Linking remote sensing and process-based hydrological models to increase understanding of wildfire effects on watersheds and improve post-fire remediation efforts

TFRSAC meeting

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Project Team

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Introduction

- Forests provide many products as well as ecosystem services
  - Wood
  - Wildlife and fish habitat
  - Recreation
  - Clean water
- Wildfire impacts on watersheds
  - Increased peak flow rates (up to 100x)
  - Increased sediment delivery to streams (up to 1000x)

Forest in Northern Idaho

Waiting for the flood after an Arizona fire

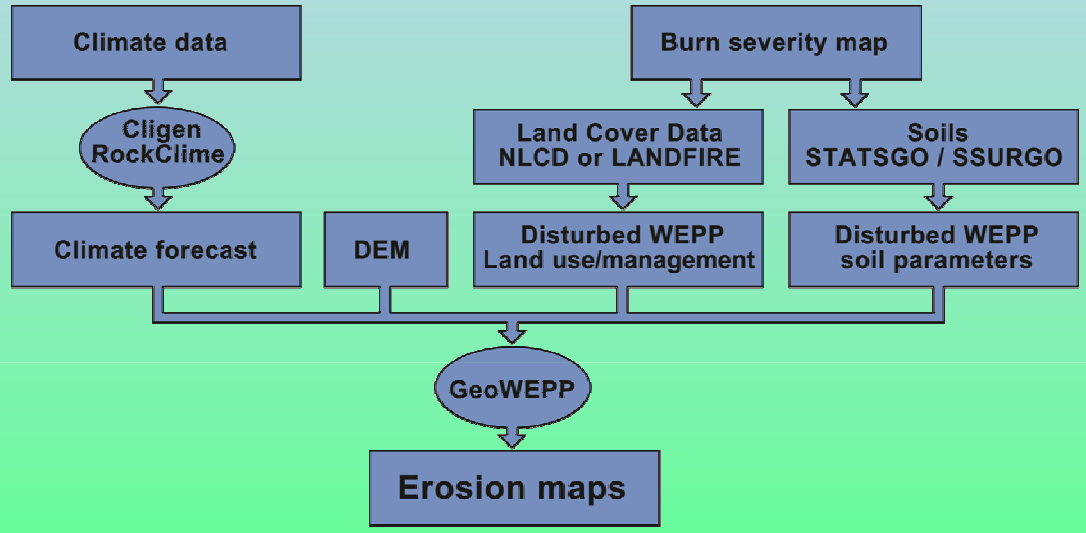
BAER Teams

(Burned Area Emergency Response)

- Mission: Protect lives, property and natural resources threatened by post-fire flooding and erosion.
- BAER Teams go to work before the fire is out.
- Treatments need to be completed before a major storm in order to be effective.

WEPP (**W**ater **E**rosion **P**rediction **P**roject) Watershed Erosion Model

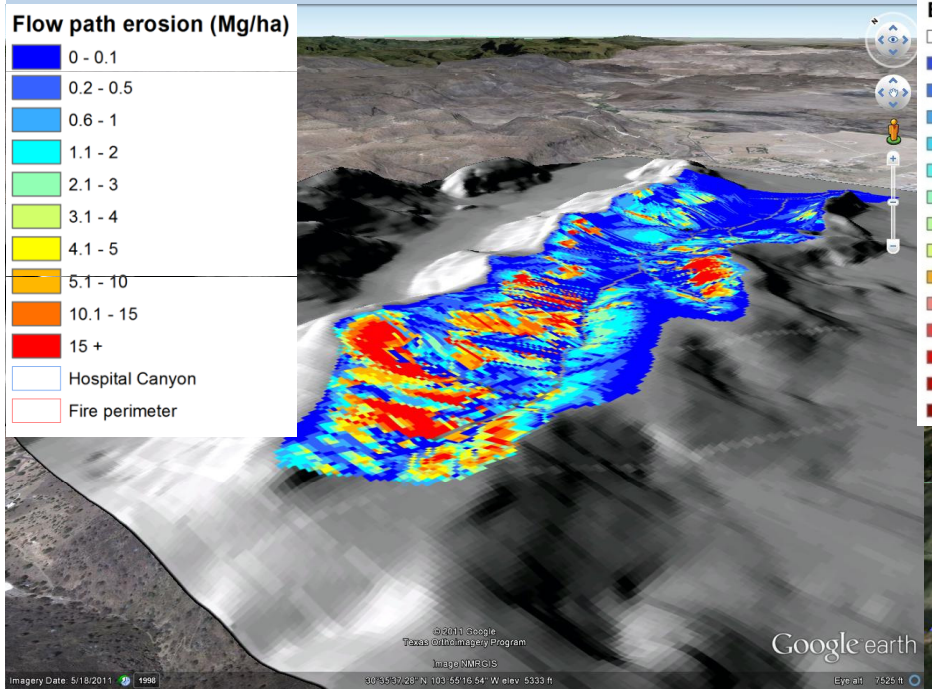
- Main inputs:
  - climate (stochastic or real)
  - Topography (typically from a 30 or 10-m DEM)
  - Soil properties (texture, % rock, and burn severity)
  - Ground cover (linked to land cover & fire severity)
- Main output:
  - Sediment production and runoff by hillslope

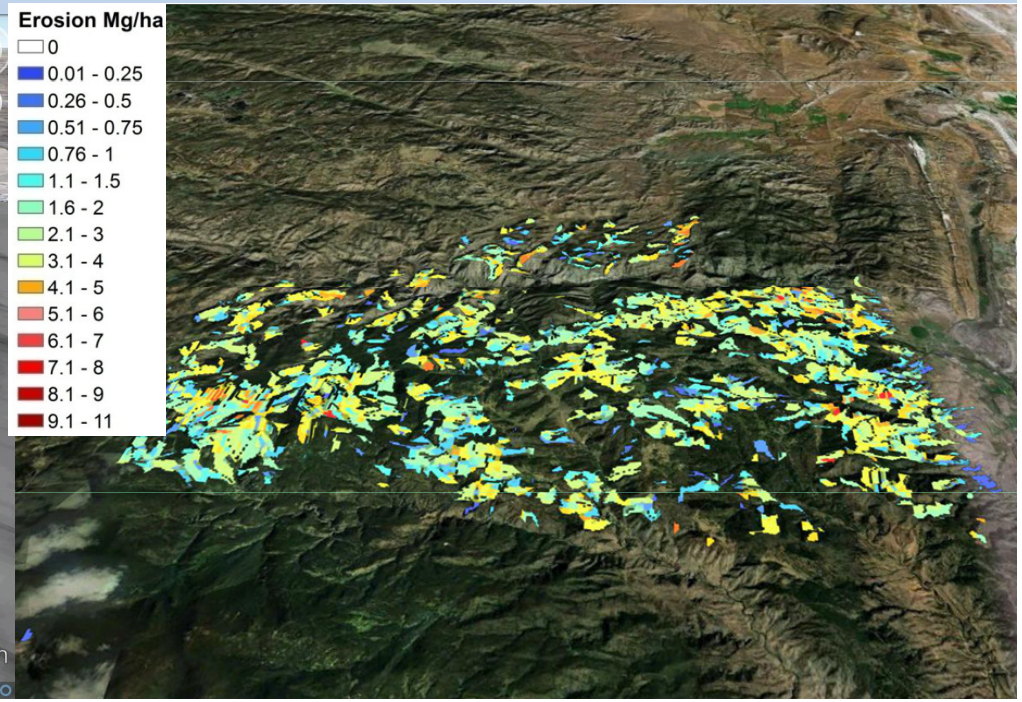


Problem - Spatial process based erosion models are currently under utilized.

Rock House Fire
Date: April 9, 2011
Location: Fort Davis, TX
Size: 314,444 acres
Hospital Canyon: 536 acres
BAER Team: National Park Service

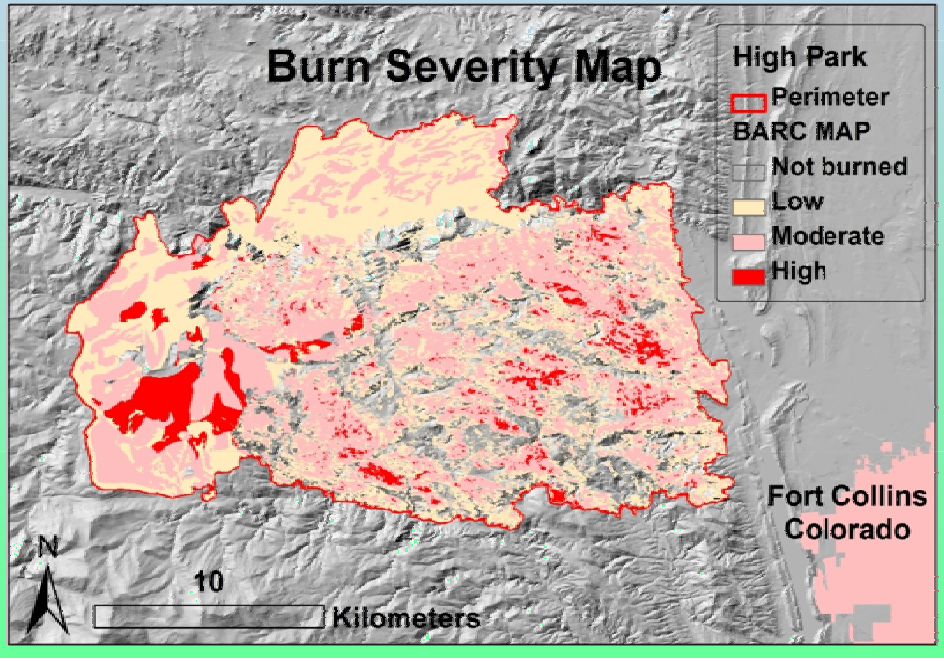
High Park Fire
Date: June 9, 2012
Location: West of Fort Collins, CO
Size: 87,284 acres
BAER Team: Forest Service

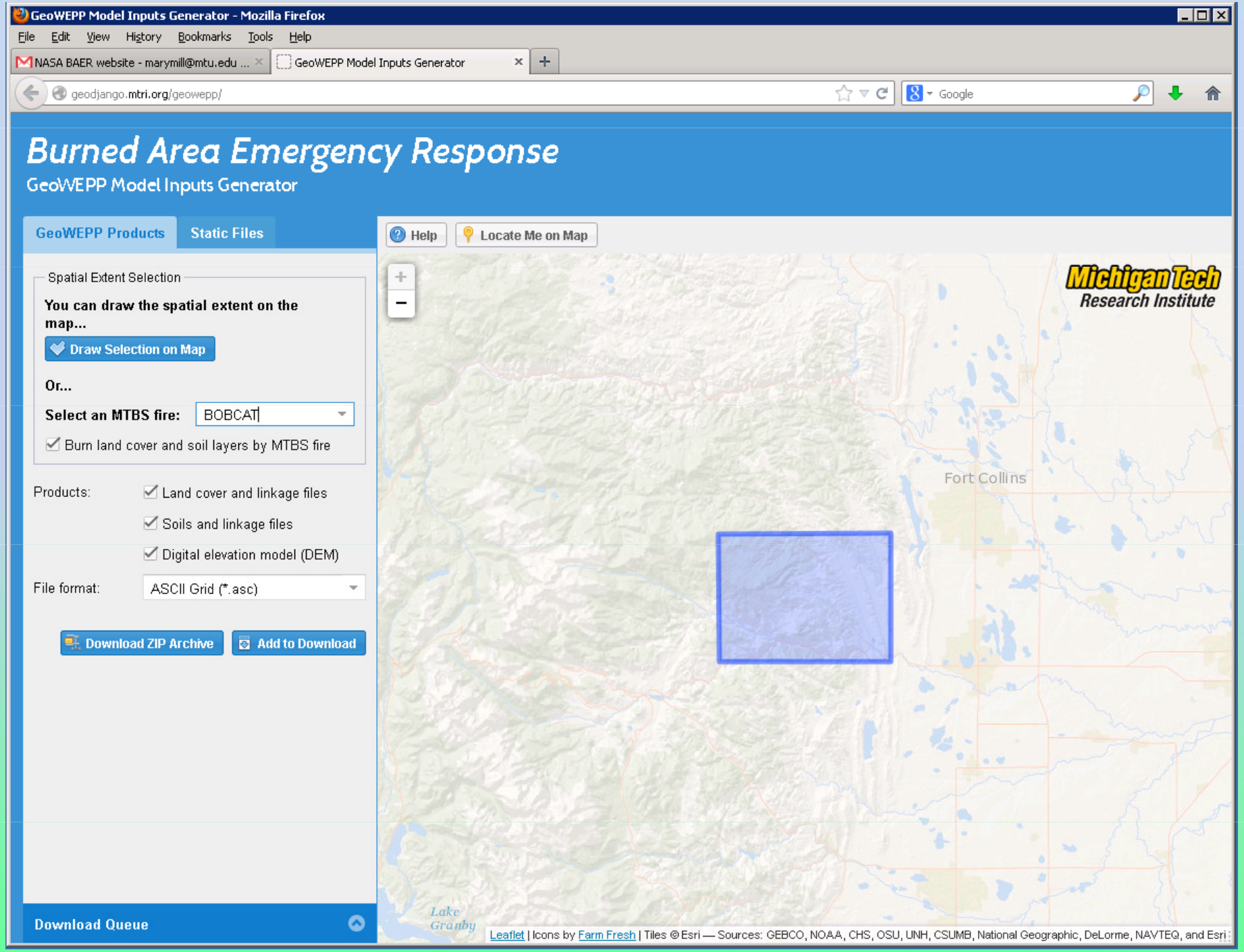




Problem / Solution

- Spatial process-based erosion models are underutilized due to time constraints; the SOLUTION is prepare the datasets and tools before the fire occurs!




GeoWEPP Model Inputs Generator - Mozilla Firefox
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NASA BAER website - marymill@mtu.edu ...
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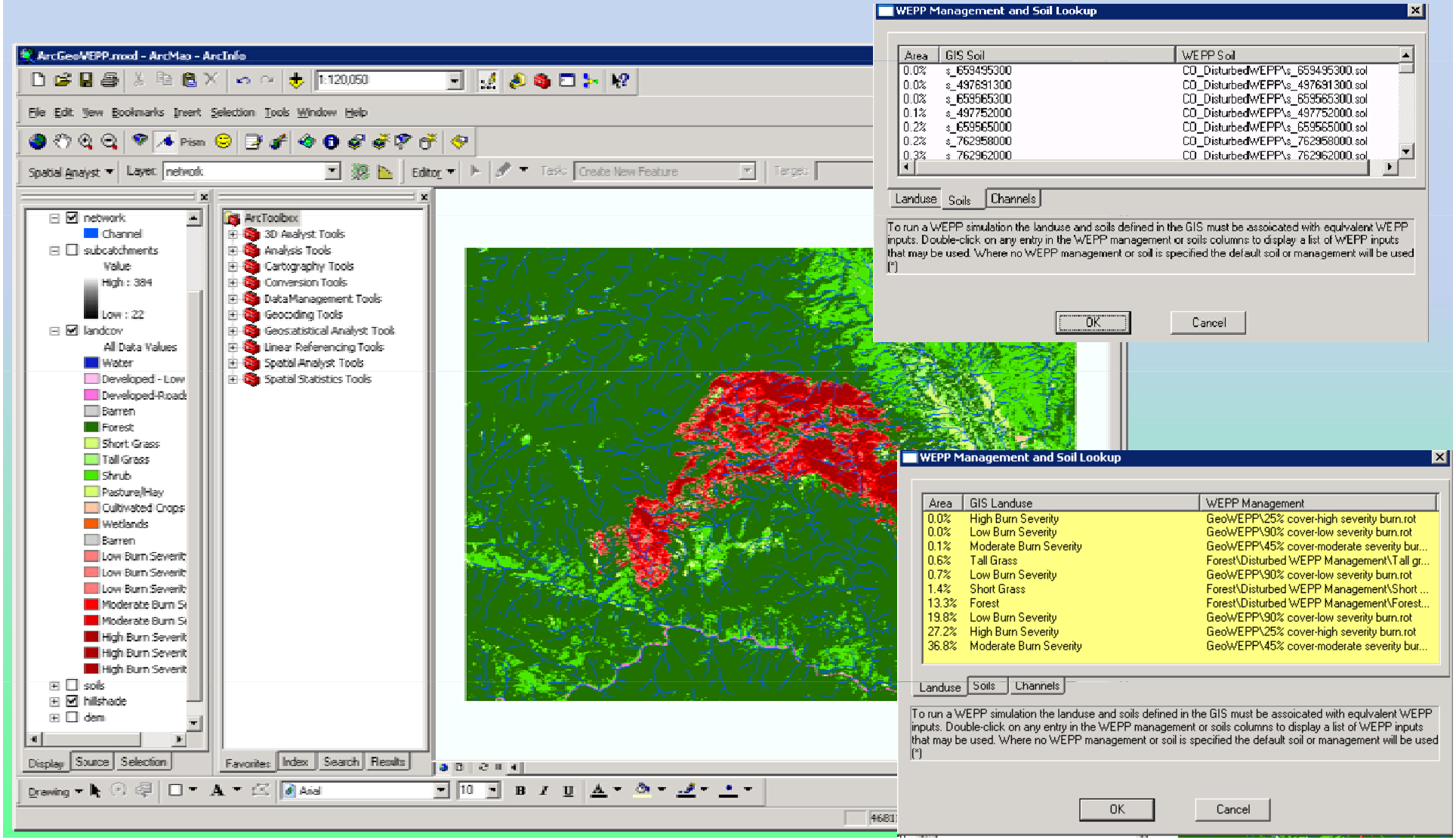
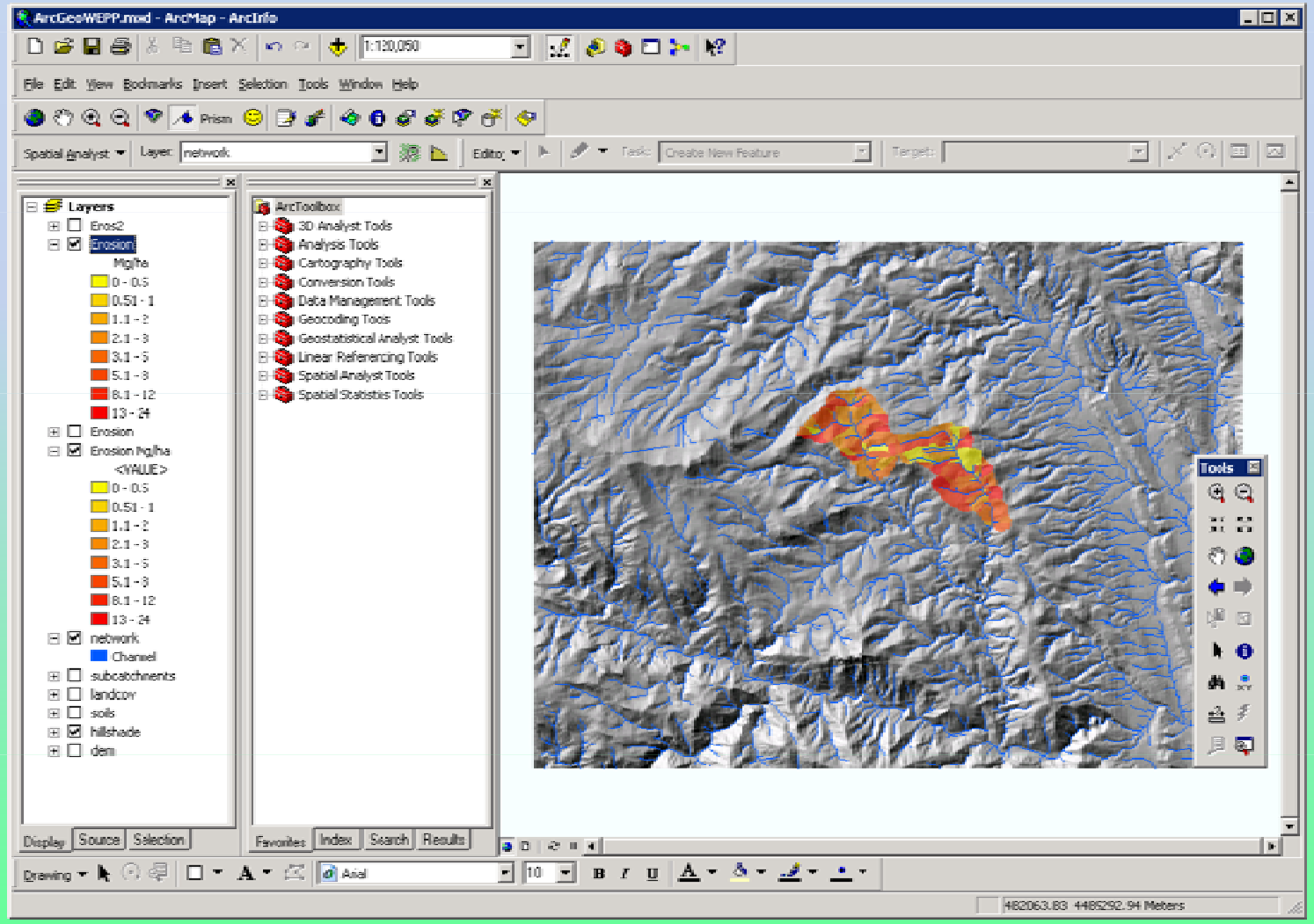
Our proto-type database creates WEPP linkage files!



BAER Teams can focus on modeling!



Future Goals

Phase 1:

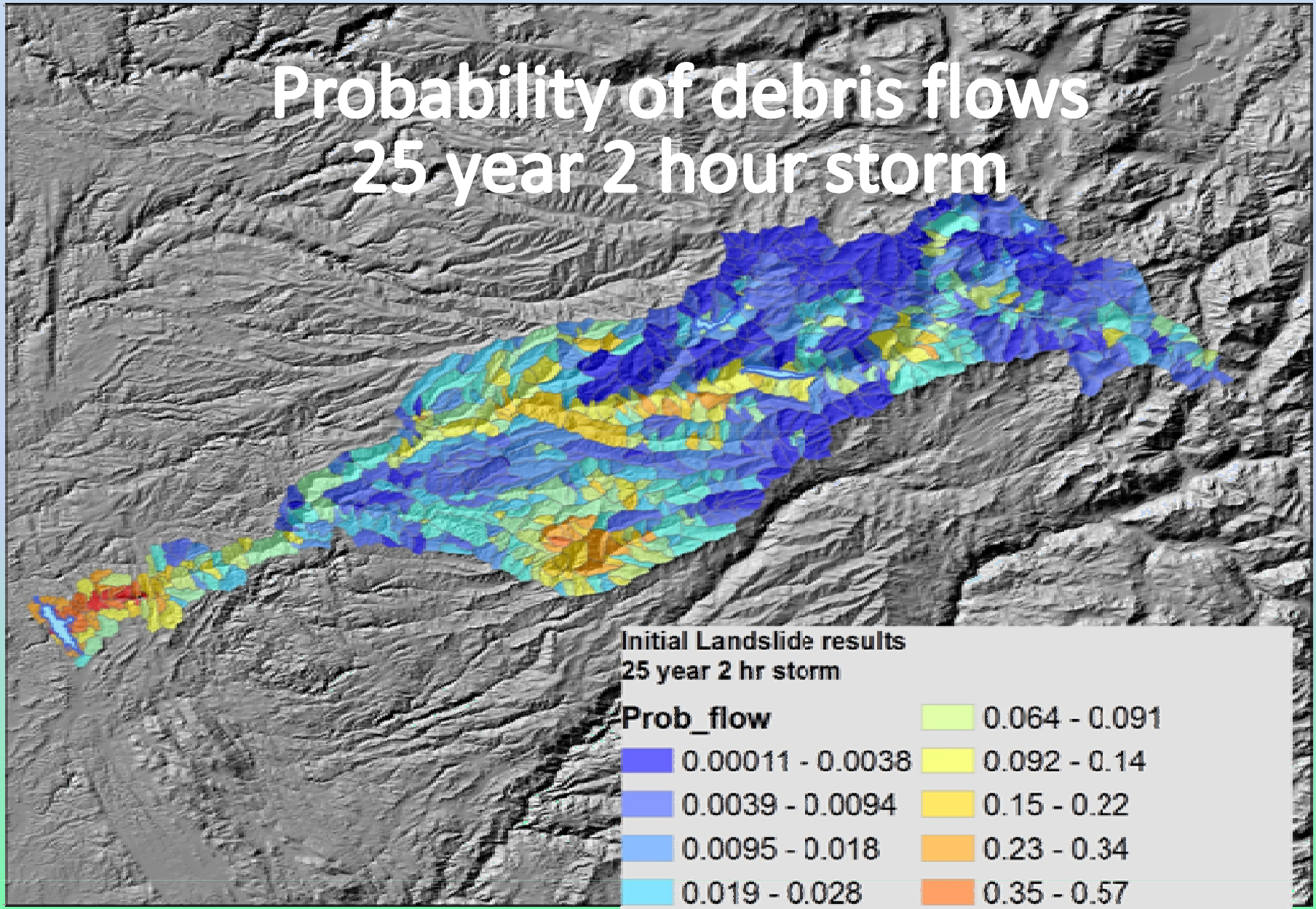
- Import real BARC maps into the online database to provide inputs for the Forest Service's online spatial WEPP and GeoWEPP.
- Expand database to include Arizona and California.

Phase 2:

- Expand database to include fire-prone Western States.
- Support other post-fire models: Debris Flow (Cannon et al. 2010) and Dry Ravel modeling
- Improve model input parameters: glaciated rock vs. talus
- Improve modeling speeds with batch processing!

Cannon, S. H., Gartner, J. E., Rupert, M. G., Michael, J. A., Rea, A. H., & Parrett, C. (2010). Predicting the probability and volume of postwildfire debris flows in the intermountain western United States. *Geological Society of America Bulletin*, *122*(1-2), 127-144.

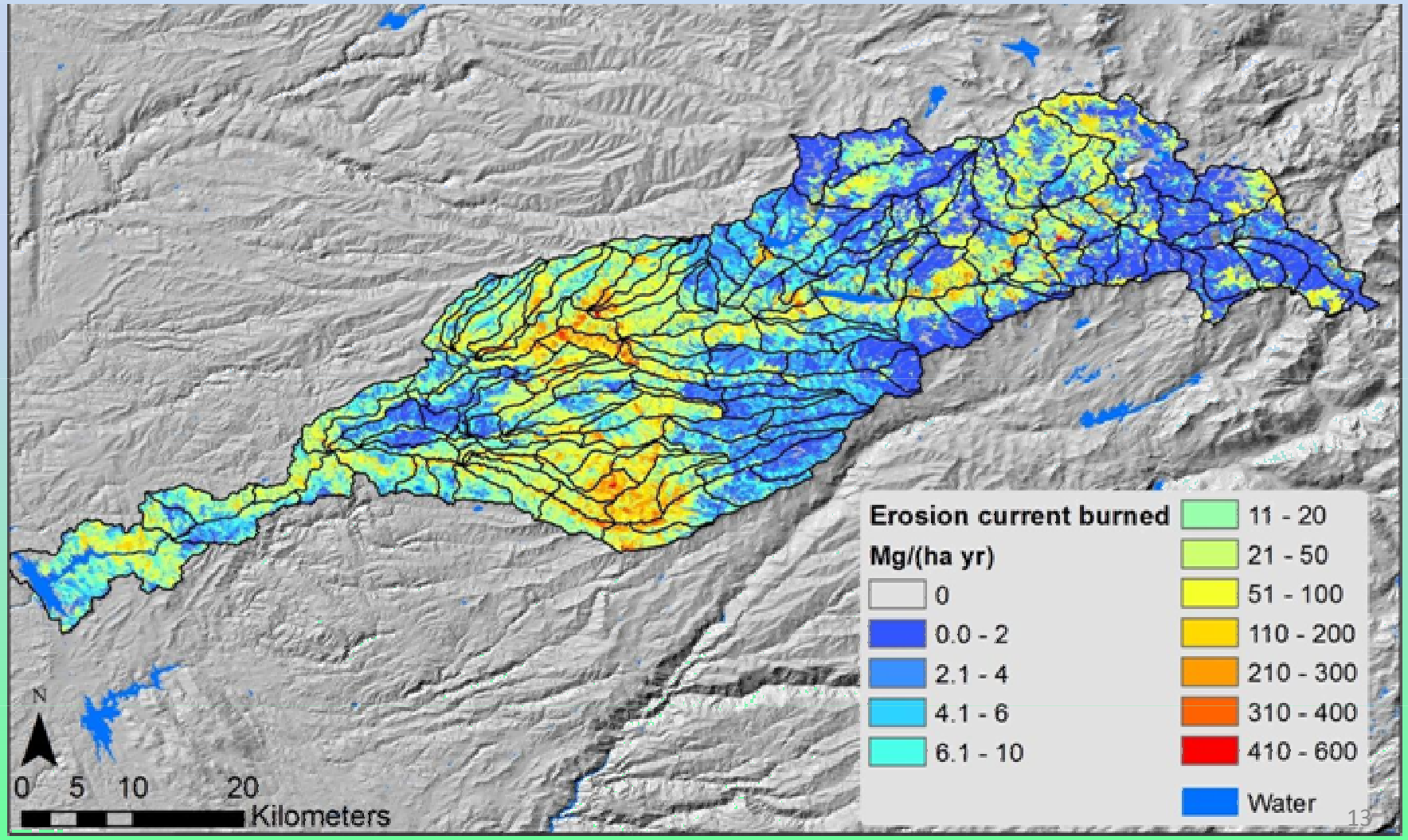
Probability of debris flows 25 year 2 hour storm



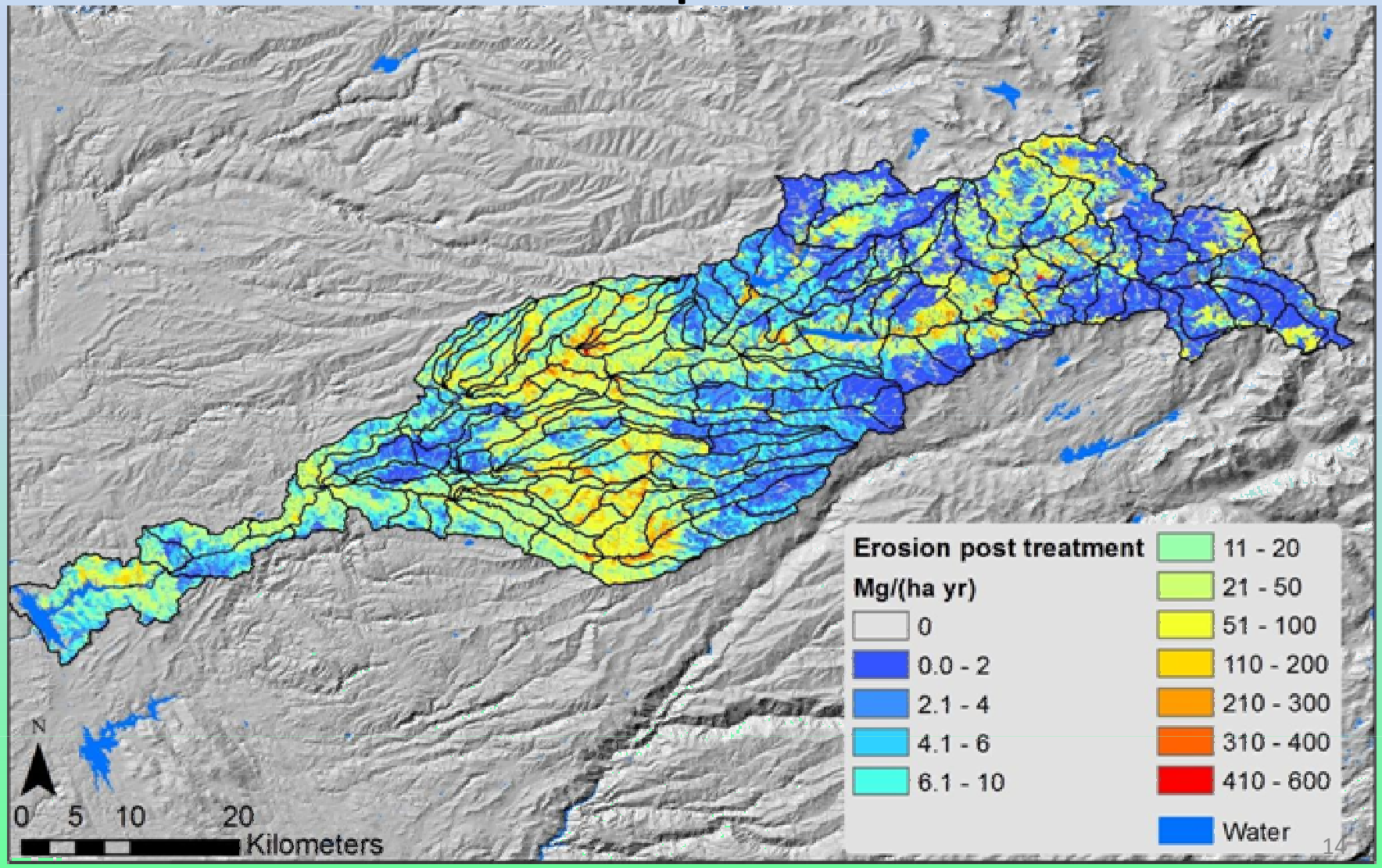
Fuel Reduction planning approach

- Determine hillslope-scale sediment production and runoff for four conditions:
  - Current conditions in the absence of fire;
  - After a fire assuming current fuel conditions;
  - After fuel treatments;
  - After a fire following treatments;
- Need to use two models:
  - **FLAMMAP** to predict fire severity and probability
  - **WEPP Watershed** to predict erosion

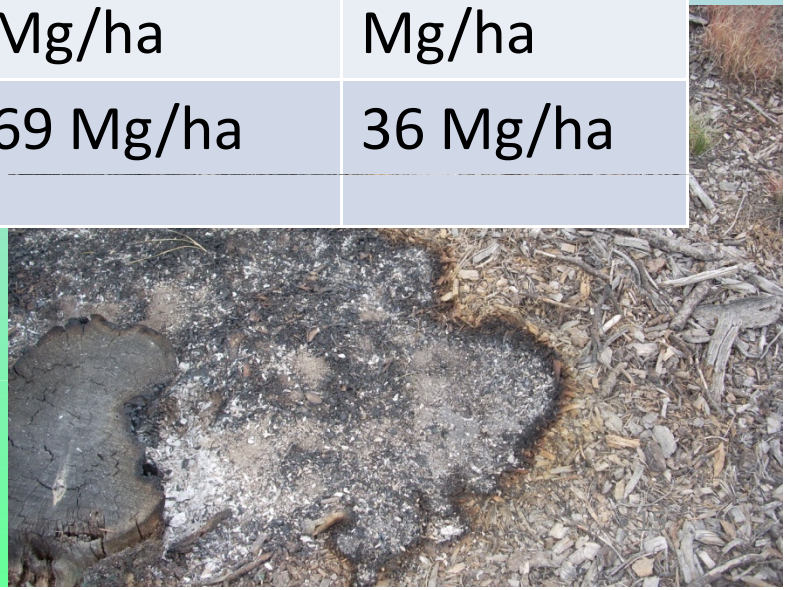
Predicted first year post-fire erosion, no treatments



Predicted first year post-fire erosion if selected hillslopes are treated



Summary of Results for Mokelumne Treatment Area

	Current Condition	Treatment Effects	Fire Following Current Condition	Fire Following Treatment
Average Erosion in Basin	0.40 Mg/ha	0.69 Mg/ha	46 Mg/ha in year 1	26 Mg/ha in year 1
Range	0 – 84 Mg/ha	0 – 84 Mg/ha	0 – 566 Mg/ha	0 – 535 Mg/ha
Standard Dev	2.5 Mg/ha	2.5 Mg/ha	69 Mg/ha	36 Mg/ha

- Steep, relatively bare areas are predicted to have high erosion rates regardless of burning.