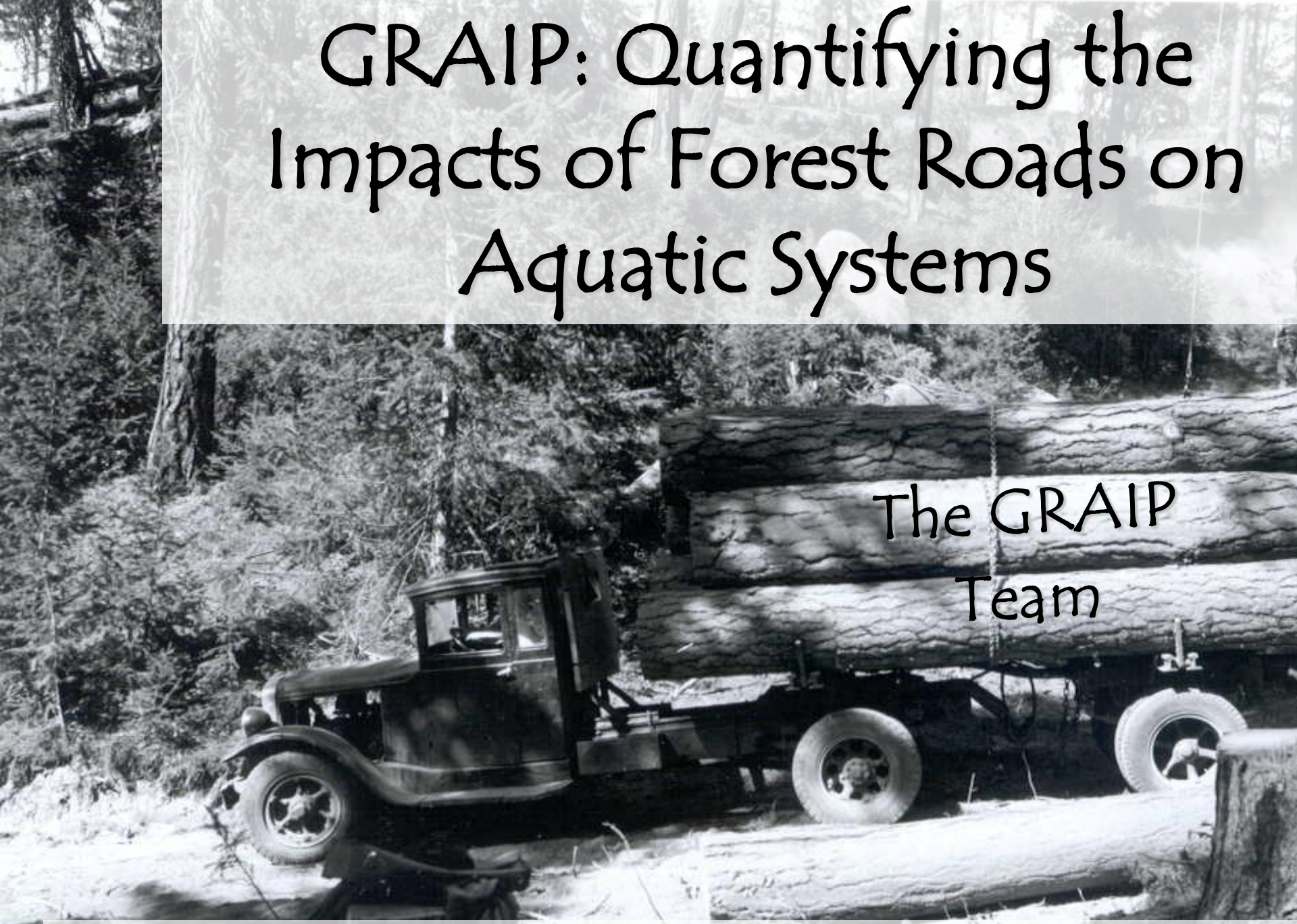
GRAIP: Quantifying the Impacts of Forest Roads on Aquatic Systems



The GRAIP Team

USDA Forest Service Rocky Mountain Research Station, Boise Idaho

Overview

- Why do we care about fine sediment
- Road inventory description
- Sediment production calculation
- Watershed Examples
- GRAIP model GIS components
  - Sediment production
  - Sediment delivery
  - Mass wasting

Organic Act of 1897

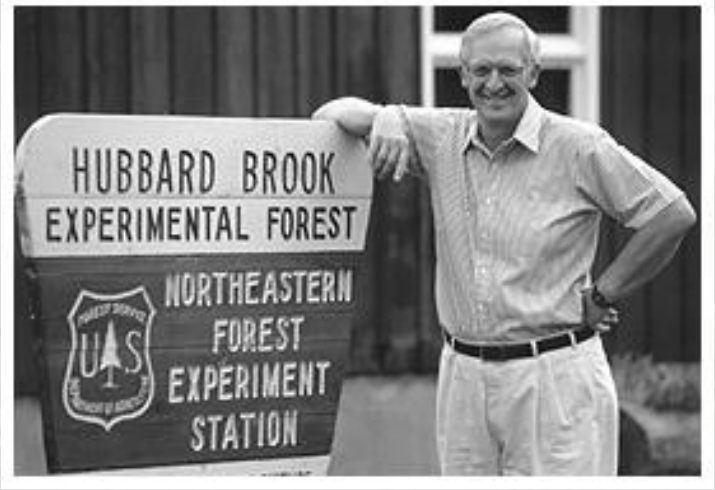
Establish forest reserves,

"to improve and protect the forest within the reservation,... securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States."

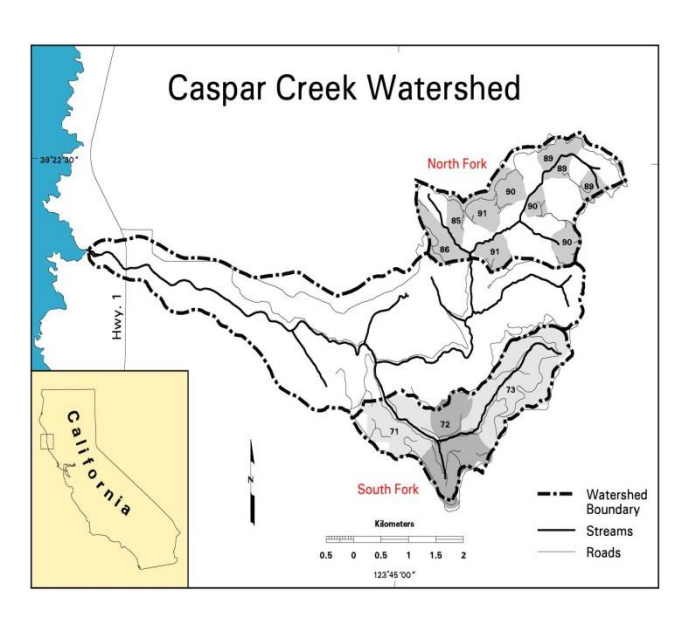
Early Watershed Studies

- Wagon Wheel Gap
- Rio Grande NF-1911
- Water Yield
- Hubbard Brook
- New Hampshire 1955
- Water, Sediment Management

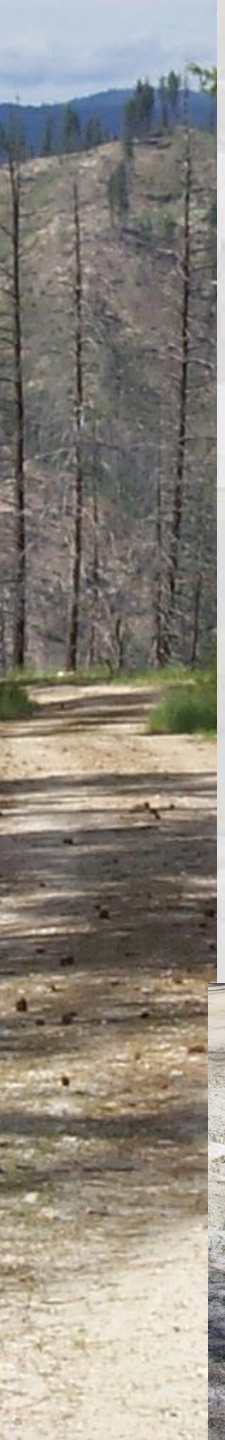
Carlos Bates, Forester in Charge, hauls supplies to the Fremont Experiment Station in 1917.



Major North American Watershed Studies



- Coweeta, NC 1939
- Andrews Forest, OR 1948
- Alsea River, OR 1959
- Hubbard Brook, NH 1955
- Casper Creek, CA 1962
- Zena Creek, ID 1972
- Carnation Creek, BC 1989



Fine sediment Issues in Streams

- Water quality- Clean Water Act
- Aquatic Organisms
  - Primary productivity
  - Invertebrates
  - Fish

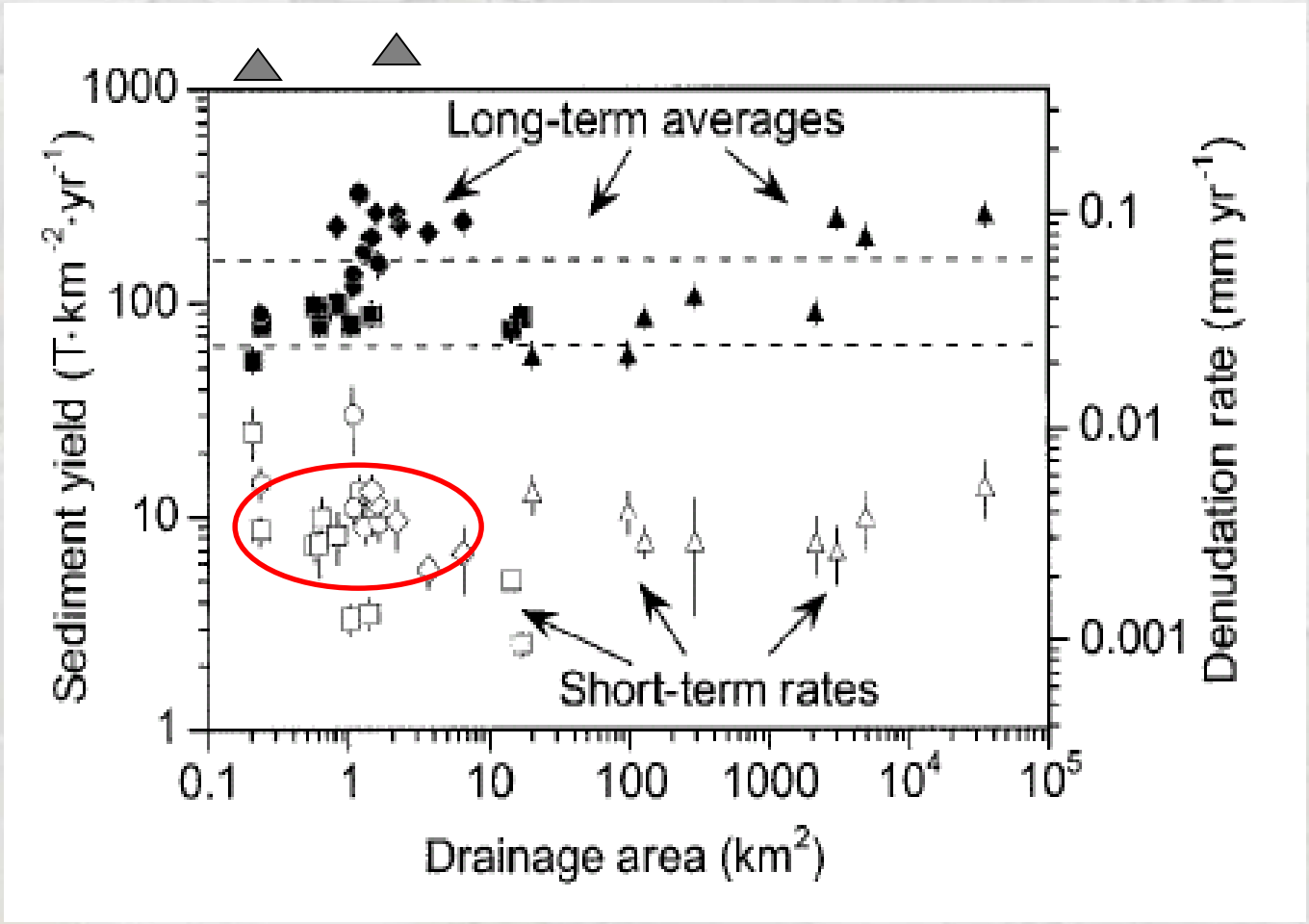
Sediment Sources to Channels Undisturbed Basins

- Bank erosion
- Flood plain erosion
- Mass wasting
- Bed erosion
- Hillslope contributions/overland flow

Sediment Sources to Channels Disturbed Basins

- Road sediment
- Disturbed hillslope contributions/ overland flow
- Elevated mass wasting
- Bank erosion
- Flood plain erosion
- Bed erosion

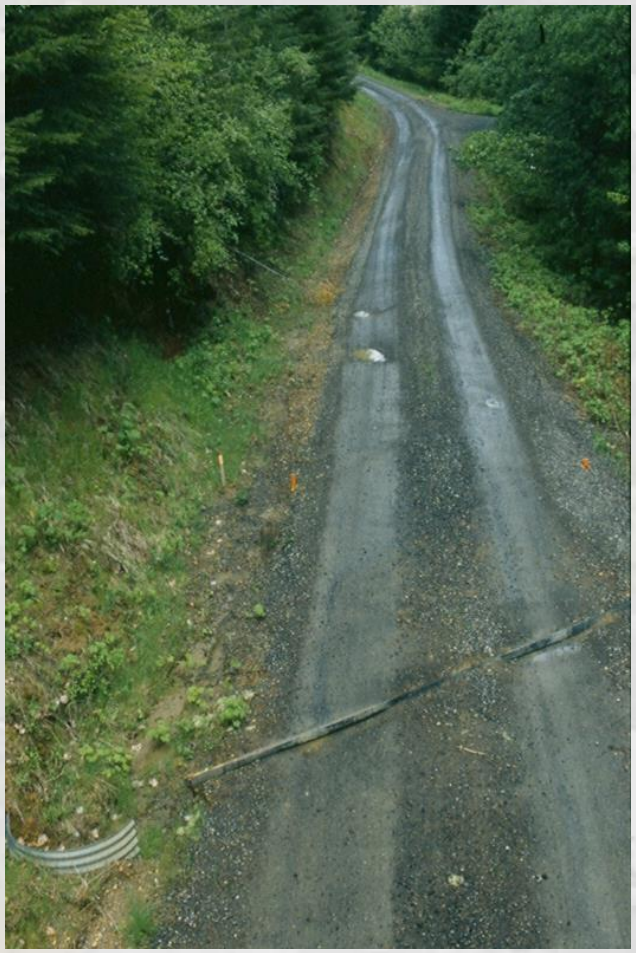
Rates in Undisturbed Systems in Western US



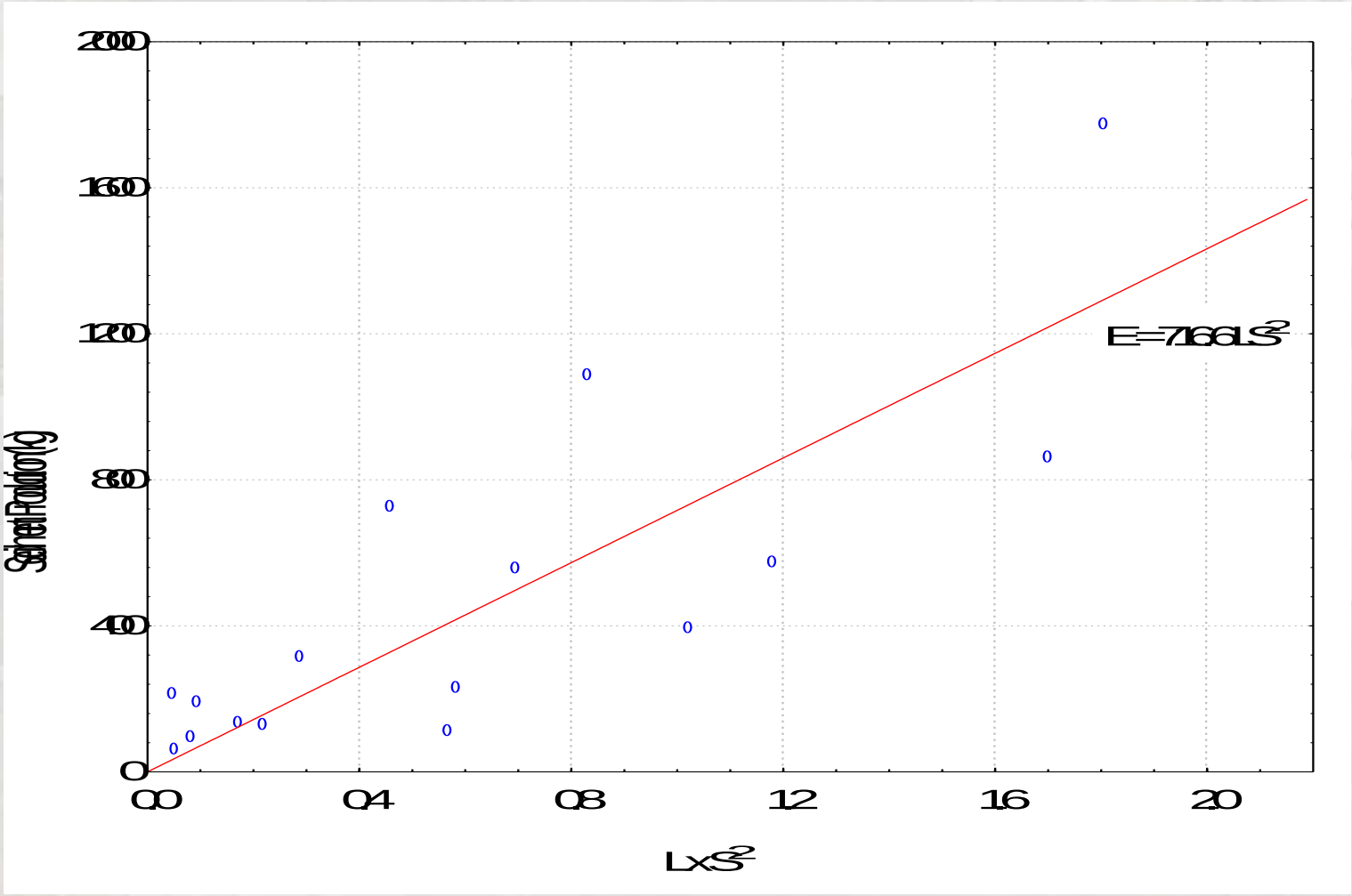
Sediment transport rates from newly roaded basins

- 3 to 770 fold increase
- Large mass wasting effect
- Large events matter
- Declining over time
- Fine sediment persists
- Most studies include harvest

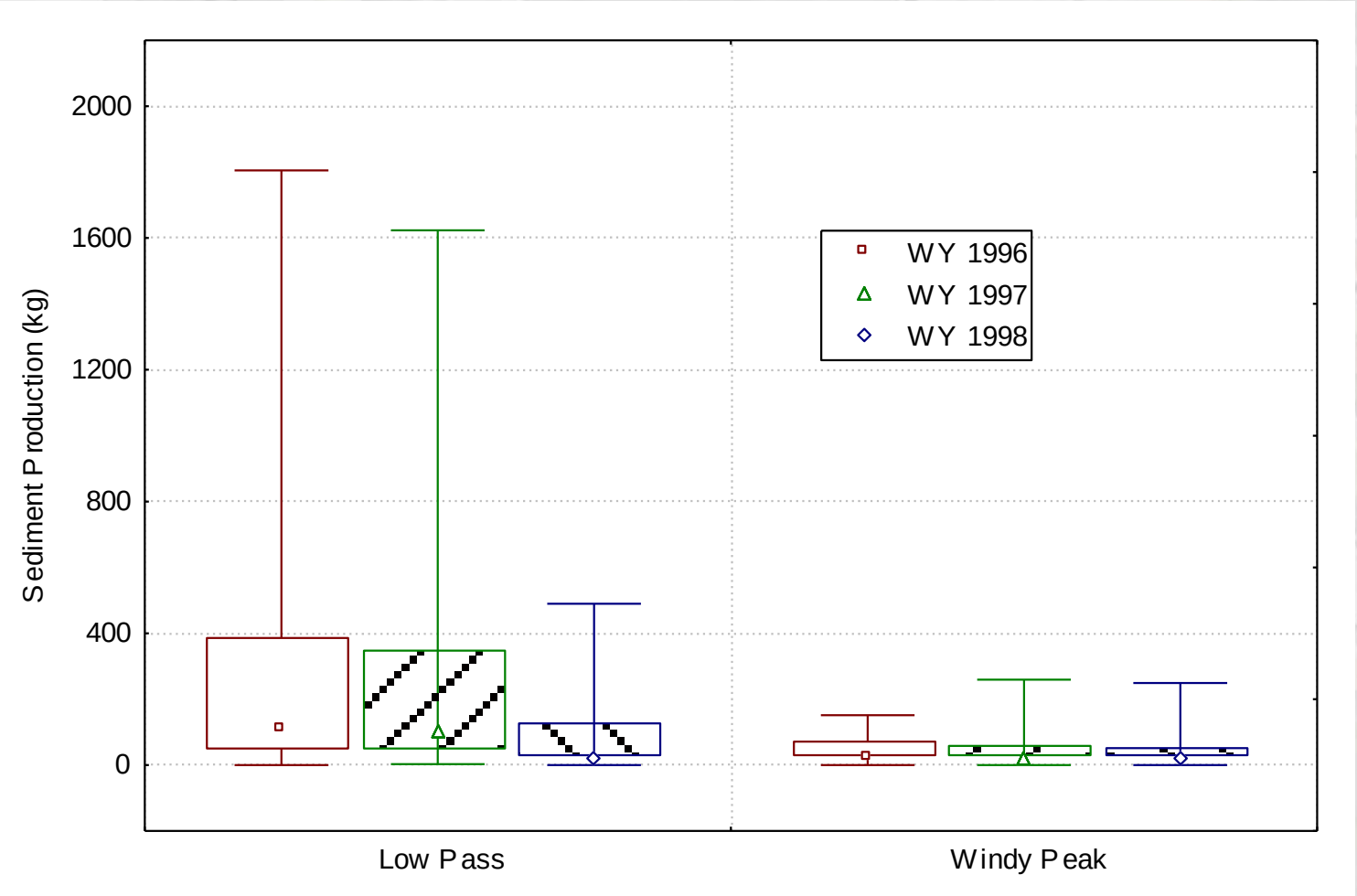
Oregon Sediment Plots



Road Sediment Plots Length and Slope



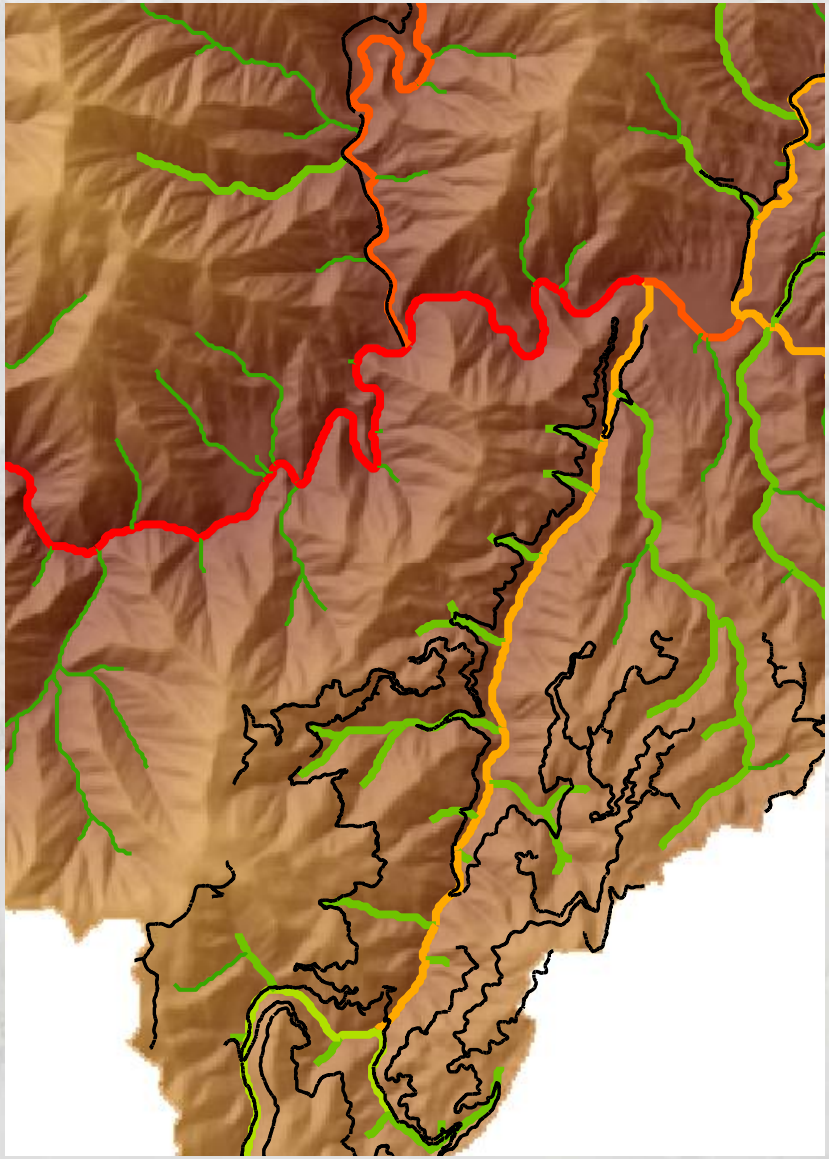
Three years of data



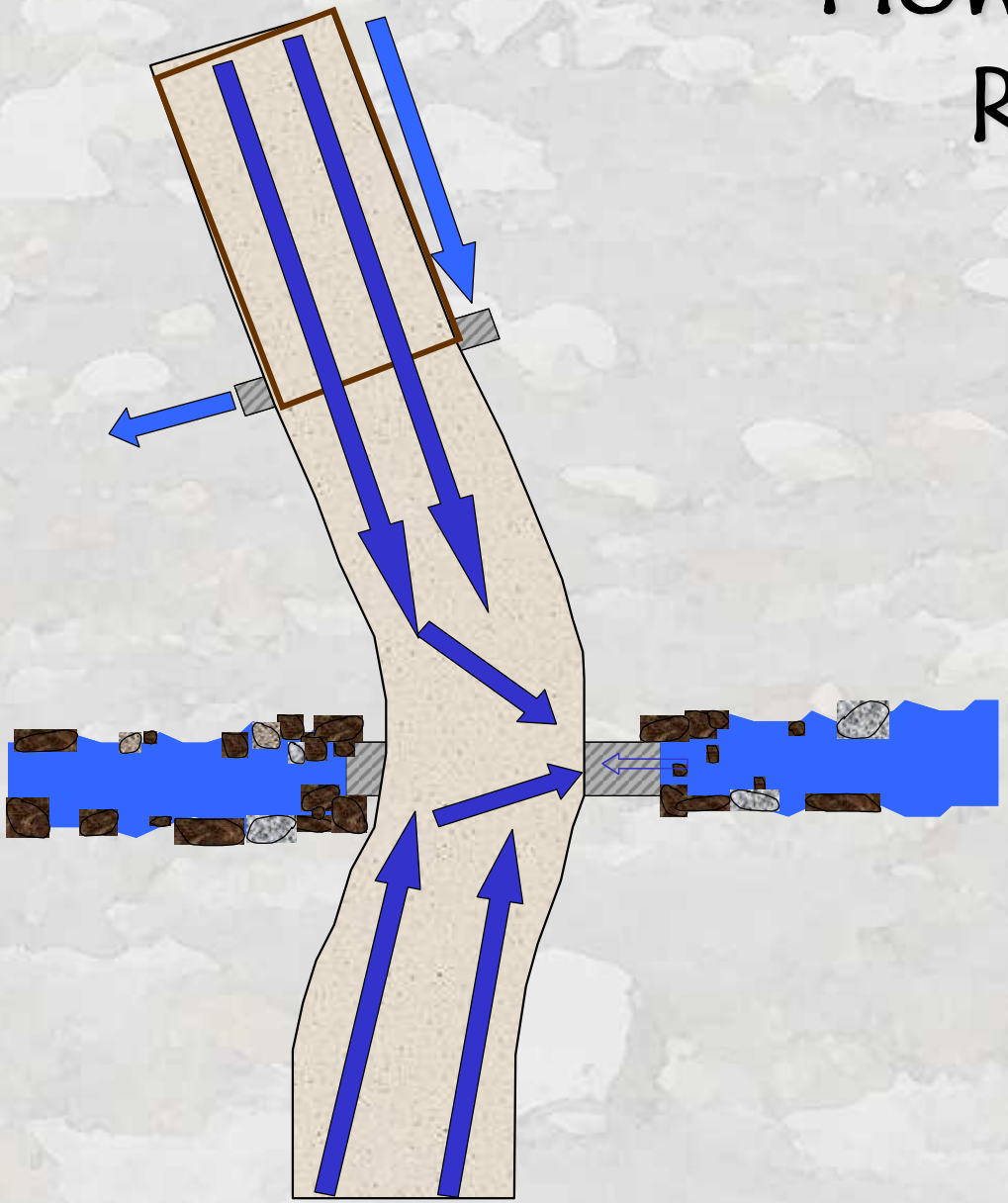
Why model road impacts?

- Difficult to measure in field
- Quantify and compare sources
- Extrapolate to areas without data
- To estimate surface erosion for forest practice applications, TMDLs, prioritizing work
- Project future conditions

GRAIP



Flow Paths and Routing



Sediment Production Estimate

Sediment production by road segment

Sed Prod=**B** x **L** x **S** x **V** x **R**

Sed Prod	Sediment production (Kg/yr)
B	Erosion base rate
L	Flow path length
S	Flow path slope
V	Vegetation factor
R	Road surface factor

***"B"* can be determined experimentally or using a physically based model (e.g. WEPP)**

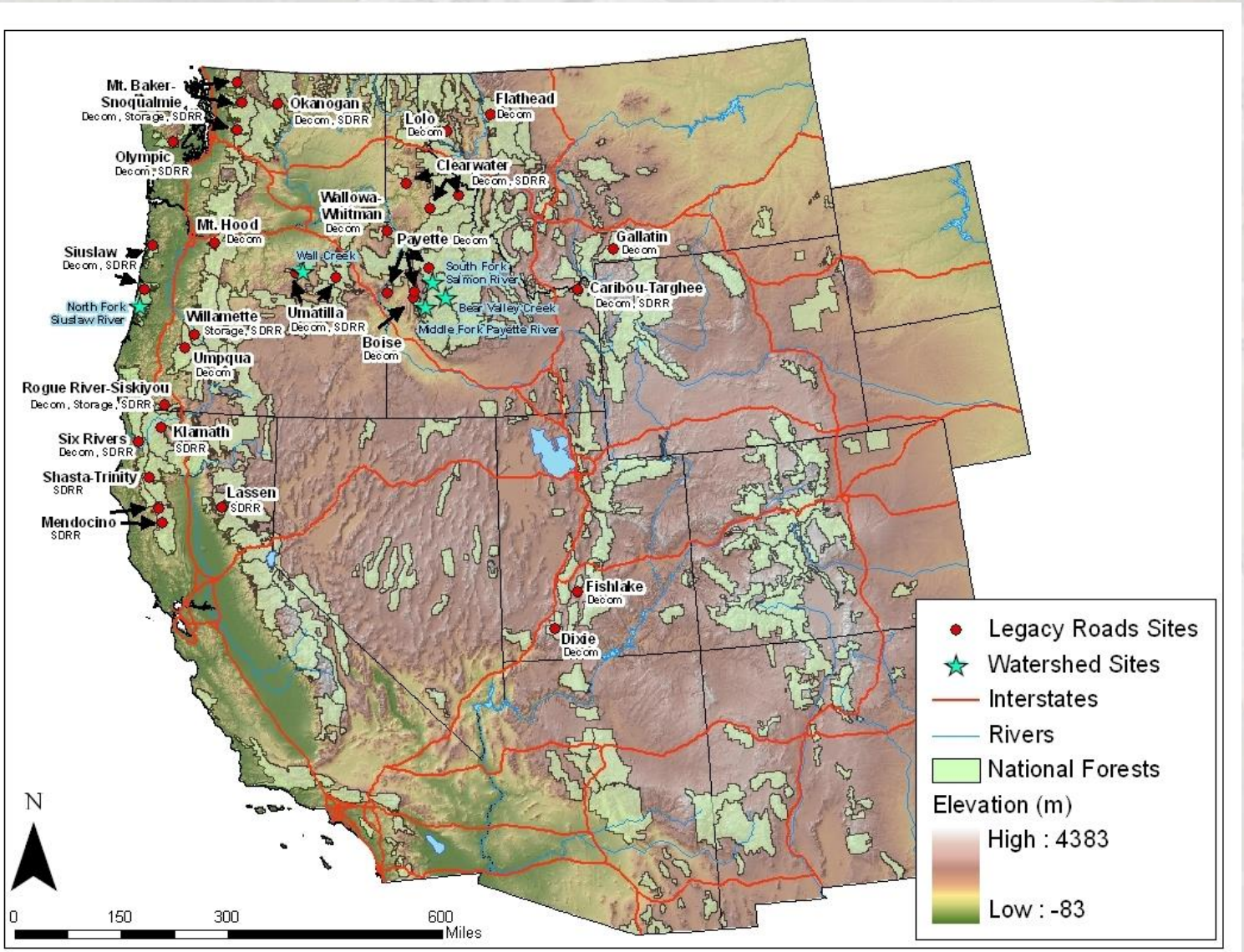
Inventory Nuts and Bolts

- Two person inventory crew
- 1-5 miles of inventory per day
- $50-$250 per mile of road
- GPS unit and vehicle

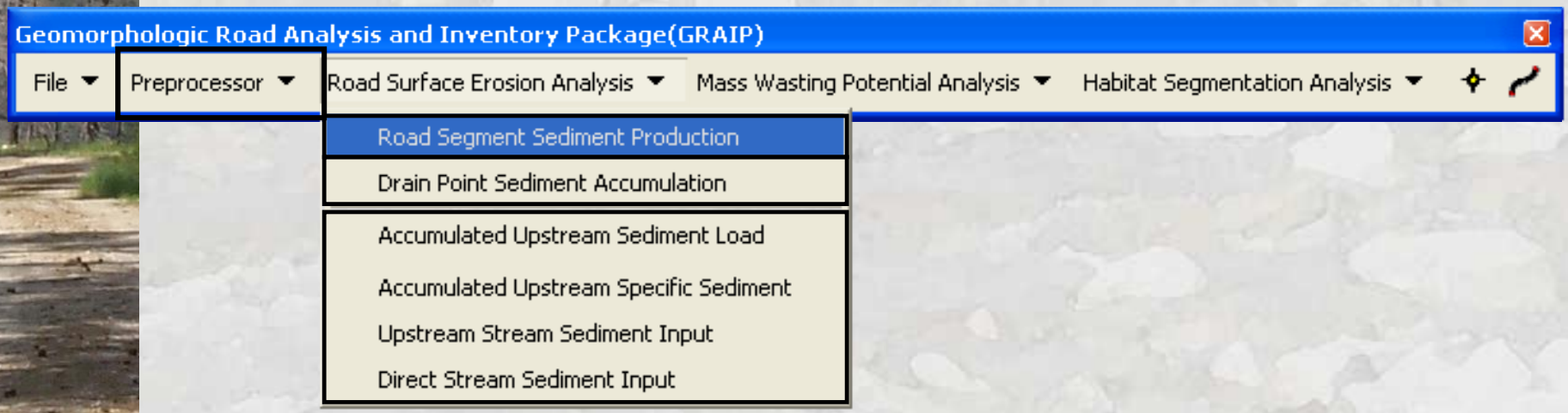
Case Studies

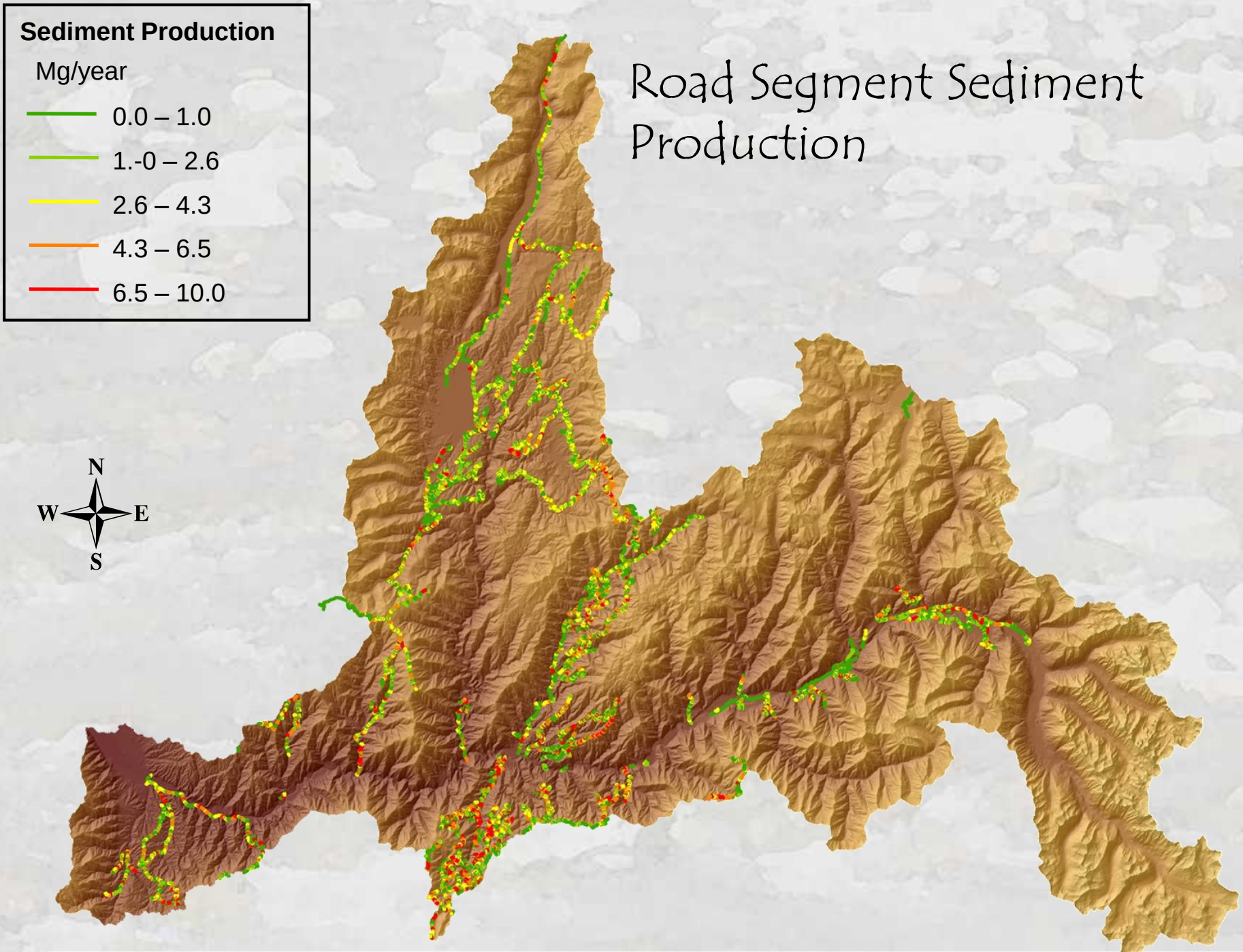
- Lake Creek, Eugene BLM, Oregon
- Spencer Creek, Klamath Falls BLM, Oregon
- Gerber Creek, Klamath Falls BLM, Oregon
- Grouse Creek, Payette NF, Idaho
- SF Payette, Boise NF, Idaho
- Upper Lolo Creek, Nez Perce Tribe, Idaho
- Wall Creek, Umatilla NF, Oregon
- Bear Valley Creek, Boise NF, Idaho
- MF Payette, Boise NF, Idaho
- Beaver Creek, IPNF, Idaho
- NF Siuslaw, Siuslaw NF, Oregon
- Crown of the Continent, MT
- SF Stillaguamish, Washington
- EF Weiser River, Idaho

Recent GRAIP Study Sites

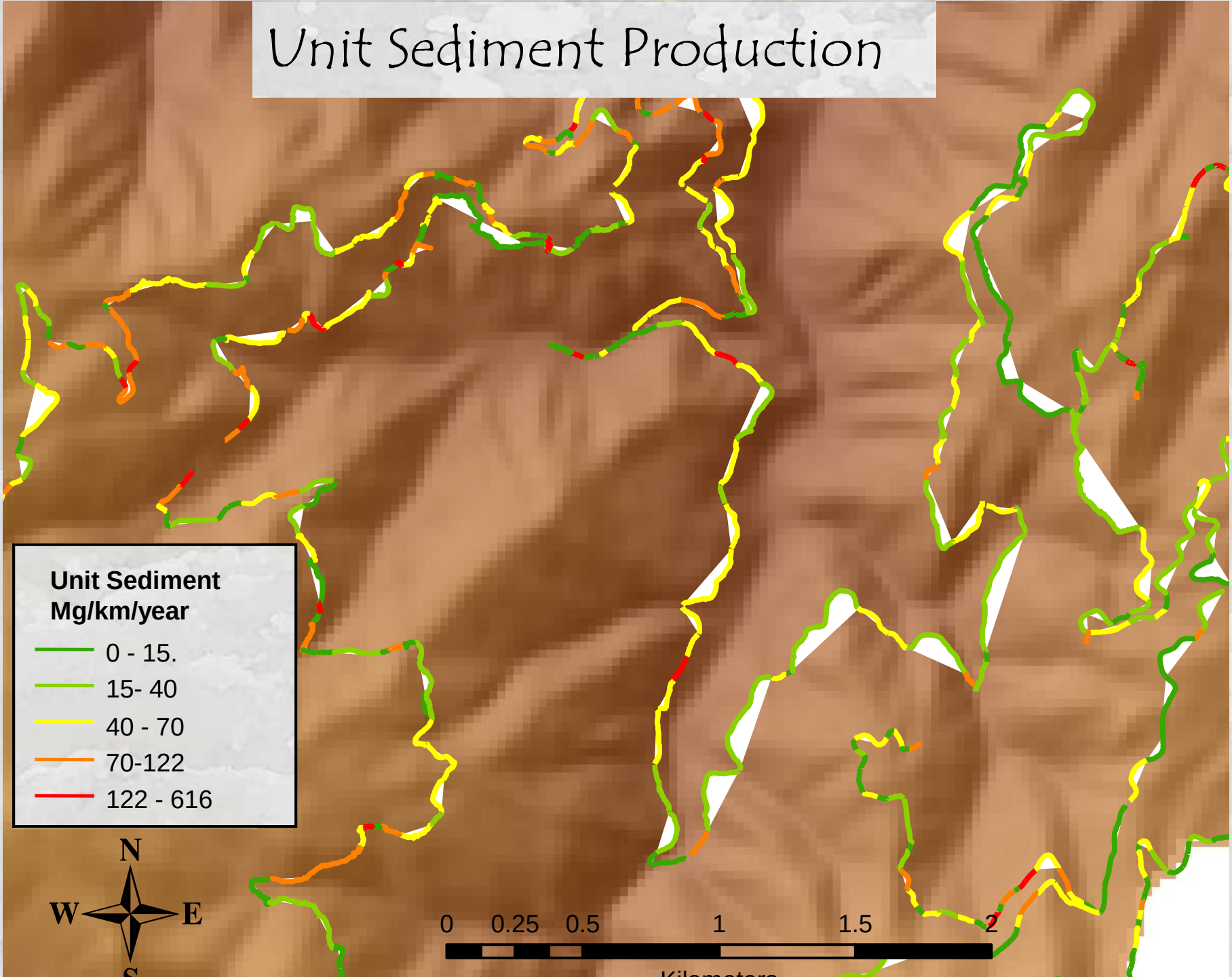


GRAIP 1 ArcGIS Tool Bar

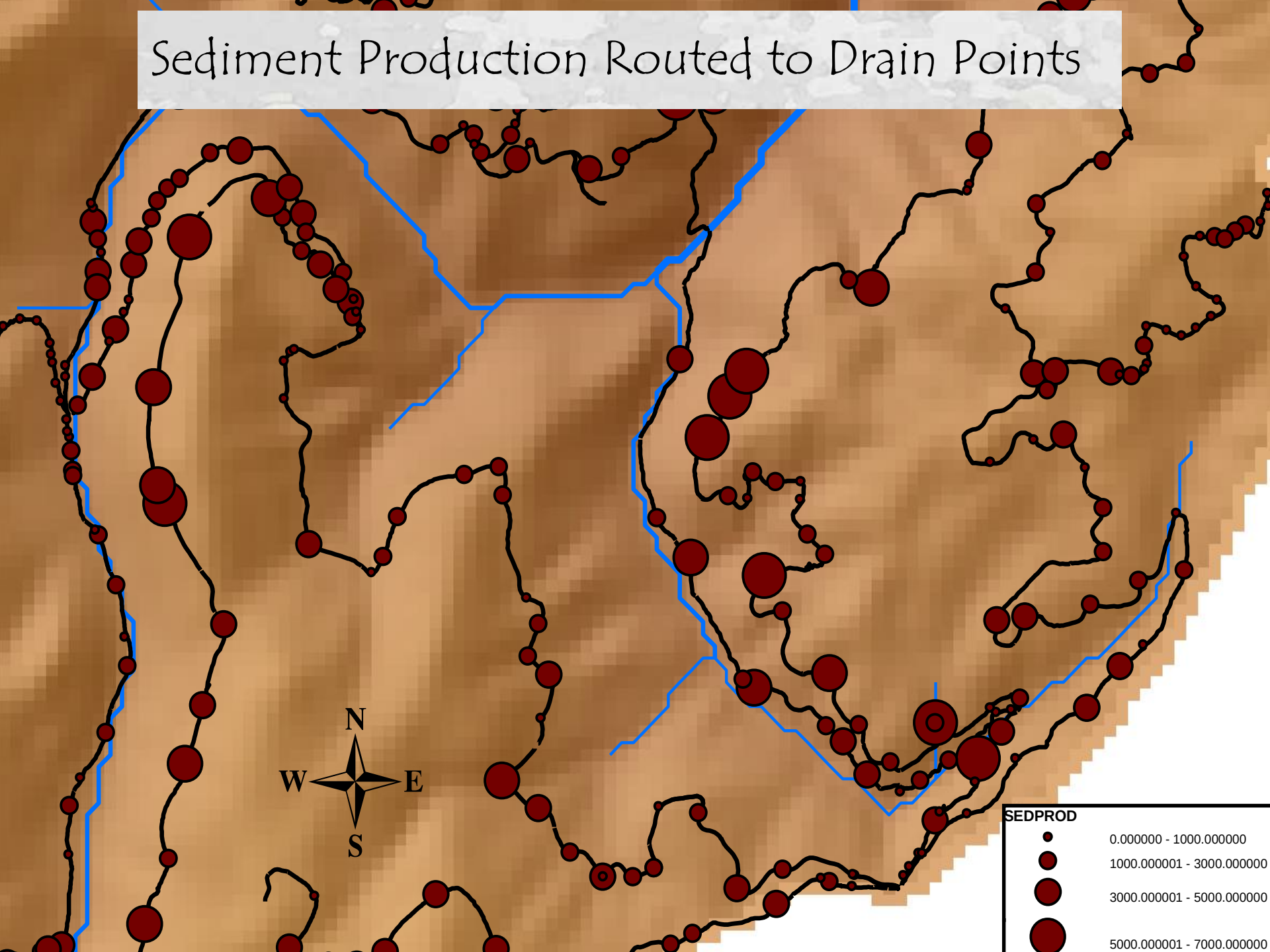



Sediment Production
Mg/year
0.0 – 1.0
1.-0 – 2.6
2.6 – 4.3
4.3 – 6.5
6.5 – 10.0
Road Segment Sediment Production
N
W
E
S

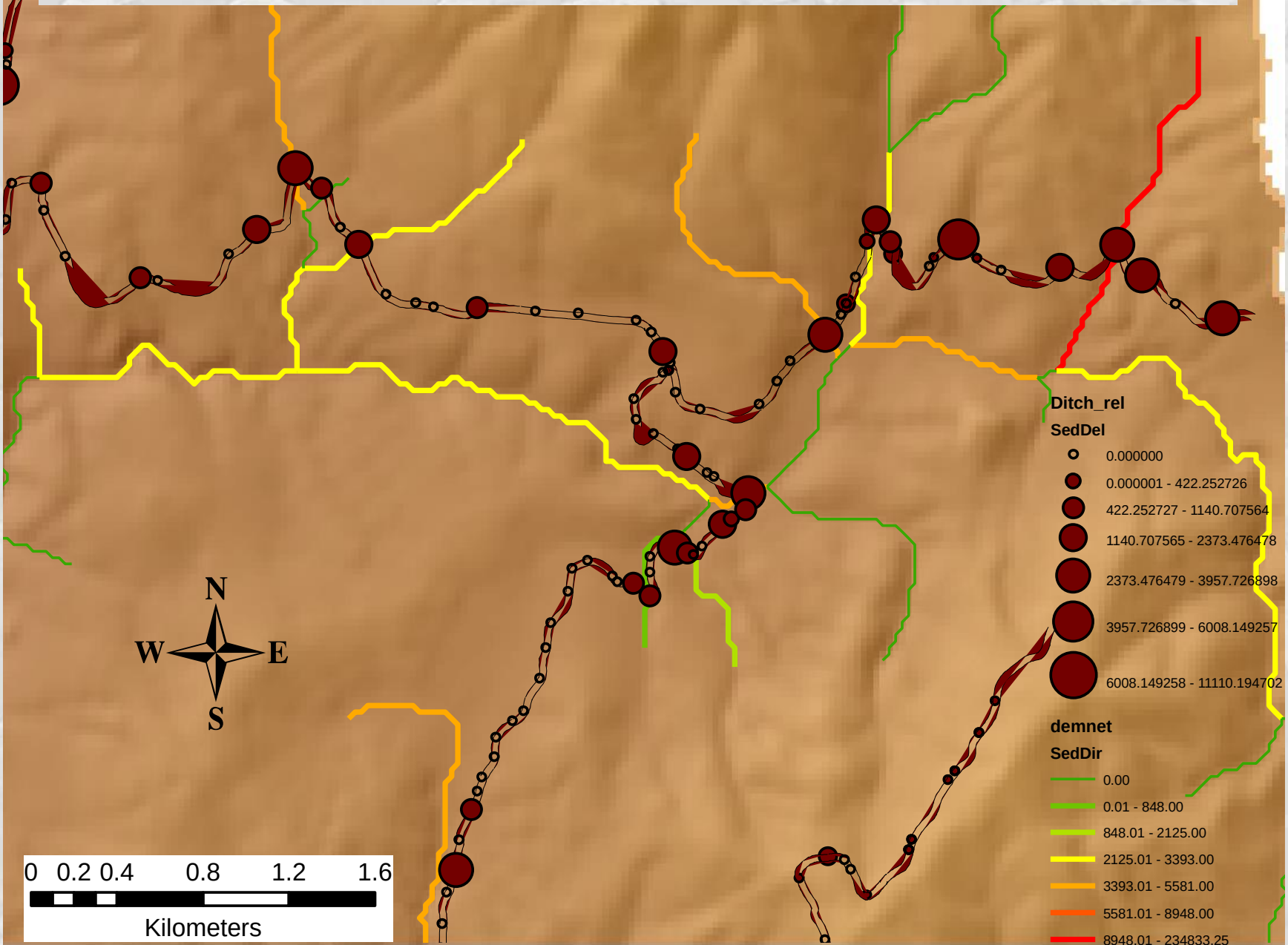
Unit Sediment Production



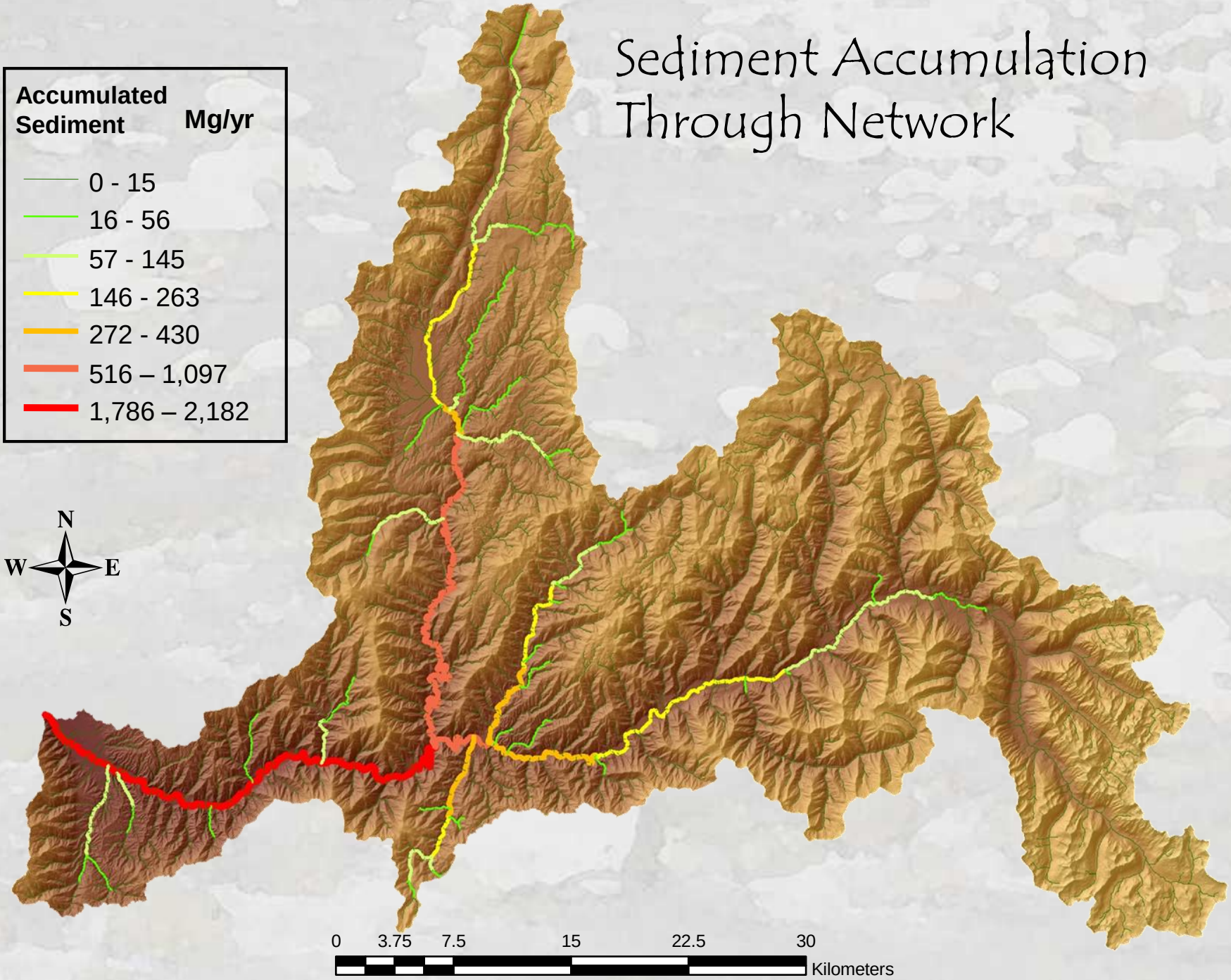
Sediment Production Routed to Drain Points



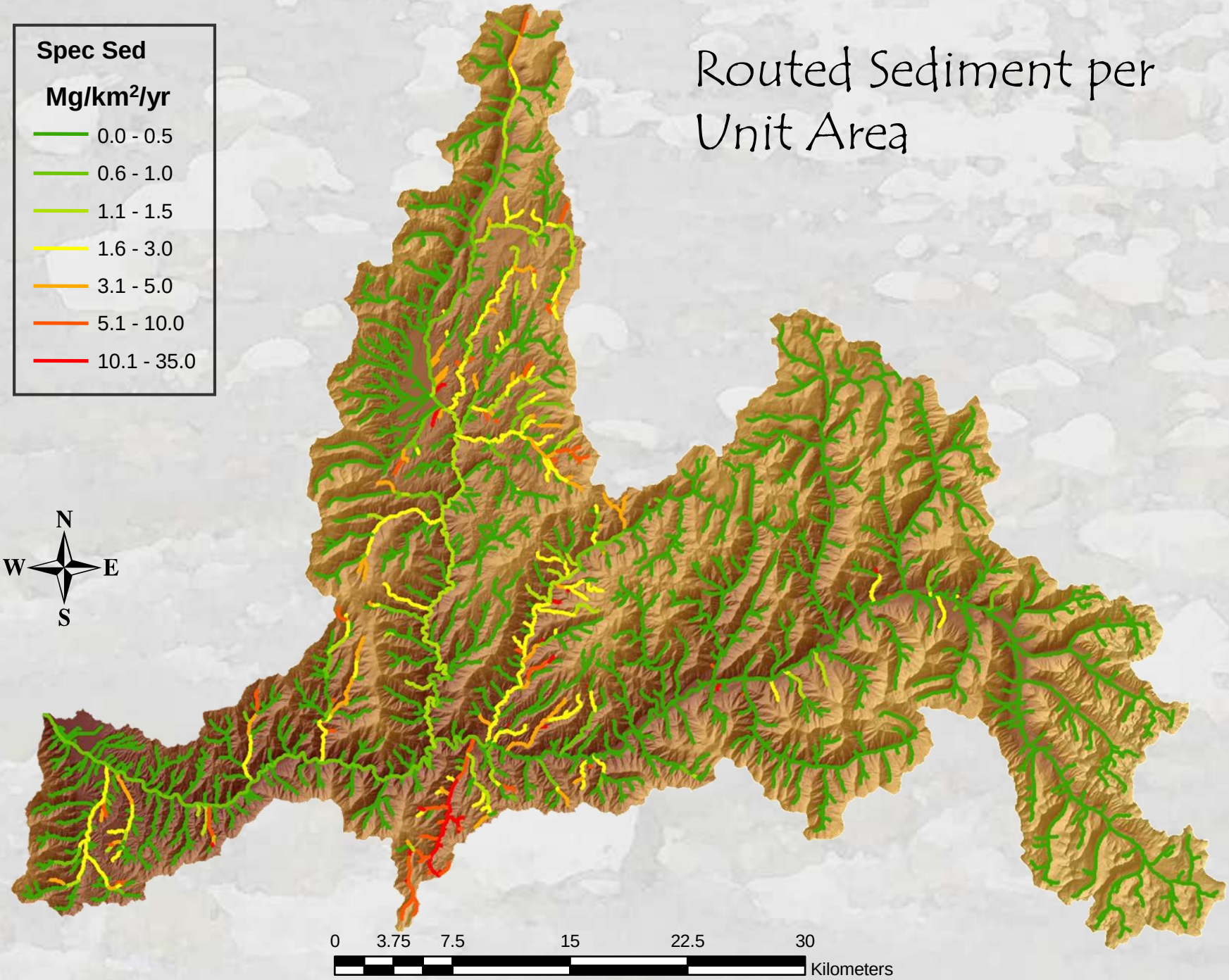
Routing from Drains to Stream Segments



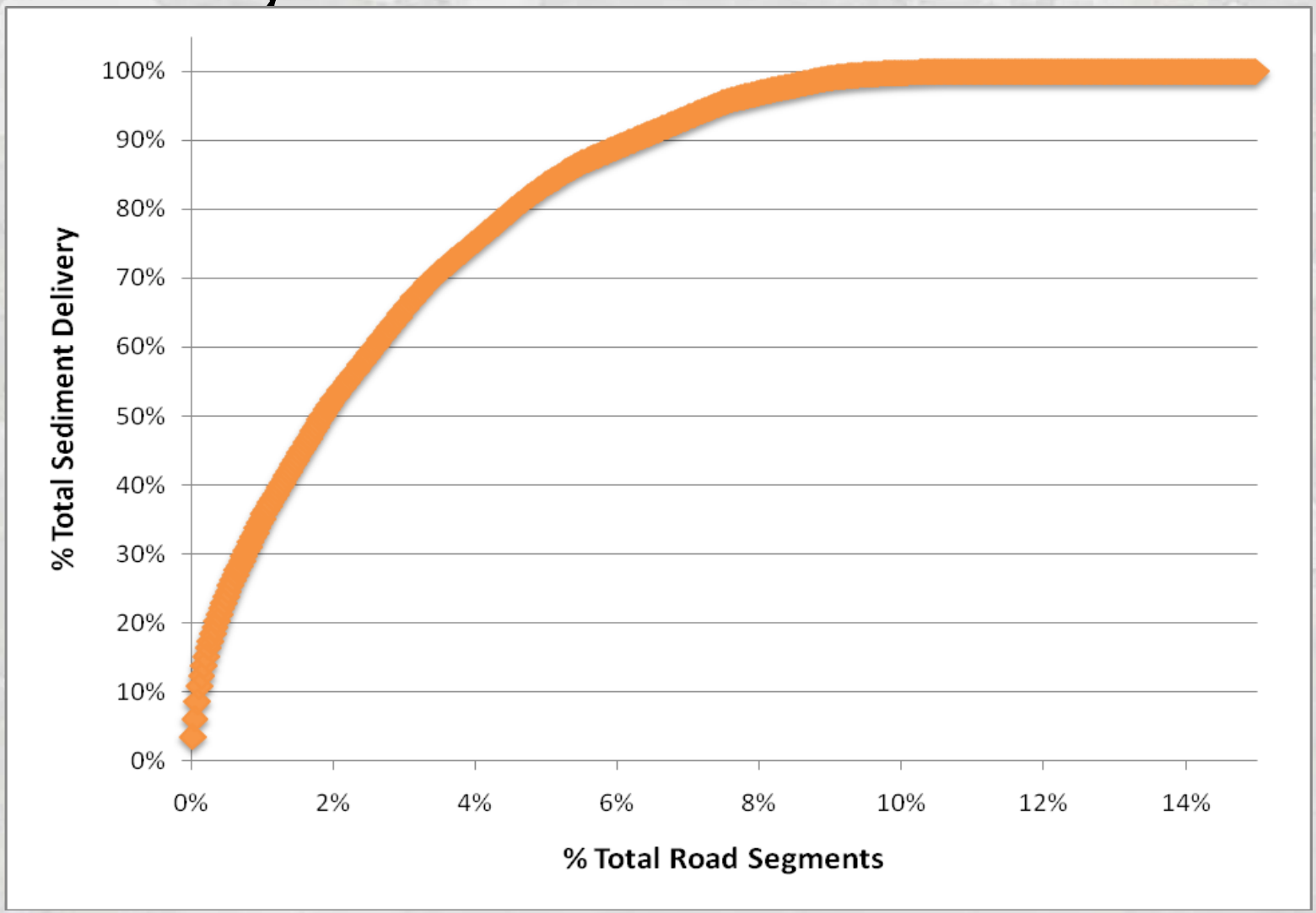
Sediment Accumulation Through Network



Routed Sediment per Unit Area



Sediment Delivery Can Be Very Localized



Drain Point Condition

N
W
E
S

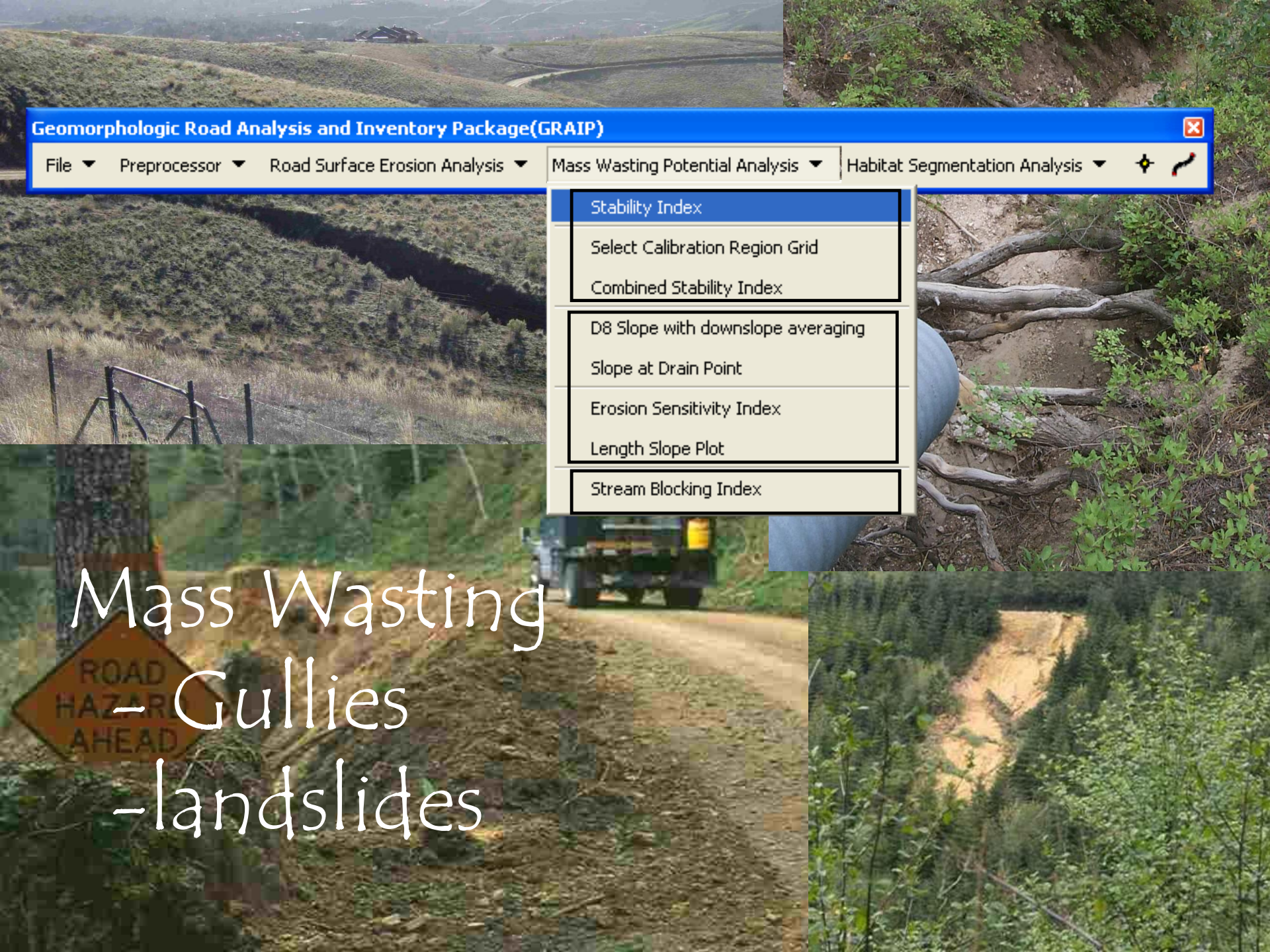
0 0.250.5 1 1.5 2
Kilometers

Road

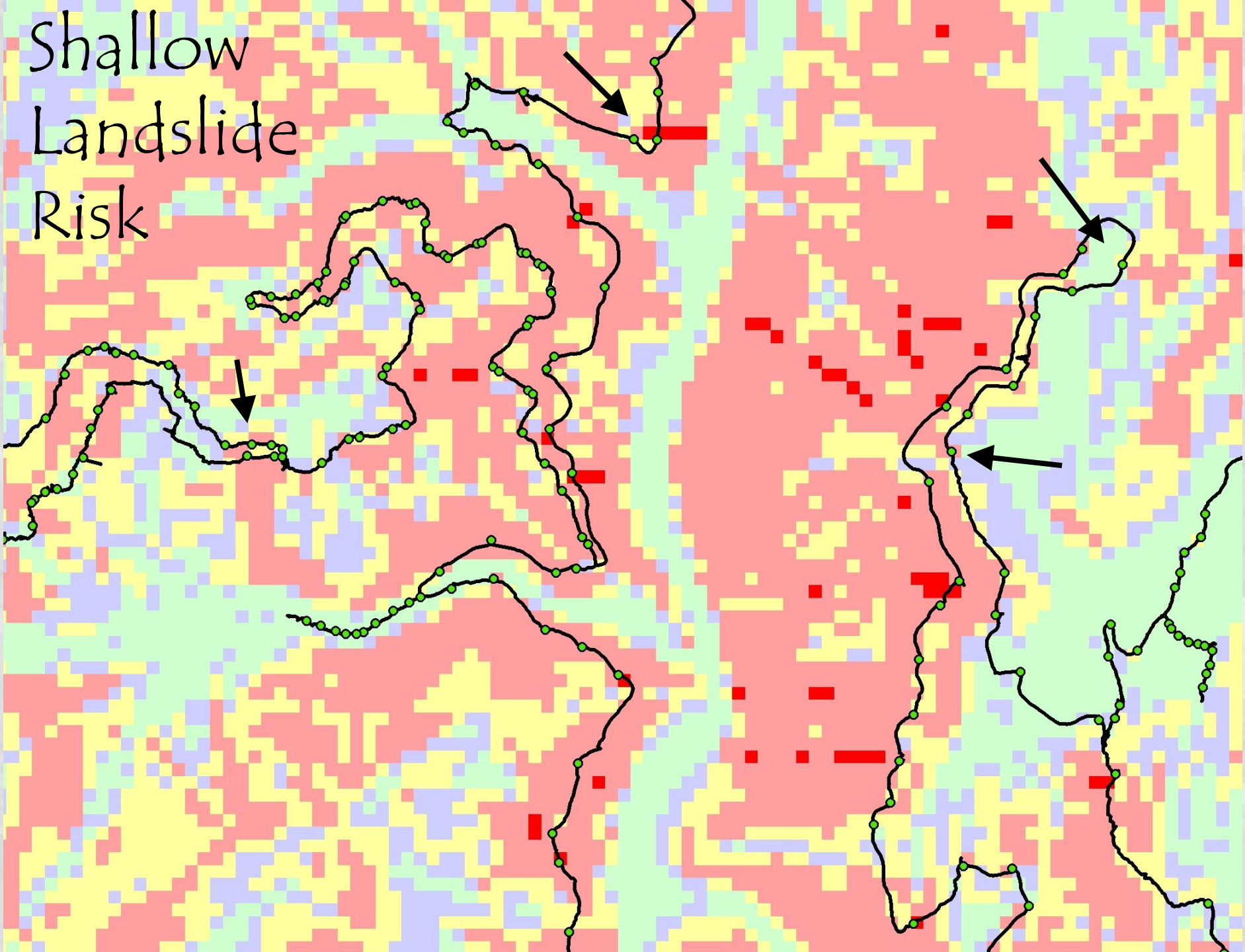
Ditch_rel

CONDIT_1

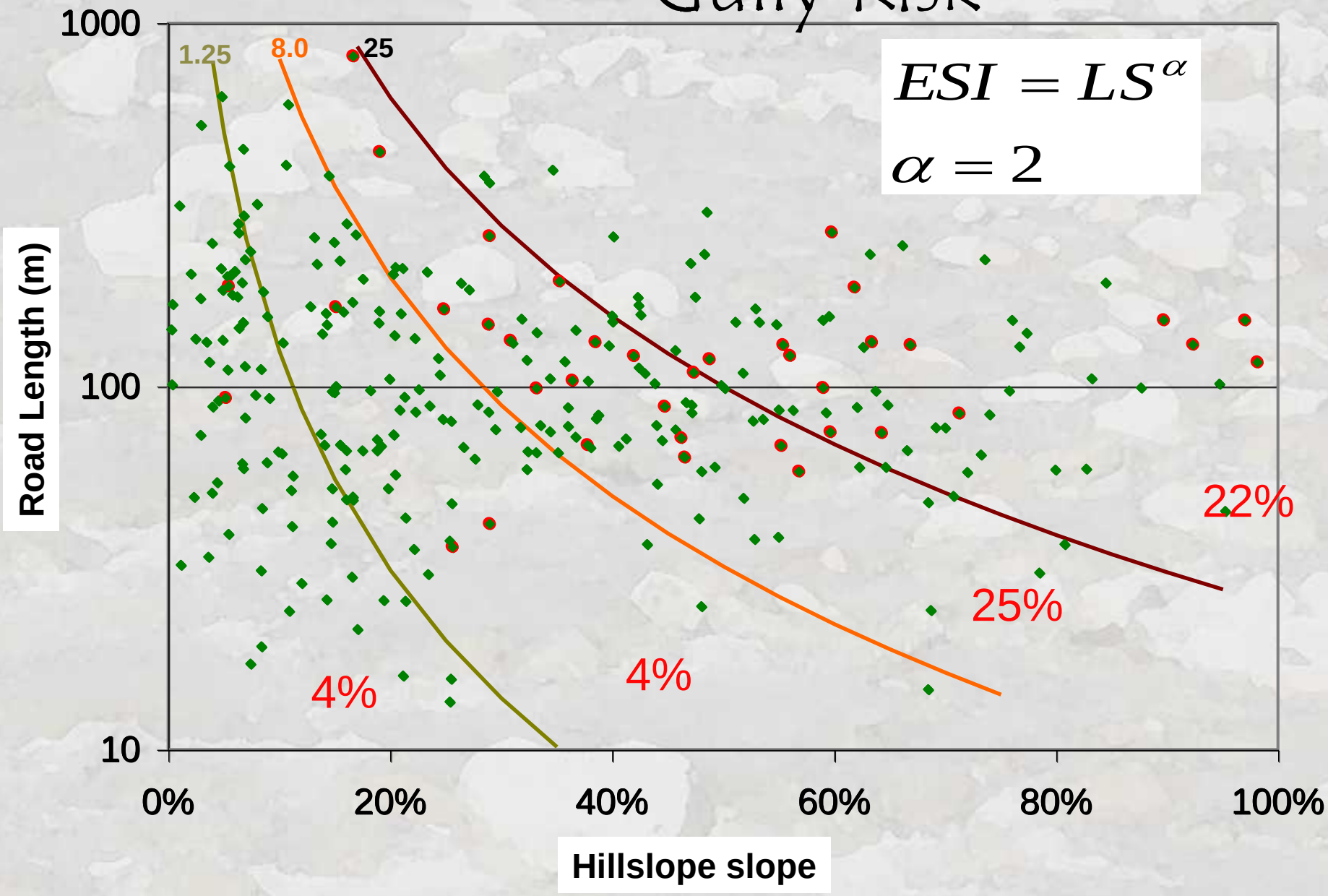
- 0
- 1-20%
- 20-80%
- 80-100%
- Flows around pipe
- Partially Crushed
- Totally Crushed
- Rusted significantly



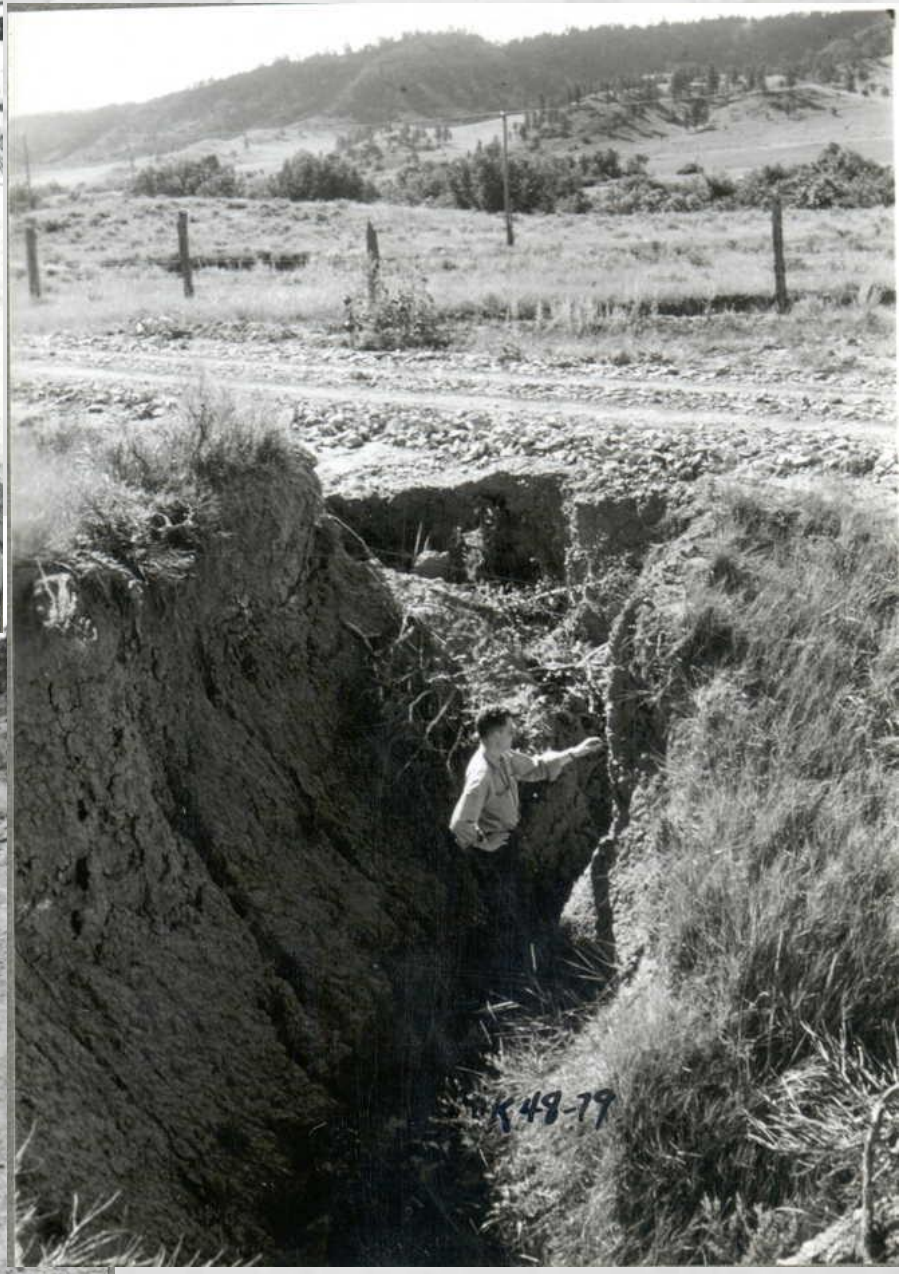
Mass Wasting
- Gullies
- landslides


Shallow
Landslide
Risk

Gully Risk


1000
100
10
Road Length (m)
1.25
8.0
25
$ESI = LS^{\alpha}$
$\alpha = 2$
22%
25%
4%
4%
0%
20%
40%
60%
80%
100%
Hillslope slope


K49-54


K48-79


K 48-74