Runoff and Erosion Data: Wildfire Rainfall Simulator Experiments

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University of Wyoming New Thinking

Southwest Watershed Research Center
Tucson, Arizona

Outline

- Review Research Objectives
- Methodology
  - Data & data reduction
- Site descriptions & characteristics
- Rainfall Simulator Experiments
  - General runoff and erosion
  - Comparison burned & unburned sites
  - Additional wildfire sites
- Model Input Parameters
- Summary

Research Objectives

- Quantify runoff and erosion from the two ecological sites immediately following the wildfire using rainfall simulator measurements.
- Measure the runoff and erosion processes during the “recovery” period.
  - Compare results from similar unburned ecological sites.
- Develop model input parameters for semi-arid grasslands for ERMiT from the runoff and erosion measurements.

Research Approach

- Variable intensity rainfall simulator experiments on the 2 burned ecological sites (2 - 4 plots/site).
  - Measure infiltration, runoff, and erosion for a range of rainfall intensities (25 – 180 mm/hr).
- Compare results from those at similar unburned ecological sites at the USDA- ARS Walnut Gulch Experimental Watershed.

➢ Results from three years of simulation on the original Ryan Fire and unburned sites.

➢ Results from two additional wildfire sites.

Walnut Gulch Rainfall Simulator

Variable Intensity Rainfall Simulator

- Computer Controlled
- Intensities:
  13 – 178 mm/hr
- 2m by 6m plot
- Oscillating boom
- 4 VeeJet nozzles
- Rainfall energy close to natural rainfall

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Measurements

- **Runoff**
  - Measured at end of plot using pressure depth gauge and precalibrated flume.
  - Each intensity applied until steady state is observed.
  - Infiltration is calculated as: (Intensity – Runoff).
- **Sediment**
  - Grab samples were taken during the rise of the hydrograph and at steady state.
- **Plot and site characteristics**
  - Point frame measurements of Canopy cover, ground cover and microtopography (400pts/plot).

Simulator setup at the Post Canyon site: year 1 (2002)

Site Characteristics

- **Loamy Upland: *Post Canyon***

Soil texture: gravelly fine sandy loam Slope: 9% Burn Severity: low

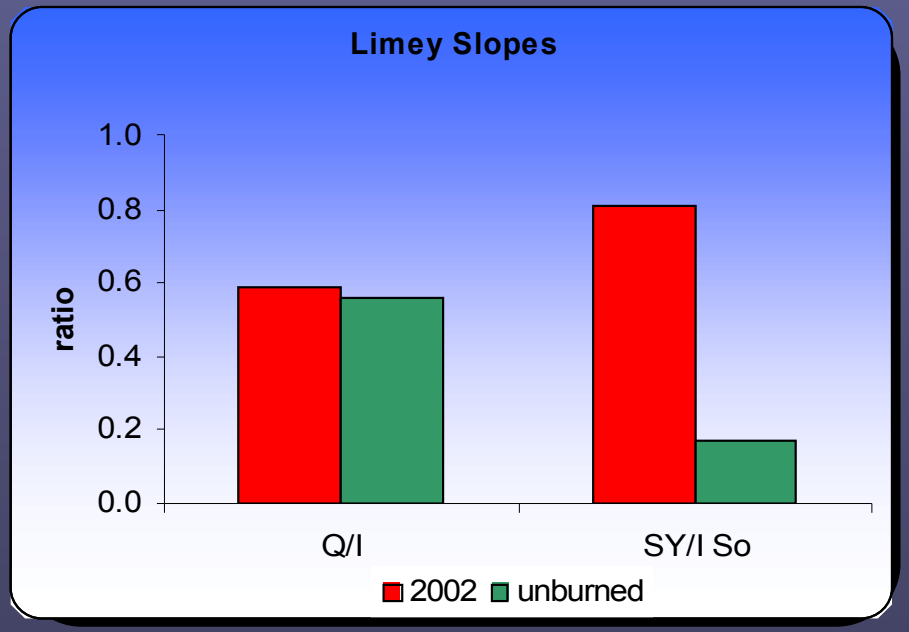
	Ground Cover	Canopy Cover
2002:	29%	0%
2003:	35%	22%
2004:	33%	55%
Unburned:	82%	88%

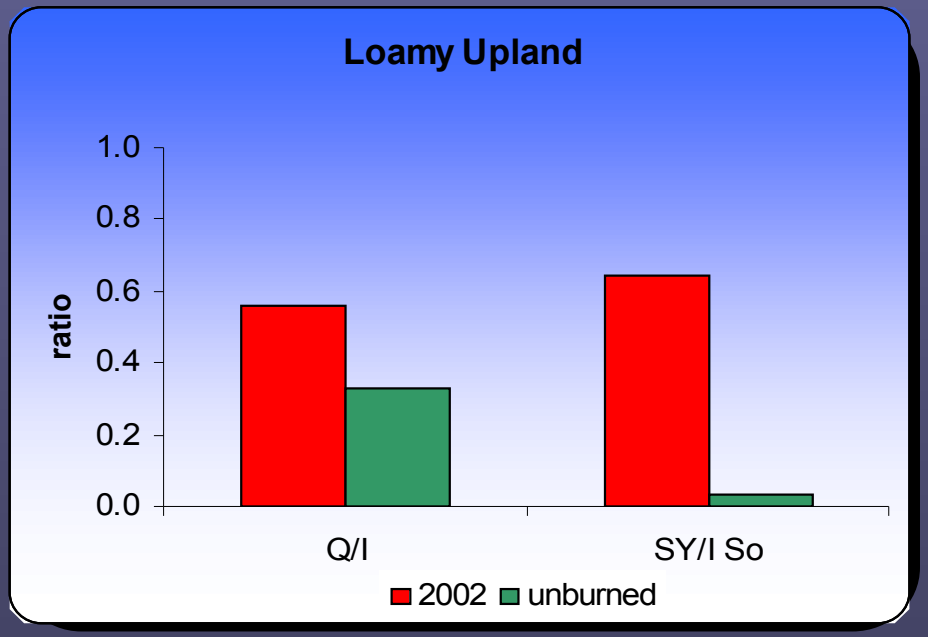
- **Limey Slopes: *East Mesa***

Soil texture: gravelly fine sandy loam Slope: 12% Burn Severity: moderate

	Ground Cover	Canopy Cover
2002:	57%	0%
2003:	57%	18%
2004:	55%	54%
Unburned:	60%	

Results: site averages





Runoff Ratio: runoff volume (Q)/ rainfall volume (I)

Sediment Ratio: sediment yield (SY)/runoff volume (Q) normalized for slope (So).

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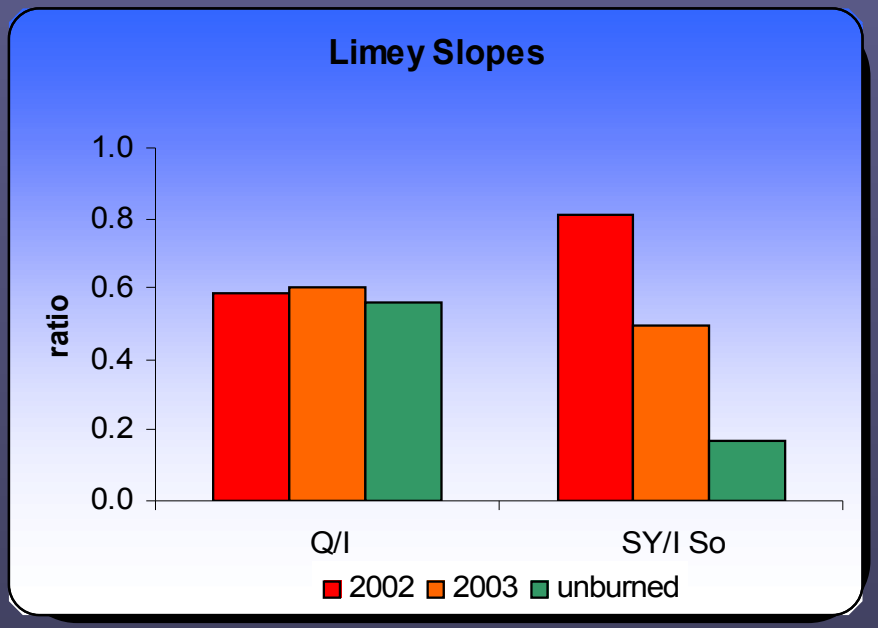
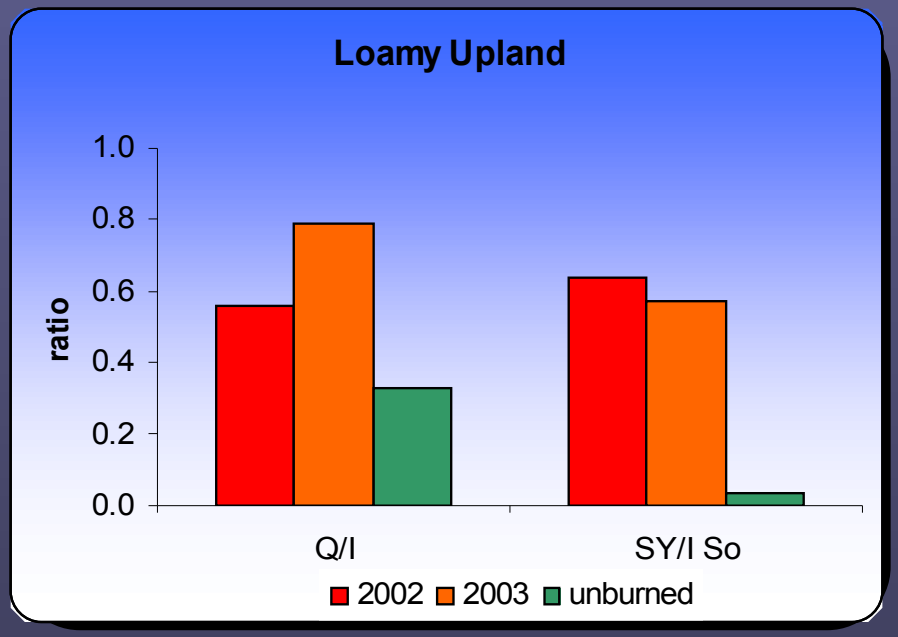
Results: site averages





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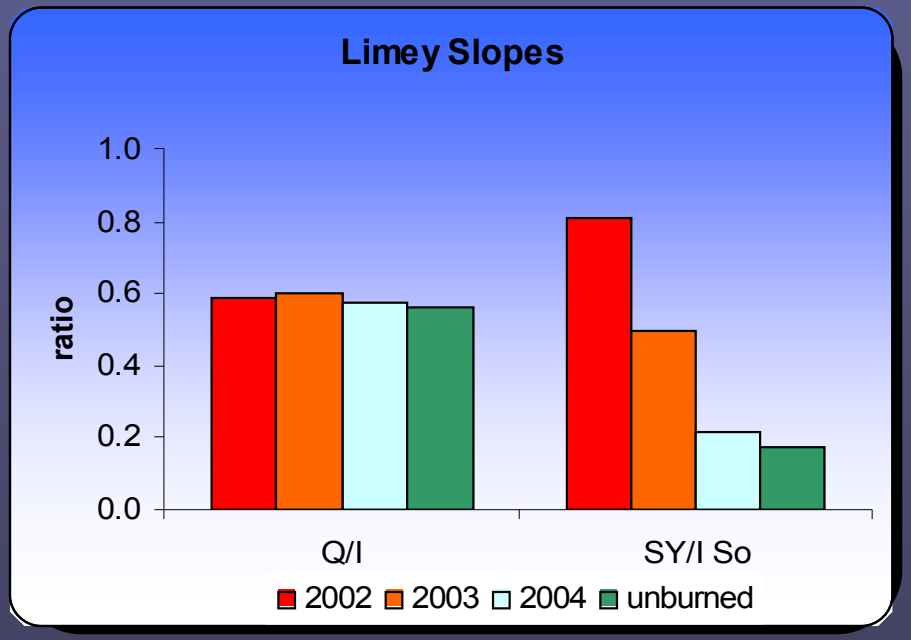
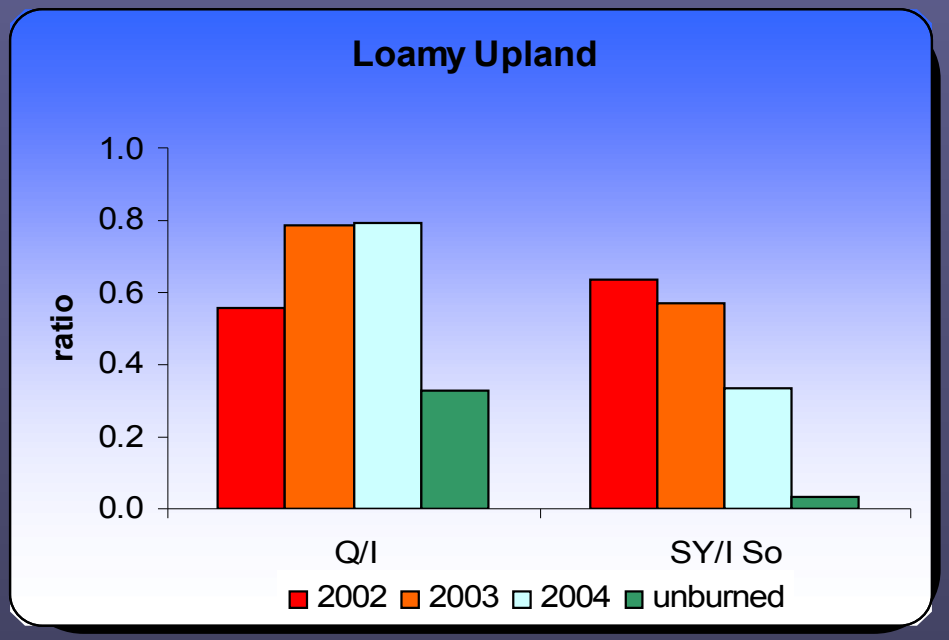
Results: site averages





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Changes in Runoff and Erosion

Burned 2002 vs. Unburned

Runoff Ratio:

- Loamy Upland 74%
- Limey Slope 5%

Sediment Ratio:

- Loamy Upland 2230%
- Limey Slope 399%

Burned 2002 vs. 2003

Runoff Ratio:

- Loamy Upland 41%
- Limey Slope 2%

Sediment Ratio:

- Loamy Upland - 11%
- Limey Slope - 38%

Burned 2003 vs. 2004

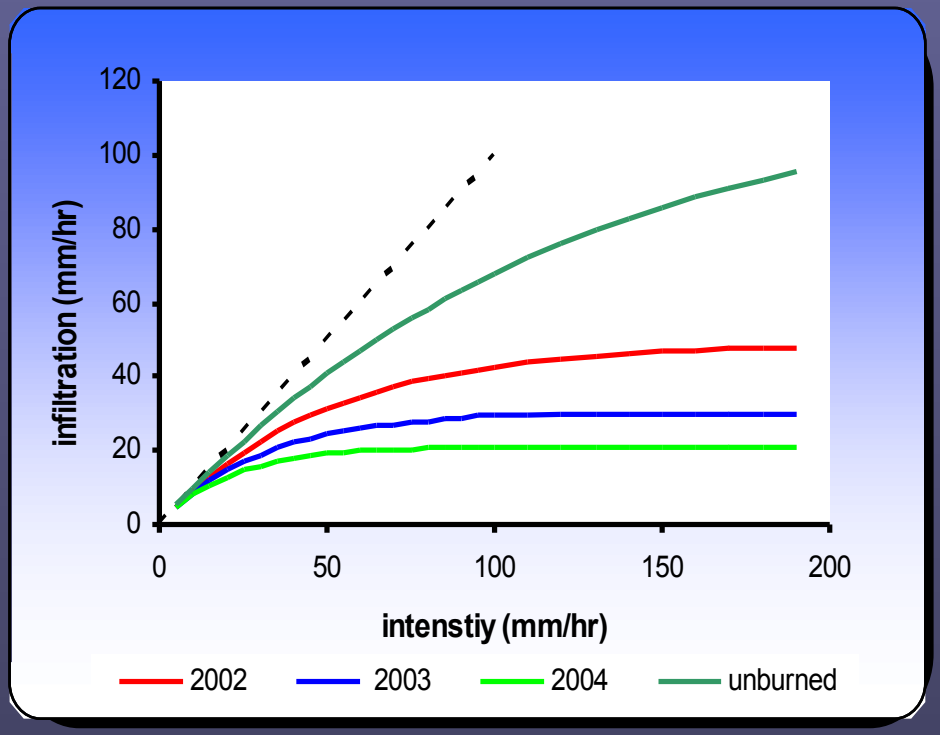
Runoff Ratio:

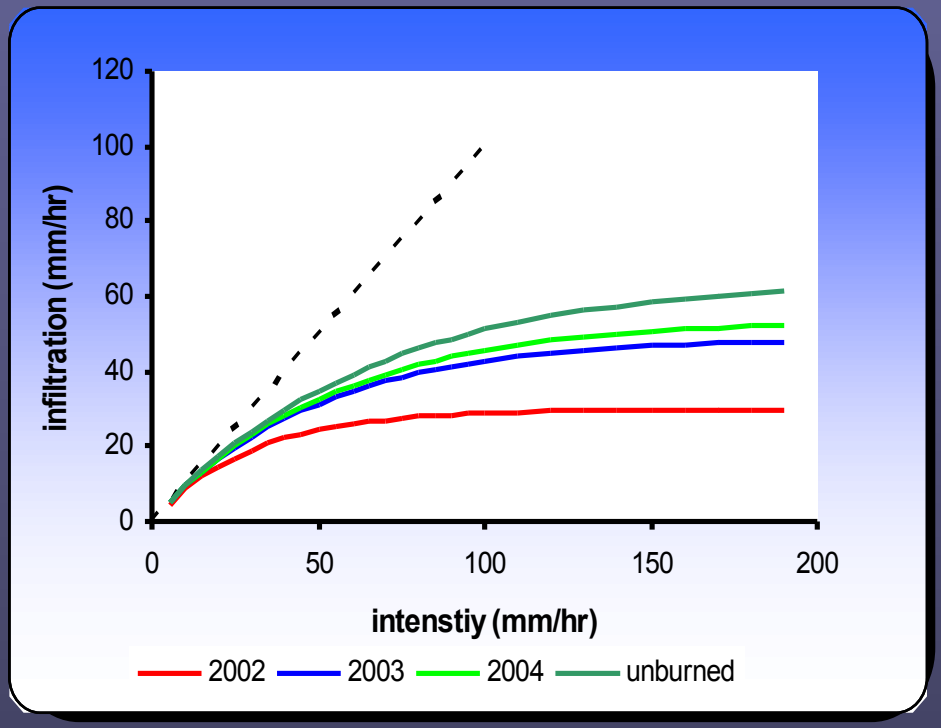
- Loamy Upland 1%
- Limey Slope - 3%

Sediment Ratio:

- Loamy Upland - 40%
- Limey Slope - 58%

Infiltration: site averages





Limey Slopes μ_f

	ave.	(range)
Unburned:	61	(40 - 85)
2002:	30	(30)
2003:	51	(30 - 75)
2004:	54	(47 – 59)

Loamy Upland μ_f

	ave.	(range)
Unburned:	120	(100 - 140)
2002:	50	(40 - 60)
2003:	28	(28)
2004:	21	(13 – 35)

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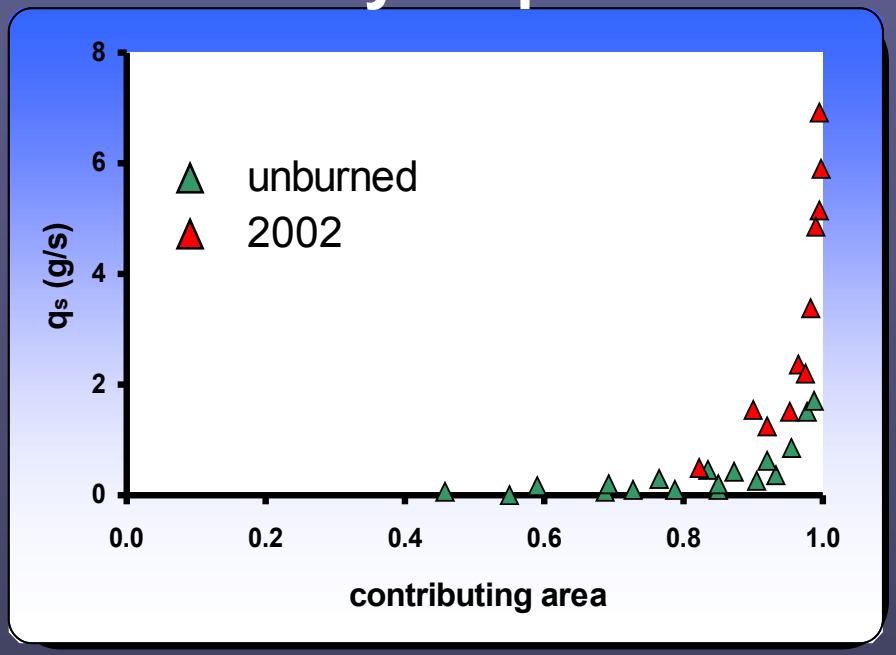
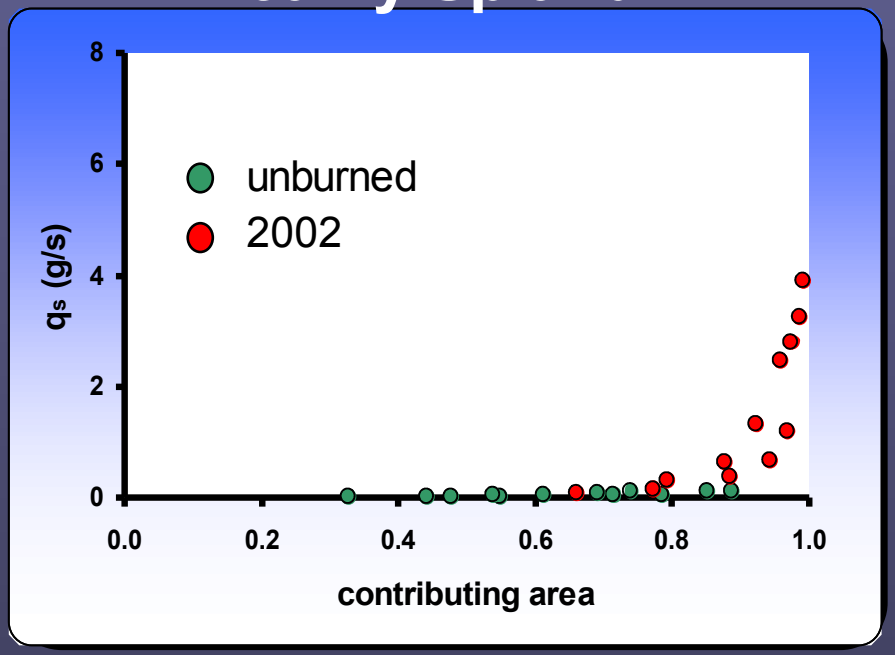
Sediment discharge

Limey Slopes



Loamy Upland



Contributing area was computed using optimized μ_f.

Steady state sediment discharge plotted vs area

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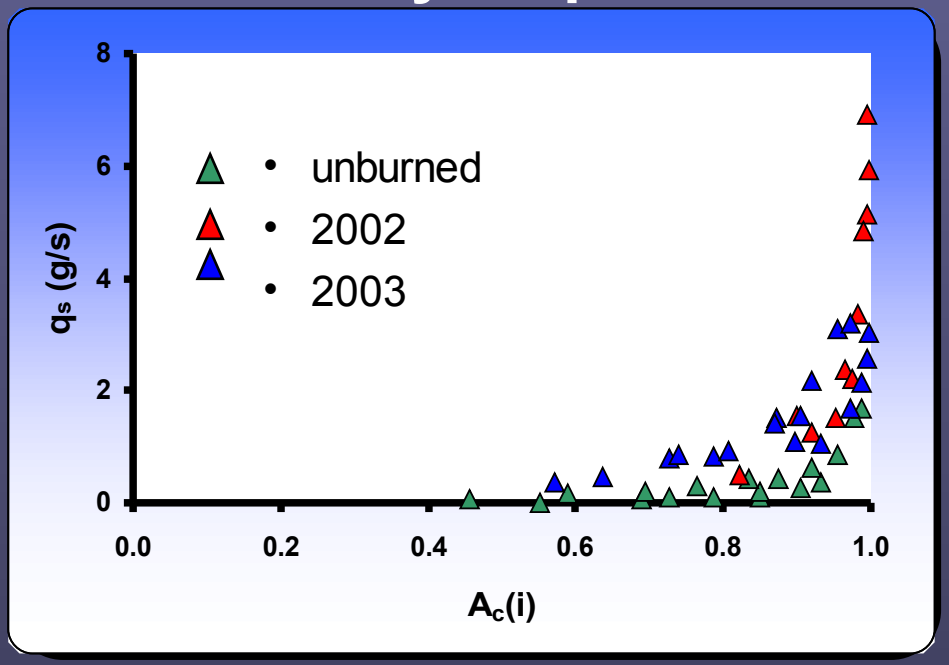
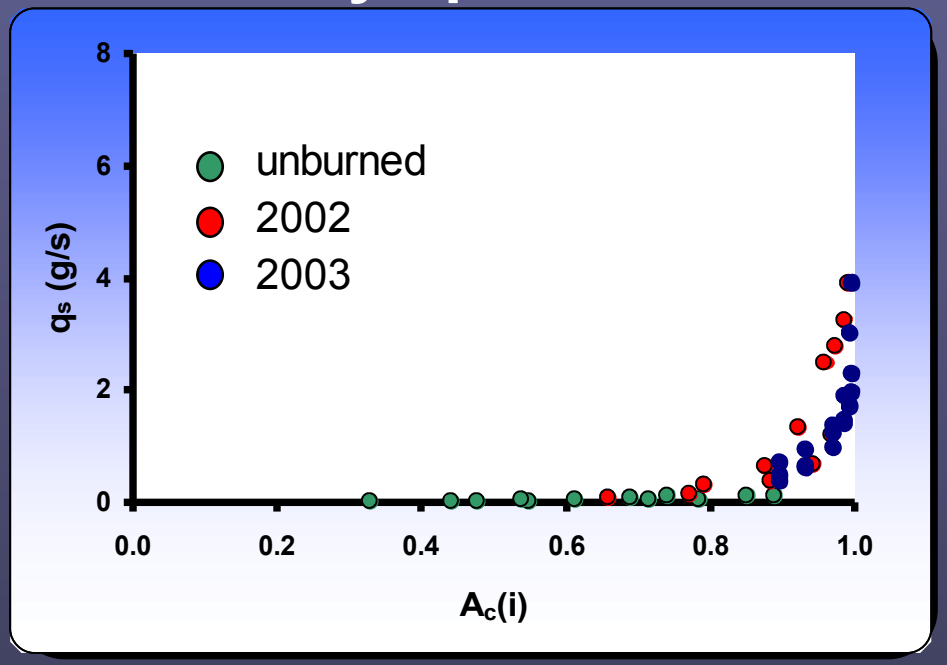
Sediment discharge

Limey Slopes



Loamy Upland



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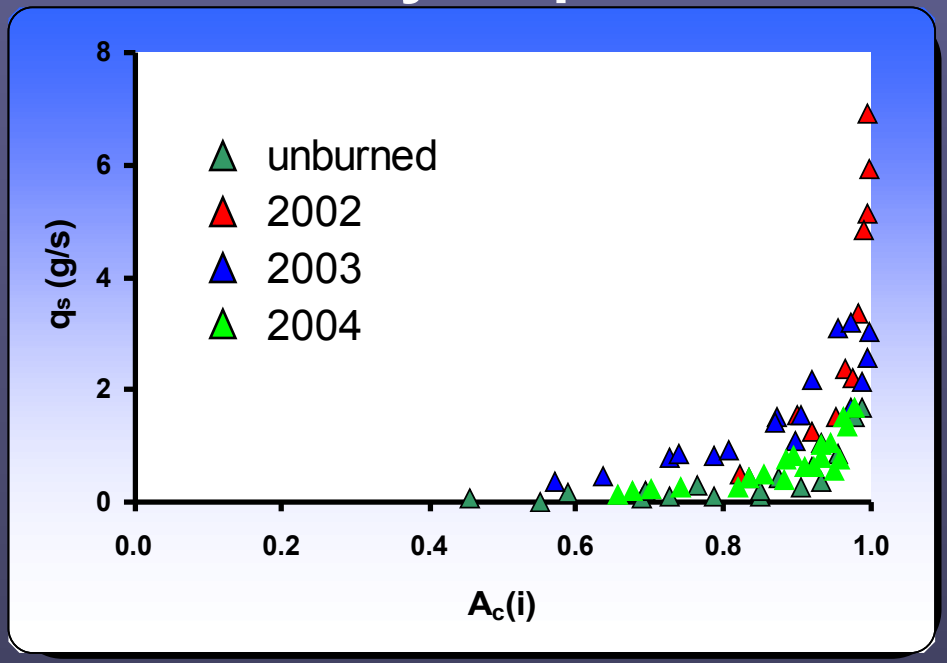
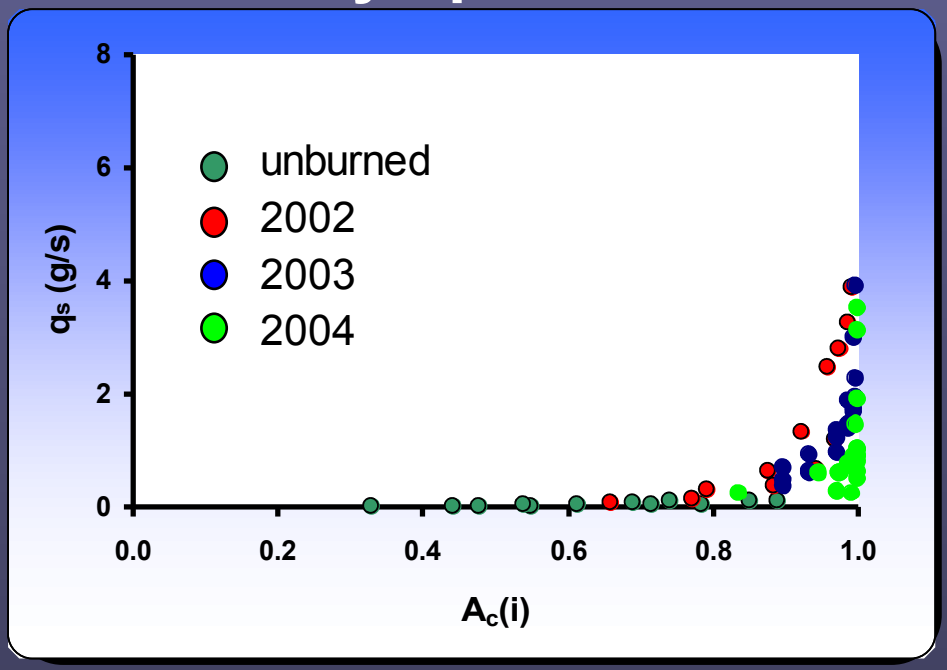
Sediment discharge

Limey Slopes



Loamy Upland



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Summary: Ryan Fire

Burned vs. Unburned:

- There were significant increases in runoff and erosion on the burn sites
  - Greater increase in erosion than runoff
  - Differences between two the sites: more significant increases for the Loamy Upland site

Recovery:

- Decreases in erosion and increases in runoff
  - Erosion rates still much higher than unburned sites
  - Differences between the two sites: *effect of ground cover?*
  - Increase in runoff indicates that there may be a decrease in the site productivity & surface sealing

Additional Wildfire Sites

ABAR Fire: 2003

Oak Woodland: Loamy Upland site

Soil: Gravelly Fine sandy loam

Slope: 9-12%

Moderate Intensity Burn

Tank Fire: 2004

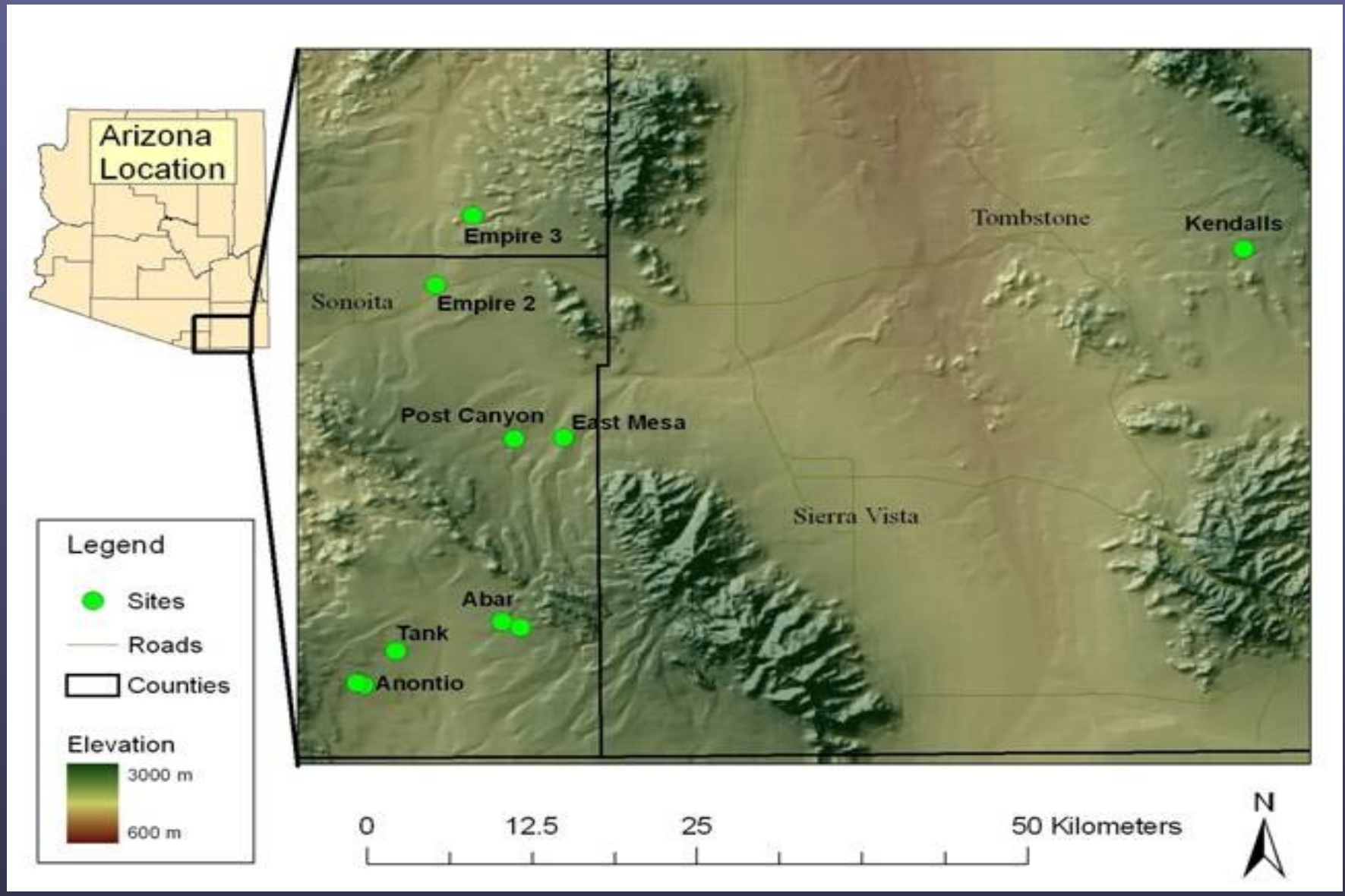
Grassland: Clay Slopes site

Soil: Clay loam

Slope: 27-30%

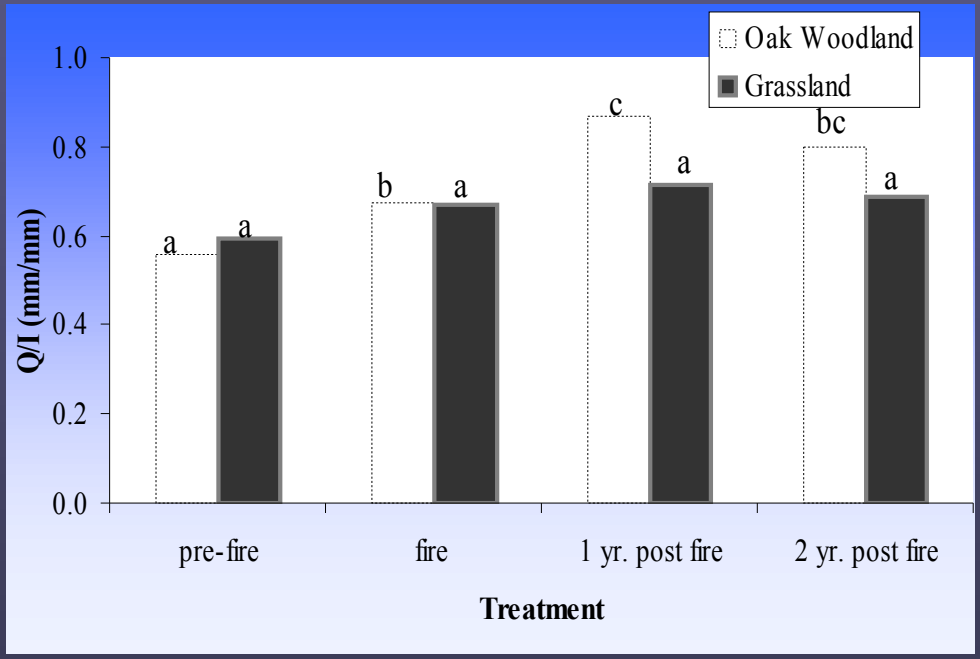
Moderate Intensity Burn

Additional Wildfire Sites



Additional Wildfire Sites

Average normalized runoff for the oak-woodland and the grassland sites

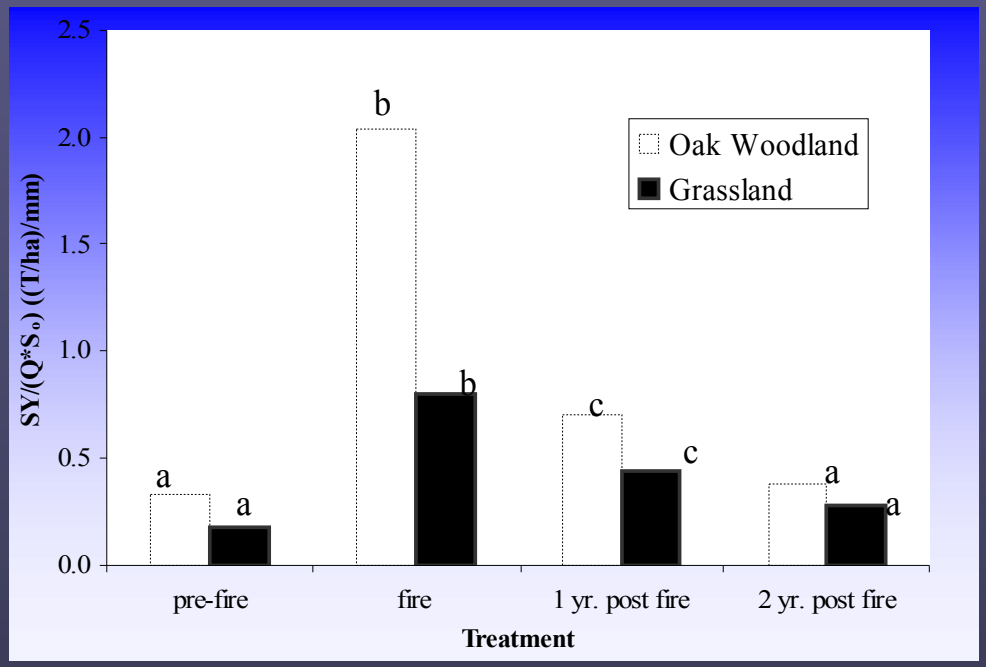


Significant increase in runoff after the fire for the oak-woodland only, significant increase again the first year post-fire

No significant change in runoff among treatments in the grassland sites.

Additional Wildfire Sites

Average normalized sediment yield for the oak-woodland and grassland sites.



Significant increase in sediment yield for both oak-woodlands and grasslands sites, more drastic in oak-woodlands.

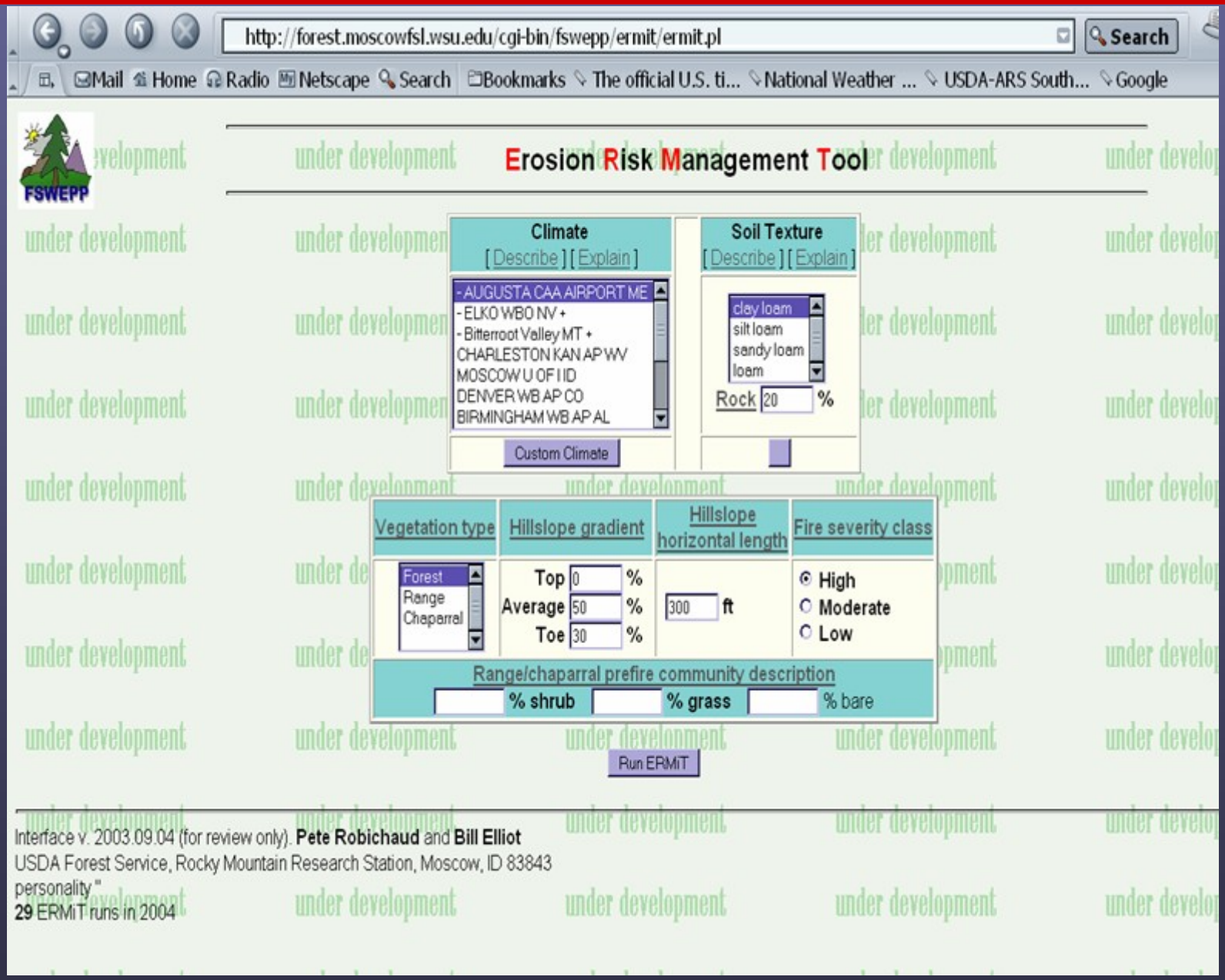
Both oak-woodlands and grasslands approach unburned conditions within two years

NEXT

The results from these and additional studies are being used to develop semi-arid grassland parameters for distributed hydrologic models

- **AGWA, KINEROS2, IRS, ARiDBasin, WEPP, and …**
- **ERMit to evaluate runoff and erosion risks following wildfires.**

ERMiT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Search
Mail Home Radio Netscape Search Bookmarks The official U.S. ti... National Weather ... USDA-ARS South... Google
FSWEPP
Erosion Risk Management Tool
Climate
[Describe] [Explain]
- AUGUSTA CAA AIRPORT ME
- ELKO WBO NV +
- Bitterroot Valley MT +
CHARLESTON KAN AP WV
MOSCOW U OF I ID
DENVER WB AP CO
BIRMINGHAM WB AP AL
Custom Climate
Soil Texture
[Describe] [Explain]
clay loam
silt loam
sandy loam
loam
Rock 20 %
Vegetation type
Forest
Range
Chaparral
Hillslope gradient
Top 0 %
Average 50 %
Toe 30 %
Hillslope horizontal length
300 ft
Fire severity class
High
Moderate
Low
Range/chaparral prefire community description
% shrub
% grass
% bare
Run ERMiT
Interface v. 2003.09.04 (for review only). Pete Robichaud and Bill Elliot
USDA Forest Service, Rocky Mountain Research Station, Moscow, ID 83843
personality "
29 ERMiT runs in 2004

Model Input Parameters

WEPP: Water Erosion Prediction Project (USDA-ARS)

Runoff:

Hydraulic Conductivity (K_e) mm/h:
Green and Ampt Infiltration Equation

Erosion:

Interrill Erodibility (K_i)
Rill Erodibility (K_r) and Critical Shear (T_c)

ERMiT: Erosion Risk Management Tool

Climate
Vegetation type: percent cover
Soil series: soil texture
Burn severity
Slope

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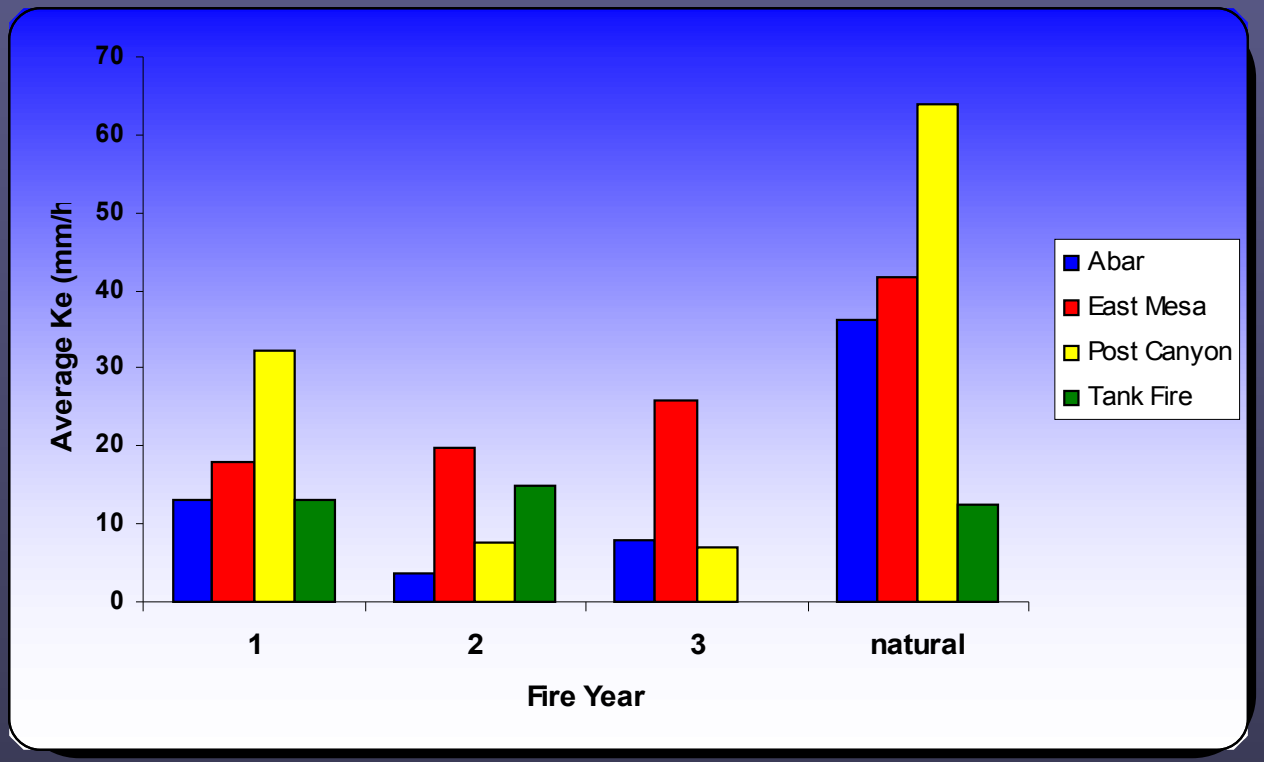
Model Input Parameter Identification

Hydraulic Conductivity



Peak Runoff Observed vs Predicted

Site	R^2
EM	0.9733
K - LS	0.9499
PC	0.9866
K - LU	0.9817
AB	0.9628
ABN	0.9268
TF	0.9801
TFN	0.9642

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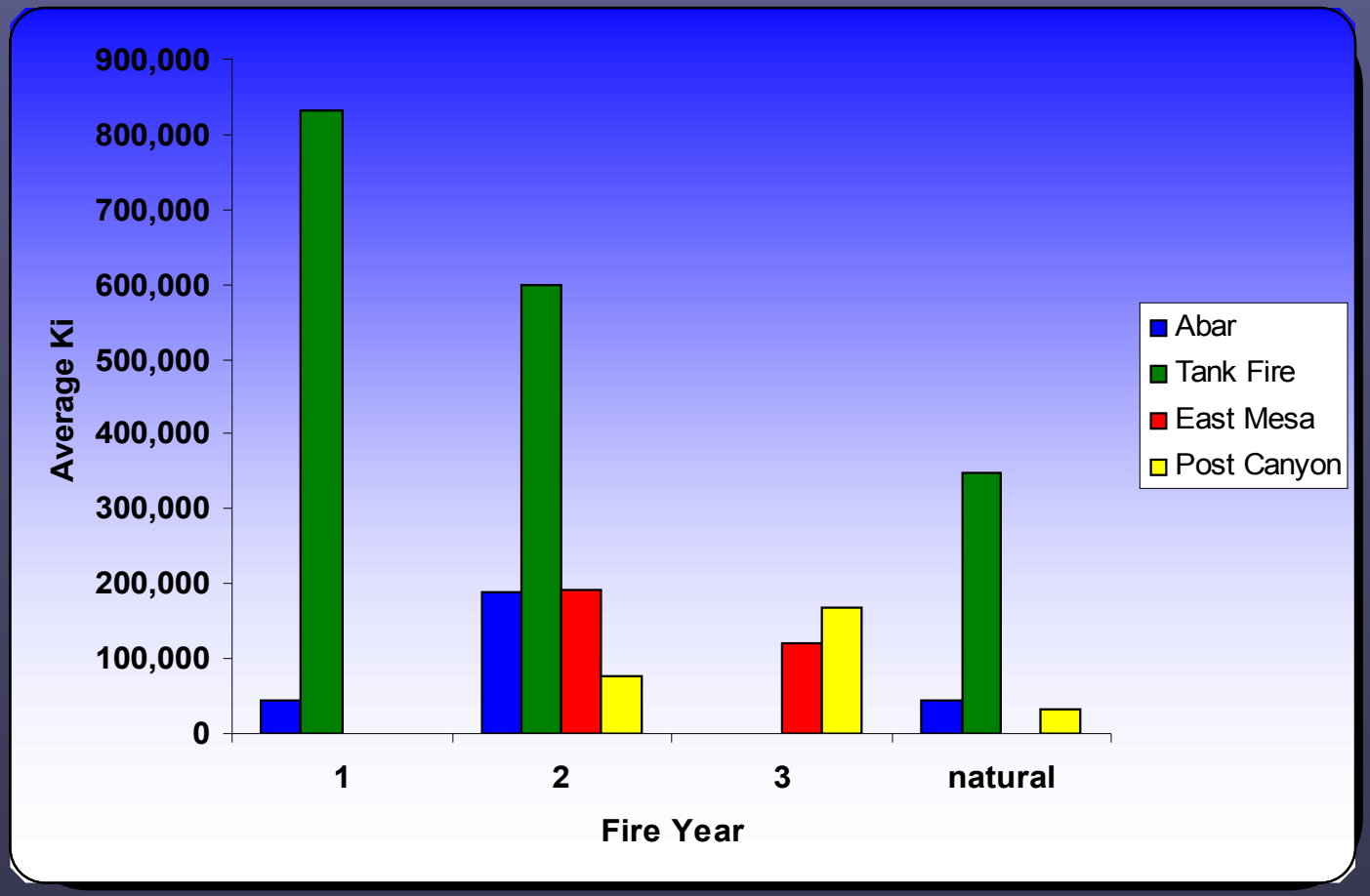
Model Input Parameter Identification

Interrill Erodibility: Average site parameters



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Summary

Model Input Parameters

- Very good fit with optimized K_e parameters for WEPP.
- Erosion parameters - strong correlations to vegetation complexes

ACKNOLWEDGEMENTS

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