



Rapid Response Tools and Datasets to support BAER assessment: Spatial WEPP modeling with QWEPP & the Rapid Response Erosion Database (RRED)

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NASA ARSET Training

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NASA Applied Sciences Program for Wildfires Grant

#NNX12AQ89G

Overview

- Importance of BAER
- WEPP (Water Erosion Prediction Project)
- NASA BAER project and the Rapid Response Erosion Database (RRED)
- QWEPP introduction and DEMO
- NASA BAER in action
- Ravel RAT & Apps for BAER
- Fuels planning with NASA BAER project

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

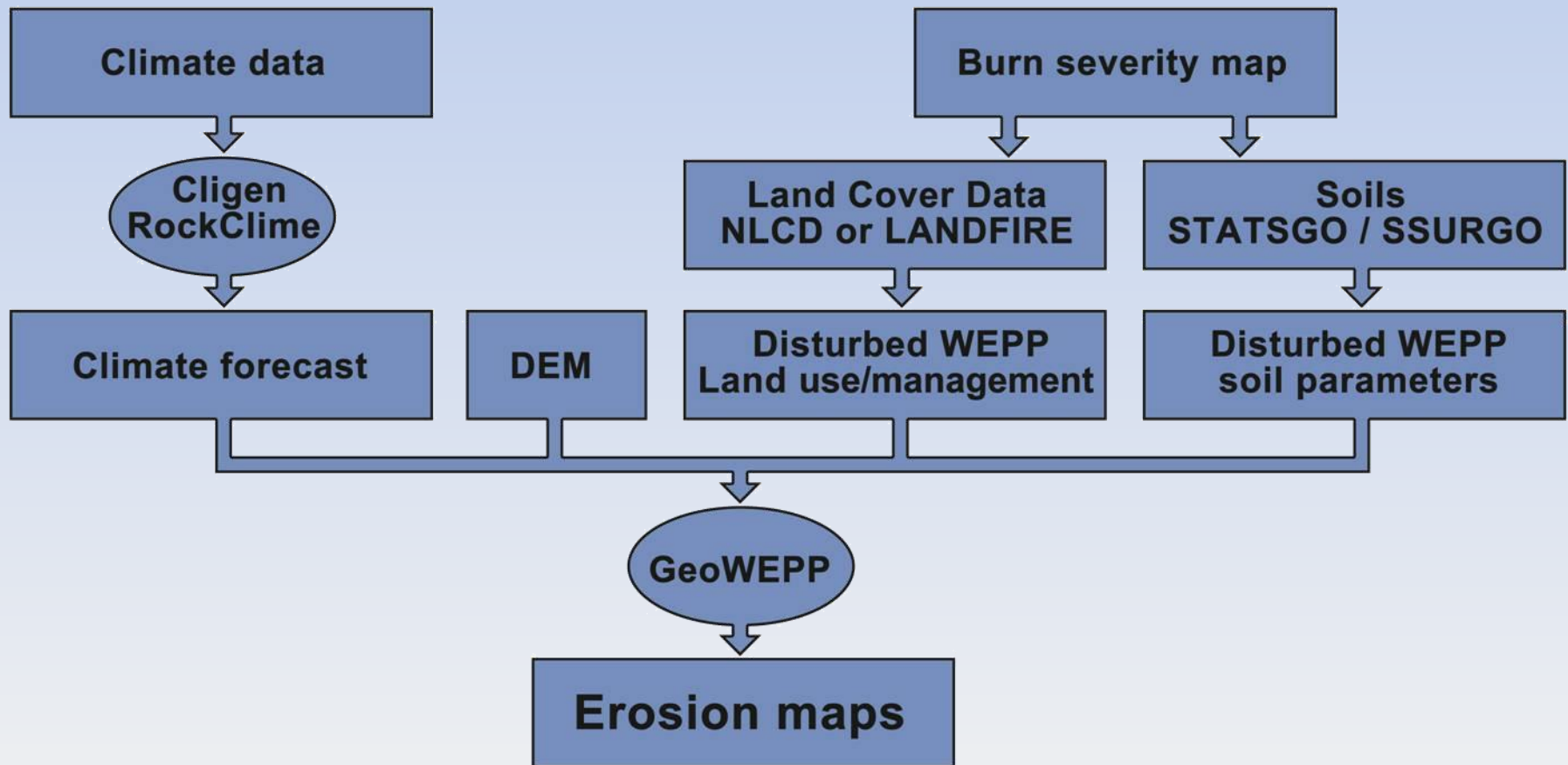
BAER Teams

(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.

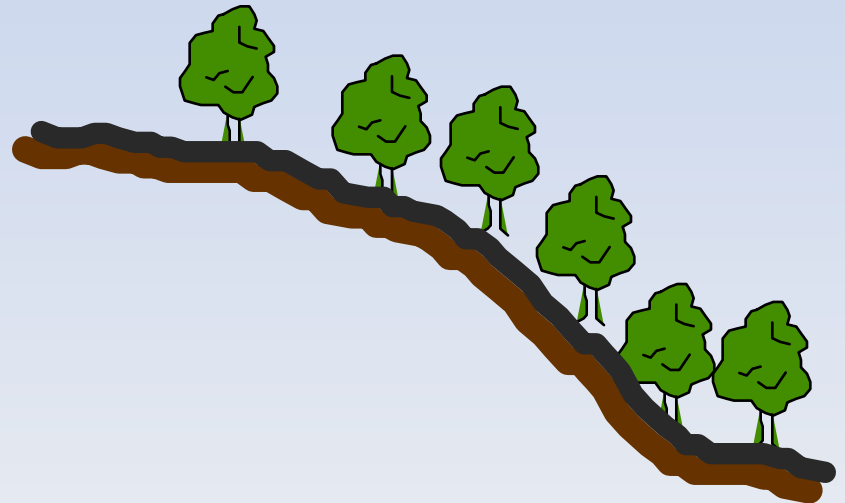


WEPP (Water Erosion Prediction Project) Watershed Erosion Model



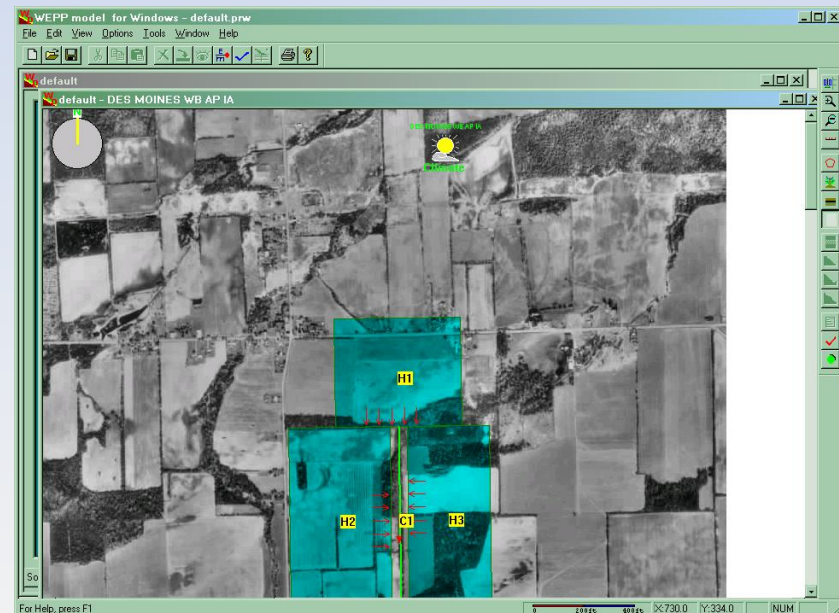
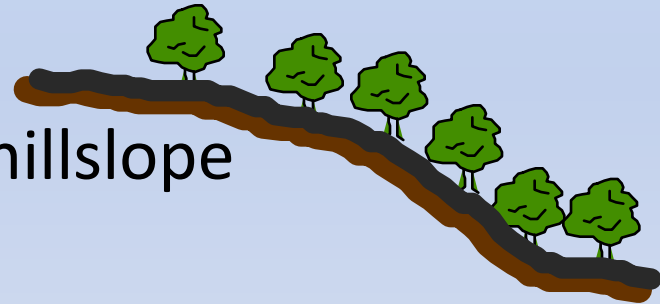
WEPP Versions

- Hillslope
 - Describes a single strip of hillslope



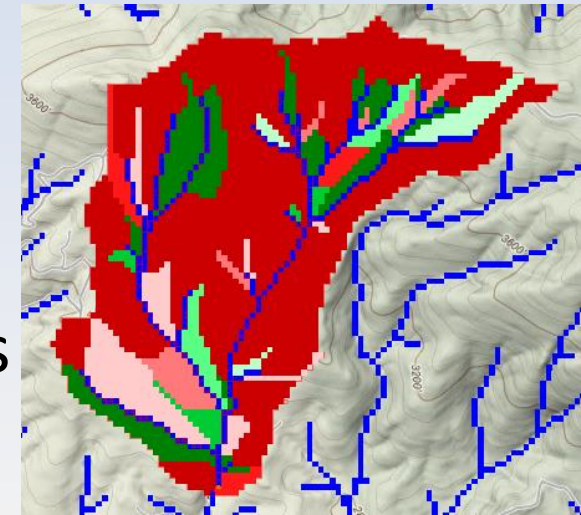
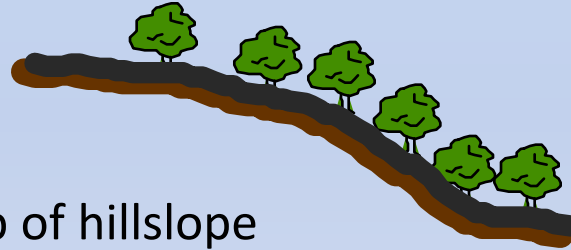
WEPP Versions

- Hillslope
 - Describes a single strip of hillslope
- Watershed
 - Links hillslopes, channels, and impoundments
 - Suits construction sites



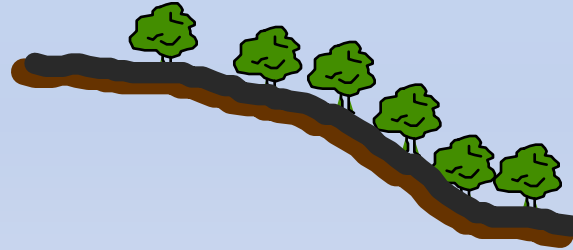
WEPP Versions

- Hillslope
 - Describes a single strip of hillslope
- Watershed
 - Links hillslopes, channels, and impoundments
 - Suits construction sites
- GIS tools
 - New QWEPP interface in QGIS
 - GeoWEPP ArcGIS Wizard
 - Online interface for U.S. databases

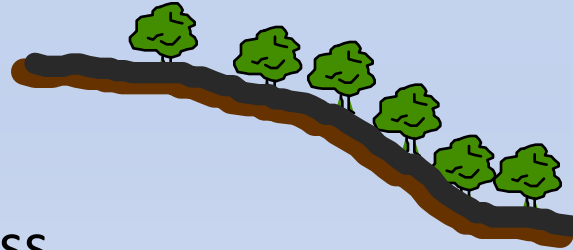


WEPP Inputs

- Slope
 - Distance - Steepness

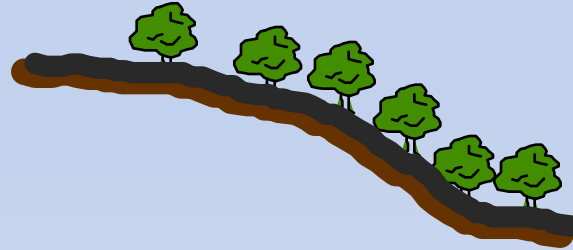


WEPP Inputs



- Slope
 - Distance - Steepness
- Soil
 - WEPP Erodibility based on texture and vegetation
 - Soil texture and depth base on Soil Survey

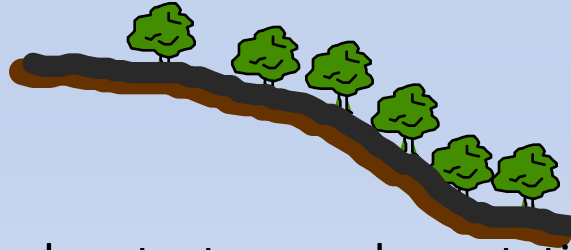
WEPP Inputs



- Slope
 - Distance - Steepness
- Soil
 - WEPP Erodibility based on texture and vegetation
 - Soil texture and depth base on Soil Survey
- Vegetation or Management
 - Initial conditions
 - Vegetation growth and residue decomposition properties

WEPP Inputs

- Slope
 - Distance - Steepness
- Soil
 - WEPP Erodibility based on texture and vegetation
 - Soil texture and depth base on Soil Survey
- Vegetation or Management
 - Initial conditions
 - Vegetation growth and residue decomposition properties
- Climate
 - Daily precip, temperatures and wind speed



WEPP Processes 1

- Rainfall, infiltration, runoff, soil water



WEPP Processes 2

- Rainfall, infiltration, runoff, soil water
- Soil detachment, transport, deposition and delivery



WEPP Processes 3

- Rainfall, infiltration, runoff, soil water
- Soil detachment, transport, deposition and delivery
- Plant growth, evapotranspiration, and senescence



WEPP Processes 4

- Rainfall, infiltration, runoff, soil water
- Soil detachment, transport, deposition and delivery
- Plant growth, evapotranspiration, and senescence
- Residue accumulation and decay



Erosion Processes 1

- Interrill Erosion
 - Raindrop splash
 - Shallow Overland Flow



Erosion Processes 2

- Interrill Erosion
 - Raindrop splash
 - Shallow Overland Flow
- Rill Erosion
 - Concentrated Channel Flow
 - Assumes about 1 m spacing between rills
 - Varied for roads

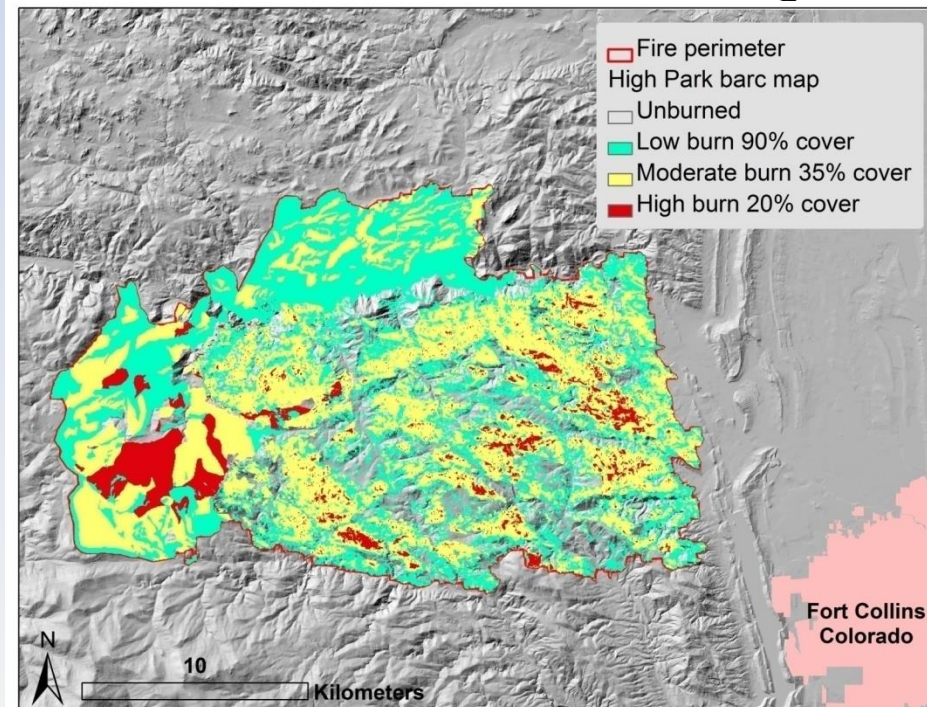
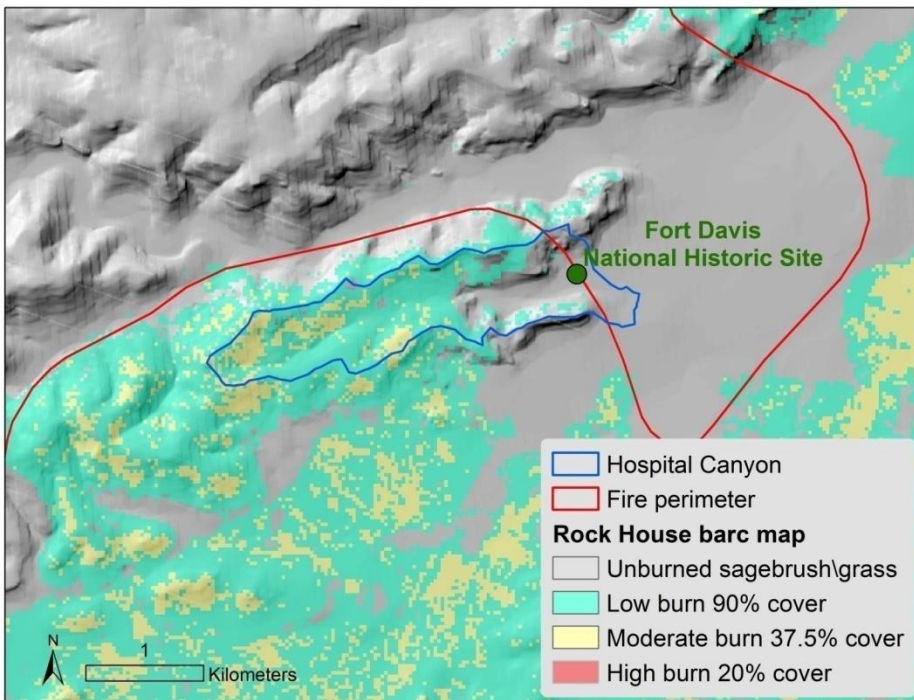


Remote Sensing Data

$$\text{NBR} = (\mathbf{R}_{\text{NIR}} - \mathbf{R}_{\text{SWIR}}) / (\mathbf{R}_{\text{NIR}} + \mathbf{R}_{\text{SWIR}}) \quad (\text{Key \& Benson, 2006})$$

Where: R is the reflectance at the satellite in either the near-infrared (NIR) or the shortwave-infrared (SWIR). The change in NBR between the pre- and post-fire conditions is calculated by:

$$\text{dNBR} = \text{NBR}_{\text{prefire}} - \text{NBR}_{\text{postfire}}$$



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 ; 127,250 ha

Hospital Canyon: 536 acres; 217 ha

BAER Team: National Park Service

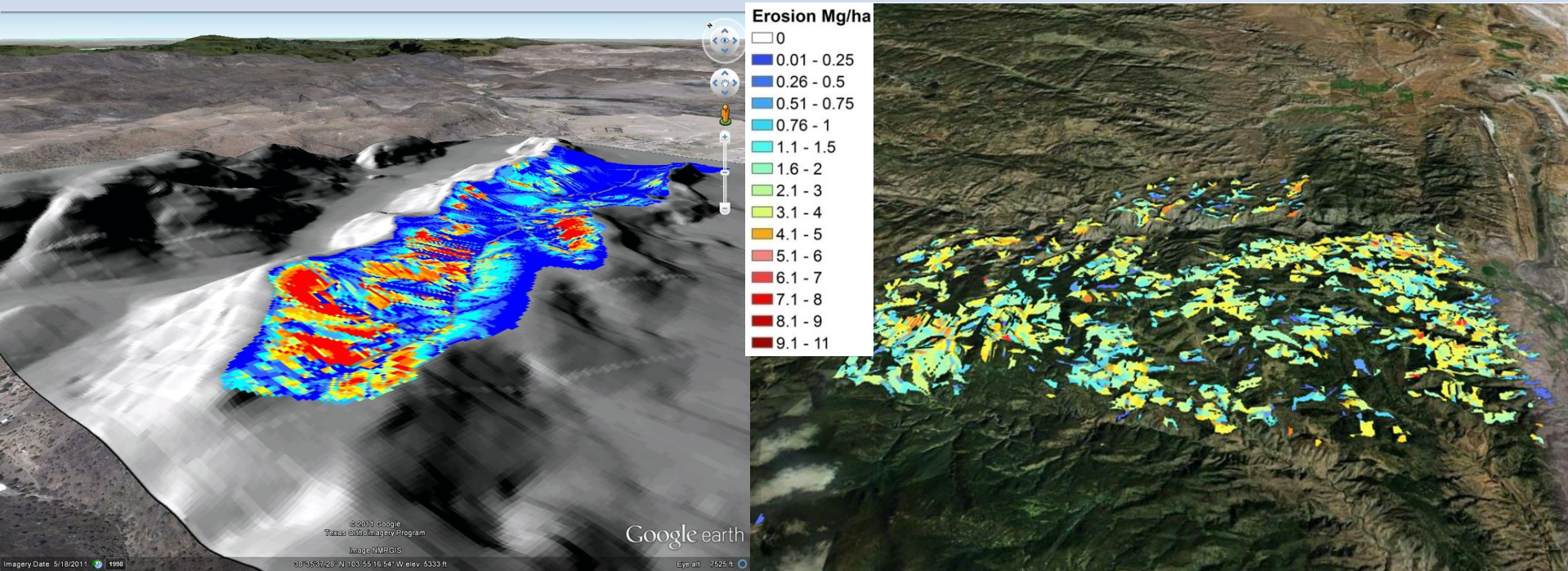
High Park Fire

Date: June 9, 2012

Location: West of Fort Collins, CO

Size: 87,284 acres; 35,322 ha

BAER Team: Forest Service



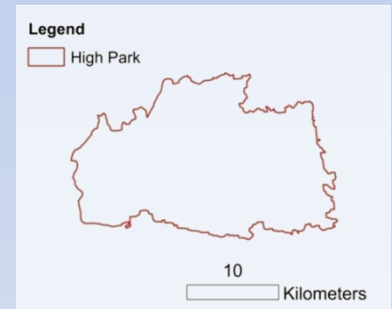
Two Case Studies: Rock House Fire / High Park Fire



Installation of model

ESRI software can be difficult to install

Tip 1: Have the model you want installed and functioning!



Model already installed and ready to go!

Tip 2: Have inputs ready!

All inputs had to be gathered after the fire:

Soils and land cover take time to build;
Soils data need processing to get key values;
Land cover and soil files need to be modified by burn severity!

Most inputs prepared ahead of time

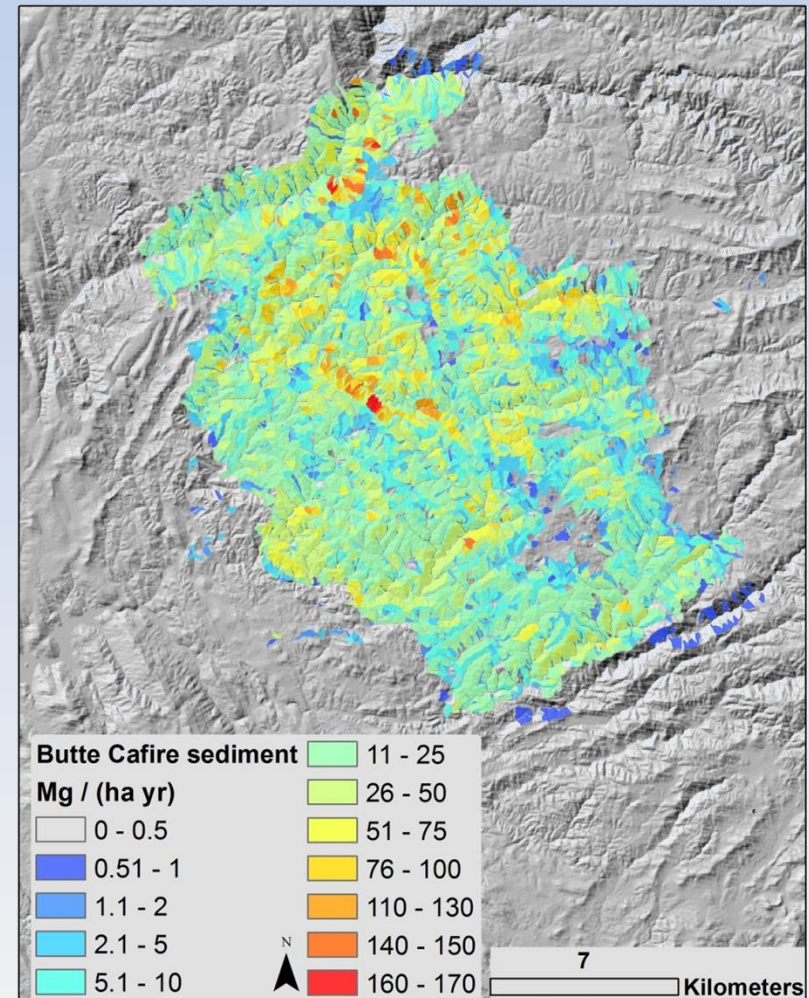
Land cover and DEM prepared;
Soils were mapped and data organized;
Still have to modify land cover and soils by burn severity!

Solution

Spatial process-based erosion models are underutilized due to time constraints;

- Prepare datasets and tools before the fire occurs!
- Modelers also need to prepare the model and practice before hand!

Calfire SBS hillslope erosion yields for Butte Fire



Modeling Datasets

- Burn Severity: User Supplied & Monitoring Trends in Burn Severity project
- Soils: USDA SSURGO and STATSGO datasets
- Land cover: Existing Vegetation Type (EVT) data from the LANDFIRE
- 30m & 10m DEM data from the United States Geological Survey (USGS) Seamless Data Warehouse.

http://geodjango.mtri.org/geowepp/

The screenshot shows a web browser window displaying the "Burned Area Emergency Response" Spatial WEPP Model Inputs Generator. The browser's address bar shows the URL "geodjango.mtri.org/geowepp/". The page has a blue header with the title "Burned Area Emergency Response" and subtitle "Spatial WEPP Model Inputs Generator".

The interface is divided into several sections:

- Navigation:** "Spatial WEPP Products" and "Static Files" tabs are visible.
- Map Controls:** Includes "Help", "Locate Me on Map", and a checked "Show available data on map" option.
- Map:** A map of the United States and Mexico is shown with a blue outline indicating a selected area. The Michigan Tech Research Institute logo is in the top right corner of the map area.
- Form Fields:**
 - Draw Burned Area Extent on the Map:** A "Draw Selection on Map" button.
 - Or, Select an MTBS Fire:** Fields for "Select state:", "Select year:", and "Select an MTBS fire:". A checked option "Burn land cover and soil layers by MTBS fire" is present.
 - Or, Use a Custom BARC Map:** "Upload BARC Map" and "Use My Private Key" buttons.
 - Options:** "Use 10m DEM" checkbox is unchecked.
 - Products:** "Land cover and linkage files", "Soils and linkage files", and "Digital elevation model (DEM)" checkboxes are all checked.
 - File format:** "ASCII Grid (*.asc)" is selected.
- Download Queue:** A "Download ZIP Arch" button is visible at the bottom of the form area.

At the bottom of the page, there is a footer with attribution: "Leaflet | Icons by Farm Fresh | Tiles © Esri — Sources: GEBCO, NOAA, CHS, OSU, UNH, CSUMB, National Geographic, DeLorme, NAVTEQ, and Esri".

Spatial WEPP Model x

geodjango.mtri.org/geowepp/

Burned Area Emergency Response

Spatial WEPP Model Inputs Generator

Spatial WEPP Products Static Files

Draw Burned Area Extent on the Map

Draw Selection on Map

Or, Select an MTBS Fire

Select state: CO

Select year: 2002 (45 fires)

Select an MTBS fire: HAYMAN_E

Burn land cover and soil layers by MTBS fire

Or, Use a Custom BARC Map

Upload BARC Map Use My Private Key

Products:

- Land cover and linkage files
- Soils and linkage files
- Digital elevation model (DEM)

File format: ASCII Grid (*.asc)

Download ZIP Archive Add to Download

Download Queue

Upload BARC Map

Select a raster file to upload:

Specify the values of burn severity classes in the uploaded raster. Any value that is not Low, Moderate, or High will be reclassified as Unburned:

Low: 2

Moderate: 3

High: 4

Optional parameters:

Buffer my burned area by 10 pixels

EPSG code (SRID):

For best results, your BARC map should have 30-meter pixels. BARC maps with a pixel size other than 30 meters will be resampled to 30 meters, which may result in misalignment of the output data compared to the original BARC map.

A private key will be generated which grants you future access to your uploaded data. Only this key can be used to access the BARC map you uploaded and it will expire, along with your uploaded data, after 14 days. Within that time, use this key instead of uploading the file again.

Cancel Upload

Michigan Tech Research Institute

United States

Chicago

Dallas

Houston

Gulf of Mexico

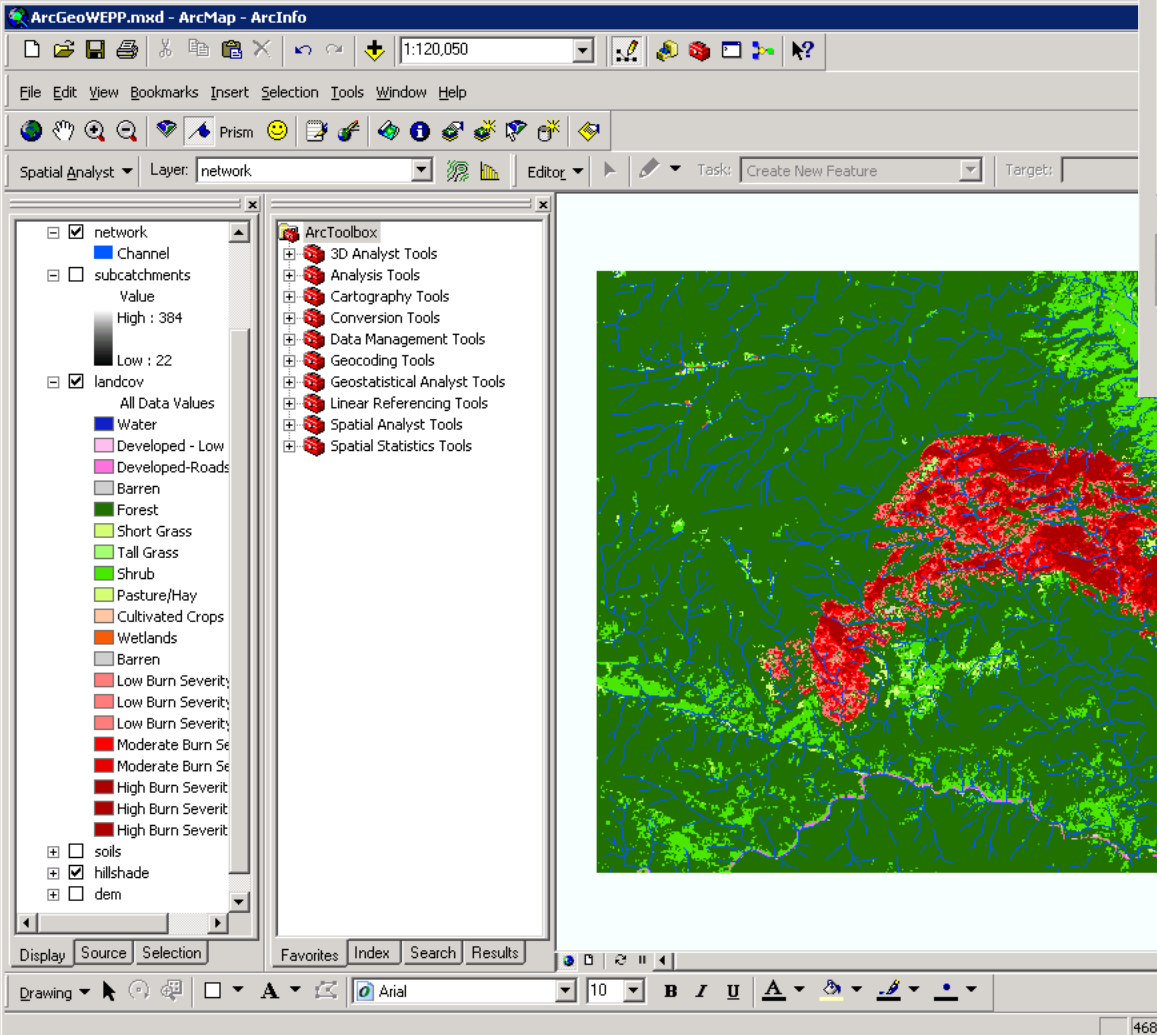
Leaflet | Icons by Farm Fresh | Tiles © Esri — Sources: GEBCO, NOAA, CHS, OSU, UNH, CSUMB, National Geographic, DeLorme, NAVTEQ, and Esri

Soil Burn Severity (SBS) Map

Most soil burn severity (SBS) maps are derived from Landsat data – so if you are creating the SBS map leaving it in the native projection and raster format is best!

- Data needs to be in a classified raster format with three classes represented numerically – low, moderate and high
- Best if raster has a resolution of ~ 30 m
- Projection needs to be standard – UTM nad83 or UTM wgs 84 work best

RRED creates WEPP linkage files!



WEPP Management and Soil Lookup

Area	GIS Soil	WEPP Soil
0.0%	s_659495300	CO_DisturbedWEPP\s_659495300.sol
0.0%	s_497691300	CO_DisturbedWEPP\s_497691300.sol
0.0%	s_659565300	CO_DisturbedWEPP\s_659565300.sol
0.1%	s_497752000	CO_DisturbedWEPP\s_497752000.sol
0.2%	s_659565000	CO_DisturbedWEPP\s_659565000.sol
0.2%	s_762958000	CO_DisturbedWEPP\s_762958000.sol
0.3%	s_762962000	CO_DisturbedWEPP\s_762962000.sol

Landuse Soils Channels

To run a WEPP simulation the landuse and soils defined in the GIS must be associated with equivalent WEPP inputs. Double-click on any entry in the WEPP management or soils columns to display a list of WEPP inputs that may be used. Where no WEPP management or soil is specified the default soil or management will be used (*).

OK Cancel

WEPP Management and Soil Lookup

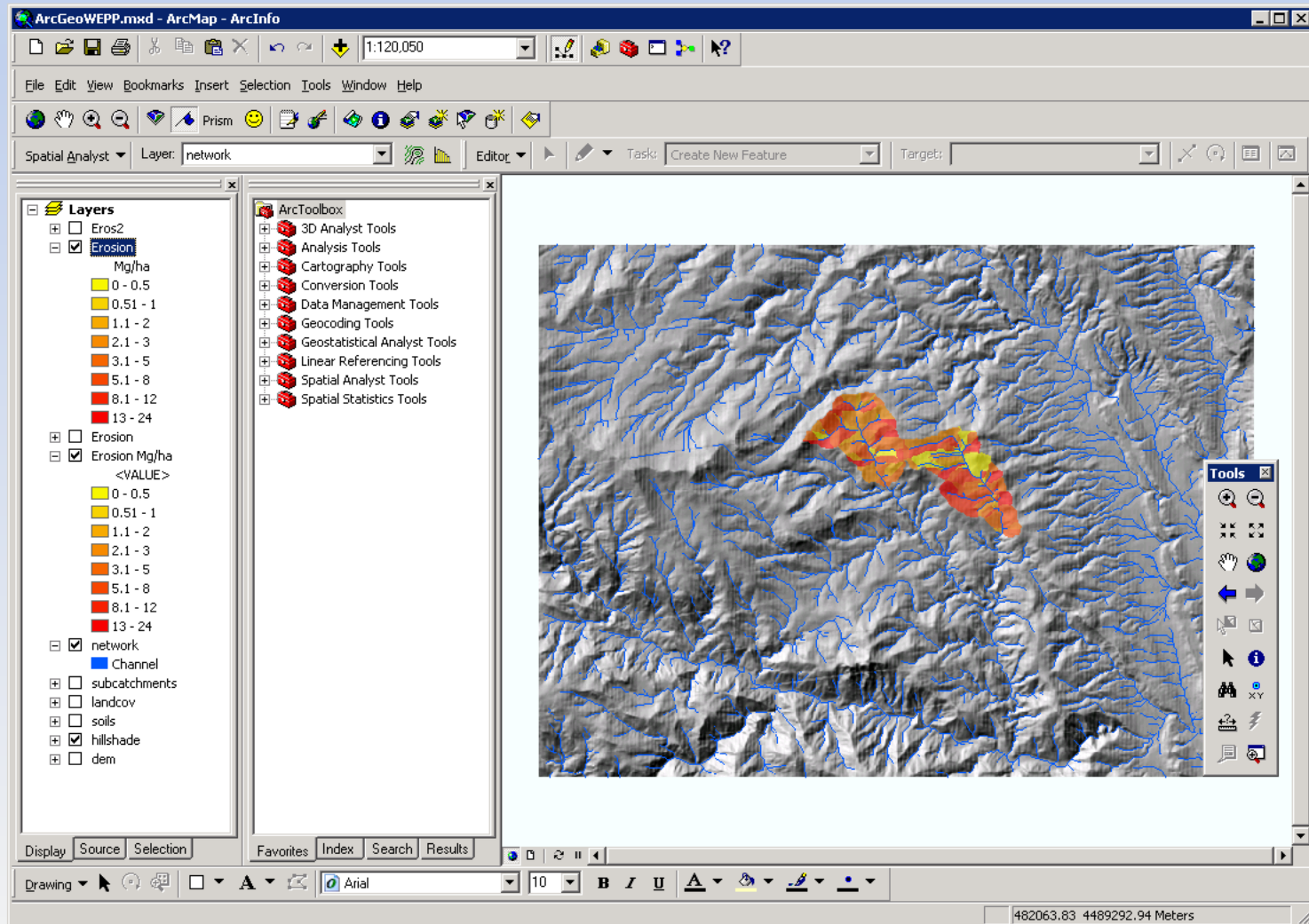
Area	GIS Landuse	WEPP Management
0.0%	High Burn Severity	GeoWEPP\25% cover-high severity burn.rot
0.0%	Low Burn Severity	GeoWEPP\90% cover-low severity burn.rot
0.1%	Moderate Burn Severity	GeoWEPP\45% cover-moderate severity bur...
0.6%	Tall Grass	Forest\Disturbed WEPP Management\Tall gr...
0.7%	Low Burn Severity	GeoWEPP\90% cover-low severity burn.rot
1.4%	Short Grass	Forest\Disturbed WEPP Management\Short ...
13.3%	Forest	Forest\Disturbed WEPP Management\Forest...
19.8%	Low Burn Severity	GeoWEPP\90% cover-low severity burn.rot
27.2%	High Burn Severity	GeoWEPP\25% cover-high severity burn.rot
36.8%	Moderate Burn Severity	GeoWEPP\45% cover-moderate severity bur...

Landuse Soils Channels

To run a WEPP simulation the landuse and soils defined in the GIS must be associated with equivalent WEPP inputs. Double-click on any entry in the WEPP management or soils columns to display a list of WEPP inputs that may be used. Where no WEPP management or soil is specified the default soil or management will be used (*).

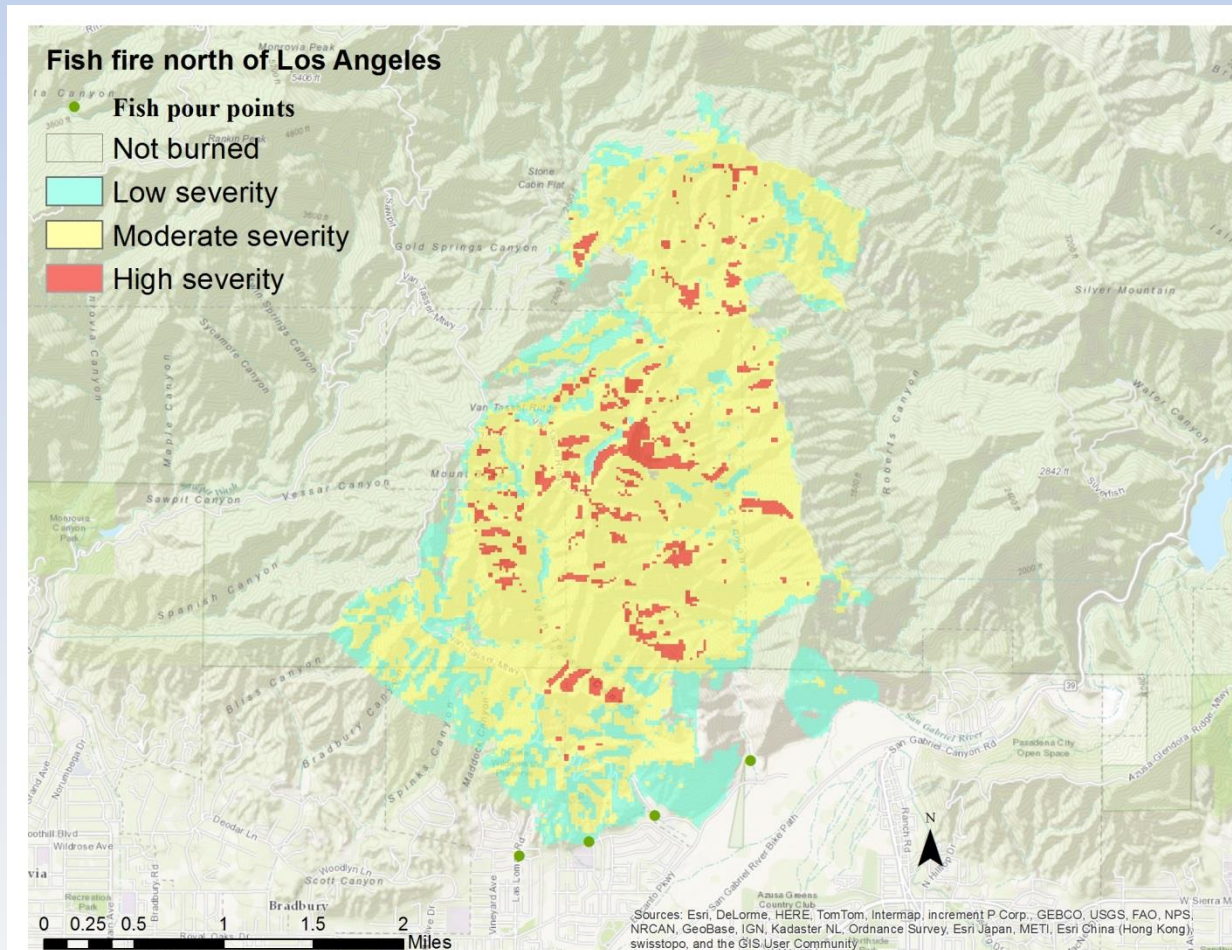
OK Cancel

BAER Teams can focus on modeling!



RRED DEMO

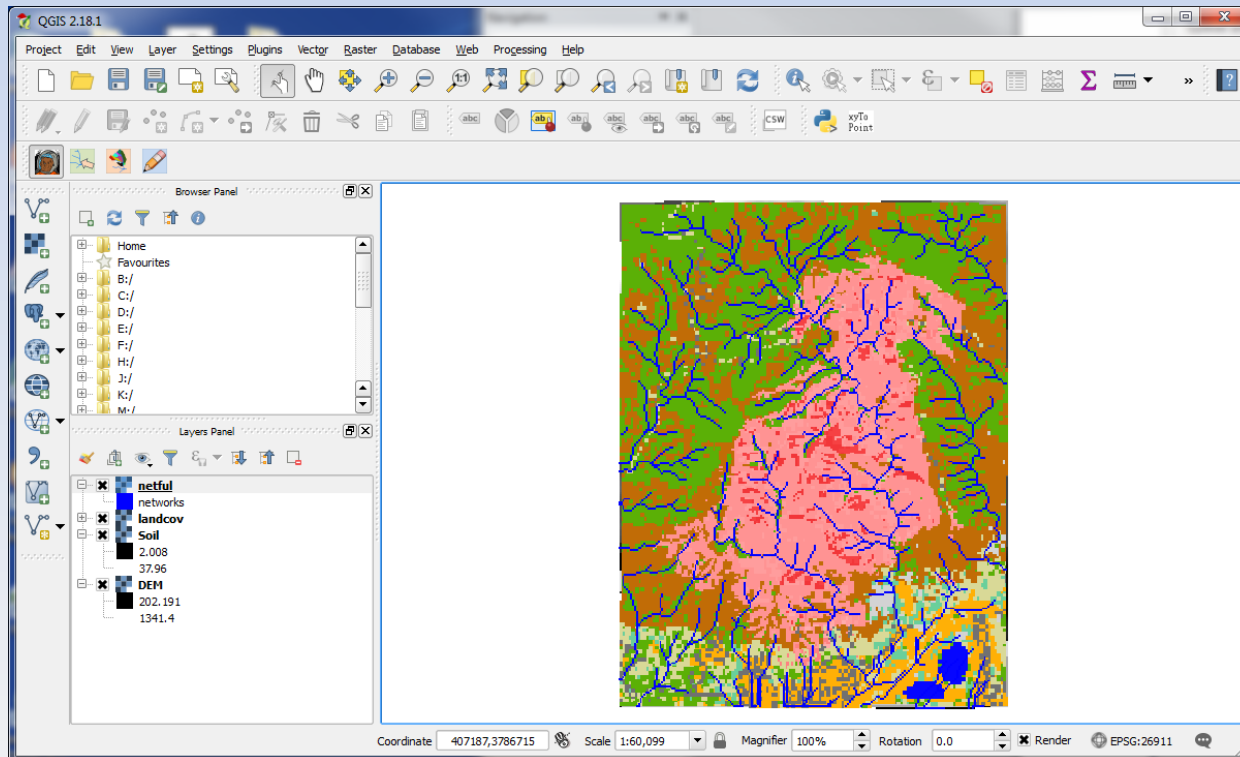
- Rapid Response Erosion Database Example



QGIS Spatial interface for WEPP

QWEPP

- Easy to use geographical interface for the **Water Erosion Prediction Project!**



QWEPP

- In order to utilize QWEPP users will need **QGIS software** installed and the **QWEPP plugin**.
- You need the .NET Framework and at least 250 MB of hard drive space.
- For QGIS installation software and instructions go to:
<http://www.qgis.org/en/site/forusers/download.html>.

QWEPP Software Components

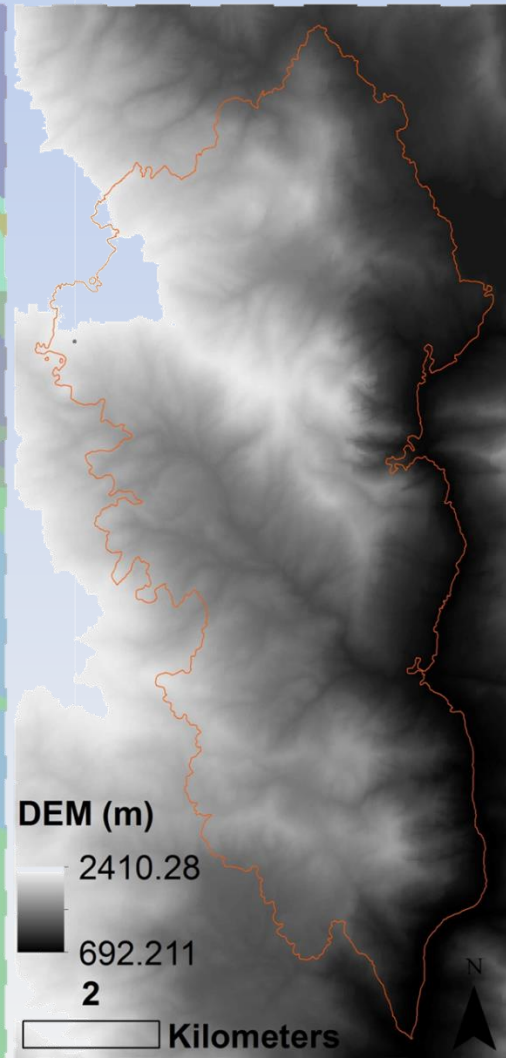
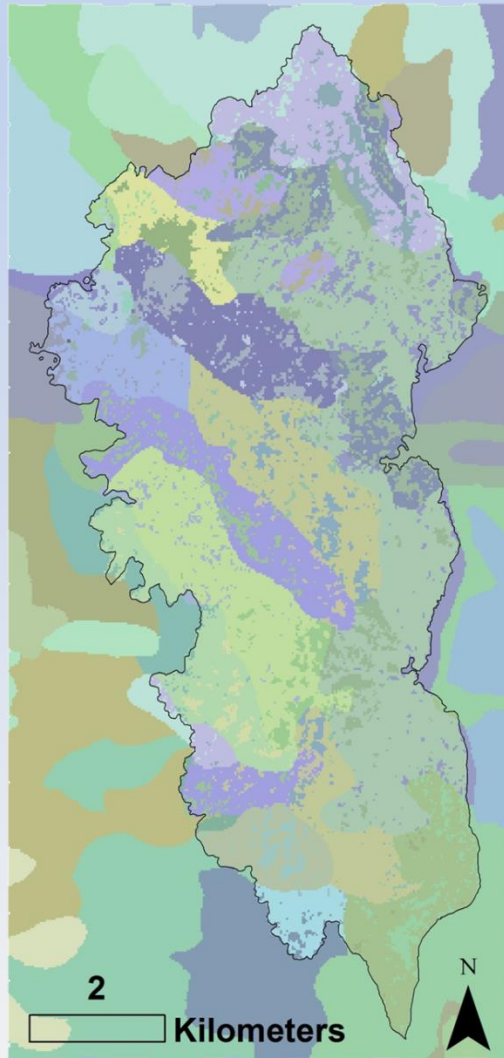
- QGIS– provides the GIS framework for display, tools for assembling and manipulating spatial data.
- QWEPP – plugin to collect user inputs, run model and assemble results.
- USDA-ARS TOPAZ - uses DEM to delineate channels, delineate watershed from outlet, create the topographic slope files needed to run WEPP.
- Topwepp2 – create WEPP inputs from gridded data and translate between TOPAZ watershed files to WEPP model inputs.
- WEPP – Process based erosion model!

Spatial Inputs from the French Fire (CA, 2014)

Soils

DEM

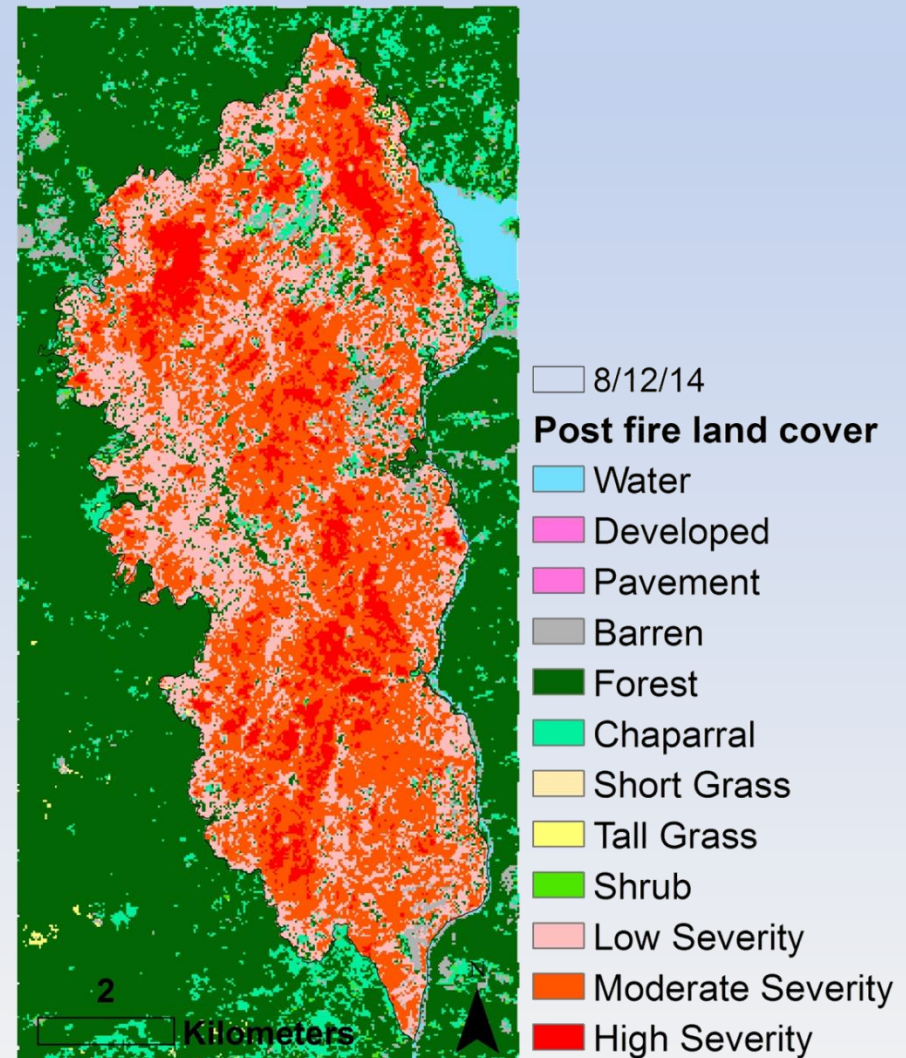
Land cover



- 8/12/14
- Post fire land cover
- Water
- Developed
- Pavement
- Barren
- Forest
- Chaparral
- Short Grass
- Tall Grass
- Shrub
- Low Severity
- Moderate Severity
- High Severity

WEPP Linkage files

- Simple text files
- Four files
 - landcov.txt
 - landusedb.txt
 - soilsmat.txt
 - soilsdb.txt



Land Cover linkage files

```
landcov.txt - Notepad
File Edit Format View Help
11 Open Water
12 snow/ice
22 Developed - Low Intensity
23 Developed-Roads
31 Barren
40 Young Forest
41 Forest
52 Chaparral
70 Short Grass
71 Tall Grass
73 Shrub
81 Pasture/Hay
82 Cultivated Crops
91 Wetlands
100 Low Burn Severity
111 Open Water
112 snow/ice
122 Low Burn Severity
123 Developed-Roads
131 Barren
140 Low Burn Severity
141 Low Burn Severity
152 Low Burn Severity
170 Low Burn Severity
171 Low Burn Severity
173 Low Burn Severity
181 Low Burn Severity
182 Low Burn Severity
191 Low Burn Severity
200 Moderate Burn Severity
211 Open Water
222 Moderate Burn Severity
223 Developed-Roads
231 Barren
240 Moderate Burn Severity
241 Moderate Burn Severity
252 Moderate Burn Severity
```

```
landusedb.txt - Notepad
File Edit Format View Help
Low Burn Severity|FC_85%.rot
High Burn Severity|FC_25%.rot
Moderate Burn Severity|FC_60%.rot
Chaparral|Mokelumne\Chaparral.rot
Open Water|GeoWepp\grass.rot
Forest|Mokelumne\Forest Perennial.rot
Young Forest|Mokelumne\Young Forest.rot
Short Grass|Mokelumne\Short grass.rot
Tall Grass|Mokelumne\Tall grass.rot
Shrub|Mokelumne\Shrub.rot
Developed - Low Intensity|Mokelumne\Short grass.rot
Developed-Roads|Pavement.rot
Barren|Mokelumne\Barren.rot
Pasture/Hay|Mokelumne\alfalfa with cuttings.rot
Cultivated Crops|Mokelumne\winter wheat, mulch till CA.rot
Wetlands|GeoWepp\grass.rot
snow/ice|GeoWepp\grass.rot
```

Soil linkage files

```
soilsmap.txt - Notepad
File Edit Format View Help
1,100,s_1014342011
2,100,s_1014342041
3,100,s_1014342070
4,100,s_1014342071
5,100,s_1014342073
6,100,s_1014343011
7,100,s_1014343040
8,100,s_1014343041
9,100,s_1014343070
10,100,s_1014343071
11,100,s_1014343073
12,100,s_1014343100
13,100,s_1014343300
14,100,s_1014344011
15,100,s_1014344041
16,100,s_1014344070
17,100,s_1014344071
18,100,s_1014344073
19,100,s_1014347011
20,100,s_1014347041
21,100,s_1014347070
22,100,s_1014347071
23,100,s_1014347073
24,100,s_1014347100
25,100,s_1014353041
26,100,s_1014353070
27,100,s_1014353071
28,100,s_1014353073
29,100,s_1014354011
30,100,s_1014354041
31,100,s_1014354070
32,100,s_1014354071
33,100,s_1014354073
34,100,s_1014355041
35,100,s_1014355070
36,100,s_1014355071
37,100,s_1014355073
```

```
soilsdb.txt - Notepad
File Edit Format View Help
s_1014342011|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014342011.sol
s_1014342041|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014342041.sol
s_1014342070|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014342070.sol
s_1014342071|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014342071.sol
s_1014342073|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014342073.sol
s_1014343011|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014343011.sol
s_1014343040|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014343040.sol
s_1014343041|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014343041.sol
s_1014343070|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014343070.sol
s_1014343071|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014343071.sol
s_1014343073|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014343073.sol
s_1014343100|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014343100.sol
s_1014343300|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014343300.sol
s_1014344011|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014344011.sol
s_1014344041|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014344041.sol
s_1014344070|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014344070.sol
s_1014344071|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014344071.sol
s_1014344073|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014344073.sol
s_1014347011|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014347011.sol
s_1014347041|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014347041.sol
s_1014347070|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014347070.sol
s_1014347071|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014347071.sol
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s_1014347100|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014347100.sol
s_1014353041|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014353041.sol
s_1014353070|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014353070.sol
s_1014353071|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014353071.sol
s_1014353073|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014353073.sol
s_1014354011|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014354011.sol
s_1014354041|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014354041.sol
s_1014354070|Disturbedwepp_KEY-4ae0f3982b6b935a9031dea3f1b3c3f4/s_1014354070.sol
```

TOPAZ inputs: CSA, MSCL

- CSA : Critical Source Area
 - Determines when a channel forms
 - Current default setting is 30 ha
- MSCL – Minimum Source Channel Length
 - Minimum channel length needed to initiate a channel
 - Current default is 100 m

TOPAZ inputs: CSA, MSCL

CSA 5 ha

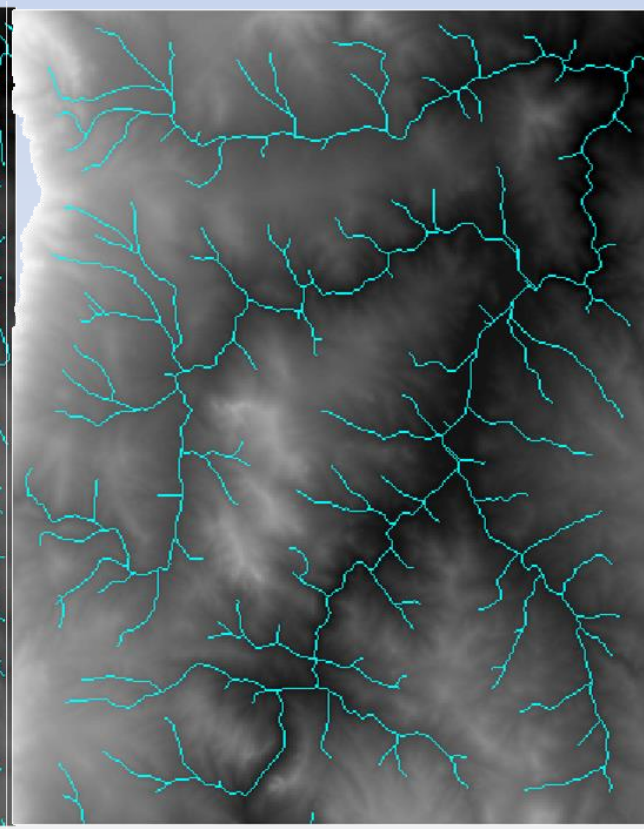
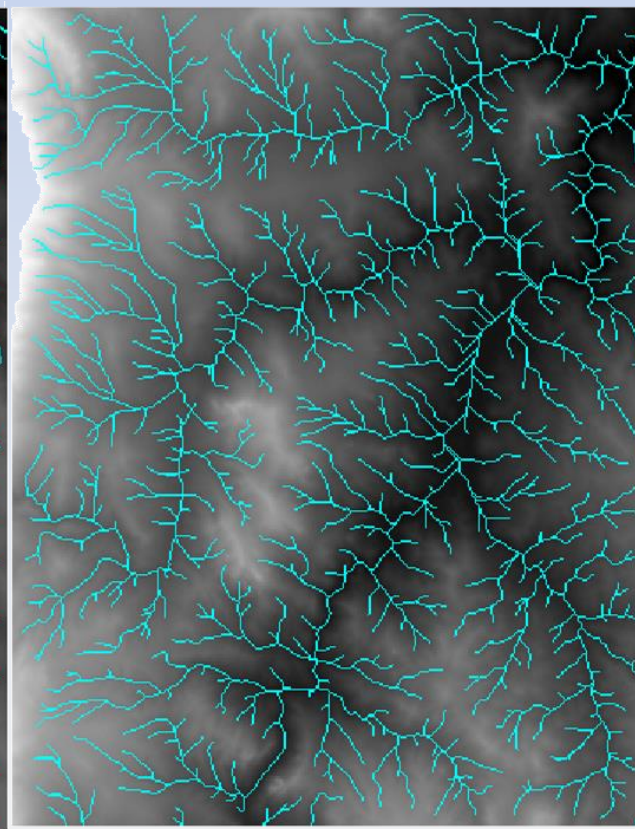
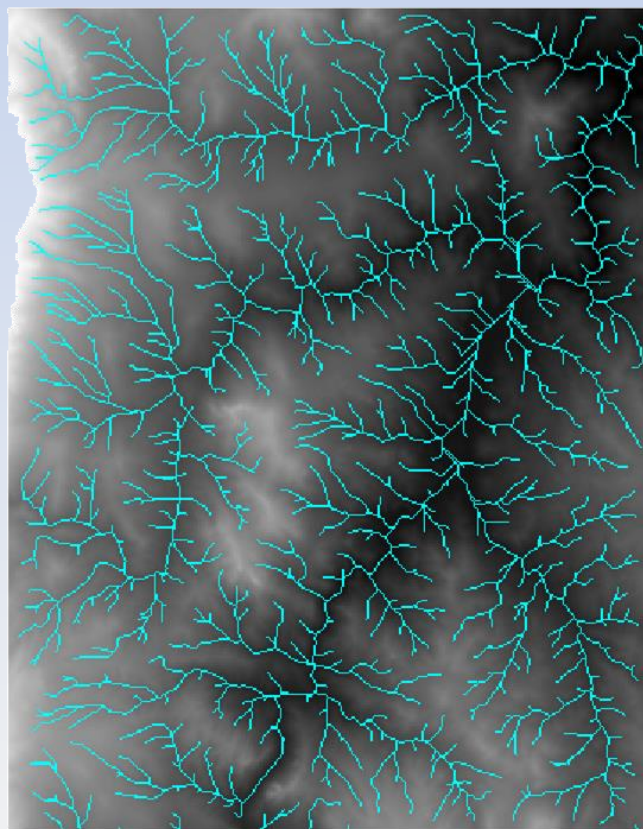
MSCL 60 m

CSA 5 ha

MSCL 100 m

CSA 30 ha

MSCL 100 m



Watershed vs. Flowpath

Watershed Method

- Each hillslope has one:
 - Slope profile
 - Dominant land cover
 - Dominant soil type
- Offsite assessment as the spatial results represent the sediment yield that leaves each hillslope

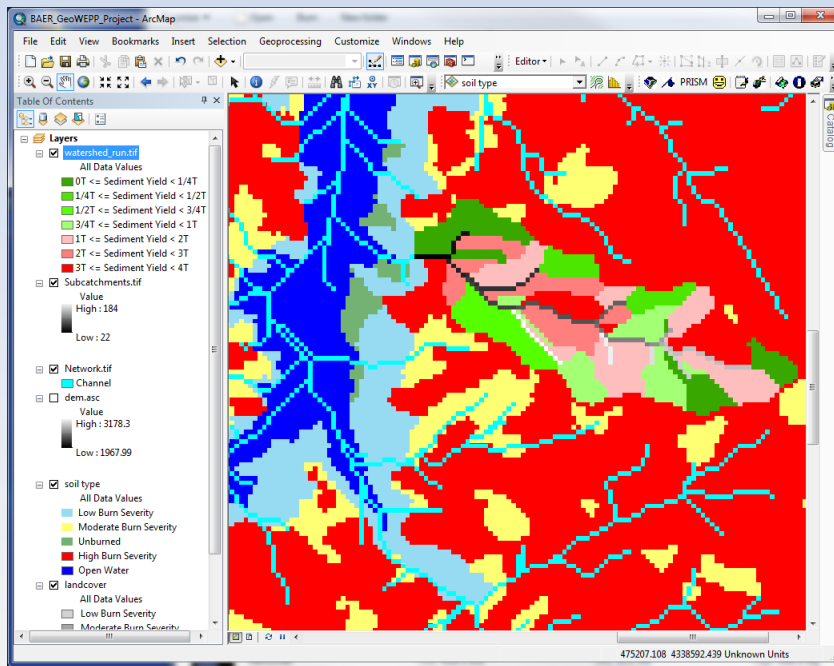
Flowpath Method

- Each flowpath has its own slope profile
- Each pixel keeps its land cover and soil type
- Flowpaths converge so they are aggregated
- Onsite assessment as the spatial results represent erosion or deposition occurring in each raster cell of the subcatchment

Watershed vs. Flowpath

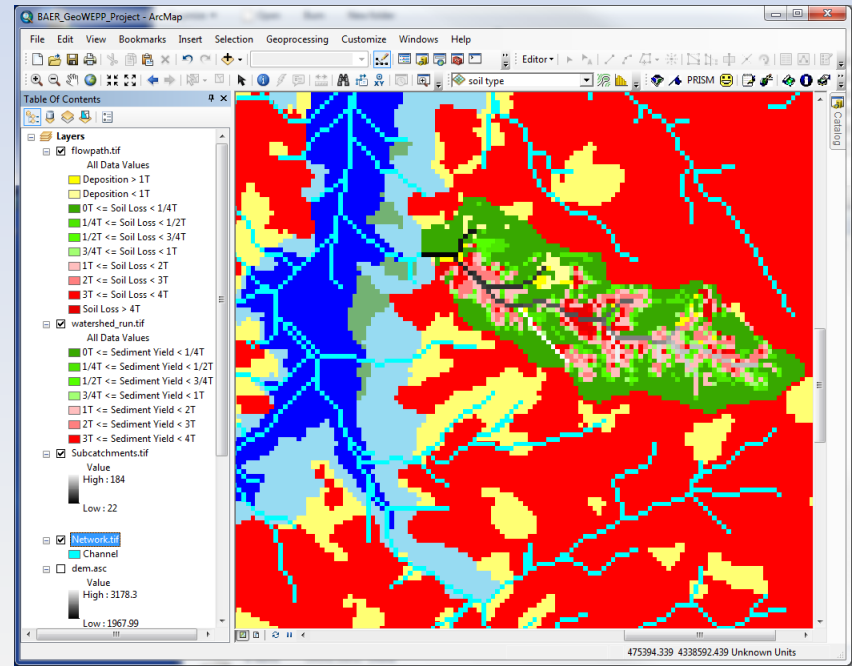
Watershed Method

- Less spatial resolution
- Faster, example 2 year run in 0:17 seconds



Flowpath Method

- More detail
- Longer to run, example 2 year run in 3:24 minutes



QWEPP DEMO

- Rapid Response Erosion Database
- QWEPP Example

ftp://ftp.mtri.org/pub/NASA_BAER/Workshop/

NASA BAER in Action!



for Fuels Planning

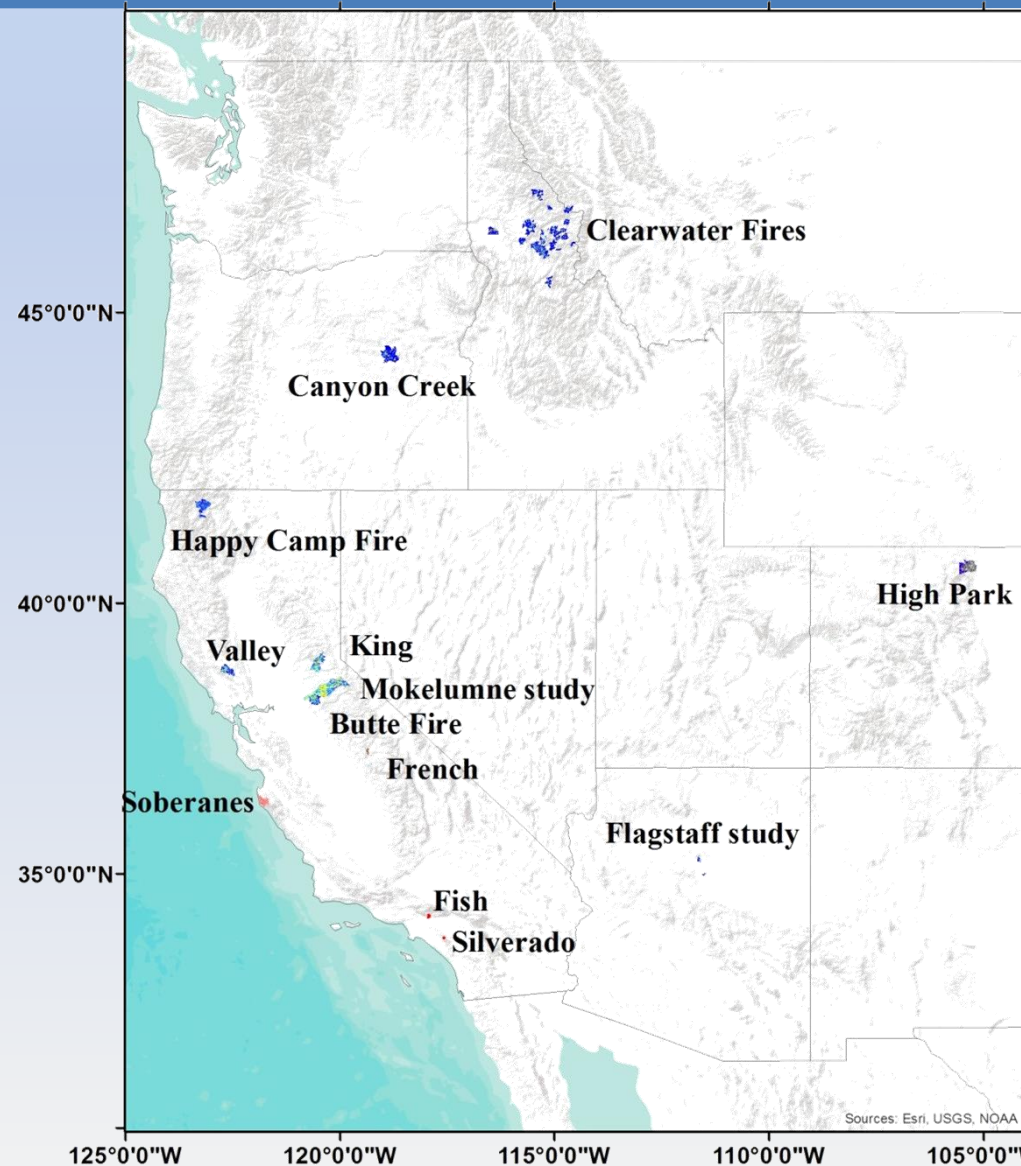
- Mokelumne
- Flagstaff

for BAER Teams

- Canyon Creek, OR
- Clearwater, ID
- Butte, CA
- Valley, CA
- French, CA
- Happy Camp, CA
- Silverado, CA
- King, CA
- Soberanes, CA
- Fish, CA
- Cedar, CA

for Validation study

- High Park, CO



Canyon Creek Fire

Cover Settings provided by BAER Team:

Low burn severity - 75% cover

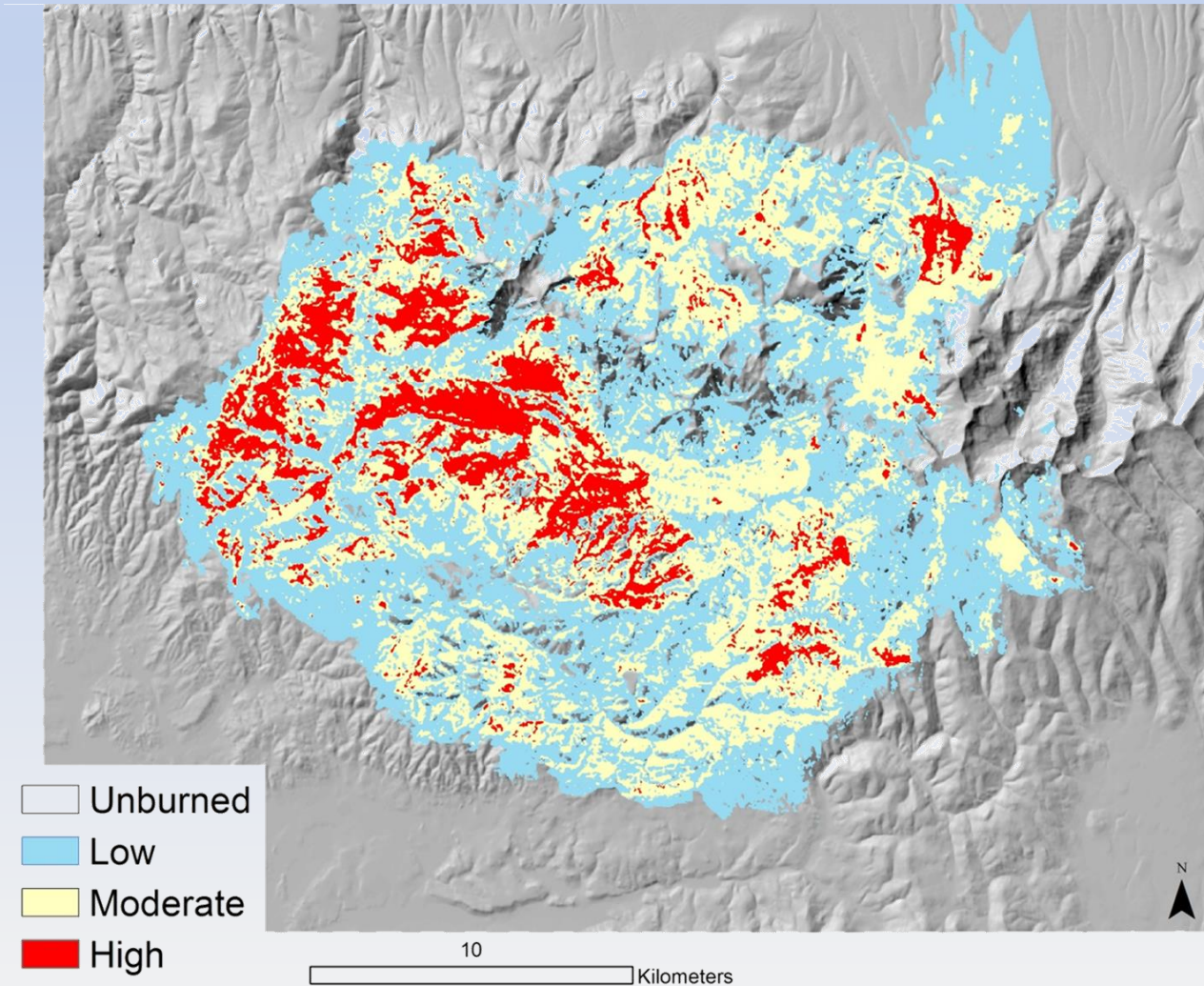
Moderate burn severity - 55% cover

High burn severity - 20% cover

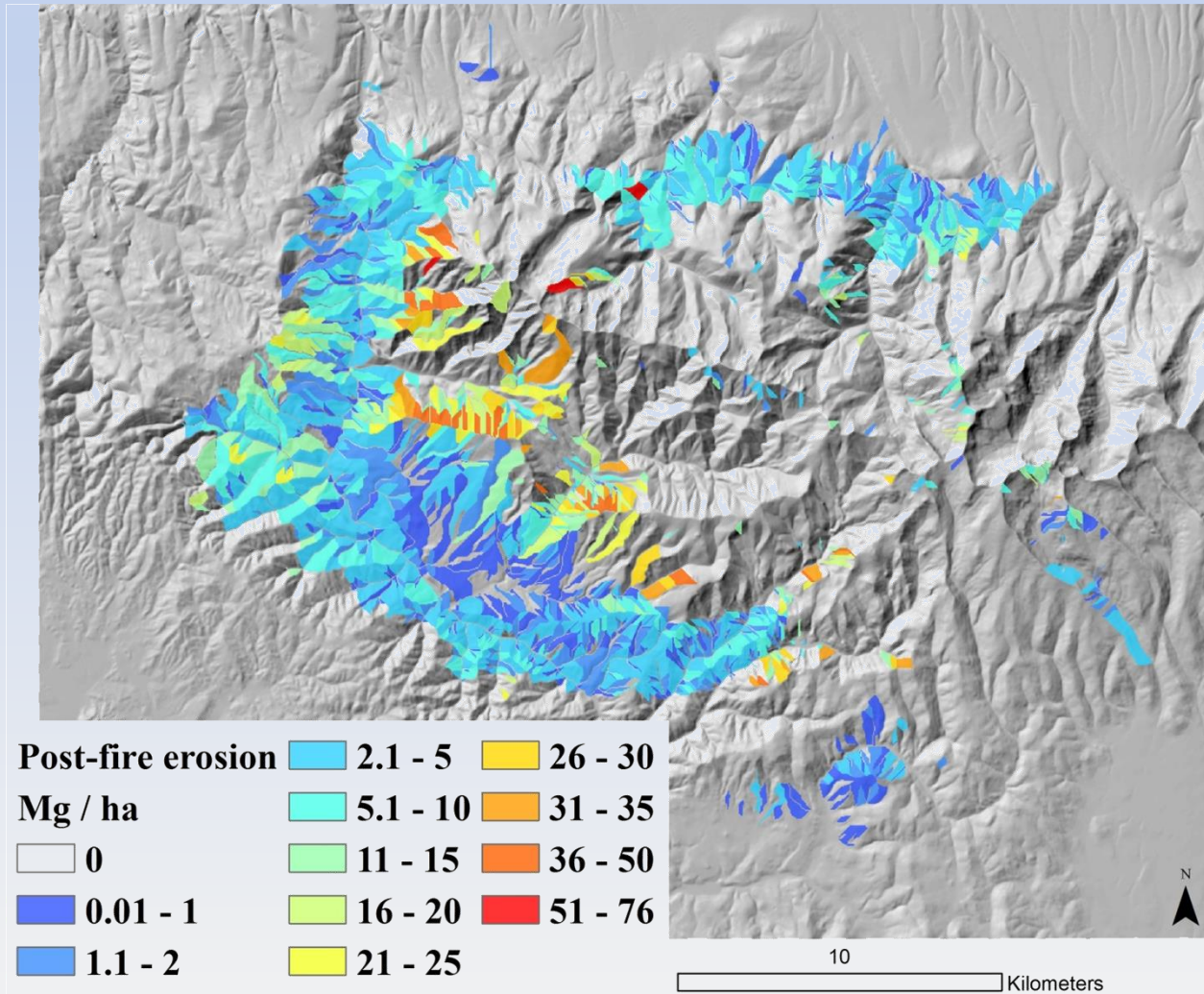
Mulch – 80% cover

Precipitation: 2.5 inches in 6 hrs with a peak intensity 1.25 in/hr, and a time to peak of 0.3 of the duration

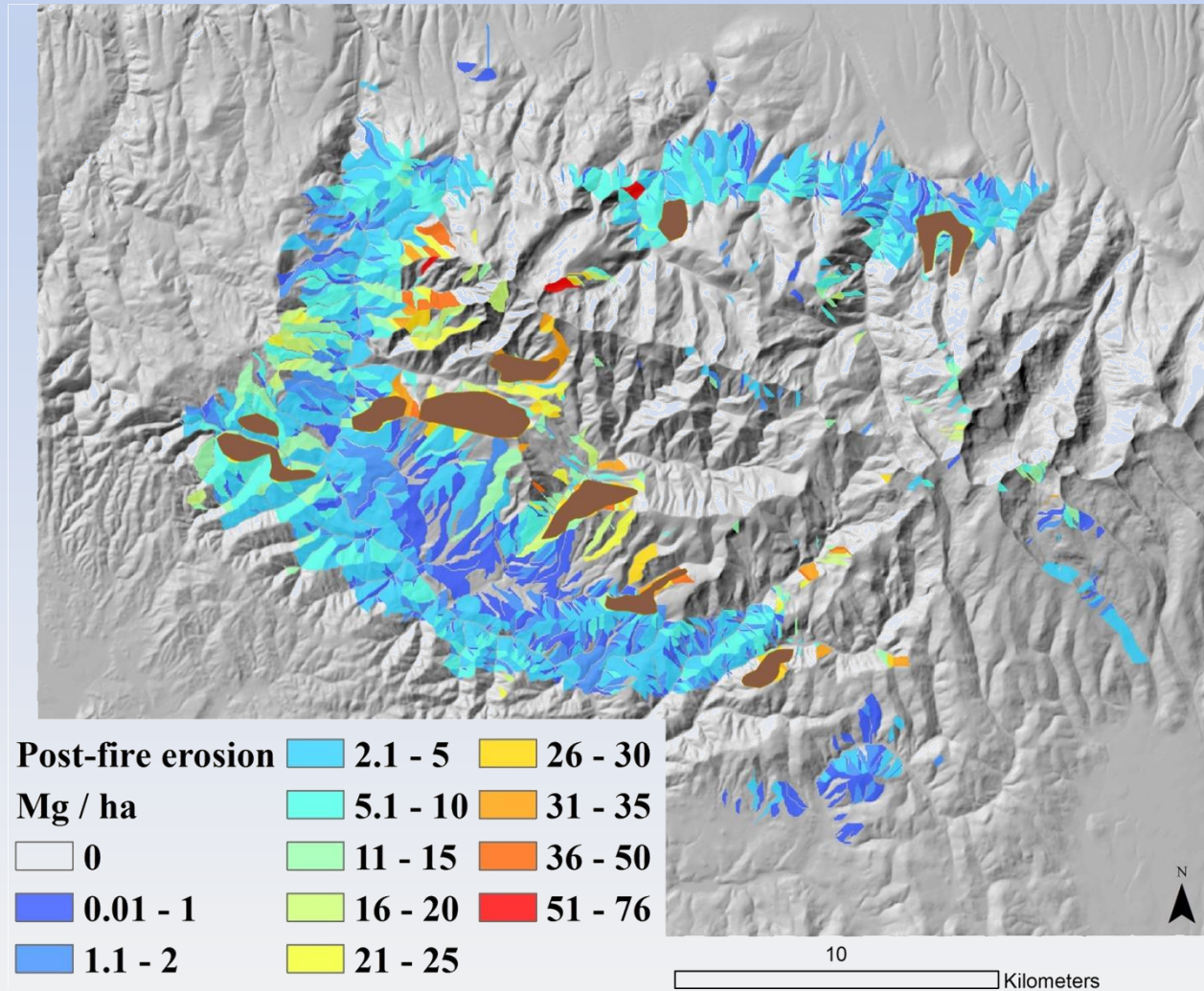
Canyon Creek Soil Burn Severity Map



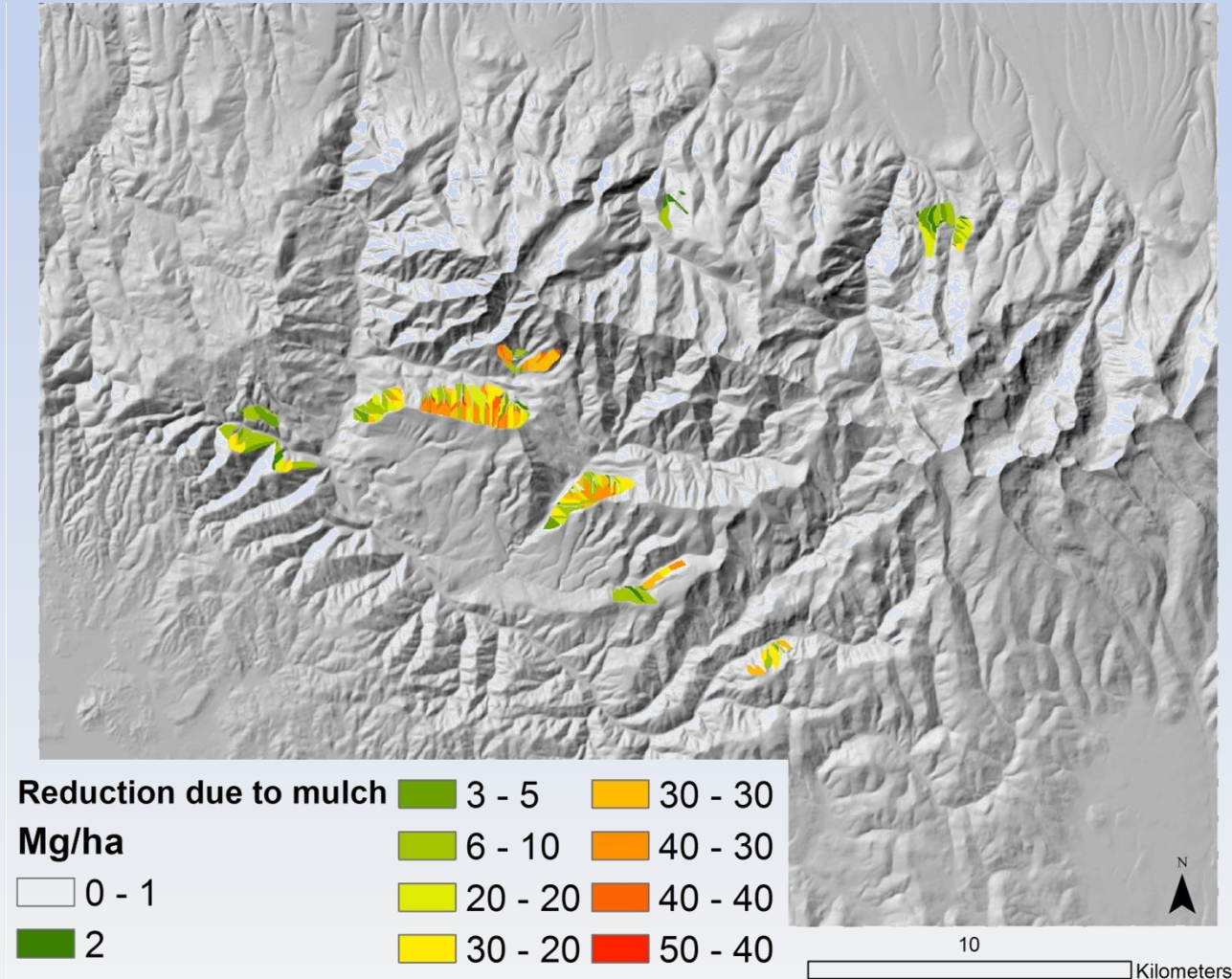
Canyon Creek – single storm event



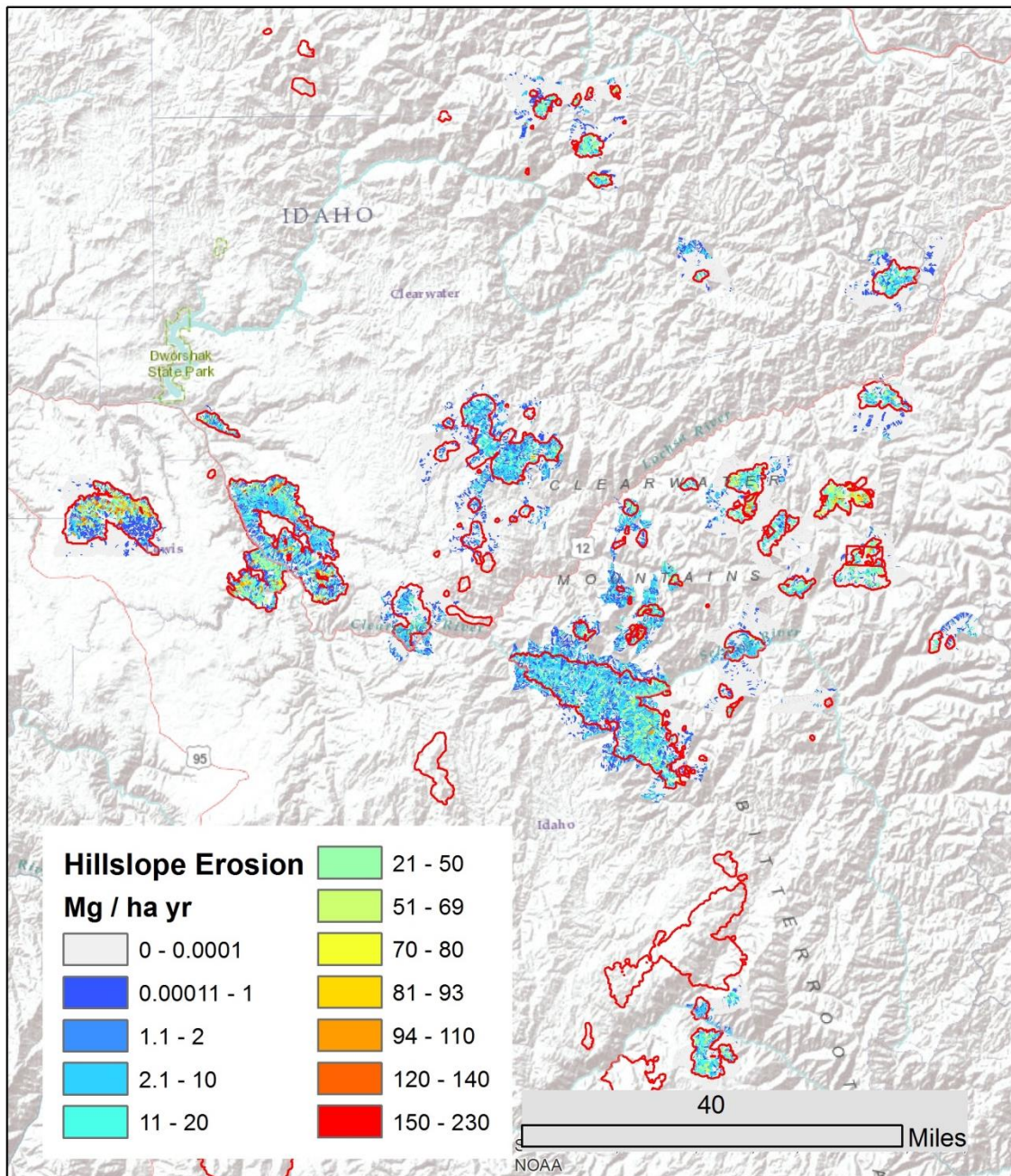
Canyon Creek – mulch treatments



Canyon Creek – predicted reduction in erosion due to proposed mulching

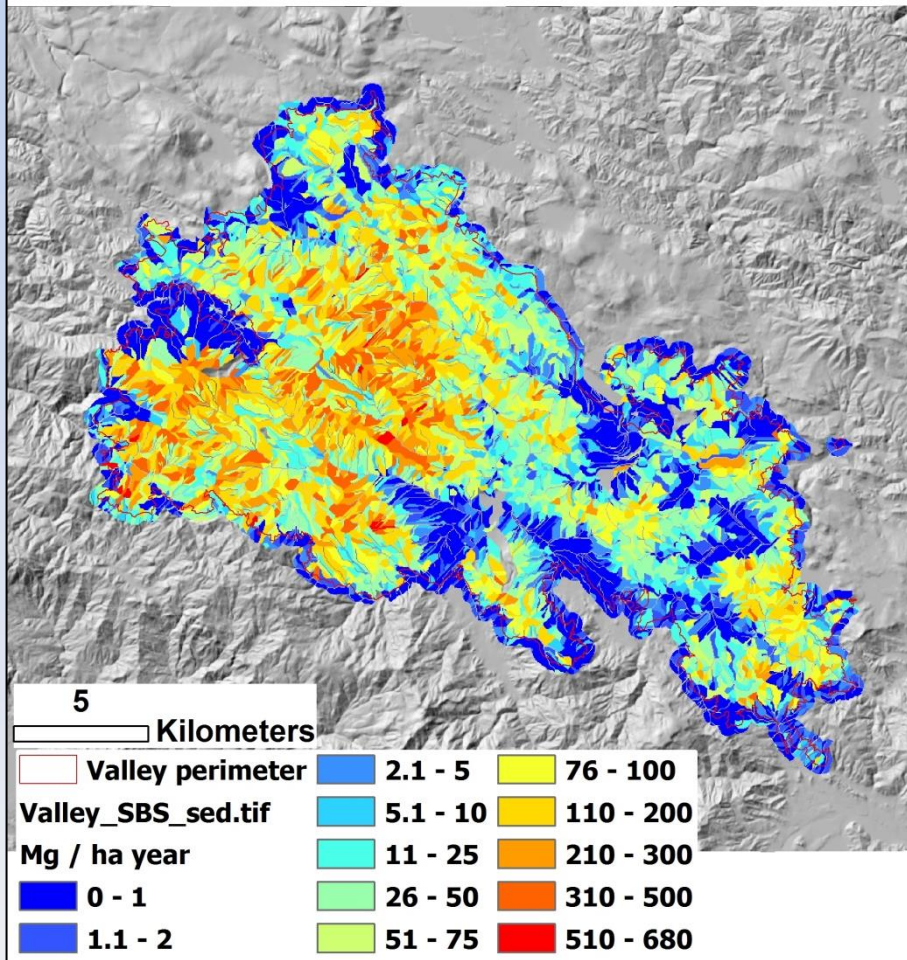


Clearwater ID Fires

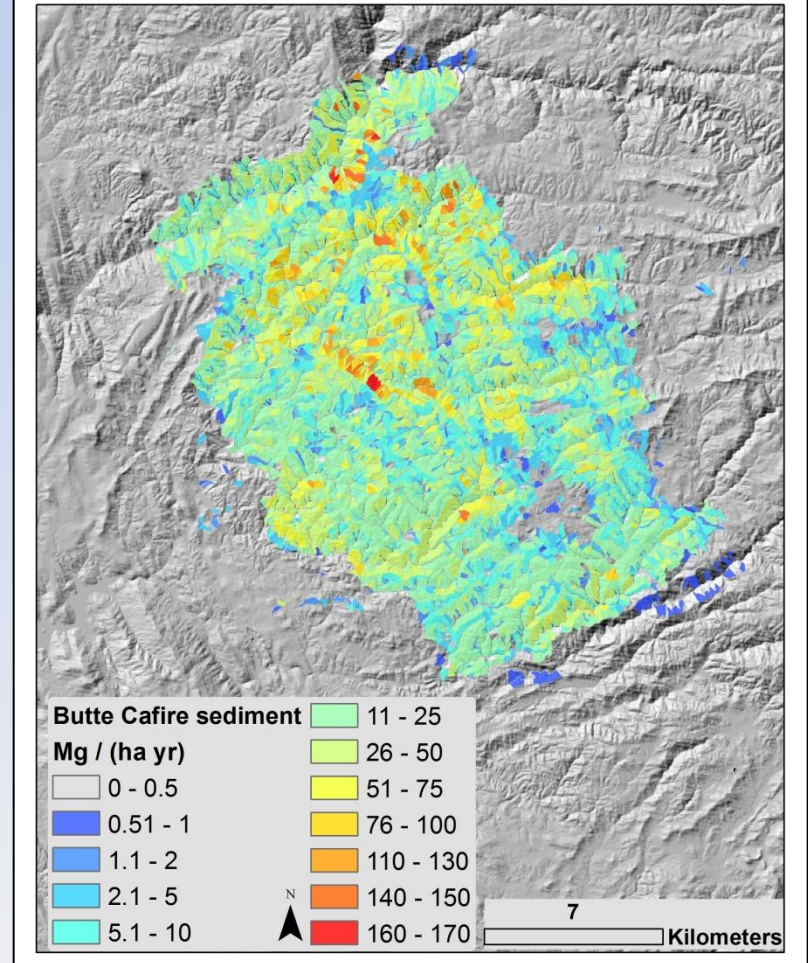


Valley & Butte Fires in California

Post Fire Erosion Modeling for Valley Fire

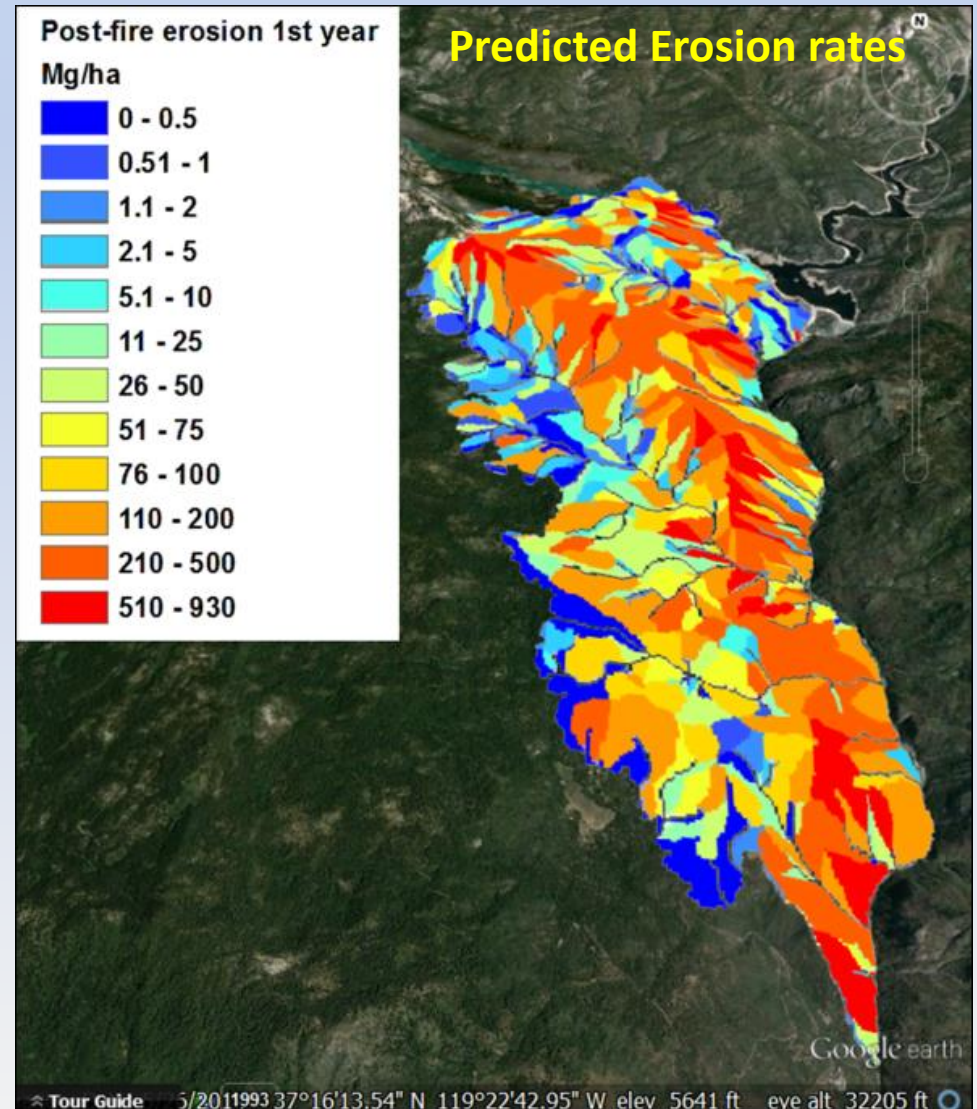
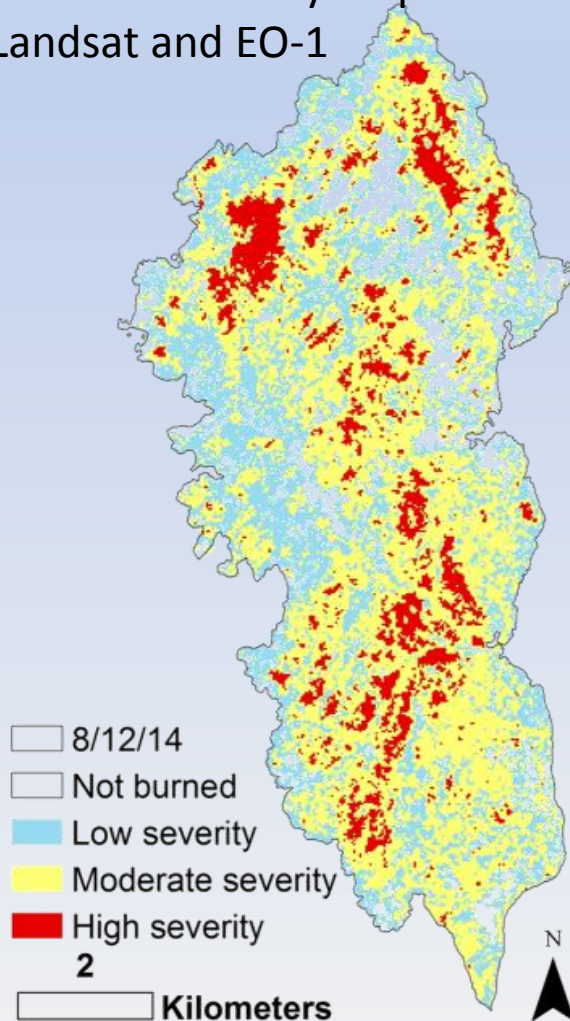


Calfire SBS hillslope erosion yields for Butte Fire

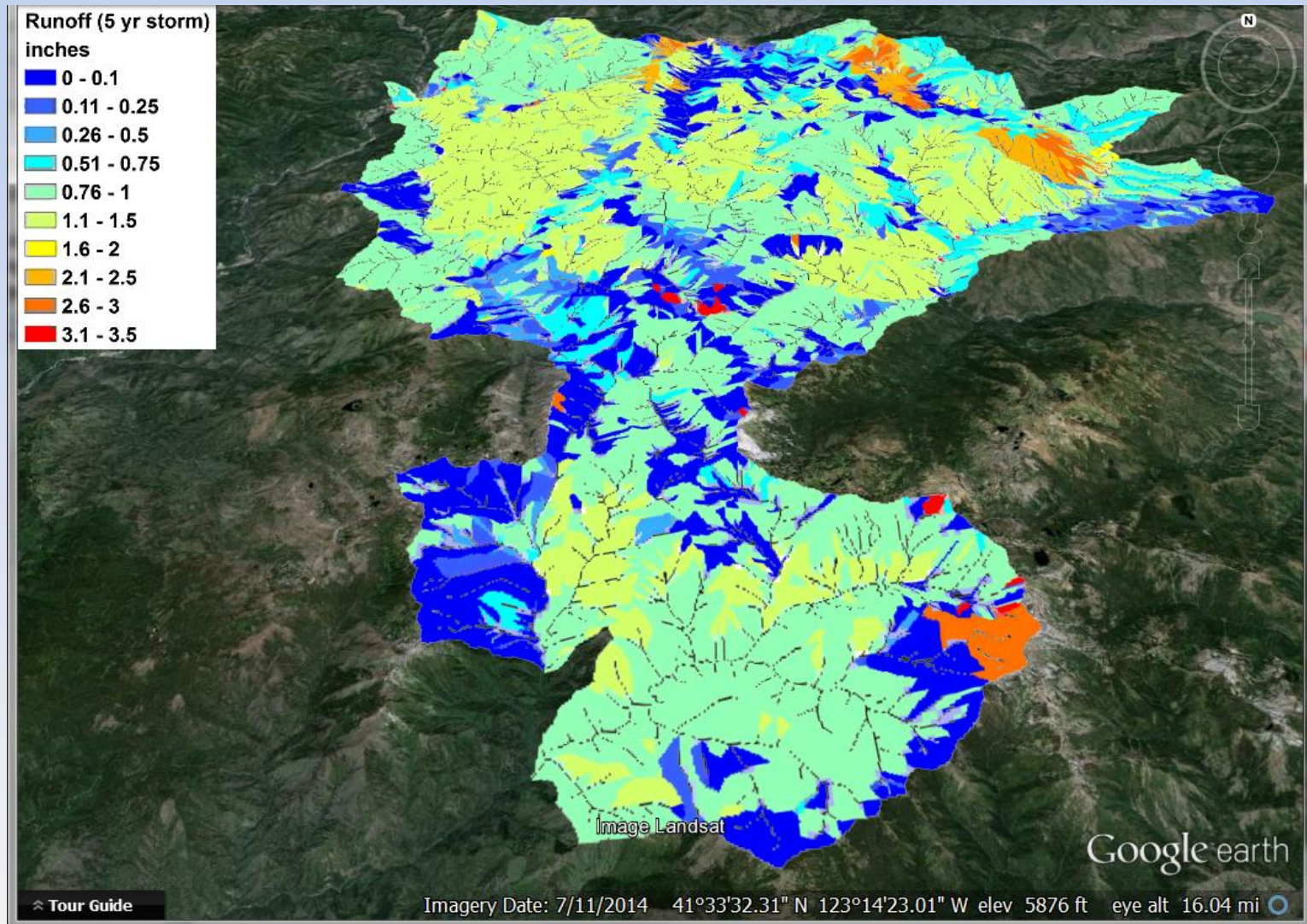


French Fire (5,600 ha)

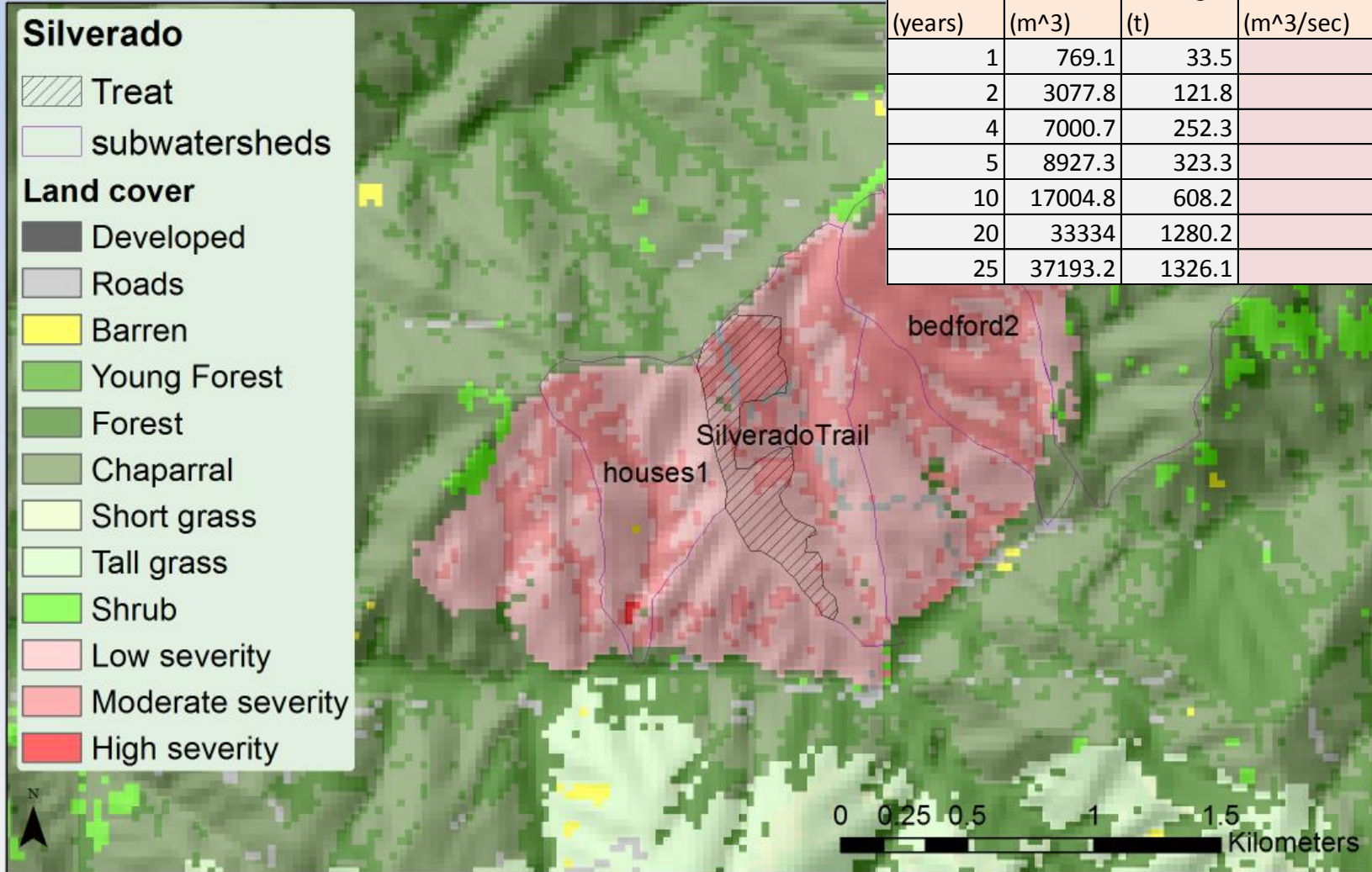
Soil burn severity map
Landsat and EO-1



Happy Camp (54,200 ha)

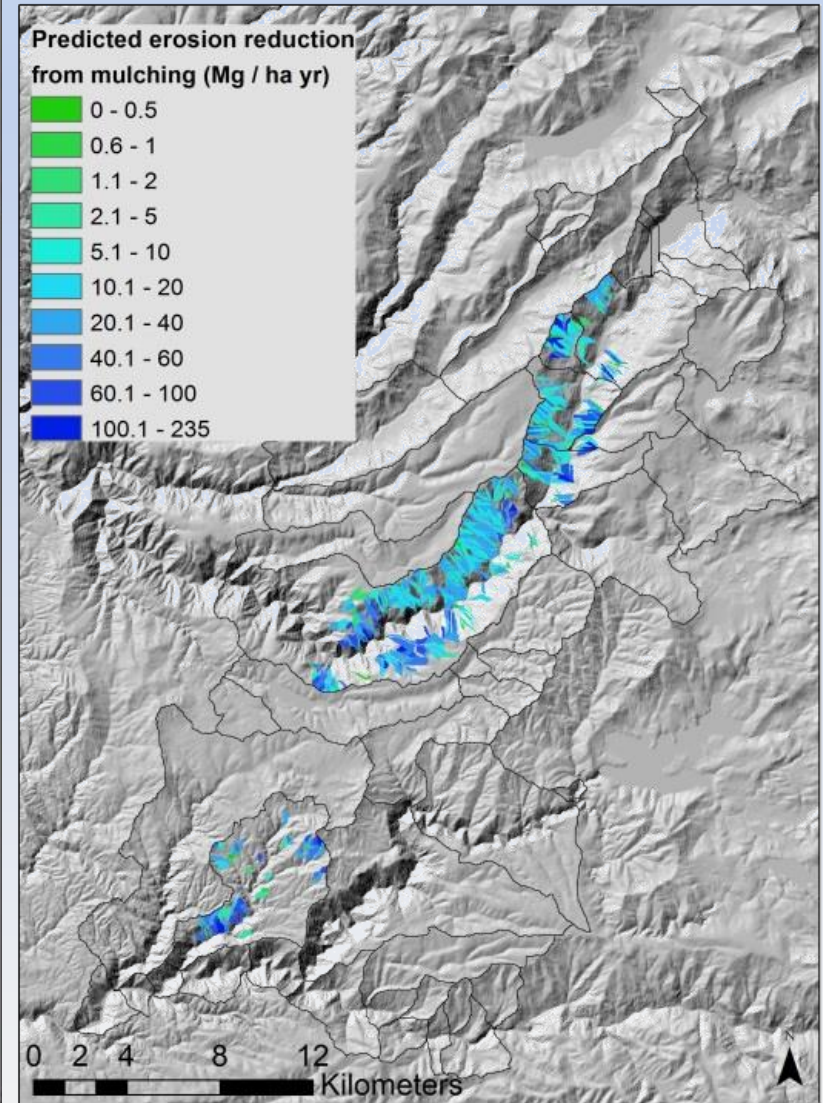
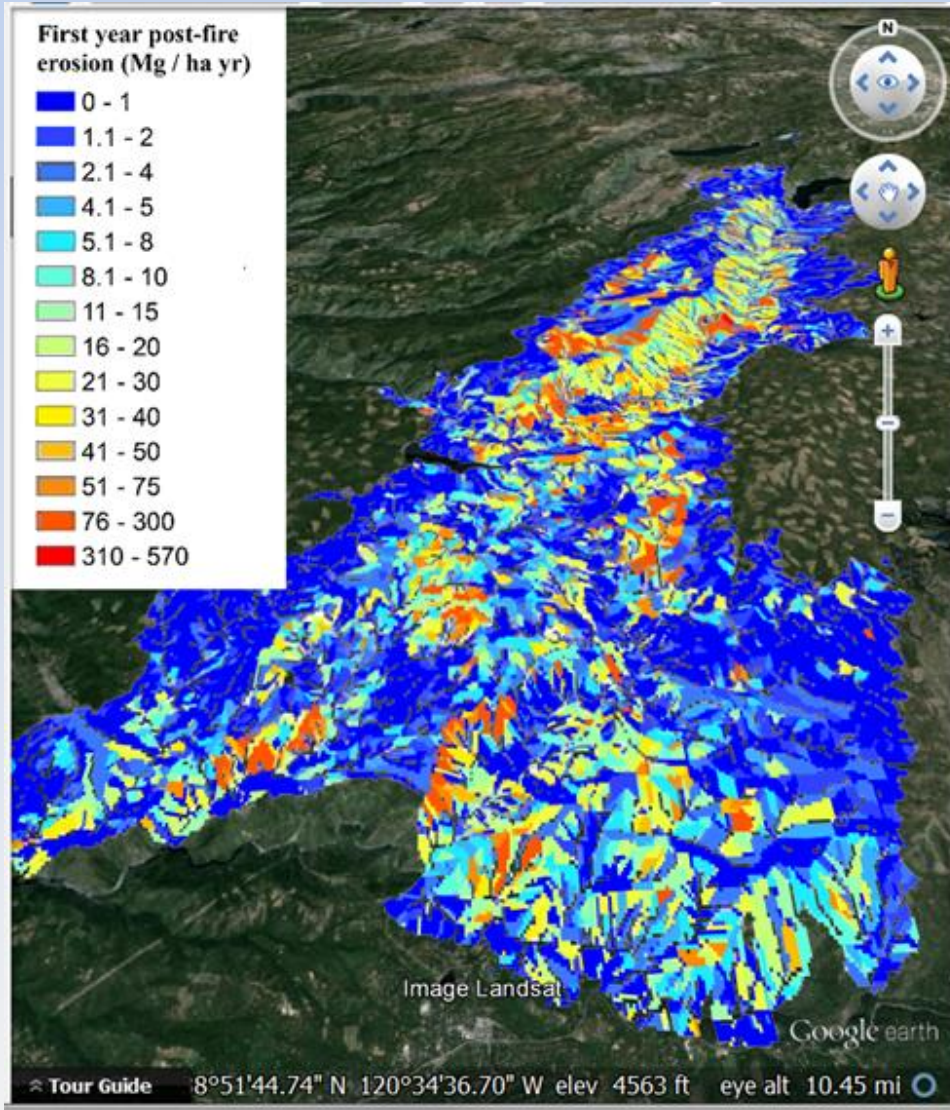


Silverado Fire (390 ha)



Return Period (years)	Runoff Volume (m ³)	Sediment Leaving (t)	Peak Runoff Rate (m ³ /sec)	Daily Precipitation (mm)
1	769.1	33.5	0.4	46.1
2	3077.8	121.8	1.5	57.9
4	7000.7	252.3	3.1	68.9
5	8927.3	323.3	3.8	72
10	17004.8	608.2	6.8	92.5
20	33334	1280.2	12.5	104.7
25	37193.2	1326.1	13.8	110.8

King Fire (39,500 ha)



Field data sheet

Appendix B—Soil Burn Severity Field Data Sheet and Key

Soil Burn Severity Assessment Field Data Sheet			Fire name:					Observers:		
Date:		Site ID:		GPS coordinates:			BARC classification:			
Observation point	Ground cover (1)	Surface color and ash depth (2)	Soil structure (3)	Roots (4)	Soil water repellency (5)			Observed soil burn severity class (6)	Photo #	Other comments
<i>EXAMPLE</i>	<i>20 to 50%</i>	<i>white, 1 mm</i>	<i>no change</i>	<i>intact</i>	<i>l</i>	<i>3 mL</i>	<i>surf</i>	<i>Mod</i>	<i>23</i>	<i>homogenous</i>
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
Average/majority for site (7)										
Site characteristics:		Aspect (deg):			Slope %:					
Slope length (ft or m):		Slope position:			Lower	Middle	Upper	Ridge	Other	
Soil texture class: clay loam, silt loam, loam		Dominant pre-fire vegetation type Chaparral Forest Sagebrush/grassland Other		Pre-fire vegetation density Low High Other		Vegetation comments:		Other notes:		
Surface rock %:										
Soil comments:										

Field App for BAER Teams

BAER
Admin Home · My Sheets · Fire Archive · Log Out

Fire Archive / Example Fire 1 / Site 1

Site Data Save to Device

Site ID

Site 1

BARC Classification

High

Observers

No observers

Location/Datum

Latitude: 42.35492348 Datum: WGS 84
 Longitude: -120.1416421

Date

2015-08-10 11:18:45.862

Site Comments

It's a comment!

Slope Characteristics

Percent	74.0%
Length	1.0m
Position	Middle
Aspect	40.0°

Soil Characteristics

Texture Class	Loam
Surface Rock	41%
Soil Comment	It's dirt!

Vegetation Characteristics

Vegetation Type	Grassland
Vegetation Density	Moderate
Comments	It's plants!

Observations

#	Ground Cover	43.0	Ground Cover	33.0	Ground Cover	47.0
1	Surface Color	White	Surface Color	Brown	Surface Color	Black
	Ash Depth	8.0mm	Ash Depth	8.0mm	Ash Depth	4.0mm
	Soil Structure	No change	Soil Structure	No change	Soil Structure	No change
	Roots	Consumed	Roots	Very fine consumed	Roots	Consumed
	Burn Severity	High	Burn Severity	High	Burn Severity	High
	GPS Ref. ID / UTM	N/A	GPS Ref. ID / UTM	N/A	GPS Ref. ID / UTM	N/A
	Datum	WGS 84	Datum	Unspecified	Datum	NAD 27
	Comments	This is a comment!	Comments	This is a comment!	Comments	This is a comment!

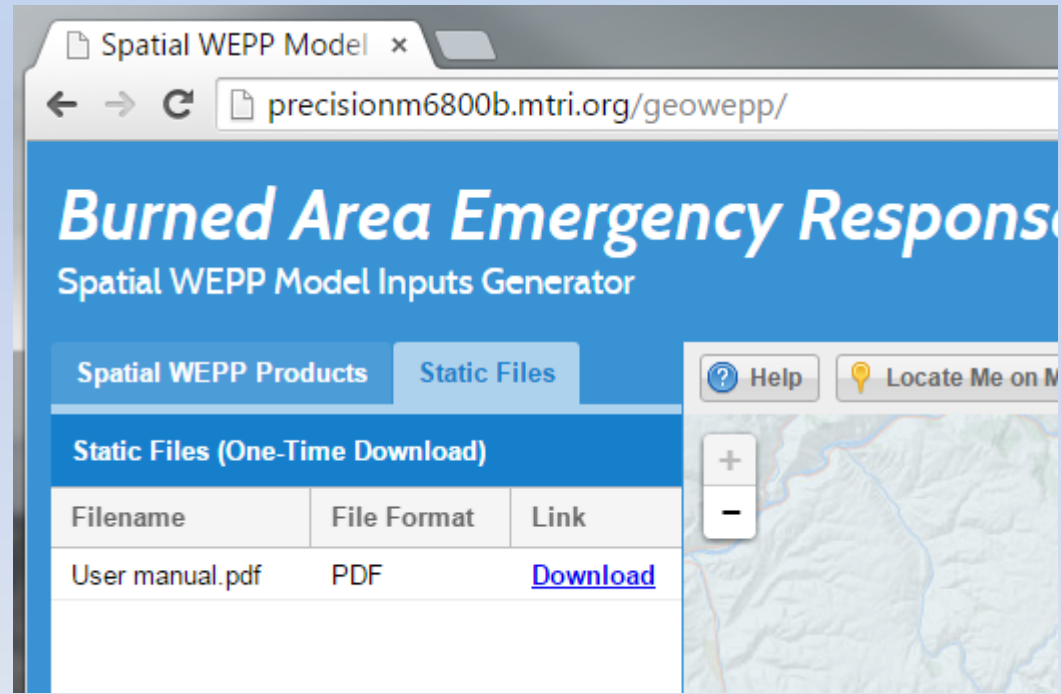
Infiltrimeter Tests		
Depth	Volume Change	Comments
5.0in	27.0mL	
12.0in	7.0mL	
11.0in	20.0mL	

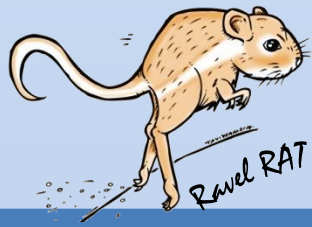
Infiltrimeter Tests		
Depth	Volume Change	Comments
4.0in	41.0mL	
10.0in	43.0mL	
5.0in	43.0mL	

Water-drop Tests		
Time (s)	Depth	Additive
42	7.0in	Chemical X, 1.0mL
23	9.0in	Chemical X, 8.0mL
49	2.0in	Chemical X

Enable Modelers

- **Training Manual available!**
- Training webinar this winter
- MTRI's NASA BAER team is ready to help with modeling



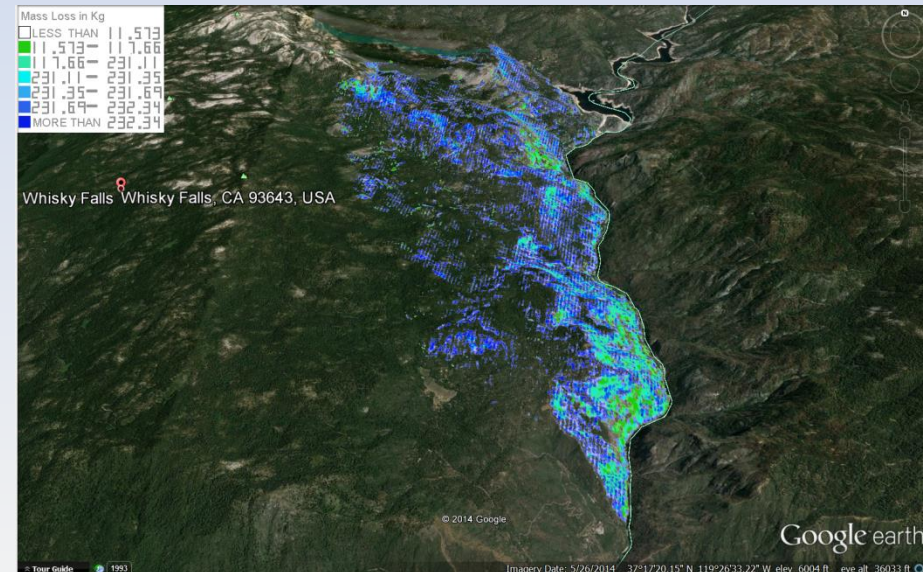
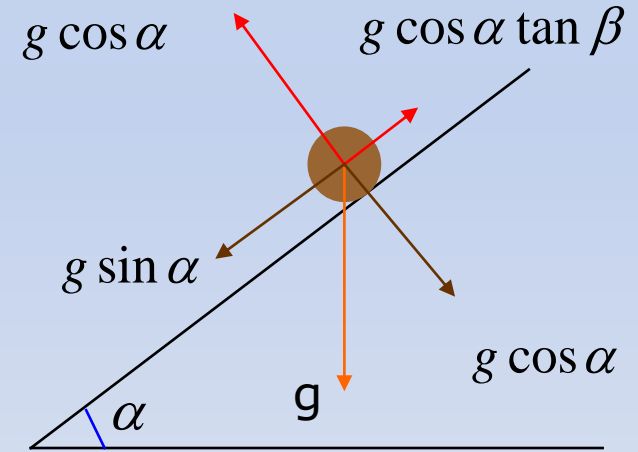


Ravel RAT

Ravel Risk Assessment Tool

Dry Ravel Inputs:

- DEM - 10 Meter Digital Elevation Map.
- Burn Severity Map
- Parameter file
 - Mean stem diameter of vegetation (0.05 m)
 - Vegetation density (1 plant/m²)
 - Burn Depths
 - Bulk density of soil (1300 kg/m³)
 - Static friction angle \ angle od repose (34°)
 - Kinetic friction angle (31.1°)







Ravel RAT

Ravel Risk Assessment Tool

RavelRat

precisionm6800b.mtri.org/ravelrat/calculator

 **RavelRAT** 

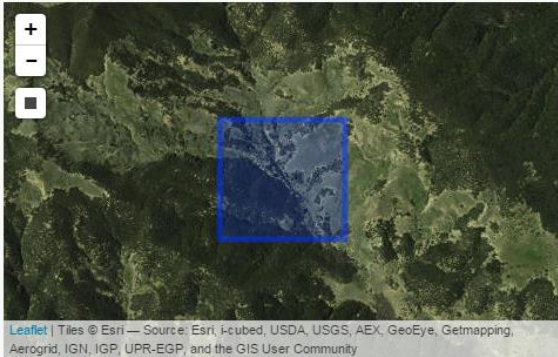
To set processing bounds, use the boxes below
OR click on the solid square tool in the map to draw. Click the tool again to redraw.

N

W E

S

Area of bounding box: 0.168 km²



Leaflet | Tiles © Esri — Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, UPR-EGP, and the GIS User Community

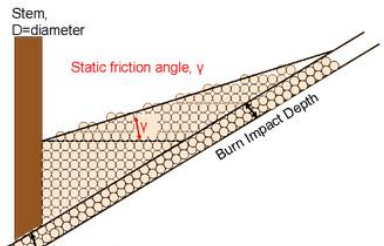
Burn impact depth (mm)	<input type="text" value="0.2"/>	Bulk density (kg/m ³)	<input type="text" value="1300"/>
Vegetation density (stem/m ²)	<input type="text" value="1"/>	Mean stem diameter (m)	<input type="text" value="0.05"/>
Static friction angle (°)	<input type="text" value="30"/>	Kinetic friction angle (°)	<input type="text" value="27"/>

RUN DRY RAVEL

Valid range: 26 to 36 °

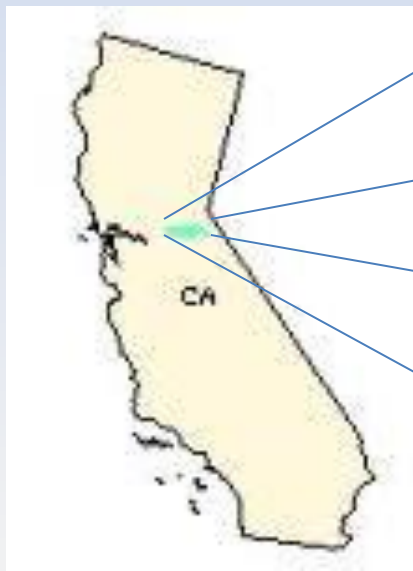
The **static friction angle** of the ravel material is the maximum angle at which ravel material can accumulate before it starts sliding. For this reason it is also known as the angle of repose.

Ravel will not originate on hill sides with slopes less than the **static friction angle**. In the San Dimas Experimental Forest in Southern California, the **static friction angle** of ravel ranged between 29 and 34 degrees.



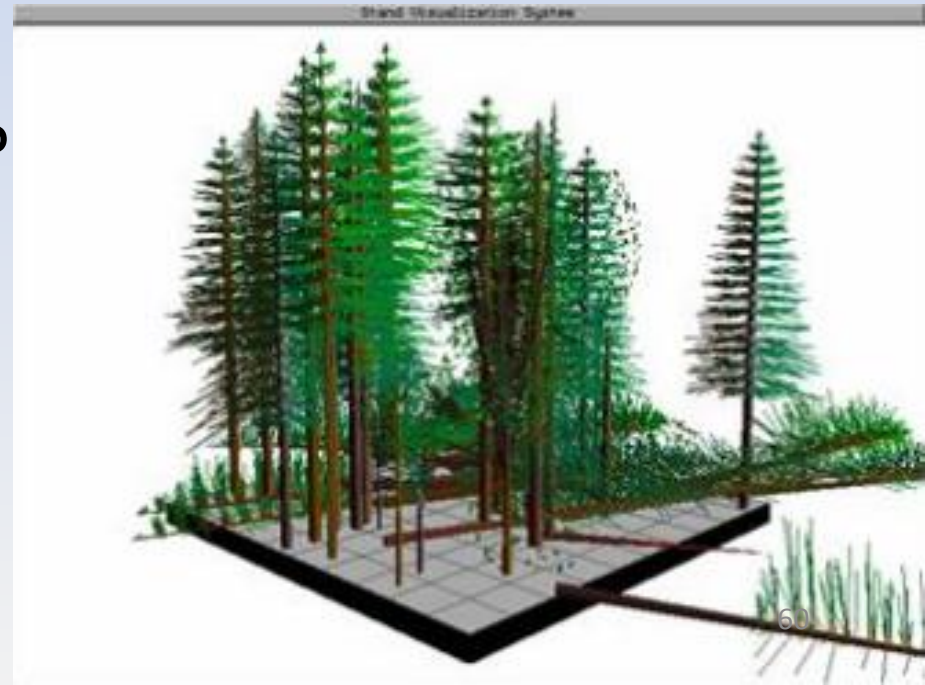
RRED for fuel planning

- Mokelumne Watershed in the Sierra Mountains in central California
 - 5500 km²
 - Vegetation: oak savannah to evergreen forest
 - 800-1430 m elev.



Key Question

- How can we
 - quantify the benefits of fuels treatments, and
 - use those benefits to pay for fuels treatments;
 - thereby reducing the risk of wildfires and associated loss of environmental services?

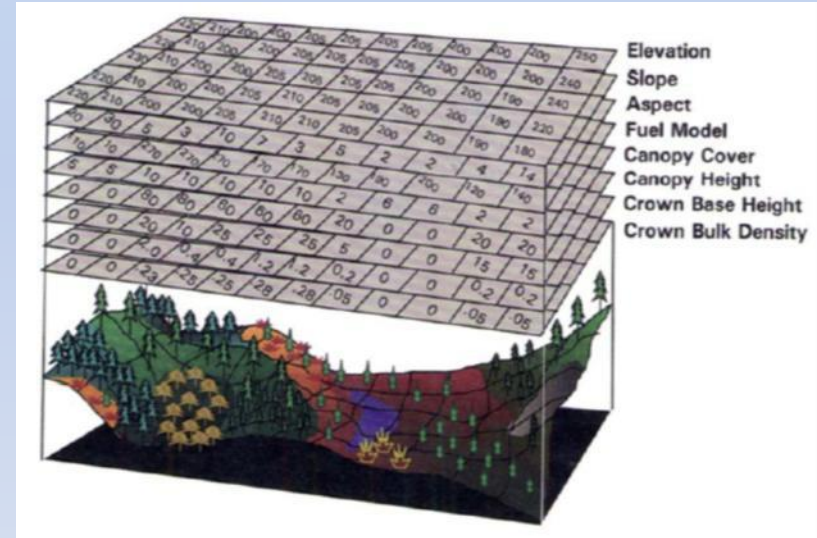


Approach

- Determine hillslope-scale sediment production for:
 - 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 three models:
 - **FLAMMAP** to predict fire severity
 - **FSIM** to predict fire probability
 - **WEPP Watershed** to predict erosion

FLAMMAP Fire Spread Model

- Main inputs:
 - Forest structure/fuels
 - Fuel moisture
 - Slope aspect and steepness
 - Average wind direction
- Key outputs for each grid cell (typically 90-m):
 - Flamelength (ft)
 - Mean fire line intensity ($W\ m^{-2}$ or W per unit length)



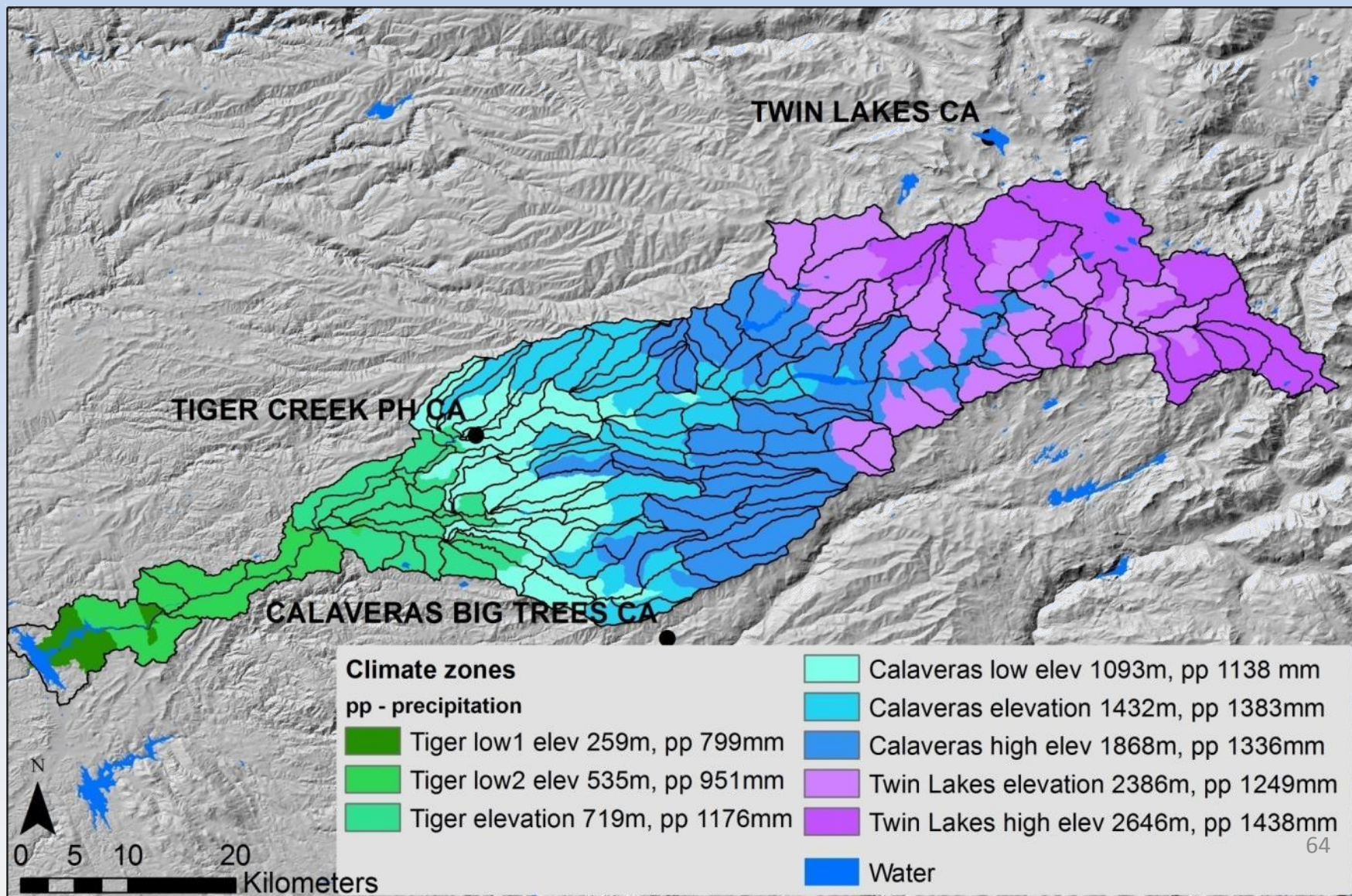
WEPP (Water Erosion Prediction Project) Watershed Erosion Model

- Main inputs:
 - Stochastic climate (50 years)
 - Topography (typically from 30-m DEM)
 - Soil properties (texture, % rock, and burn severity)
 - Ground cover (linked to land cover & fire severity)
- Main output:
 - Sediment production by hillslope polygon (~6 ha for this study)

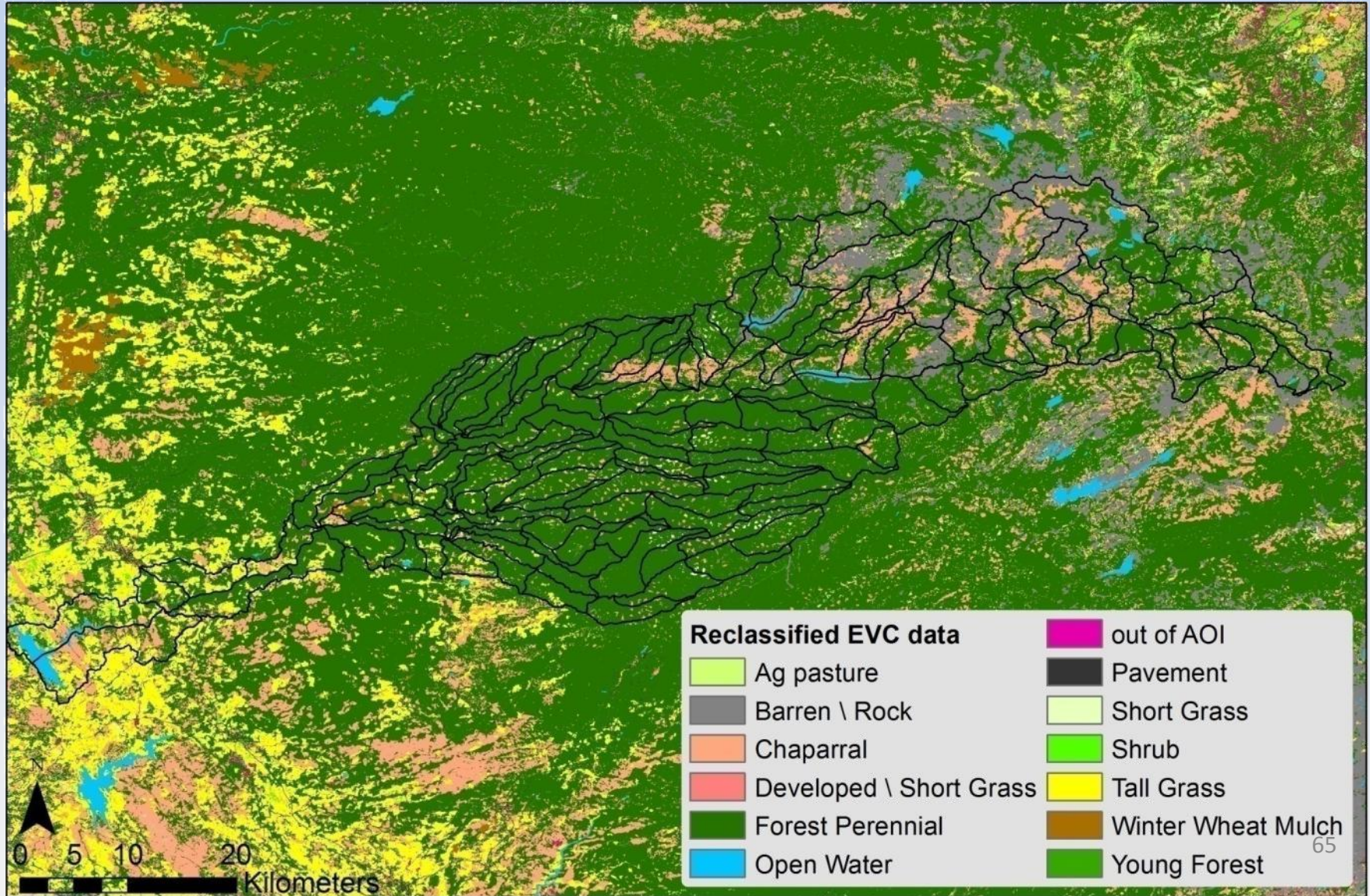


Klamath Complex Fire, California

Weather stations used to generate climate statistics, and spatially distributed using PRISM

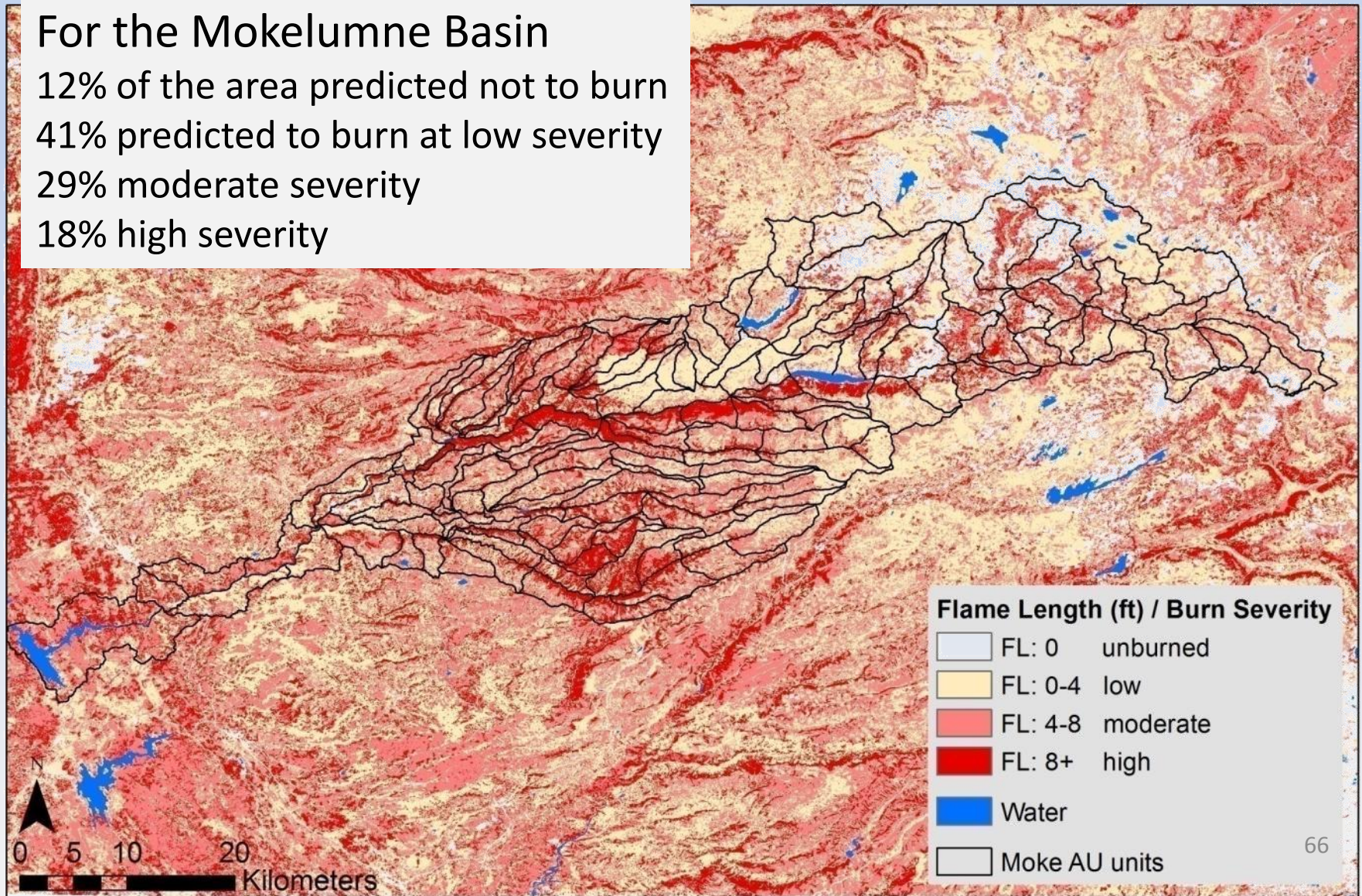


Land cover: Existing vegetation cover map was simplified to the categories in WEPP



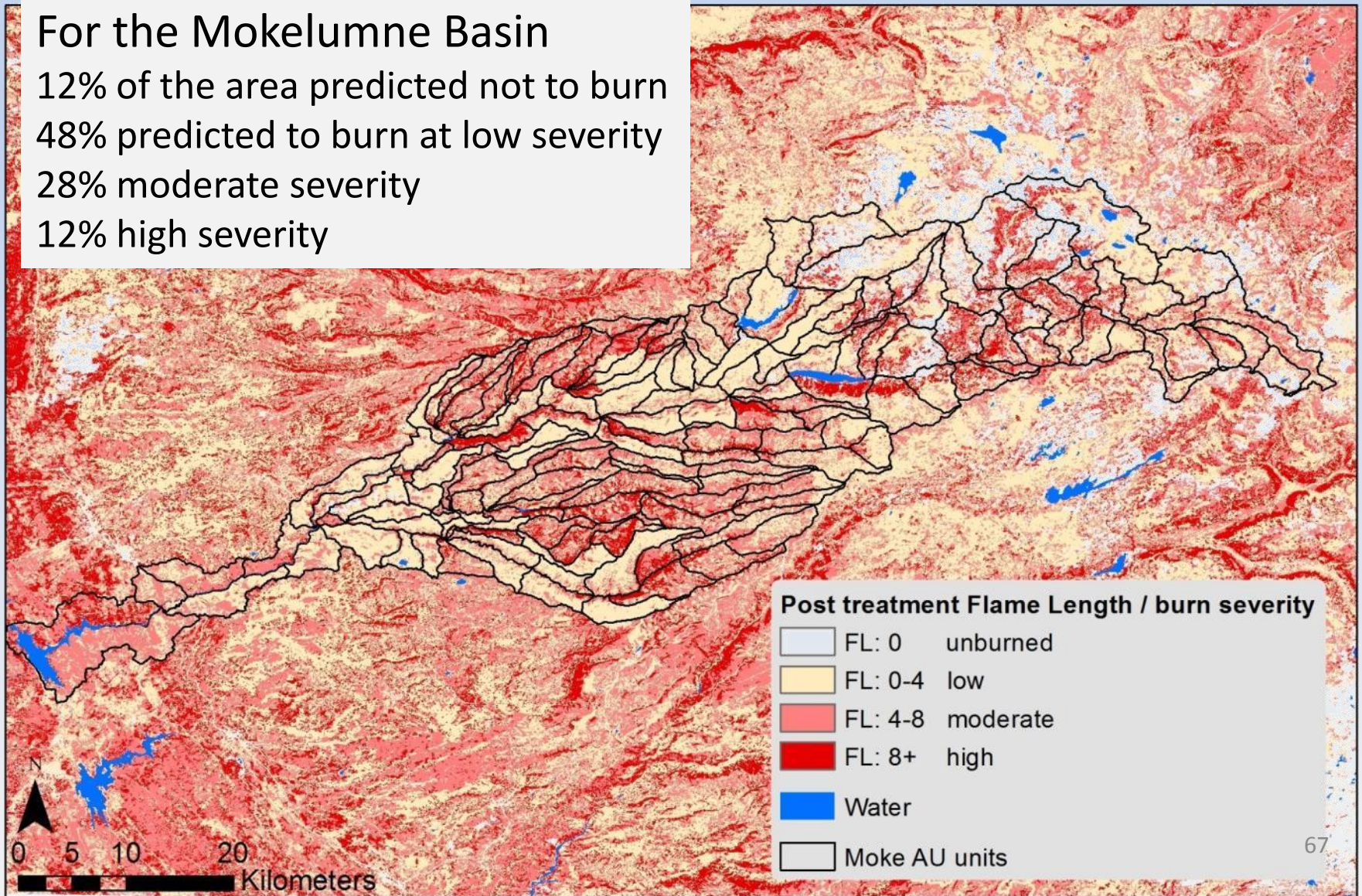
Output and Input: Flame length predictions reclassified to burn severity

For the Mokelumne Basin
12% of the area predicted not to burn
41% predicted to burn at low severity
29% moderate severity
18% high severity

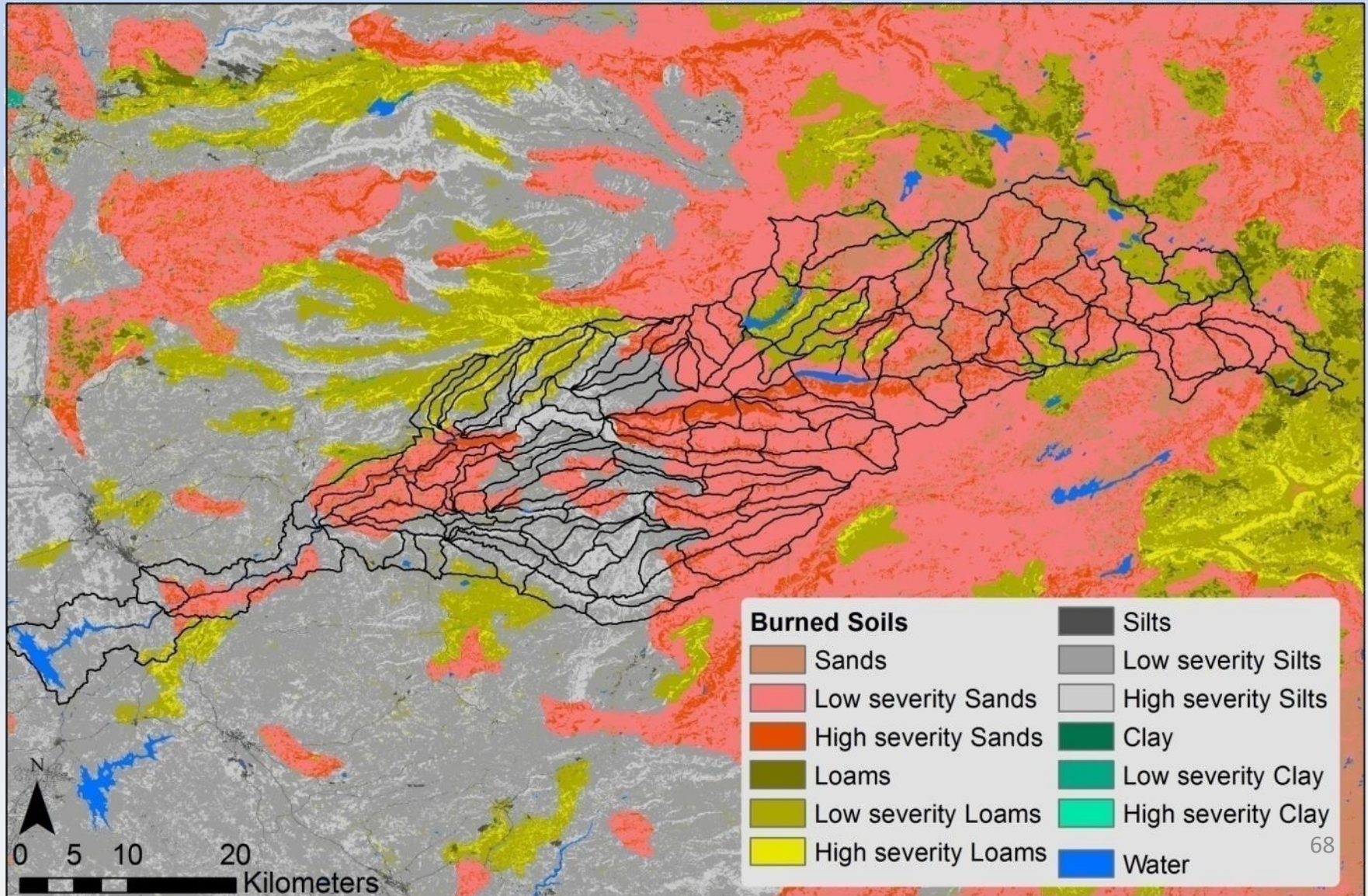


Burn Severity Map post treatment

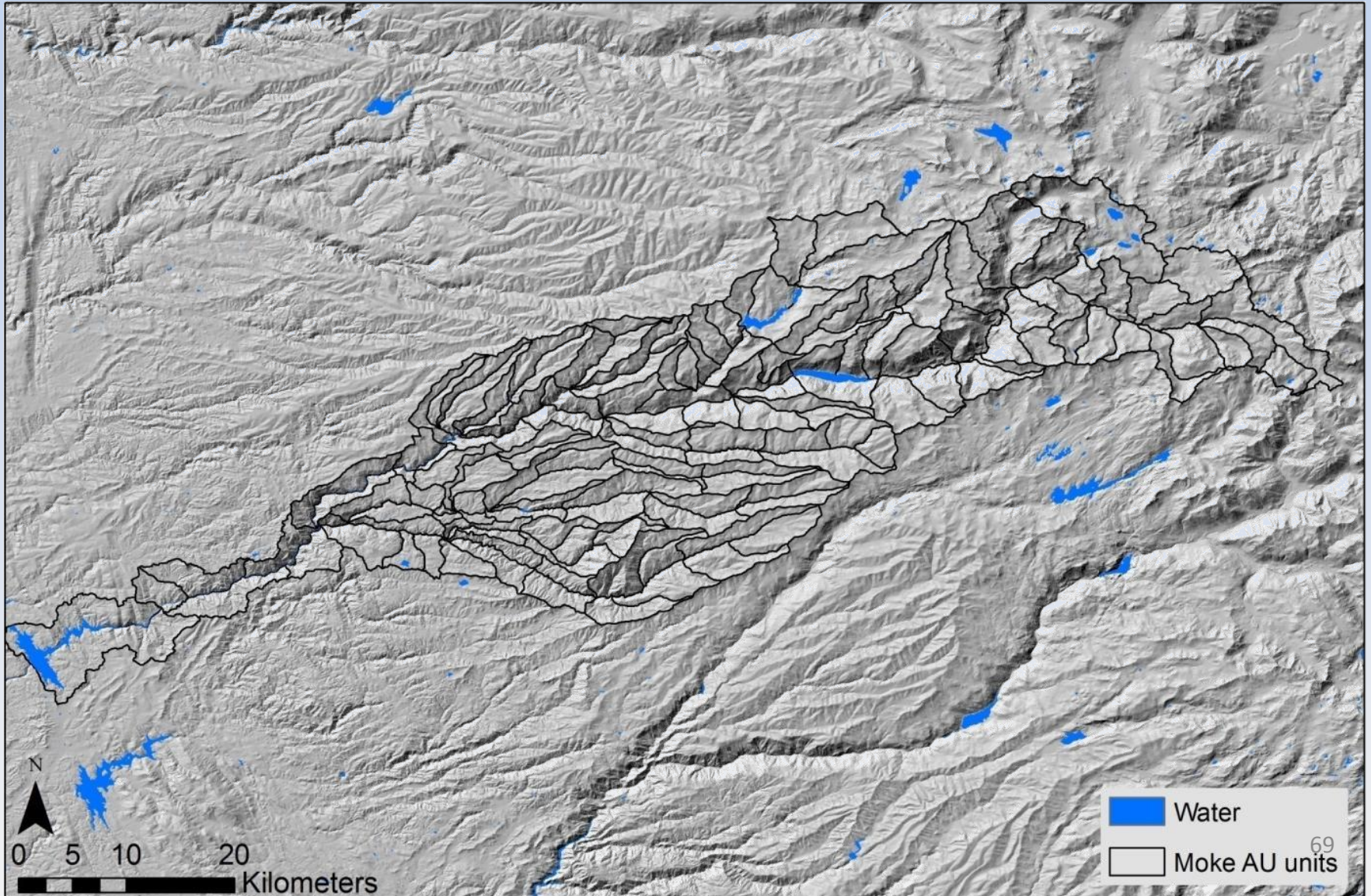
For the Mokelumne Basin
12% of the area predicted not to burn
48% predicted to burn at low severity
28% moderate severity
12% high severity



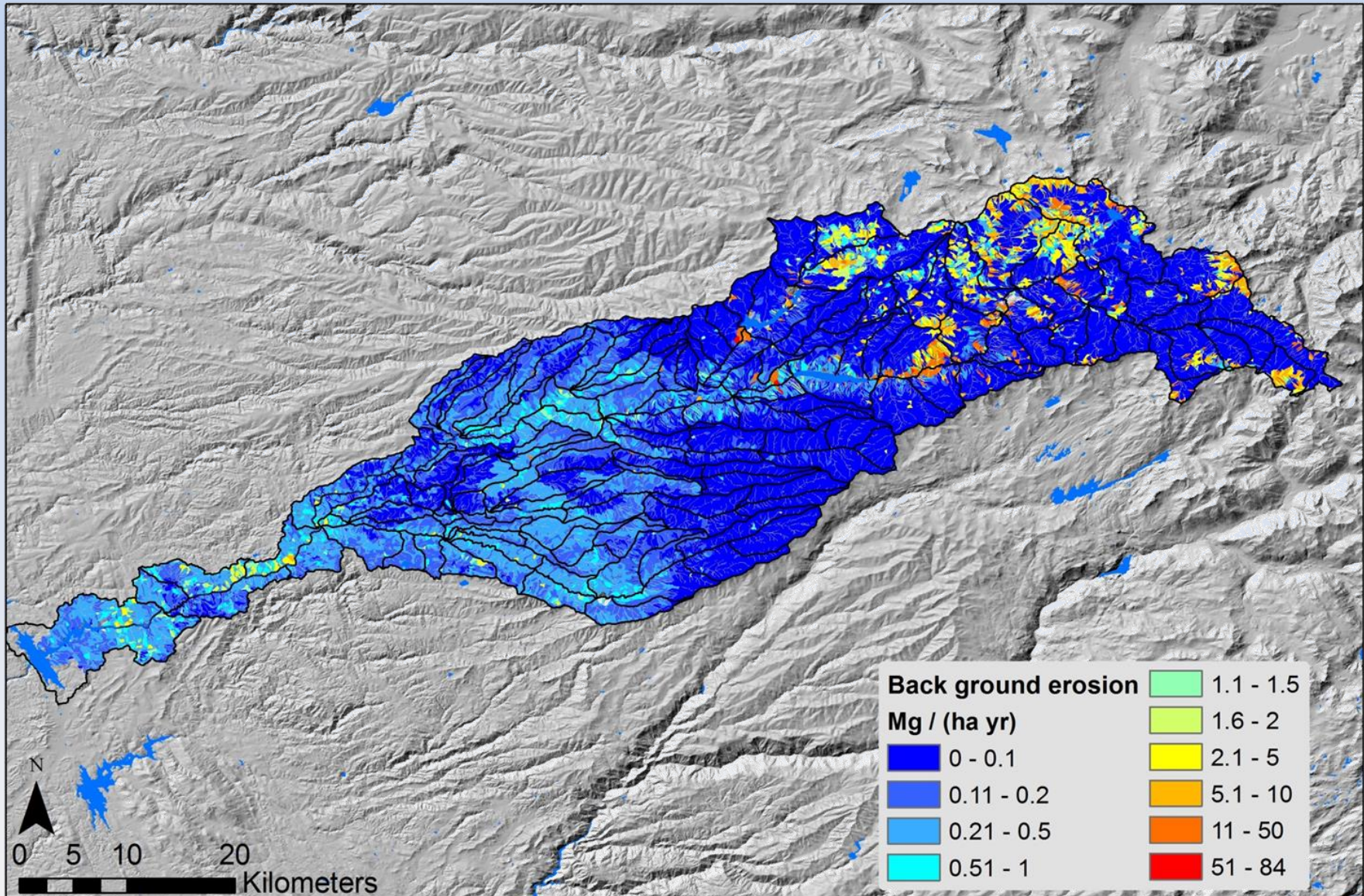
Inputs: Soils modified by burn severity and land cover



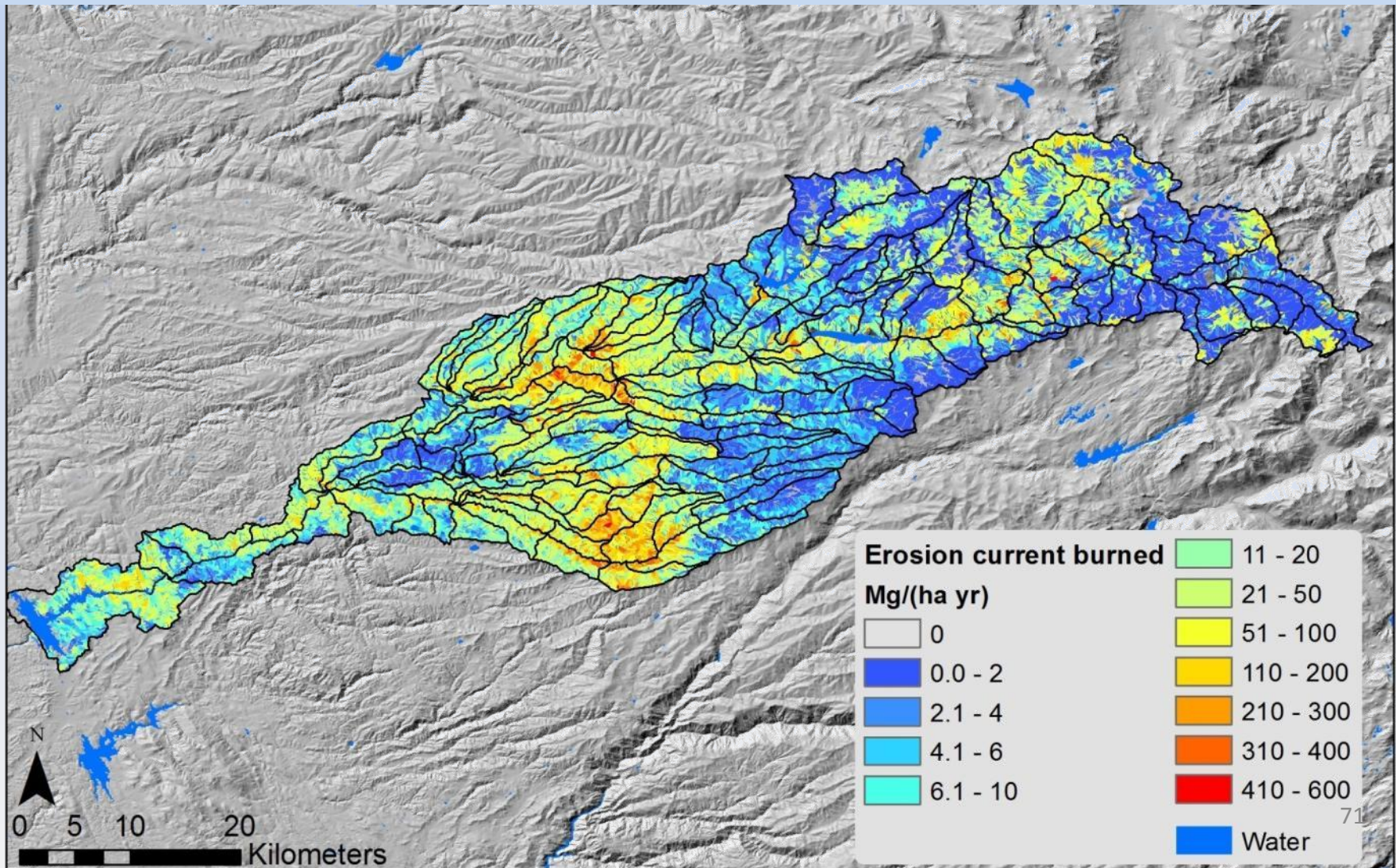
Inputs: 30-m National Elevation Dataset



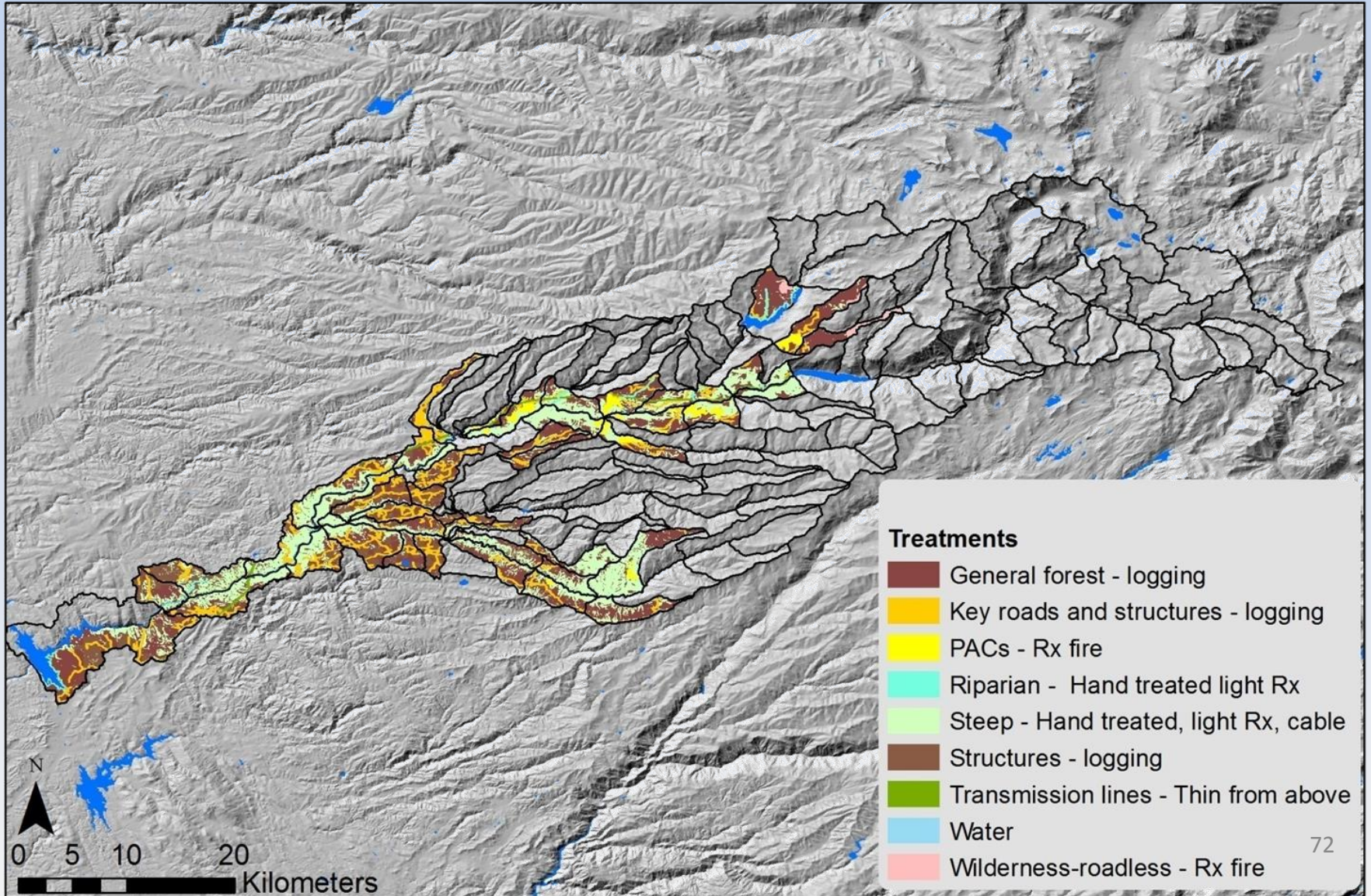
Results: Predicted annual hillslope-scale erosion for current land cover (NO Fire)



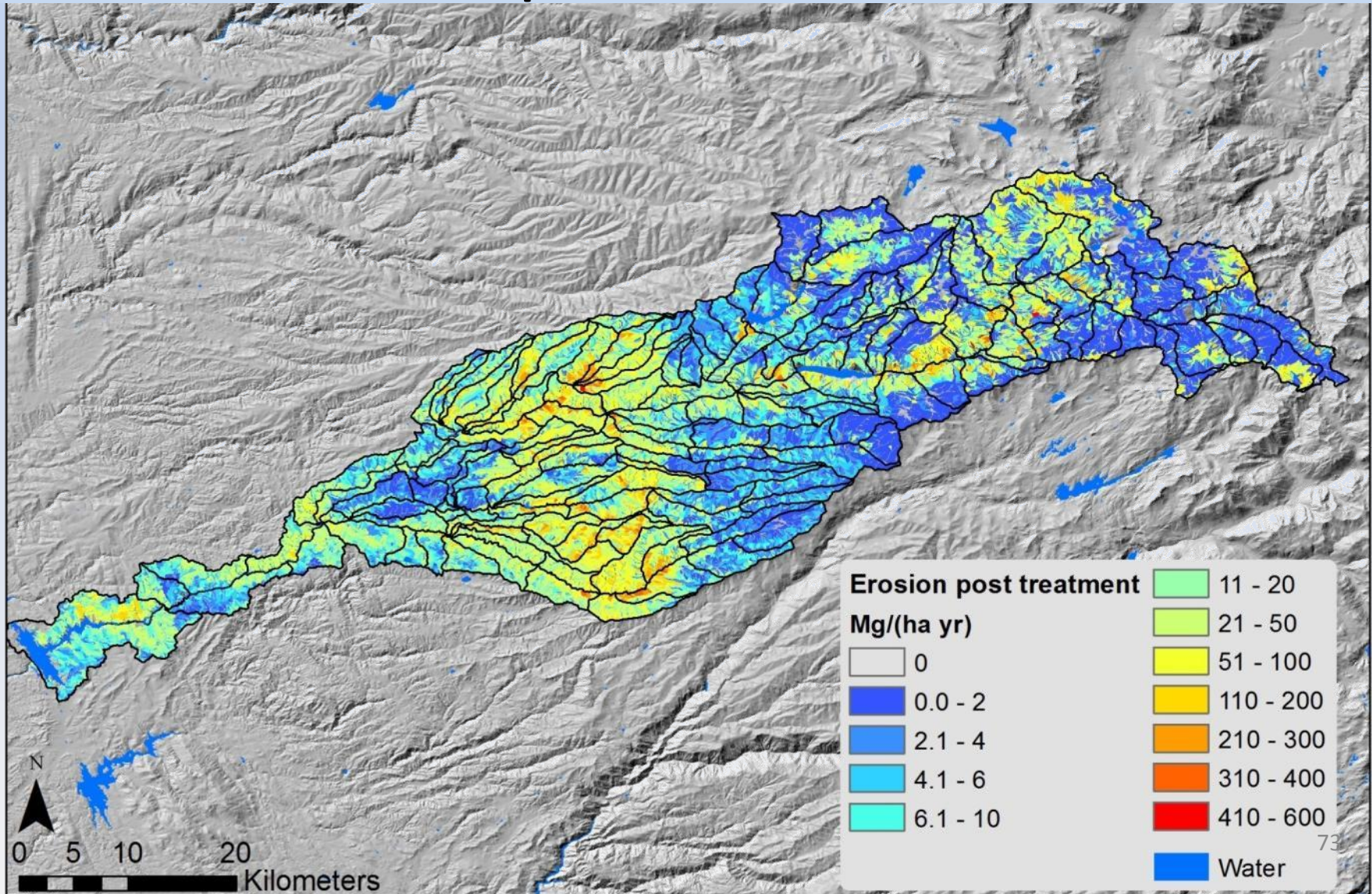
Results: Predicted first-year hillslope erosion AFTER burning, no treatment



Treatment Maps



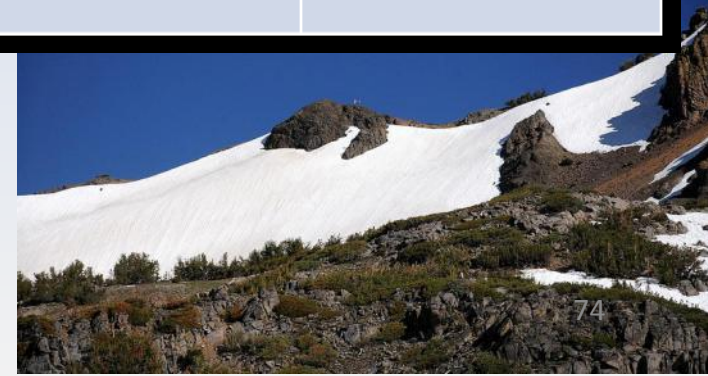
Predicted first year erosion if selected hillslopes are treated



Summary of Results

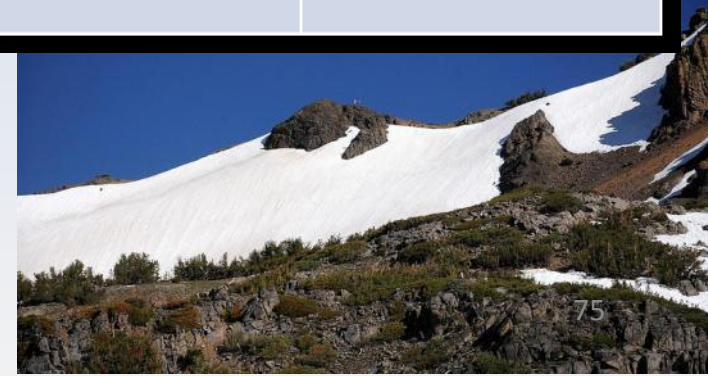
	Current Condition	Fire Following Current Condition	Treatment Effects	Fire Following Treatment
Average Erosion in Basin	0.67 Mg/ha	32 Mg/ha in year 1	0.69 Mg/ha	26 Mg/ha in year 1
Range	0 – 84 Mg/ha	0 – 566 Mg/ha	0 – 84 Mg/ha	0 – 535 Mg/ha
Standard Dev	3.0 Mg/ha	55 mg/ha	2.5 Mg/ha	44 Mg/ha

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



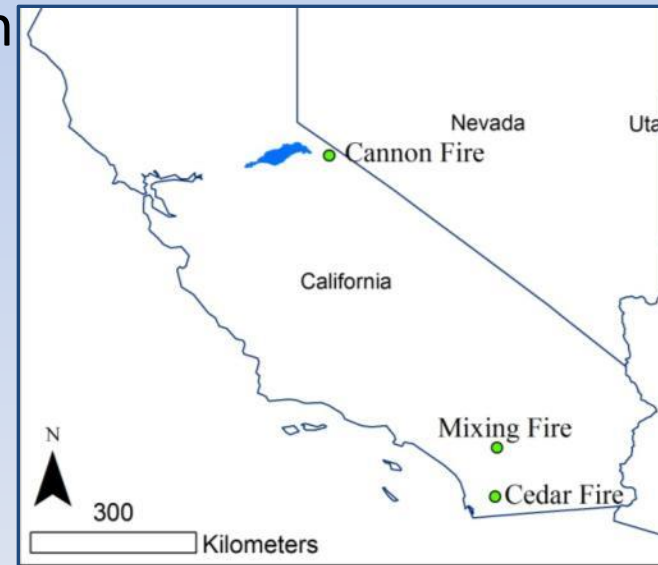
Summary of Results for Treatment Area

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



Are the results reasonable? (average value of 32 Mg ha⁻¹ yr⁻¹)

- Average annual first year post-fire erosion values observed recently in California:
 - Mixing Fire were 6-13 Mg/(ha yr⁻¹)
 - **Cannon Fire were 2.5-15 Mg/(ha yr⁻¹)**
- **closest site**
 - Cedar Fire 19-46 Mg/(ha yr⁻¹)



Avg. Prediction for Mokelumne Fire 32 Mg/(ha yr⁻¹)

- In all cases, the observed climates were drier (604 mm, 658 mm, and 398 mm respectively) than the Mokelumne Basin which ranged from 799 mm to 1438 mm.

How do we put wildfire erosion in context?

- Wildfire is part of disturbance driven forest ecosystem
- An “average annual” erosion from fire can be estimated by:
Avg Erosion = Wildfire Erosion x Probability



“Average Annual” Erosion

$$\text{Average Erosion}_{cc} = E_{cc_fire} * bp_{cc_fire} + (1 - bp_{cc_fire}) * E_{nf} \quad (\text{Eq 1})$$

$$\text{Average Erosion}_{tr} = E_{tr_fire} * bp_{tr_fire} + (1 - bp_{tr_fire}) * (24 * E_{nf} + E_{tr})/25 \quad (\text{Eq 2})$$

where:

E_{cc_fire} is the mapped post-fire erosion rates for current conditions.

E_{tr_fire} is the mapped post-fire erosion rates following fuel treatments.

E_{tr} is the mapped erosion rates due to the effects of the fuel treatments.

E_{nf} is mapped erosion rates for current conditions in the absence of fire.

bp_{cc_fire} is the mapped probability of fire under current conditions.

bp_{tr_fire} is the mapped probability of fire following fuel treatments.

For treated portion of the watershed

$$\text{Average Erosion}_{cc} = 0.64 \text{ Mg yr}^{-1} \text{ ha}^{-1}$$

$$\text{Average Erosion}_{tr} = 0.52 \text{ Mg yr}^{-1} \text{ ha}^{-1}$$

Fuel Planning Conclusions

1. FLAMMAP and WEPP can be used to quantify the changes in fire severity and erosion associated with fuel reduction treatments;
2. Knowing the distribution of potential erosion is useful to forest and watershed managers;
3. Managers can expect a significant reduction (19%) in sediment delivery with fuel treatment;

Thank you

Be Prepared!

- ✓ Have the data ready
- ✓ Have plan to incorporate Earth Observations
- ✓ Have your model installed and ready!



Questions?



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memiller@mtu.edu

(734) 994-7221

<http://geodjango.mtri.org/geowepp>