CBRFC/Western Region

Flash Flood Analysis Project

Alternative methods for determining flash flood potential and guidance

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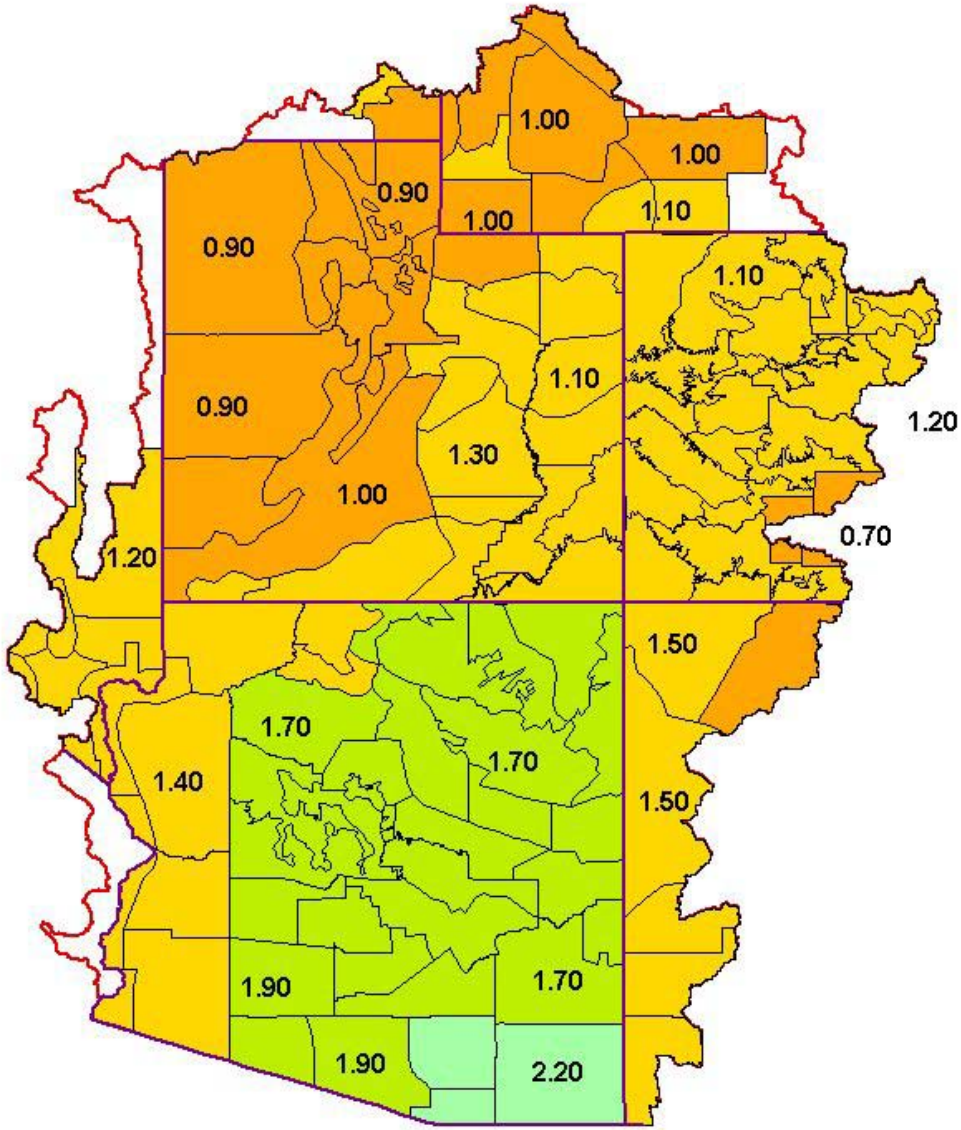
Colorado Basin River Forecast Center

Presented to: Southwest Weather Symposium – Las Vegas, NV Sep 2002

Gypsum Wash – Near Las Vegas, NV

1-Hour CBRFC Flash Flood Guidance

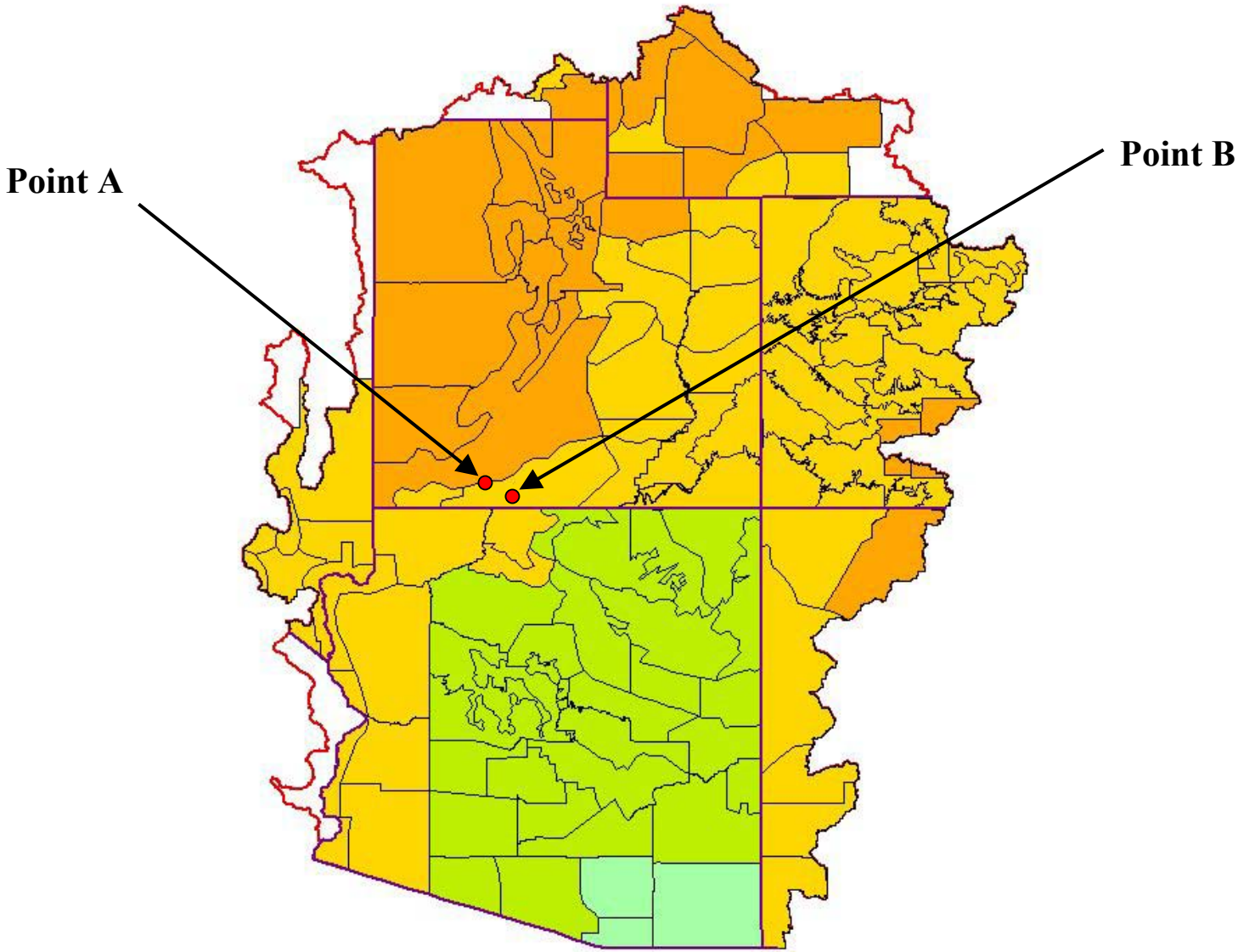


Flash Flood Guidance Inches

- 0.01 - 0.50
- 0.51 - 1.00
- 1.01-1.50
- 1.51 - 2.00
- 2.01 - 2.50

August 2001

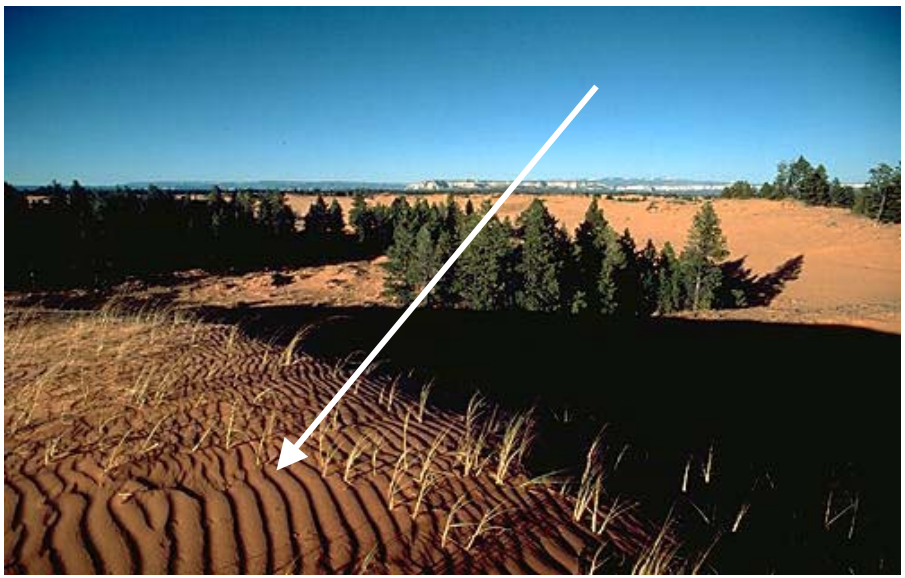
A Comparison of Flash Flood Guidance



POINT A

Parunuweap Canyon on the East Fork of the Virgin River – well known classic flash flood canyon about 10 miles northwest of point B.

Current Method Implies Similar Hydrologic Response



POINT B

Sand dunes near Moquith Mountain.

1-Hour Flash Flood Guidance on this date = 1.10” for both point A and B.

1 Hour Flash Flood
Guidance = 1.10”

FFG for 8/15/2001

1 Hour Flash Flood
Guidance = 1.00”

FFG for 8/15/2001

1 Hour Flash Flood
Guidance = 1.00”

FFG for 8/15/2001

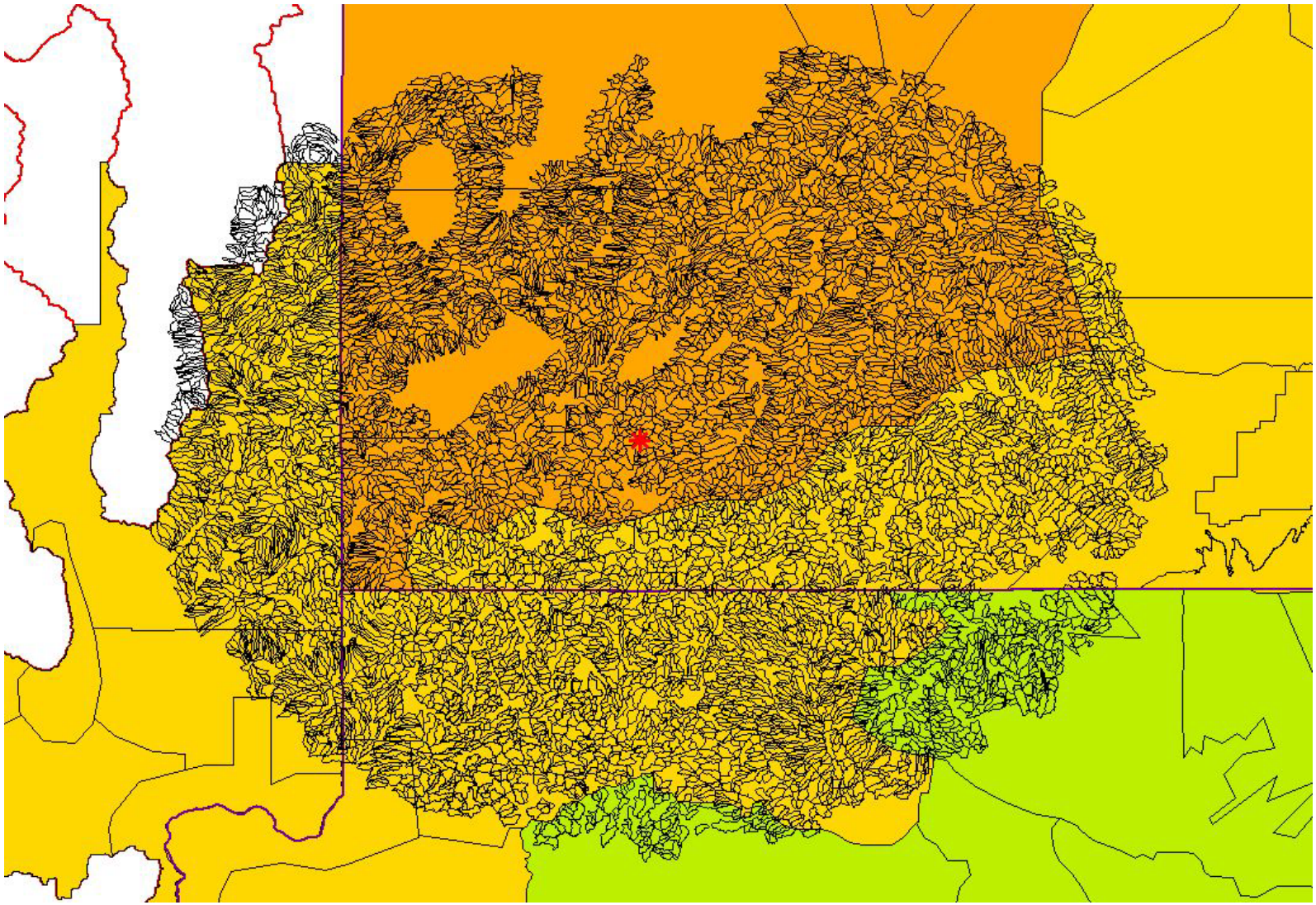
1 Hour Flash Flood Guidance = 1.00” for both the barren clay hills in the foreground and alpine mountainous country in the background

Photos courtesy Southern Utah Wilderness Alliance

FFG for 8/15/2001

KICX AMBER/FFMP basins overlayed with current zone guidance

Tools like this emphasize the need for greater spatial detail flash flood potential or guidance information



So Where Are We ?

Current FFG Method:

- ⇧ Empirical in nature, grounded in some truth.
- ⇧ Favors rainfall intensity over soil moisture as a driving force behind flash flooding
- ⇩ Dependent on unrealistic long term drought index for temporal variation
- ⇩ No account for changes to surface hydrologic response caused by urbanization or fire etc.
- ⇩ No direct account for spatial distribution of physiographic properties
- ⇩ Not robust – FFG lacks spatial variation
- ⇩ Modernized FFG programs/methods – inadequate for Western Region needs

With the advent of FFMP, (i.e. the widespread use of AMBER), FFG will become much more important and will be reviewed much more critically. (We need to be careful about what we issue).

We need to look at alternative methods for producing FFG information.

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Take a big step back – View from a flash flood potential perspective

Is it even possible to create accurate guidance values ?

- **What physiographic properties make an area susceptible to flash flooding – can we identify these ?**
- **What changes in these features or properties increase/decrease an area's susceptibility to flash flooding.**
- **Identify areas susceptible to flash flooding, relative to one another, based solely on these properties.**

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Utilize GIS tools/methodology to carry out such an analysis

- **Acquire static raster datasets linked to hydrologic response:**
  - **Basin geography (slope and shape information)**
  - **Soil information & derived hydrologic properties**
  - **Vegetation coverage information**
  - **Forest coverage/canopy information**
  - **Land use information, etc.**
- **Perform analysis on raster datasets using GIS map algebra**
  - **On individual layers – assign relative flash flood potential indicators**
  - **Merge layers – yield single gridded relative flash flood potential layer**

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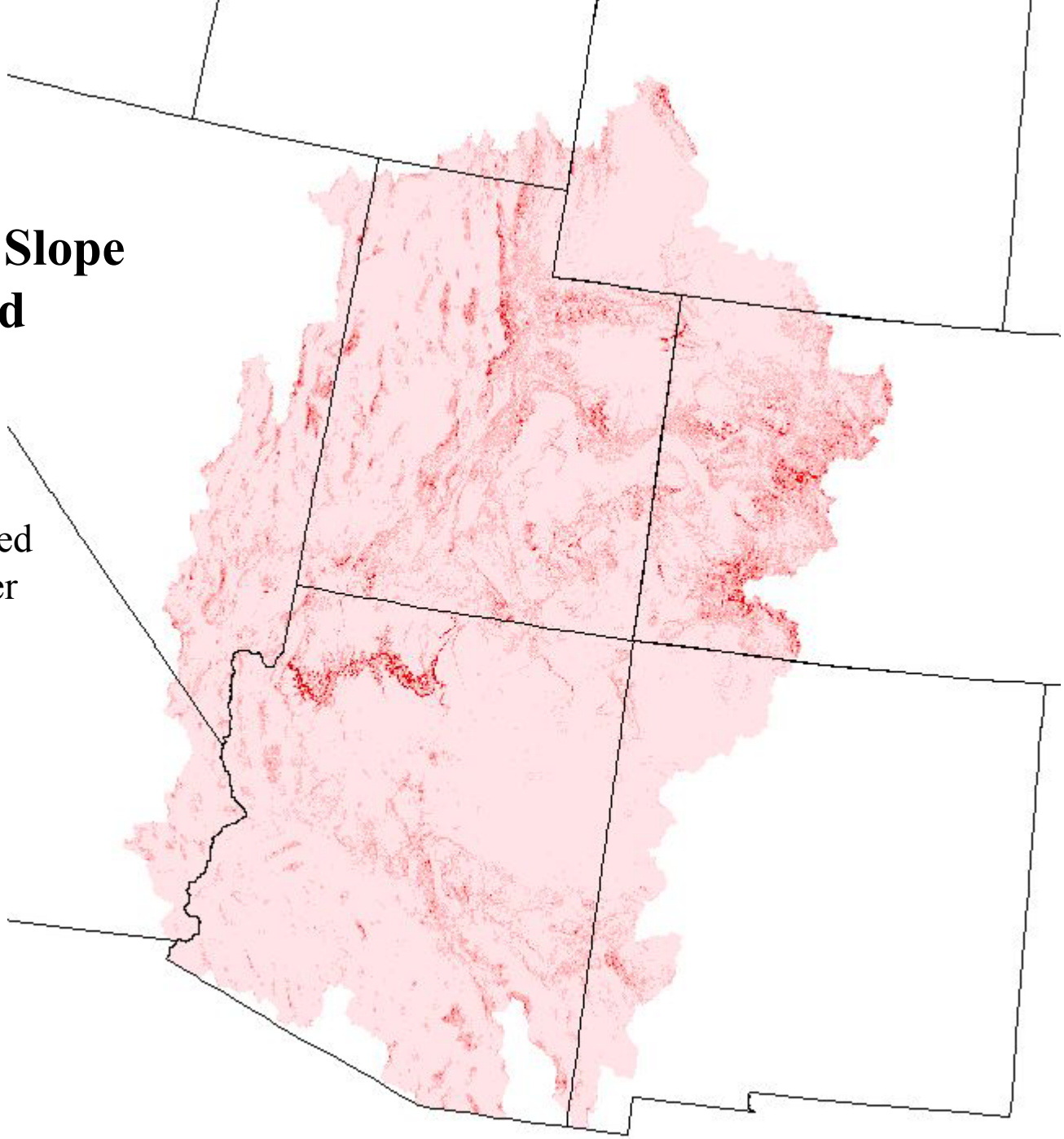
Example

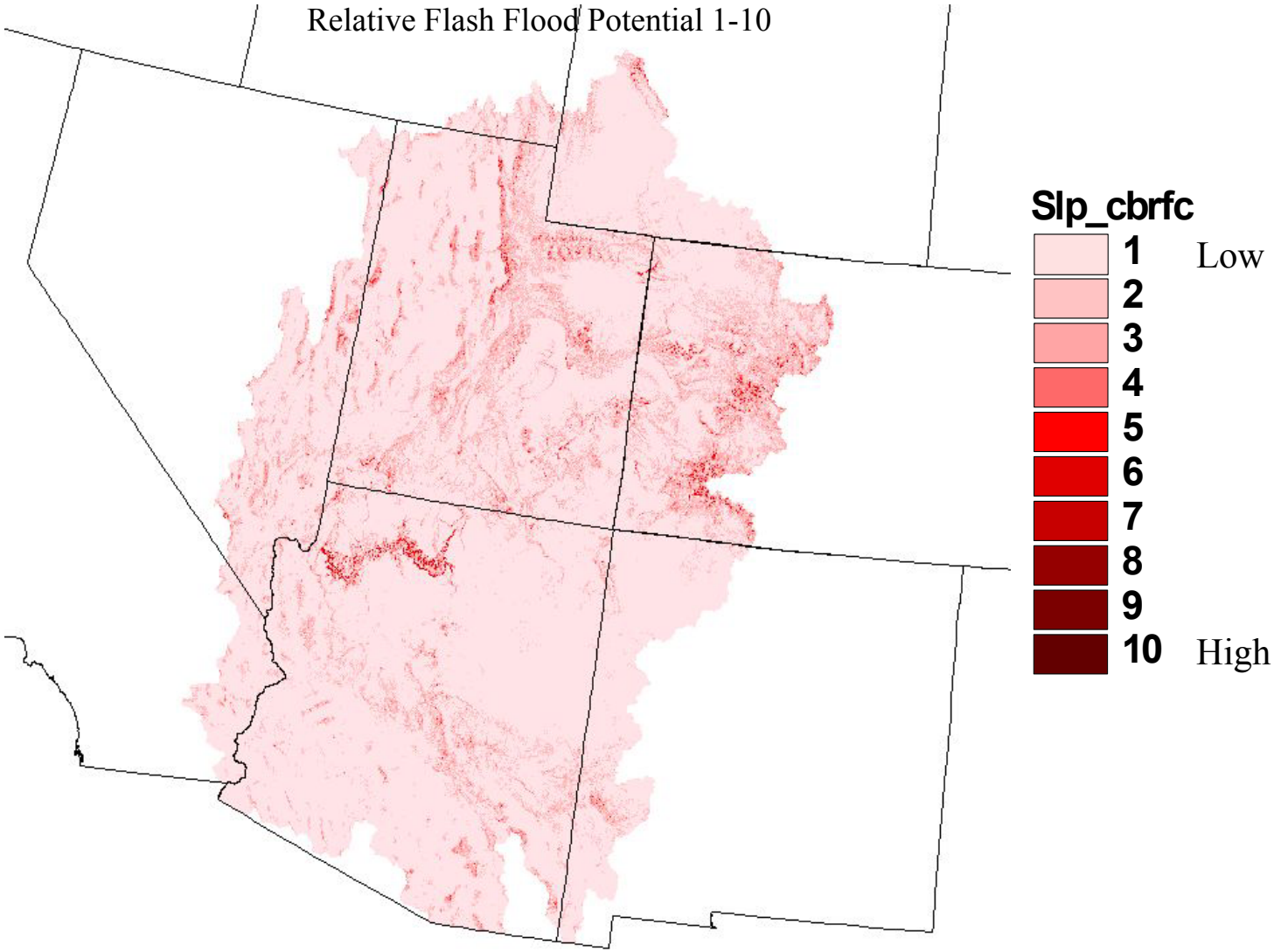
- **A first shot analysis for the CBRFC area using readily available data**
  - **Four raster data layers used – (re-sampled to 400 meter grid – coarse!)**
    - **Percent Slope Grid (terrain steepness factor)**
    - **Rock Volume Grid (% rock fragments – affecting infiltration) - STATSGO**
    - **Fractional Soil Grid (% clay, sand etc.) – USGS STATSGO**
    - **Forest Density Grid - NOAA AVHRR**
  - **Datasets were all geo-registered prior to manipulation**
  - **Datasets re-sampled to consistent resolution – Bilinear method**
  - **Equal weighting given to each data layer**
  - **Flash Flood Indicators assigned (1-10) – equal interval re-classification**
  - **Utilized Arc-Info map algebra routines to output a single gridded layer**

Percent Slope Grid

Re-sampled 400 meter DEM

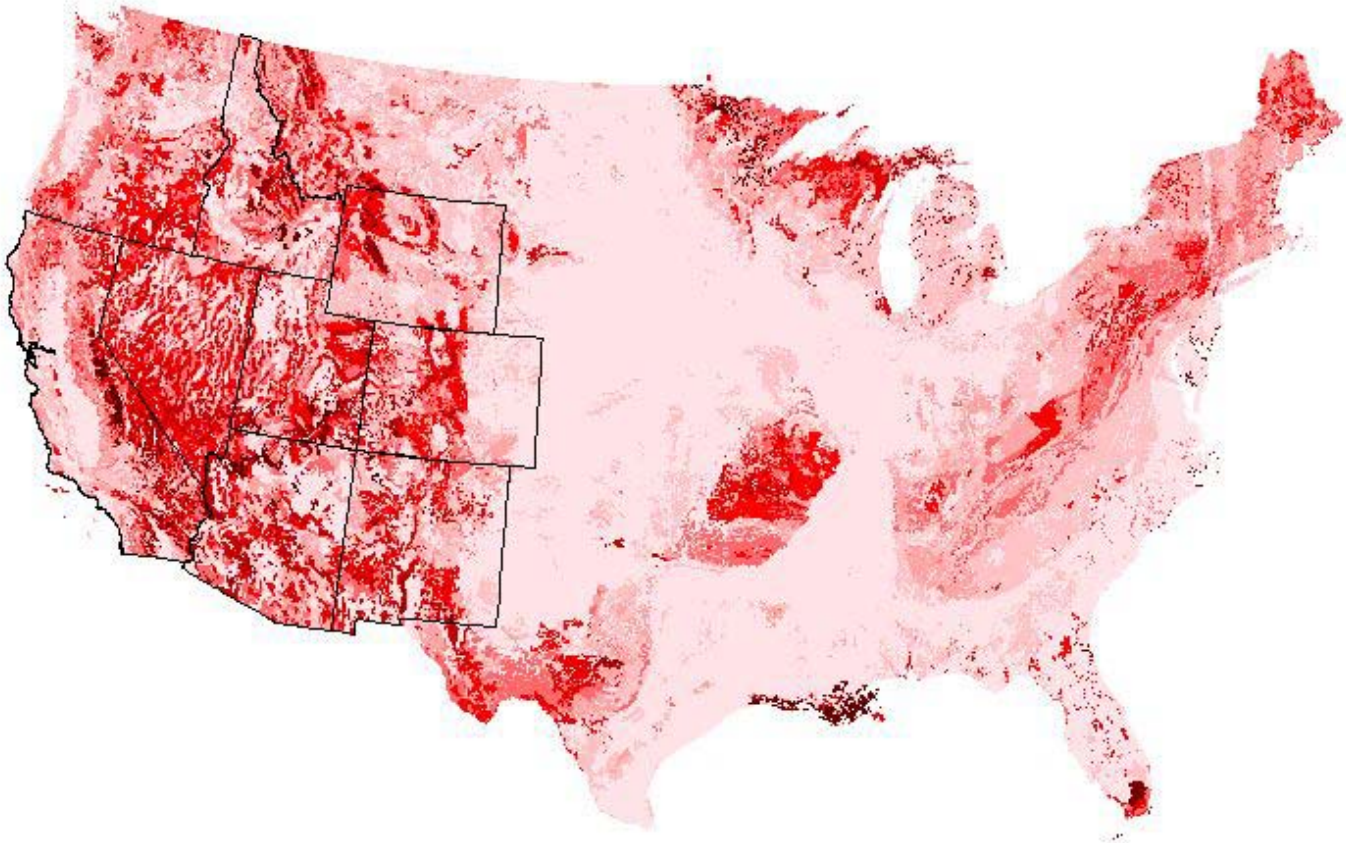


Reclassified Percent Slope Grid



Rock Volume Grid

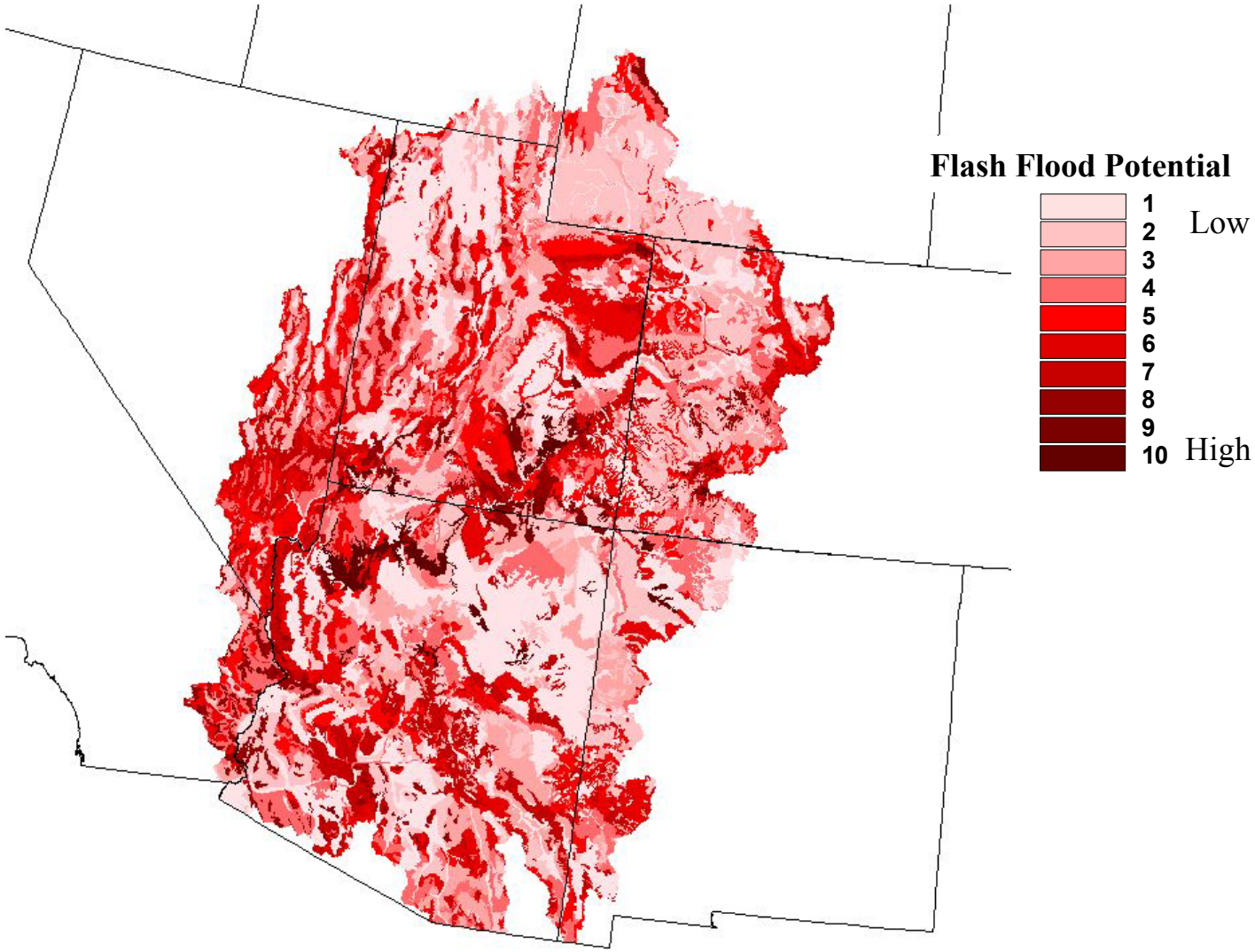
Rock fragments in the soil > 2mm



source: STATSGO

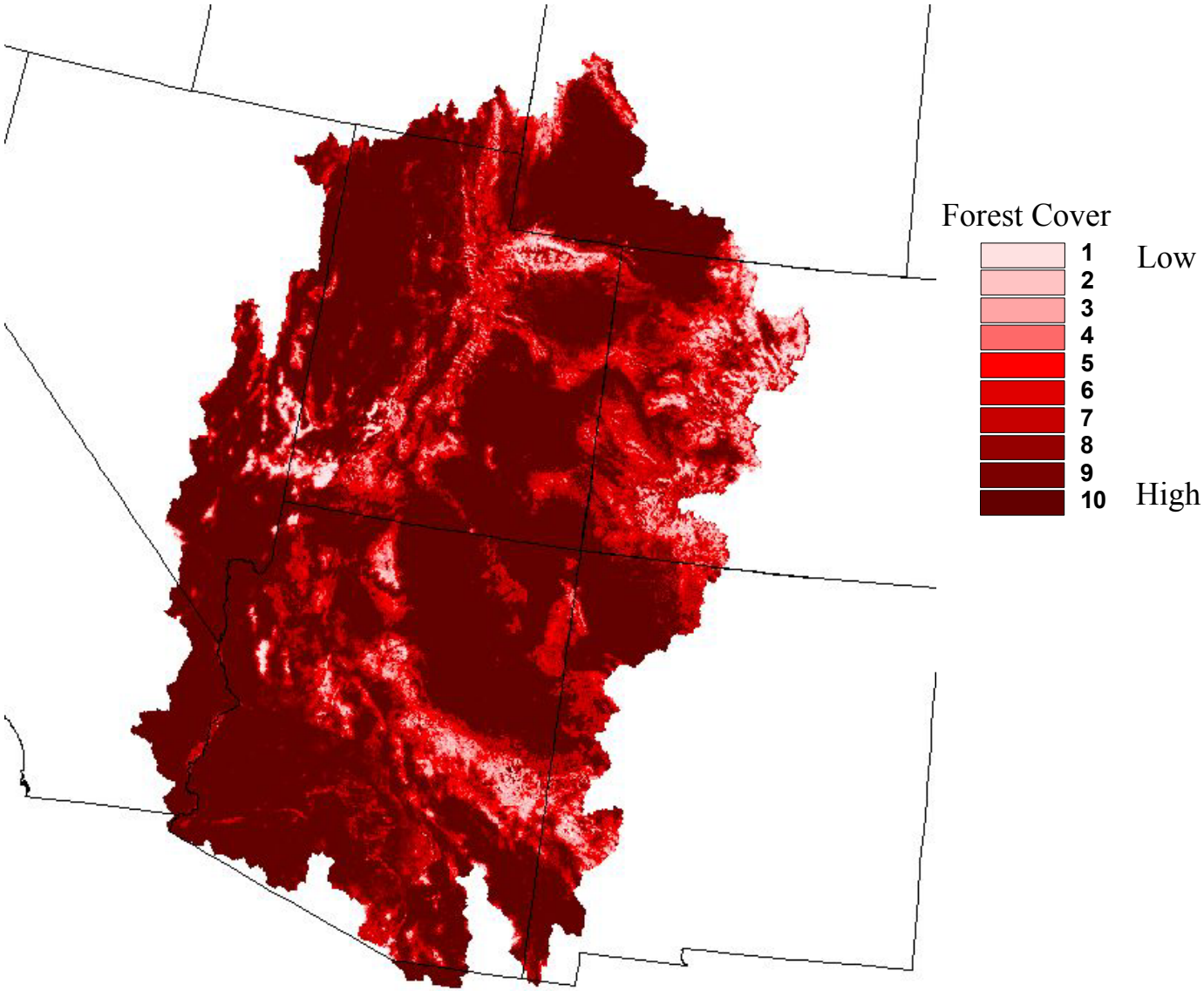
Reclassified Rock Volume Grid

Relative Flash Flood Potential 1-10



Percent Forest Cover

Reclassified Percent Forest Cover

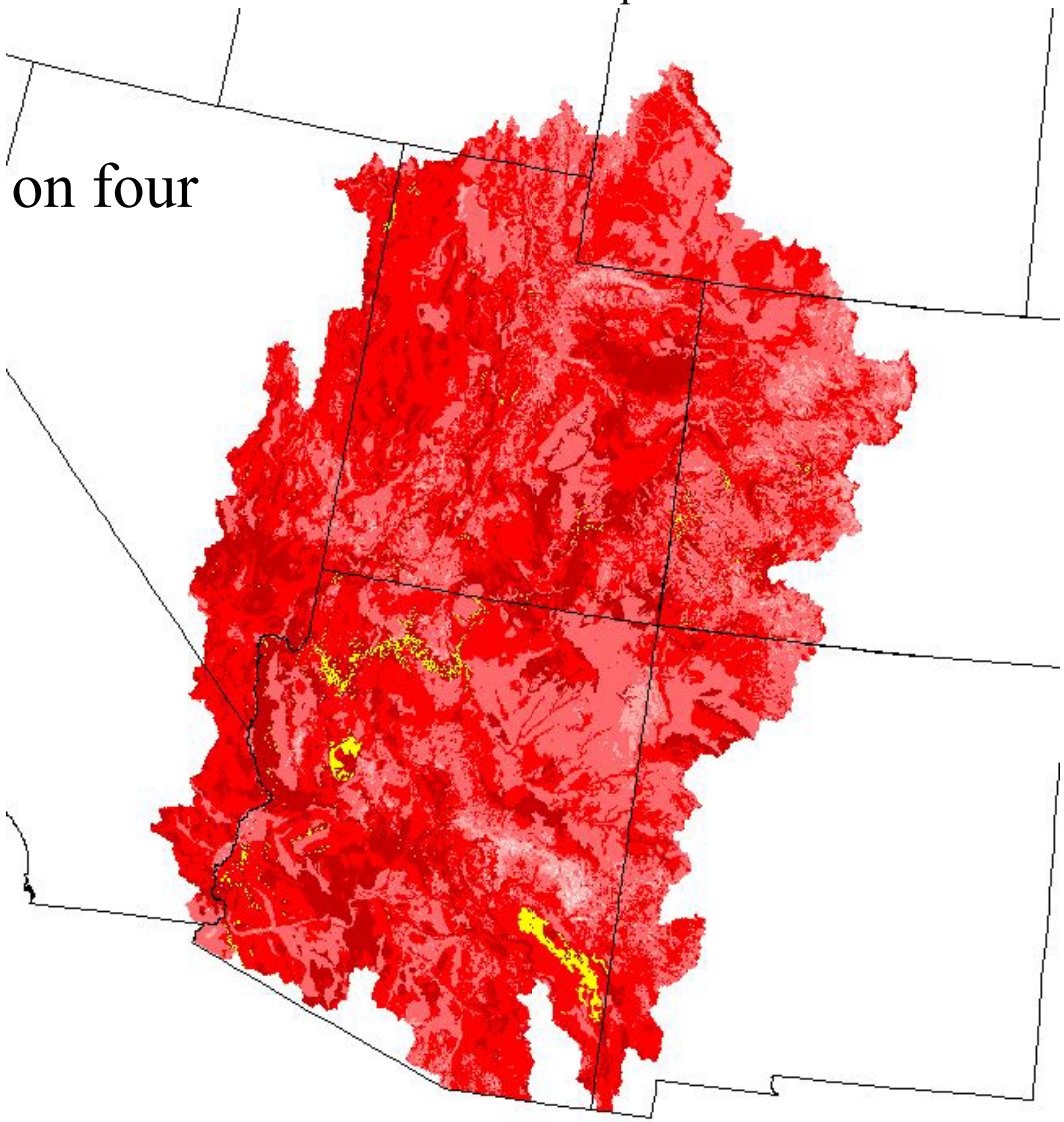


Flash Flood Indicators

static relative flash flood potential

Analysis based on four themes:

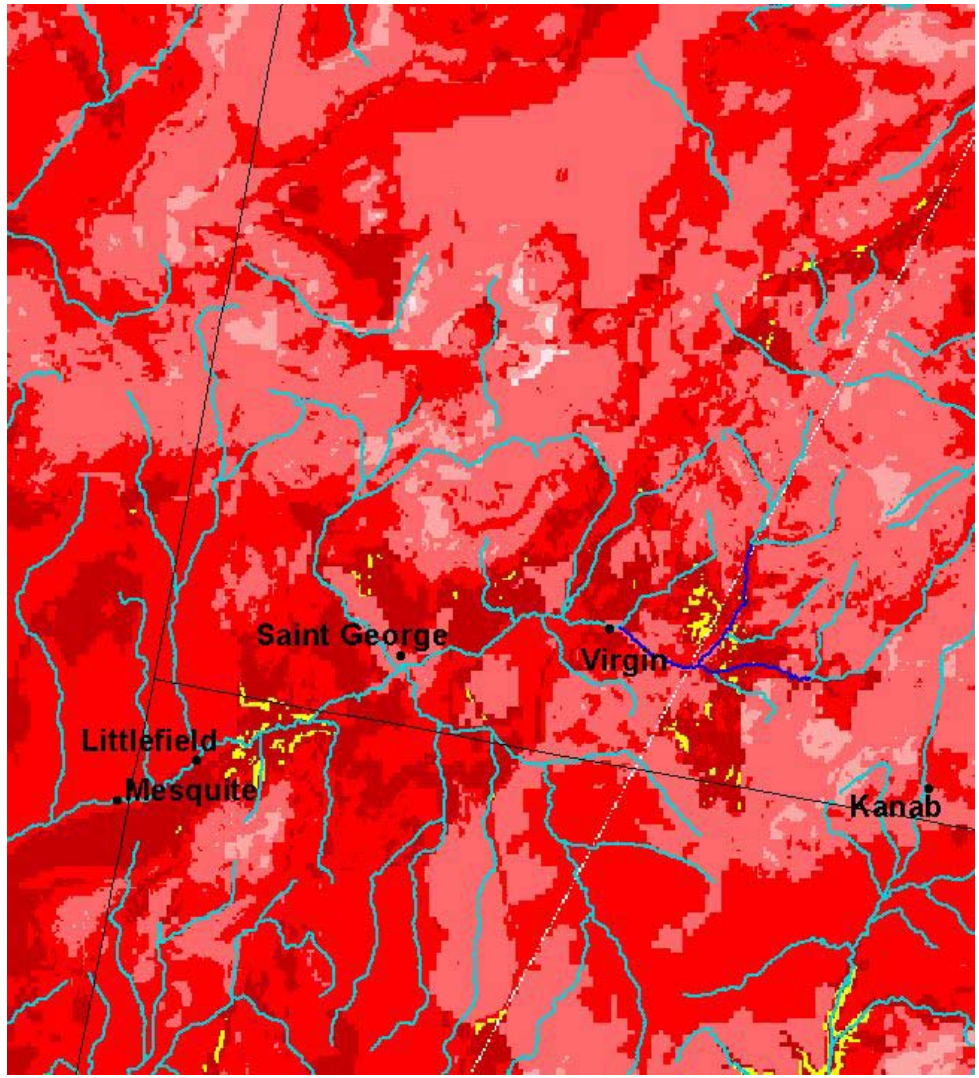
Volume of rock
Fractional Soil
Slope
Forest Density



Flash Flood Indicators

static relative flash flood potential

North and East Fork
Virgin River



FFI_CBRFC
- 1- Low
- 2- Low
- 3- Low
- 4- Moderate
- 5- Moderate
- 6- High
- 7- High

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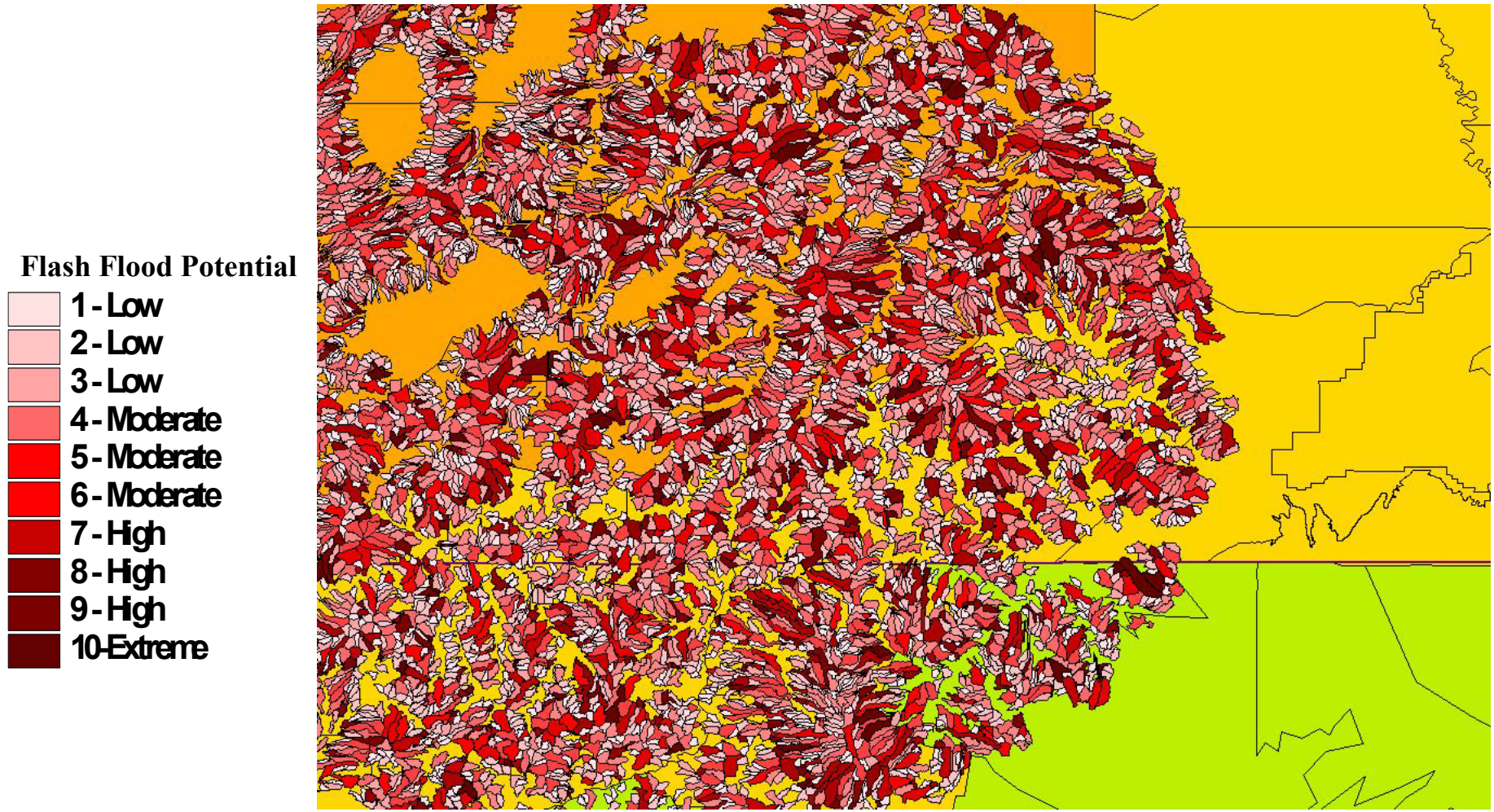
Output – Thematic layer of relative flash flood potential

- **A data layer for spatial variation of current FFG**
- **Initial output is gridded**
- **Interpolate to FFMP/AMBER or other geographic layer**
- **Add basin geometry component to FFG output weighting**

Cedar City AMBER/FFMP Basin Flash Flood Potential

hypothetical example



CB
Flash

Move from a stati

- **Seasonal bas**
  - **Vegetation**
  - **Snowpack**
- **Event based**
  - **Fire effects**
  - **Land use o**
- **Daily based on:**
  - **Precipitation component**
  - **Modeled soil moisture index**

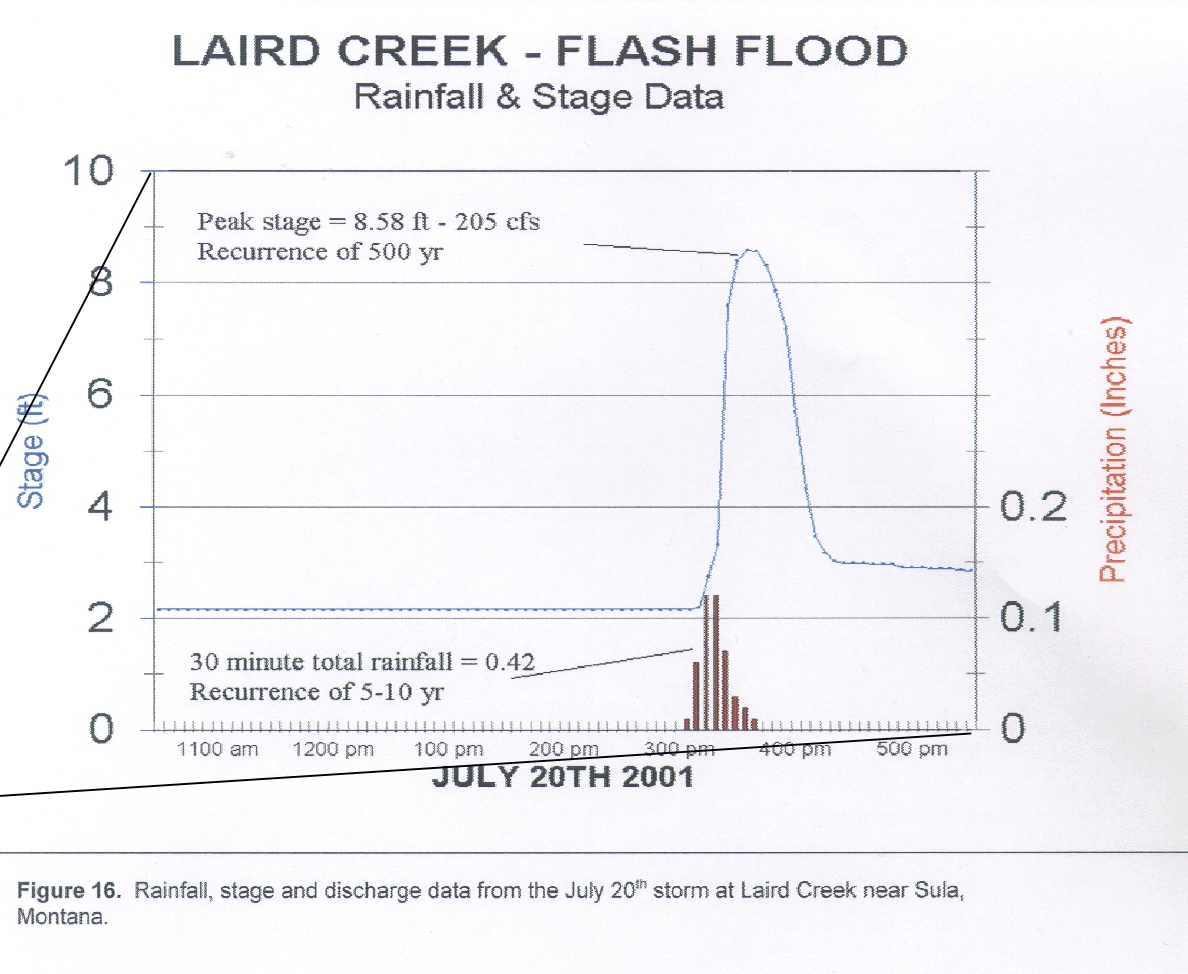
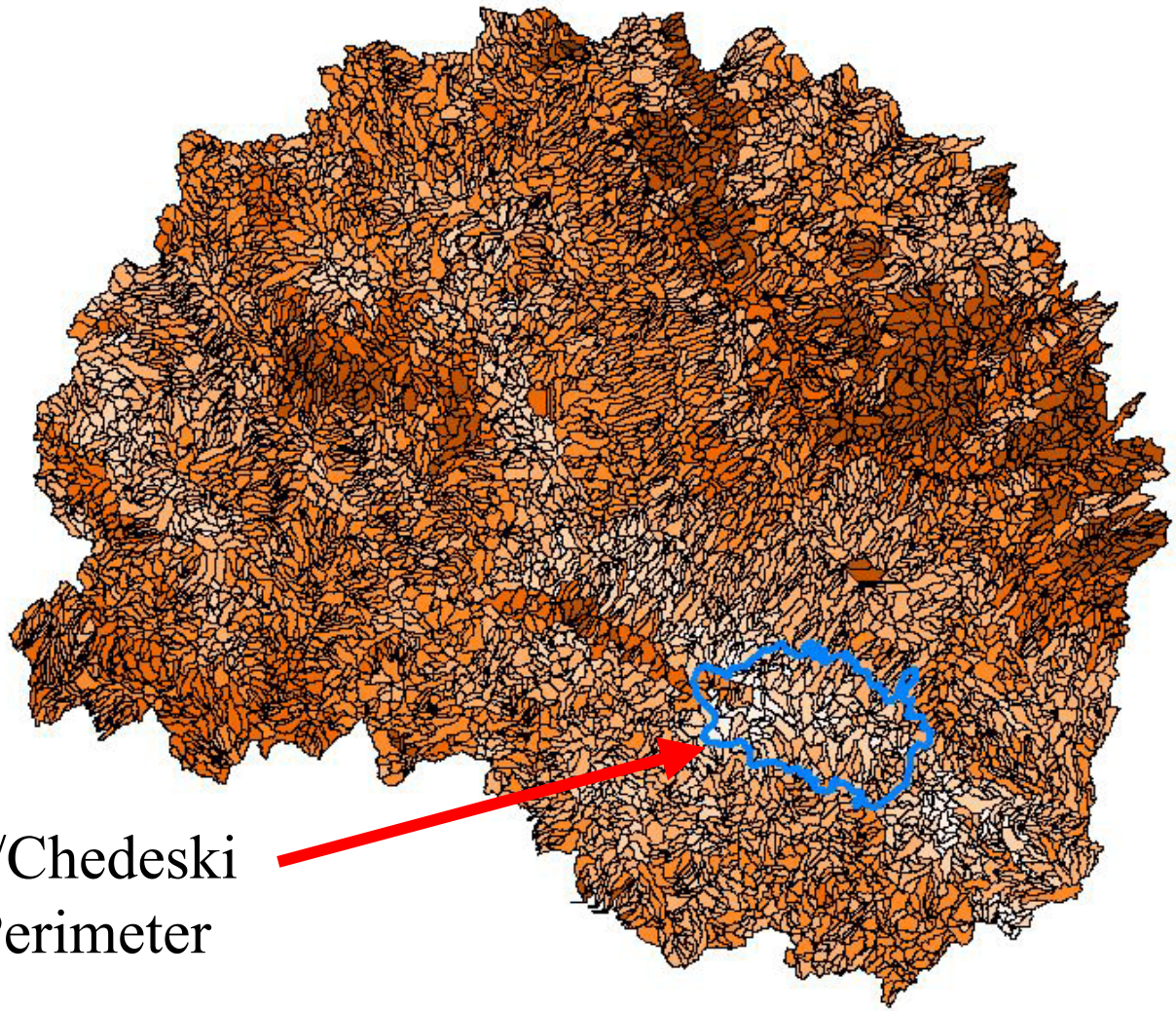


Figure 16. Rainfall, stage and discharge data from the July 20th storm at Laird Creek near Sula, Montana.

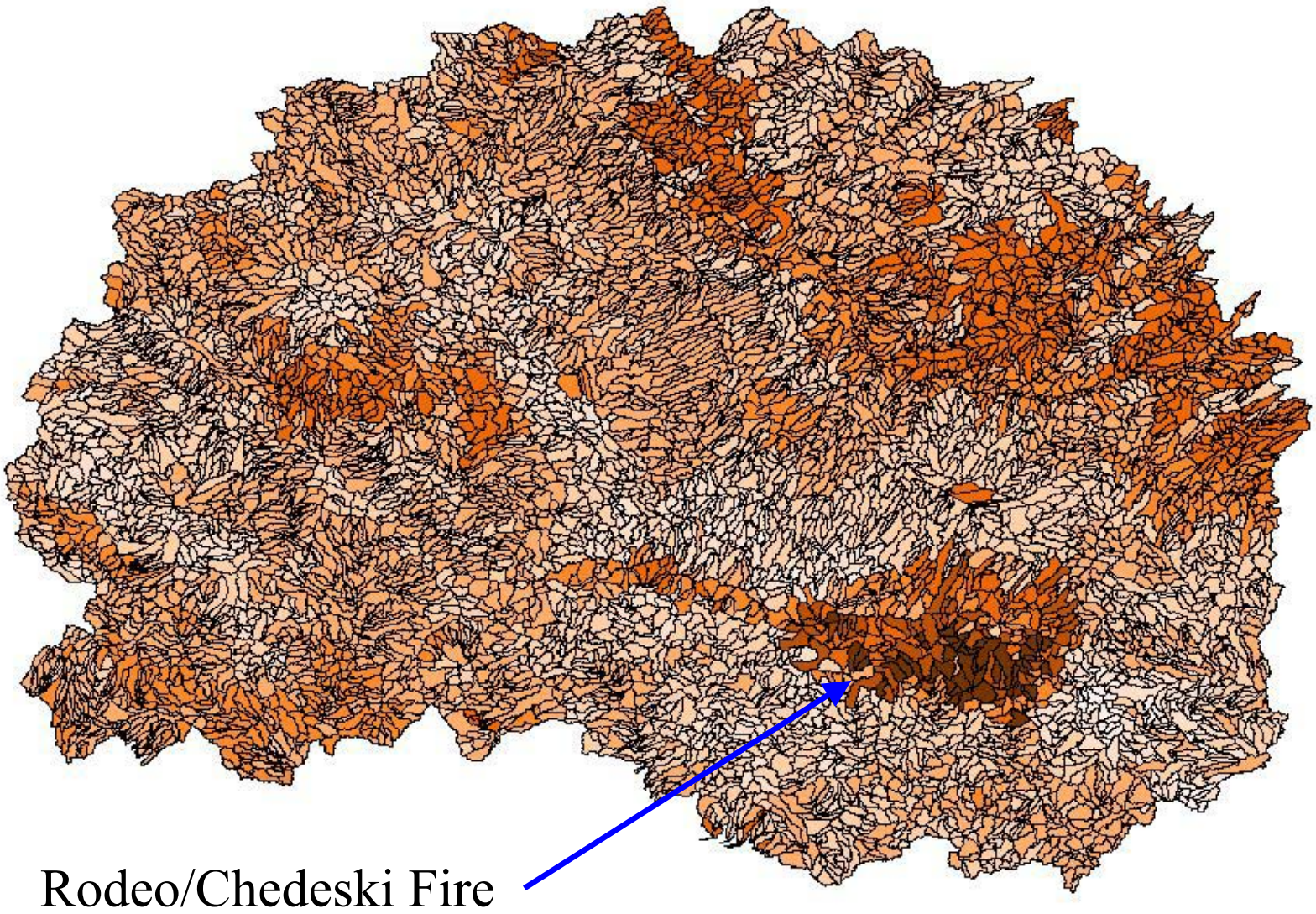
Flagstaff FFMP/AMBER Basins – Flash Flood Potential Layer



Rodeo/Chedeski
Fire Perimeter

Flagstaff FFMP/AMBER Basins – Flash Flood Potential Layer

Fire Event Included (3 levels of burn intensity)



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Develop ability to generate FFG guidance values

- **Assign a FFG value to each of the FFPI categories**
  - **Simple assignment**
  - **Regression approach using layer info and observed info**
  - **Other?**
- **Incorporate precipitation return frequency information**
  - **May vary by physiographic characteristics**
  - **May vary regionally by climate, etc.**
- **Incorporate distributed model component**
- **Incorporate observed flash flood event information**
  - **Important to ground in observational truth**

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How do you verify output ?

- **Based on documented flash flood events**
- **Based on local knowledge of flash flood prone areas**
  - **Create thematic data layers of observed events and known areas**
  - **Determine common characteristics re-apply elsewhere**
- **Other**

Important to ground analysis in observational truth

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Numerous GIS considerations to keep in mind

- **Error Propagation**
  - **Quantitative attributes, positional, categorical**
- **DEM uncertainties and derived attributes**
- **Determining proper datasets for application-correlation of datasets**
- **Data Representation**
  - **Soil attributes – Pedotransfer functions propagate error.**
  - **Data collection process and previous re-sampling methods**
- **Varying resolution and coverage between datasets**
- **Properly geo-register datasets prior to analysis**

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Conclusions ? – Directions ?

- **Only visual analysis possible at this point in time**
  - **Comparison with known/expected flash flood areas**
  - **Some positives but not enough info for anything conclusive yet**
- **Need for data layers of observed/documented events**
  - **Perhaps also a starting point for guidance values**
- **Determine additional valid datasets for use**
  - **Acquire-derive additional-finer resolution data layers**
  - **Review decisions about each layers hydrologic response contribution**
- **Determine weighting schemes for data layers**
  - **Weigh layers based on contribution to hydrologic response**
    - **Fire events (hydrophobic soils)**

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Conclusions ? – Directions ?

- **Define Study Area – Focus Analysis**
  - **Identify a sub area for more in depth analysis (Virgin River)**
  - **Obtain finer resolution DEM and other data if available**
  - **Focus on documenting events in this area**
  - **Visit to obtain local knowledge if necessary (i.e. Park Service)**

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How best to document FF events ?

- **Can we get the WFO SH or Hydro Focal Point involved ?**
  - **Assist in documenting event parameters**
  - **Parameters that could be derived would be determined by the RFC**
  - **A simple interface to document these events – databased at RFC**
  - **Future and at least some historical information is desired**

It is imperative observed information be collected if the FFG products are to improve

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To document or not to document – what do we call a flash flood ?

It's probably best just to focus on the initial concepts we are working with when deciding whether to document an event.

Primarily trying to relate surface physiographic characteristics conducive to a hydrologic response of exceptional high and/or sudden discharge that is on a similar scale as the short duration high intensity rainfall. If an event falls into this type of hydrologic response category.. document it.

If it is questionable.. document it.

WR FFG Team Members

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