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Hillslope Toolbox to Support Post-Wildfire Erosion and Sediment Models

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Project Background

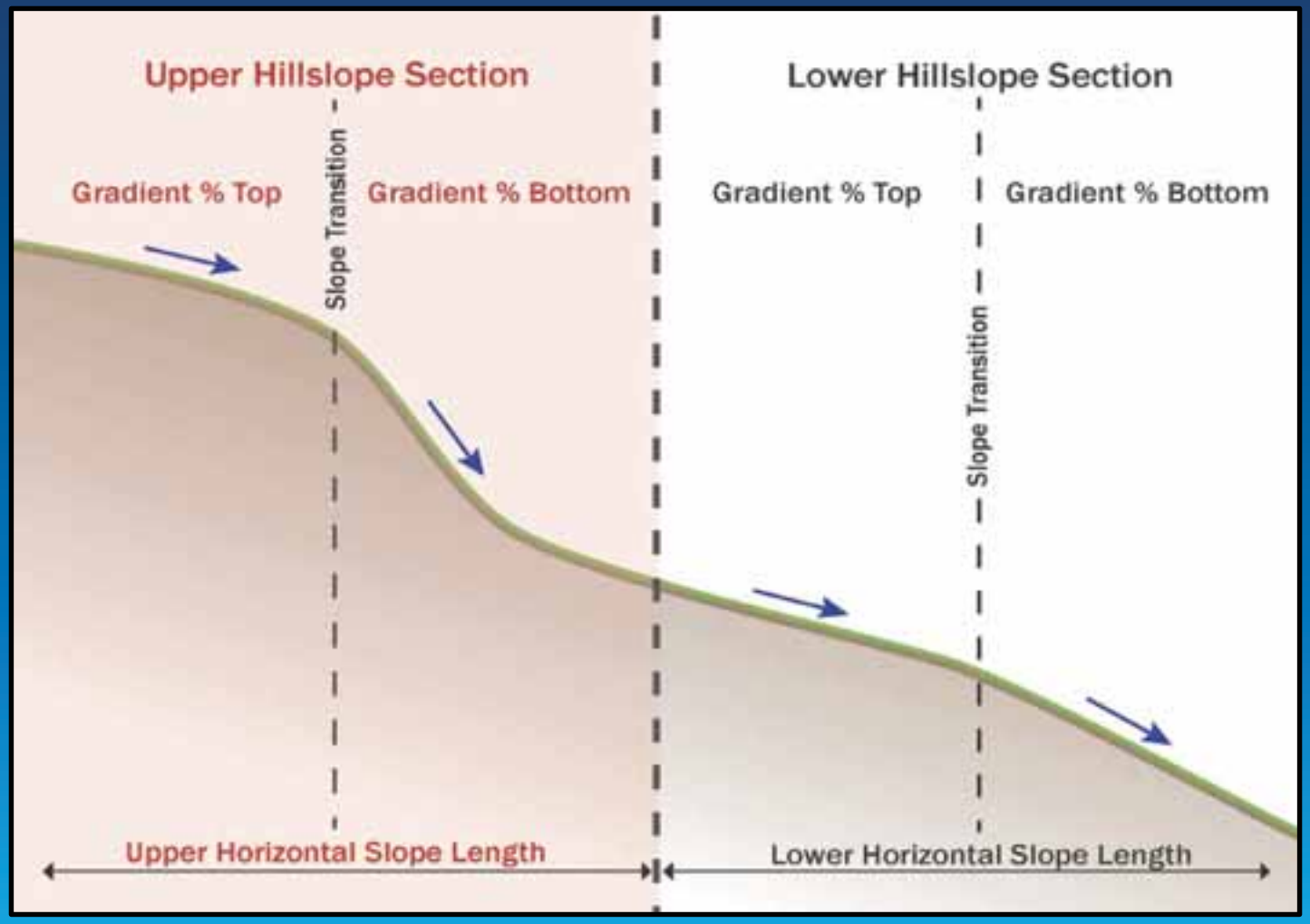
All photos courtesy of Pete Robichaud, Rocky Mountain Research Station

Post-Fire Soil Erosion and Sedimentation

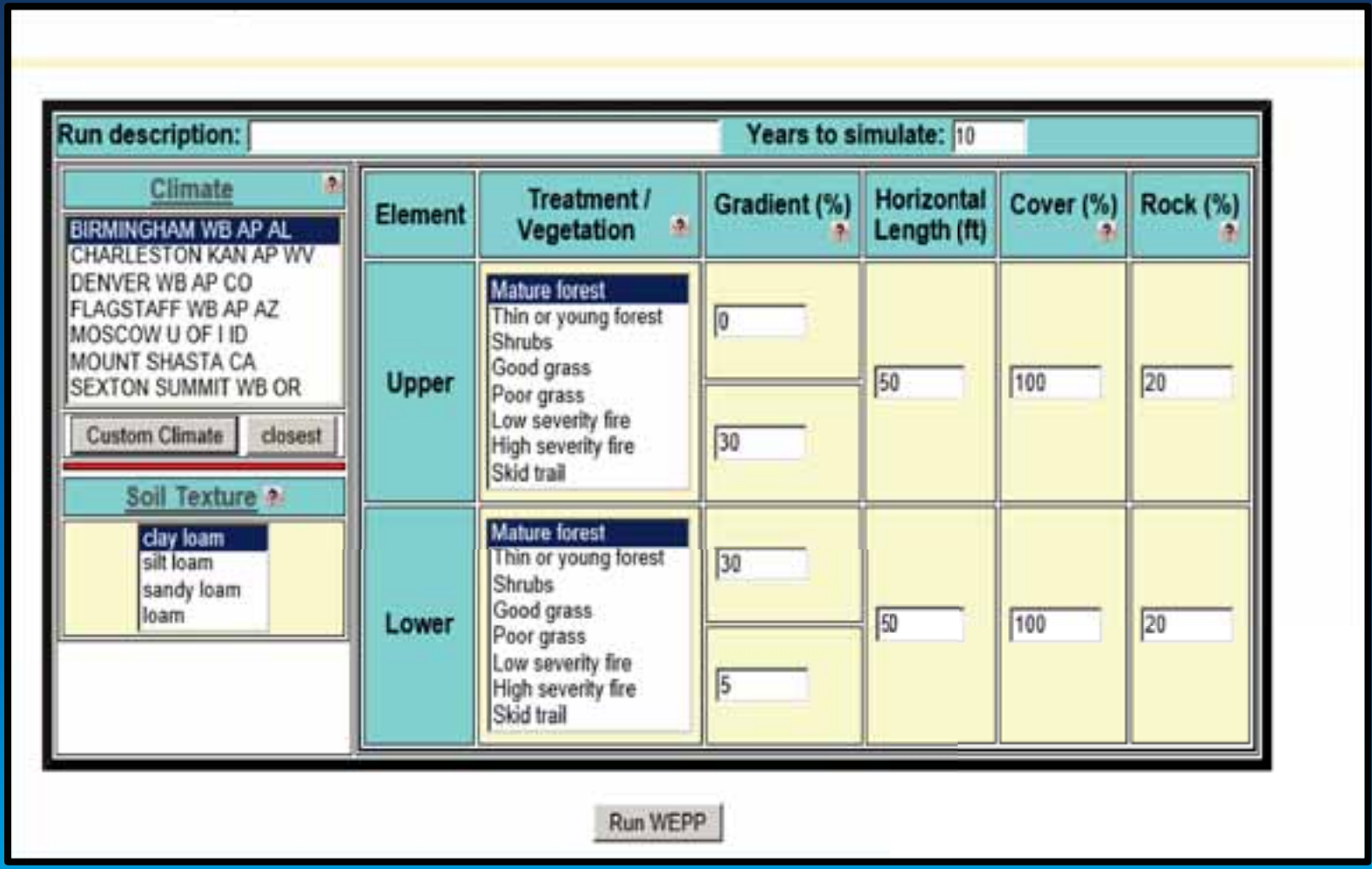
- Increase in number and severity of wildfires in recent decades
- Results:
  - Increased soil erosion
  - Negative water impacts
  - Catastrophic damage from floods and debris


More than just
muddy water....
Values are at risk!
JUL 12 2006

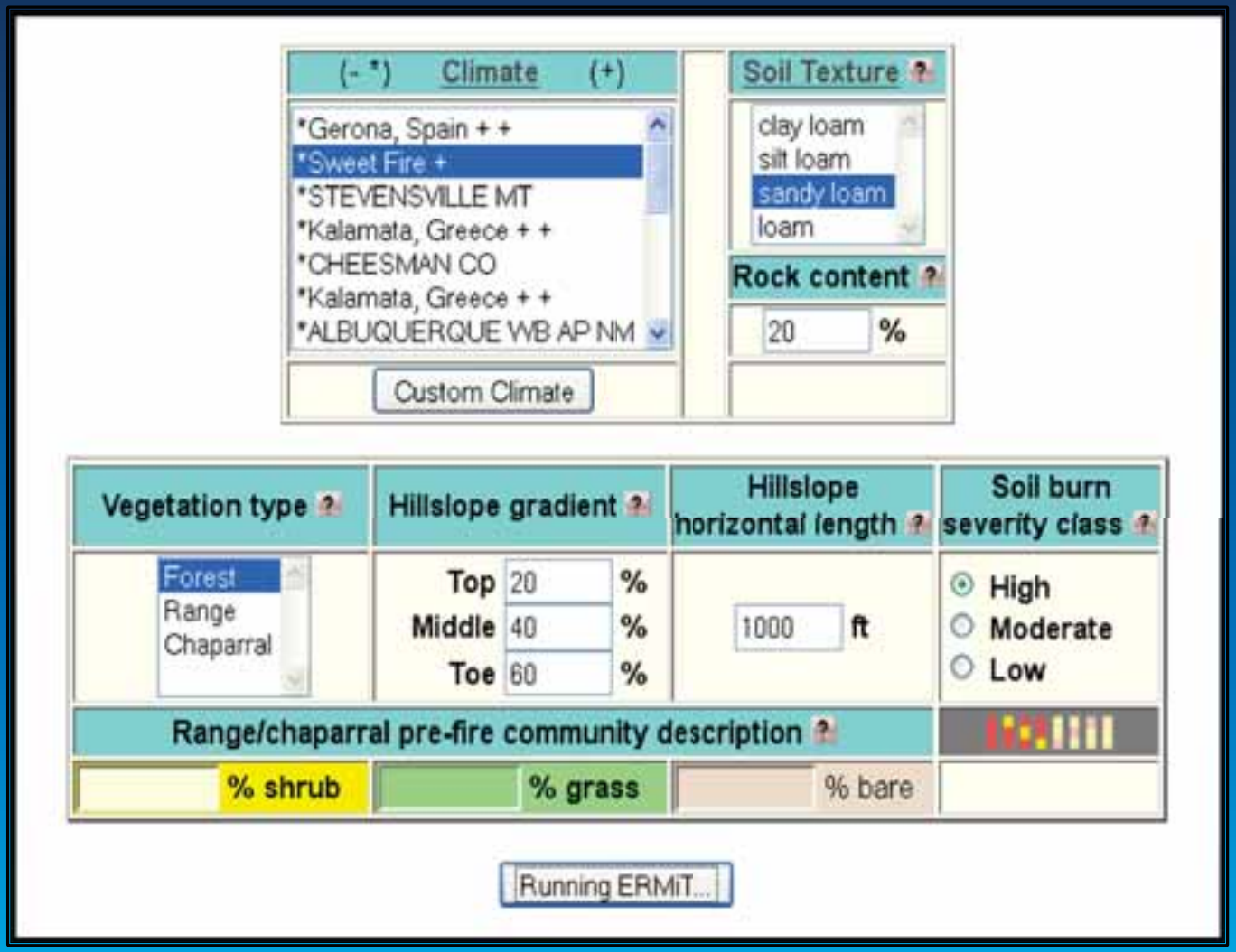
Hillslope Erosion and Sediment Models



Disturbed Water Erosion Prediction Project (WEPP)



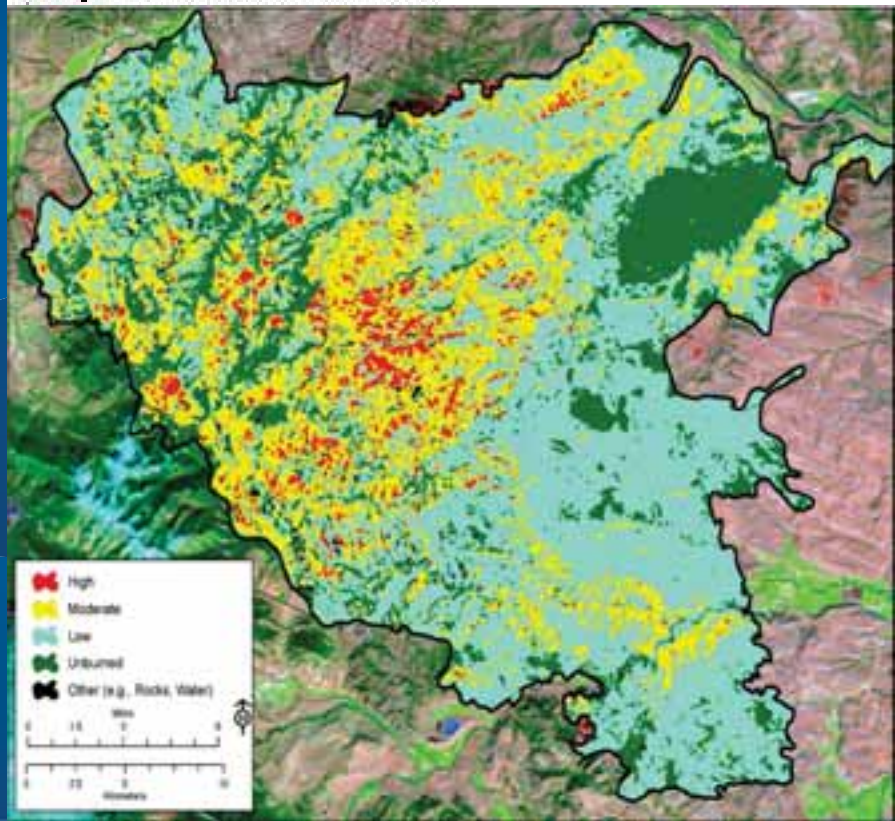
Erosion Risk Management Tool (ERMiT)



Model Inputs and Existing Methods

- Models rely on hillslope data
- Hillslopes modeled individually, delineated by hand
- GeoWEPP interface
- Excel batch-processing tools

Hillslope Delineation Toolbox



Hillslope Delineation Toolbox Objectives

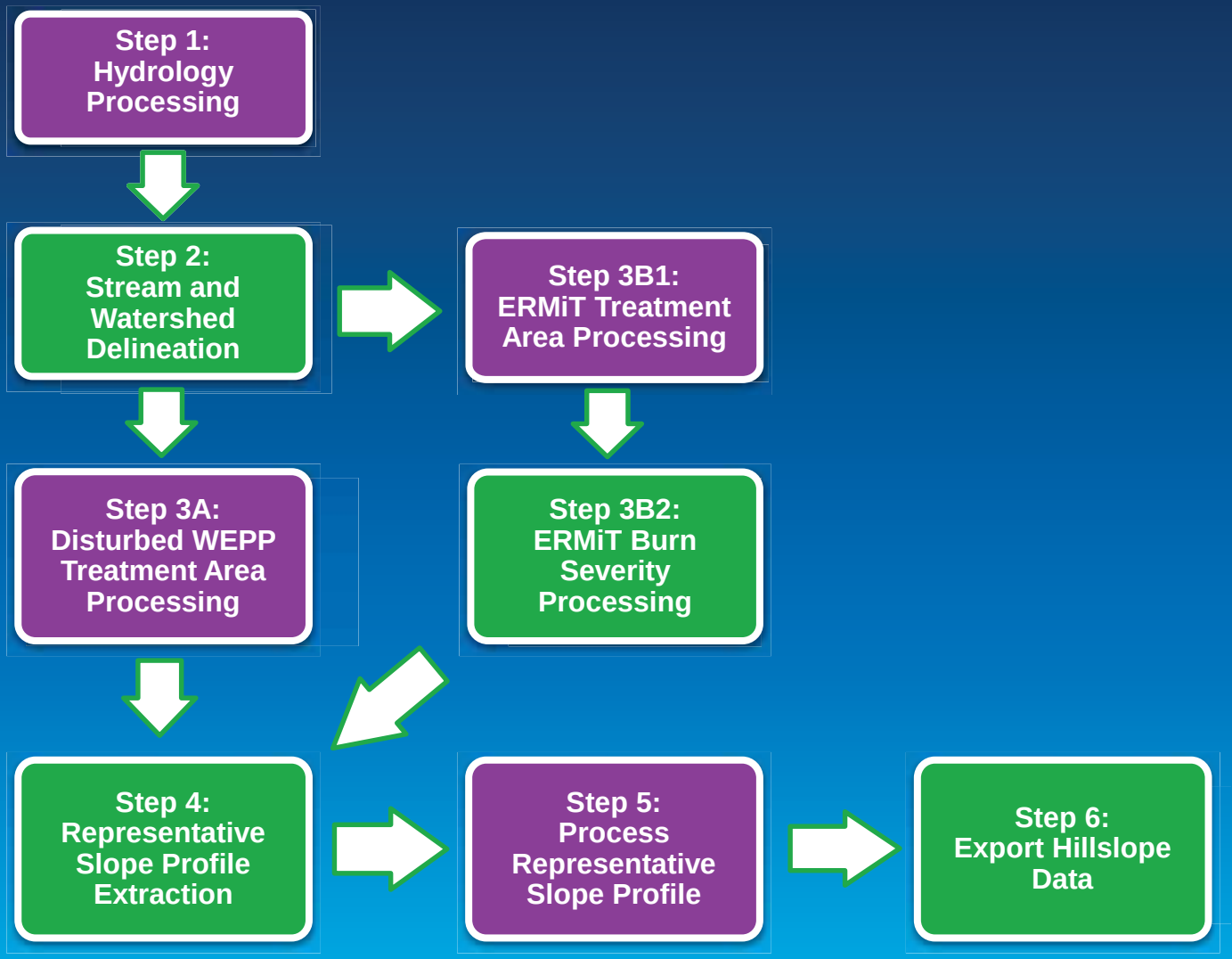
- **Toolbox goals:**
  - **Generate hillslope data for models**
  - **Step-by-step interface**
  - **Transparent output**

- **Toolbox not designed to:**
  - **Eliminate need for desktop GIS or data collection**

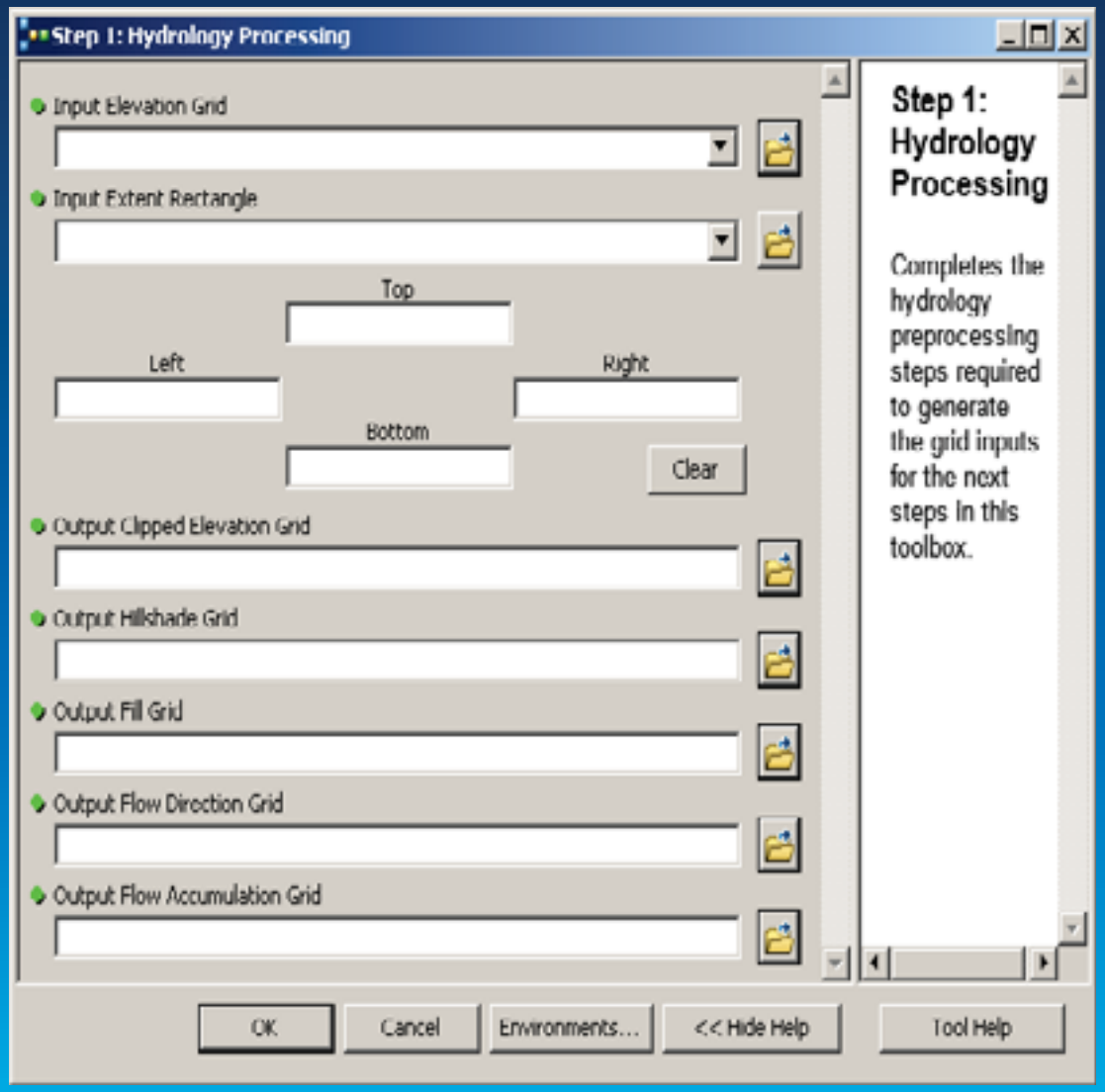
Hillslope Toolbox Requirements

- ArcGIS v9.3 or v10.0
- Spatial Analyst extension
- Batch ERMiT and WEPP spreadsheets
- Data:
  - Elevation grid
  - Treatment polygons
  - Soil polygons
  - BARC burn severity raster (ERMiT only)

Hillslope Delineation Toolbox Overview

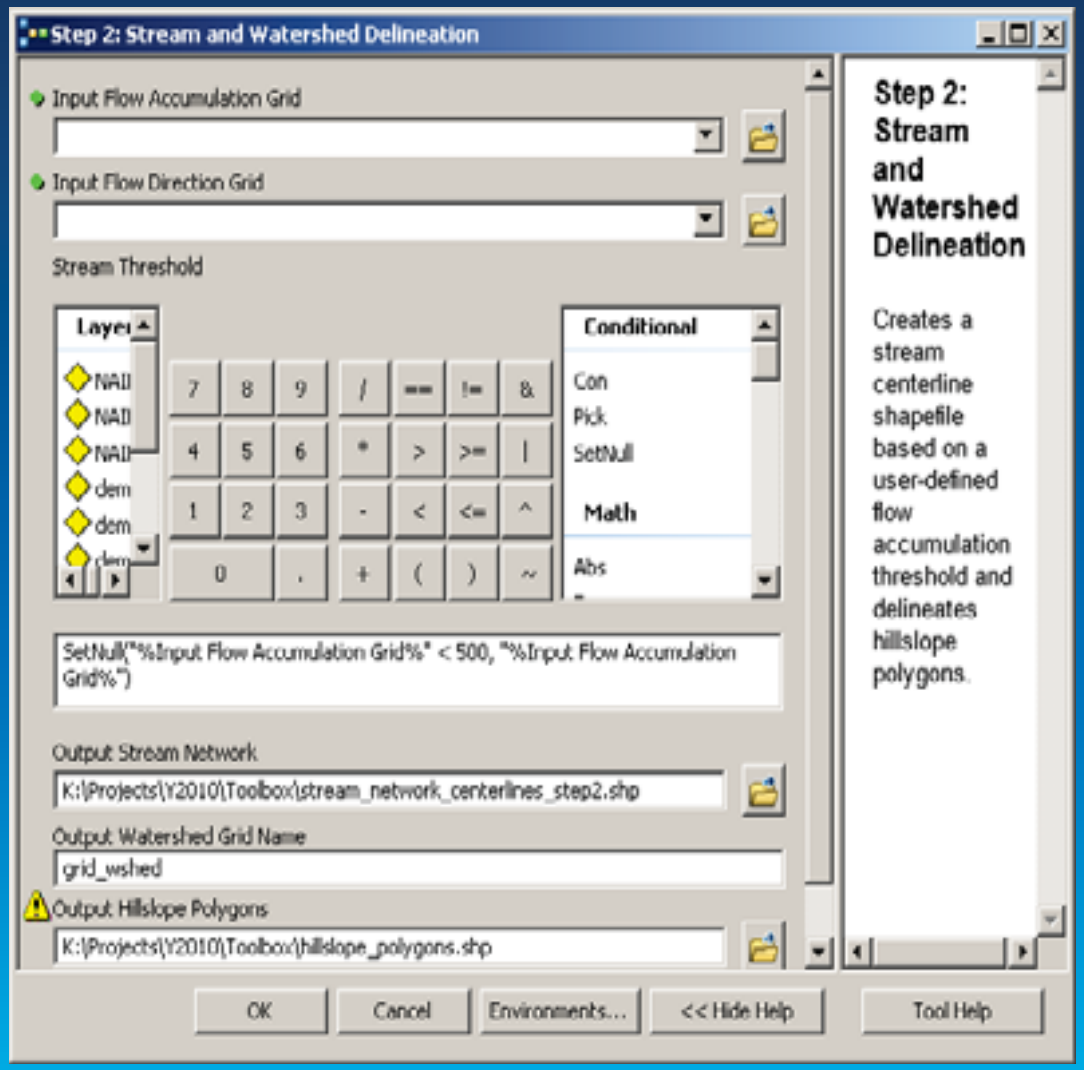


Step 1: Hydrology Processing

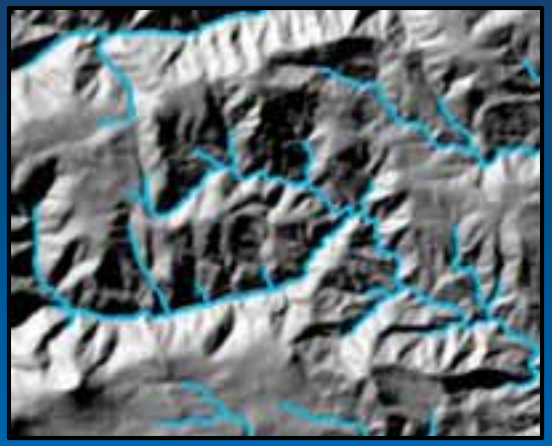


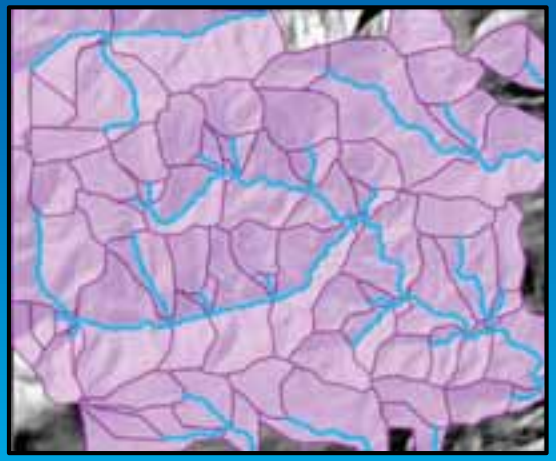
Tool Output

Step 2: Stream and Watershed Delineation



Tool Output





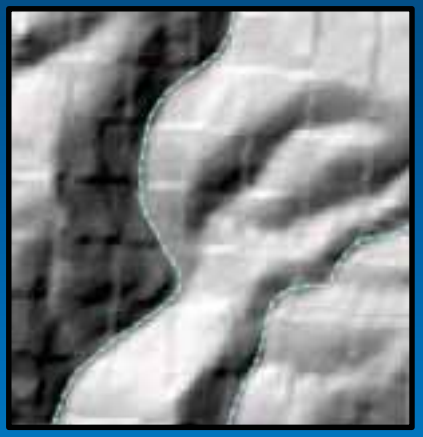
Step 2: Stream and Watershed Delineation

Stream networks and hillslopes are very sensitive to grid resolution and contributing drainage area!

100 pixels (0.01 km2)

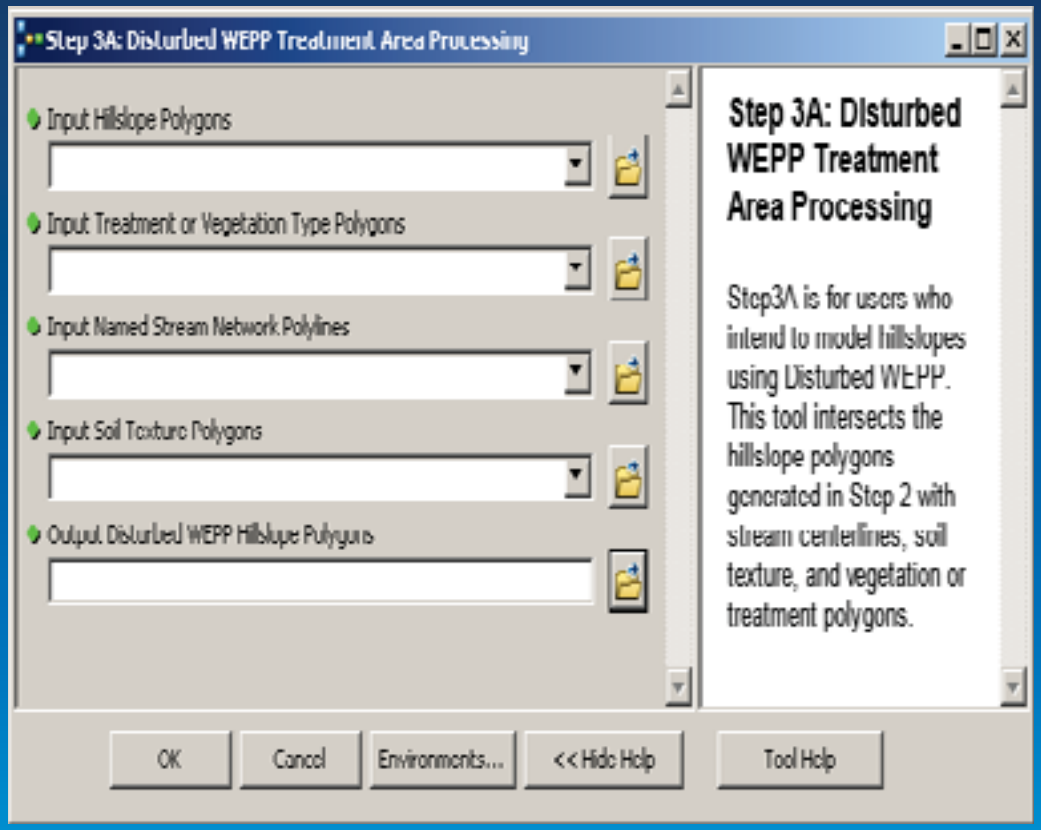
500 pixels (0.05 km2)

1000 pixels (0.1 km2)

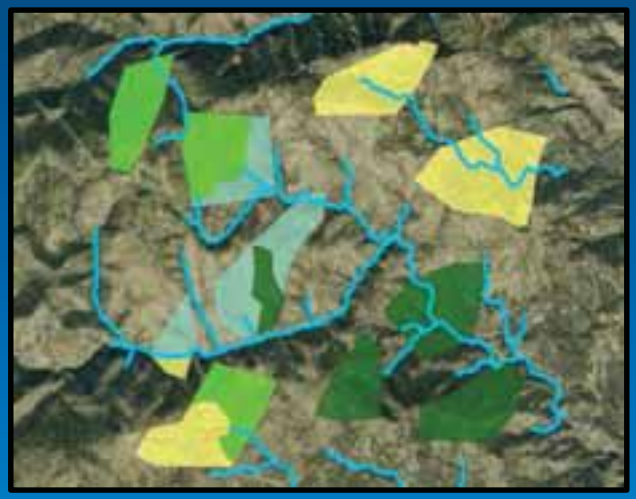


USGS Stream Delineation

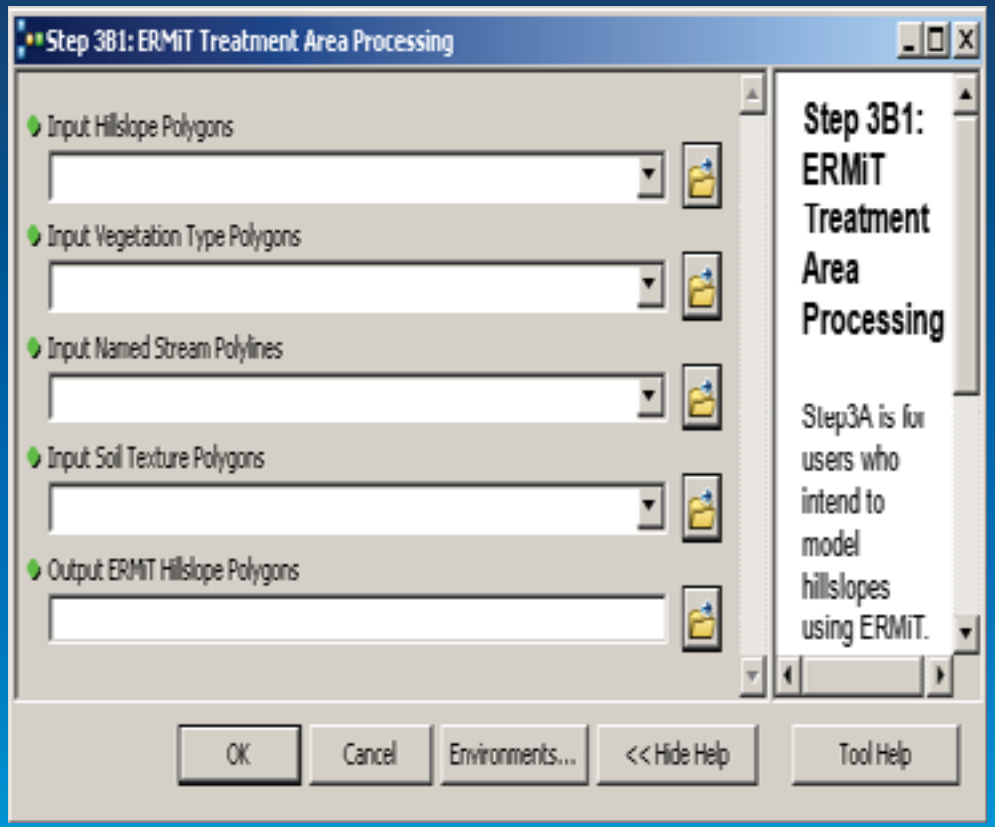
Step 3A: Disturbed WEPP Treatment Area Processing



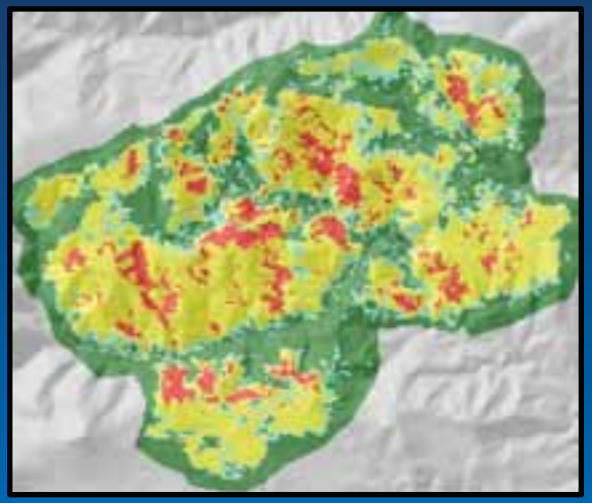
Tool Output

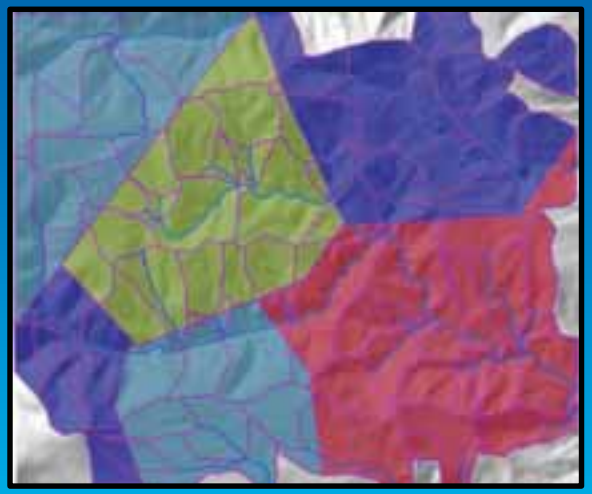


Step 3B: ERMiT Treatment Area Processing

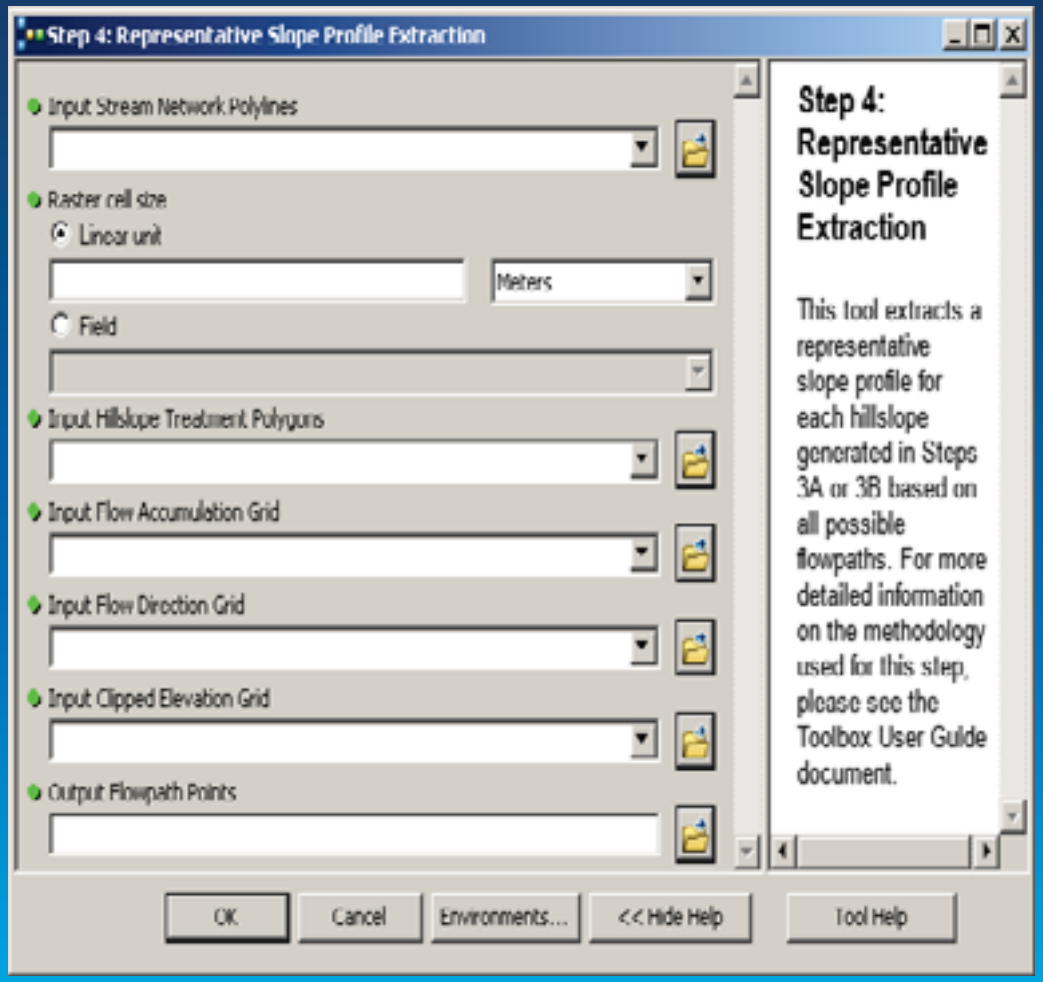


Tool Output





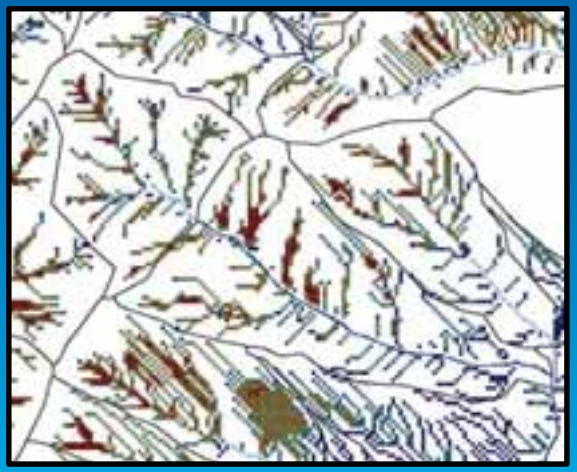
Step 4: Representative Slope Profile Extraction



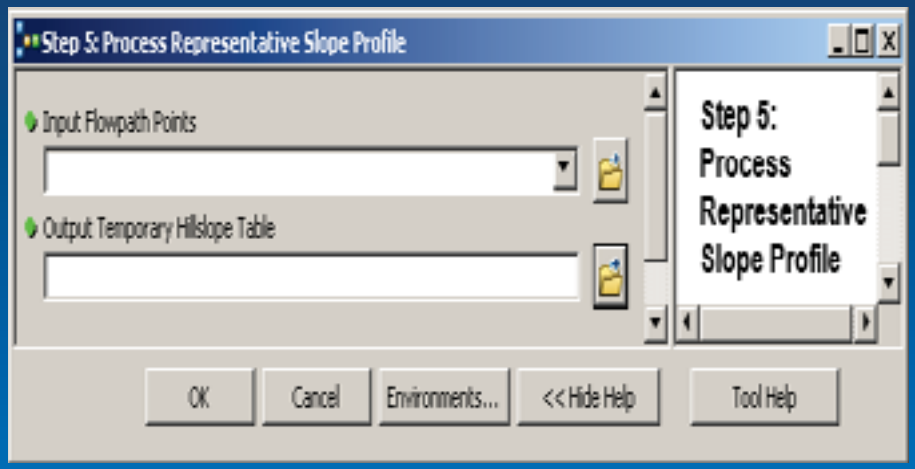
Tool Output

Flow Length

Percent Slope



Step 5: Process Representative Slope Profile



- 3 representative slope profile algorithms reviewed
- Method chosen: linear averaging
- Assumes all gradients influence soil loss equally

Step 6: Export Hillslope Data

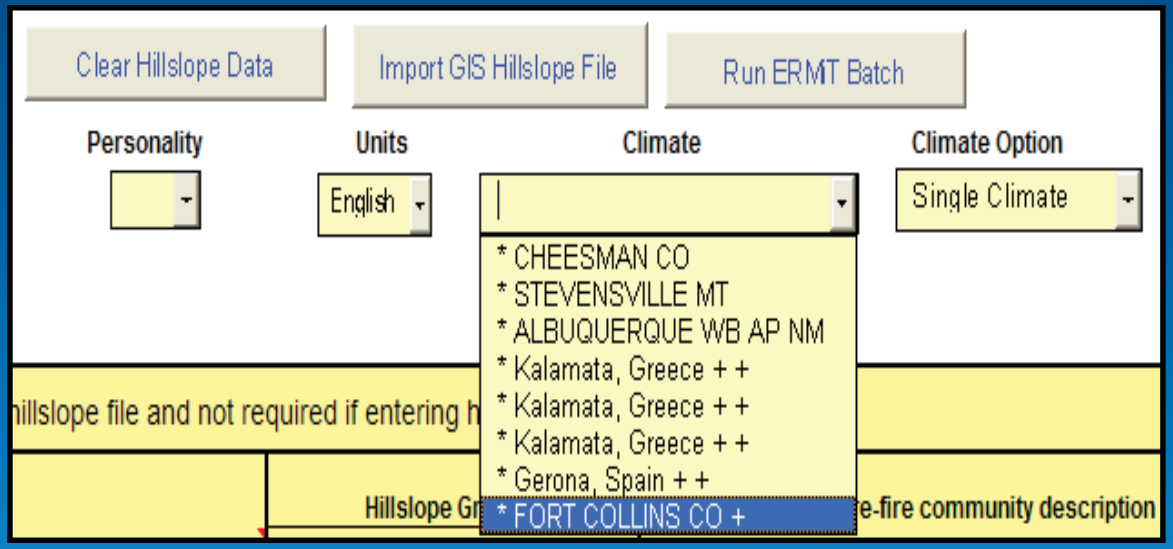
Tool Output

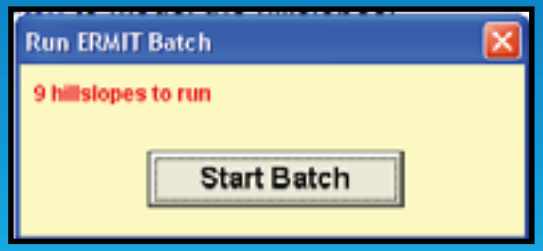
Table 1. Formatted hillslope output table fields.

Field Description	Field Name	Field Type
Hillslope Unique ID	HS_ID	Long
Unit ID Number	UNIT_ID	Text
Land Type Code	LAND_TYPE	Text
Area (Acres)	AREA	Double
Upper Treatment Area Type	UTREAT	Text
Upper Hillslope Slope Profile Length	USLP_LNG	Double
Upper Hillslope Top Slope (Percent)	UGRD_TP	Double
Upper Hillslope Bottom Slope (Percent)	UGRD_BTM	Double
Lower Treatment Area Type	LTREAT	Text
Lower Hillslope Slope Profile Length	LSLP_LNG	Double
Lower Hillslope Top Slope (Percent)	LGRD_TP	Double
Lower Hillslope Bottom Slope (Percent)	LGRD_BTM	Double
Adjacent Stream Name	ADJ_STRM	Text
Stream Tributary	TRIB_TO	Text
ERMIT Top Slope (Percent)	ERM_TSLP	Double
ERMIT Middle Slope (Percent)	EM_MSLP	Double
ERMIT Bottom Slope (Percent)	ERM_BSLP	Double
ERMIT Burn Severity	BURNSEV	Double

Disturbed WEPP and ERMiT Batch Models

- **Excel-based batch tools for WEPP and ERMiT**
- **Run using GIS hillslope output**





Disturbed WEPP and ERMiT Batch Models

USFS ERMiT Batch Program - Year 1 Results By Hillslope

Select the hillslope code to view the year 1 sediment delivery results. Select the desired probability % by clicking on the percentage column headers in row 13.

Select Hillslope Code 1

Year 1 Sediment Delivery (tons/acre)

To change probability % for a column click on the probability cell and select the desired probability

	Probability %			
	30%	40%	70%	50%
Untreated	12.22	5.02	0.14	3.05
Seeding	12.22	5.02	0.14	3.05
Mulch (0.5 tons/acre)	1.54	0.43	0	0.23
Mulch (1 tons/acre)	0.46	0.36	0	0.18
Mulch (1.5 tons/acre)	0.45	0.35	0	0.17
Mulch (2 tons/acre)	0.44	0.34	0	0.16

Year 1 is defined as the first summer after the fire.

Challenges and Lessons Learned

Toolbox Limitations

- **Desktop GIS and Spatial Analyst required**
- **Users have to collect and process their own data**
- **Easy to make bad resolution decisions**
- **Step-by-step does not equal intuitive!**

Project Challenges

- Specific to each version of ArcGIS
- Not every desktop process is easy to make repeatable
- Organic development
- Model Builder vs. Python
- Budget constraints

Proposed Improvements

- Web-based platform
- Develop video user tutorials
- More in-tool help options
- Automate importing WEPP and ERMiT model output into GIS

- **Toolbox and documentation available for download at: http://forest.moscowfsl.wsu.edu/fswepp/batch/HillslopeDelineationToolbox.html**

- **Thank you to the USDA Forest Service Rocky Mountain Research Station, specifically Pete Robichaud, William J. Elliot, David Hall, and Sue Miller, and Mary Larkin and David Yu of Herrera Environmental Consultants.**

Questions?

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