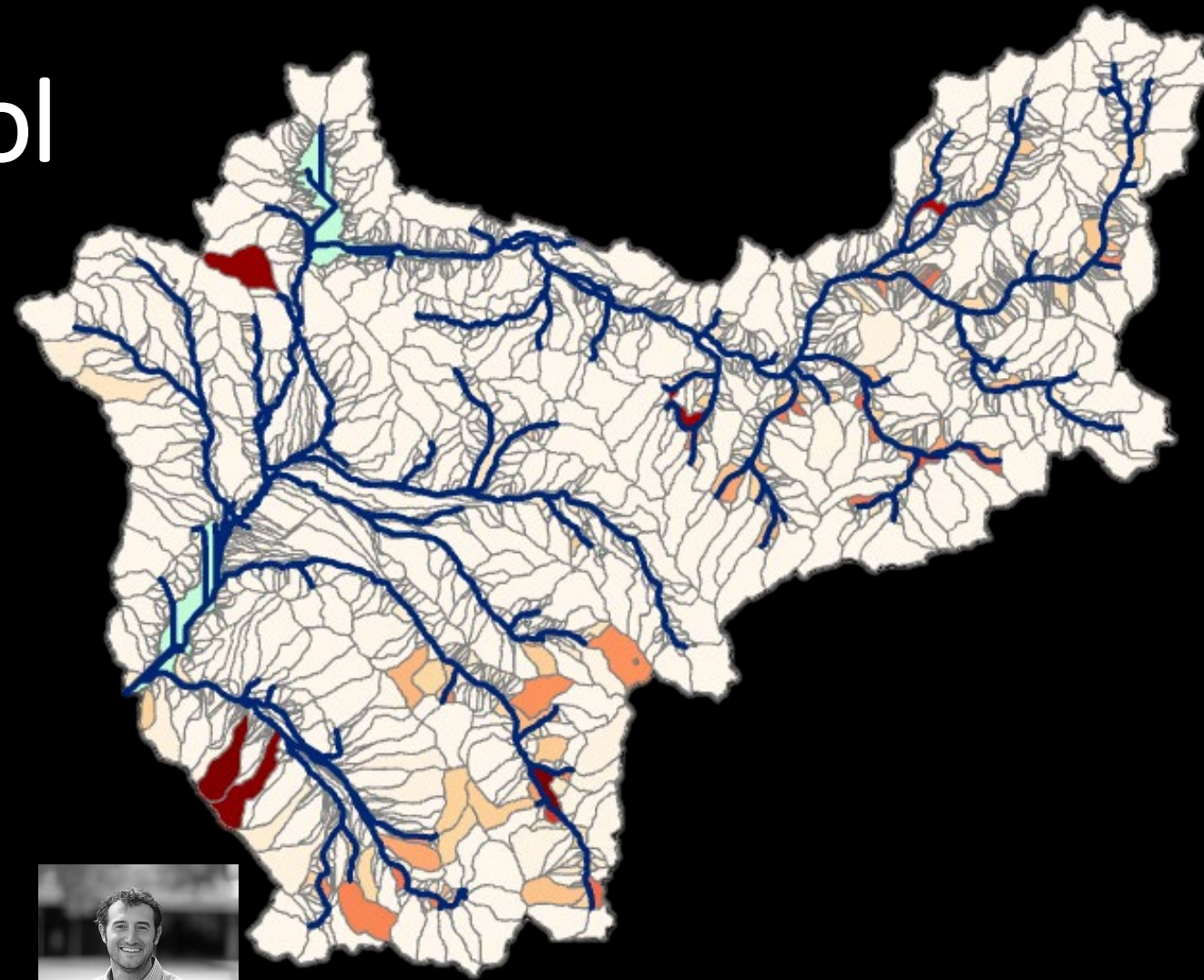


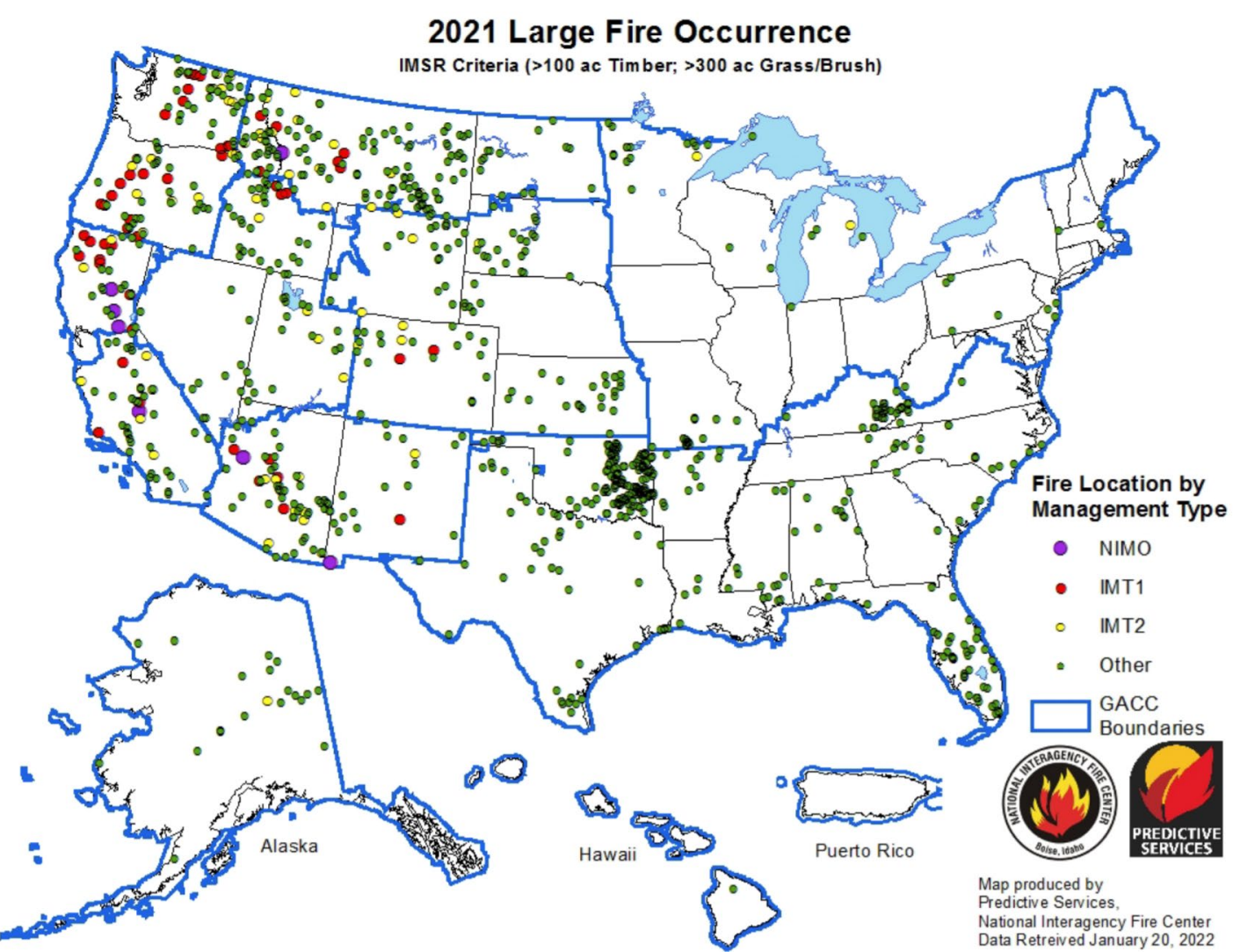
Proactive planning tool to reduce wildfire sedimentation risks



Patrick Belmont, Scott David, Brendan Murphy

Contact: patrick.belmont@usu.edu

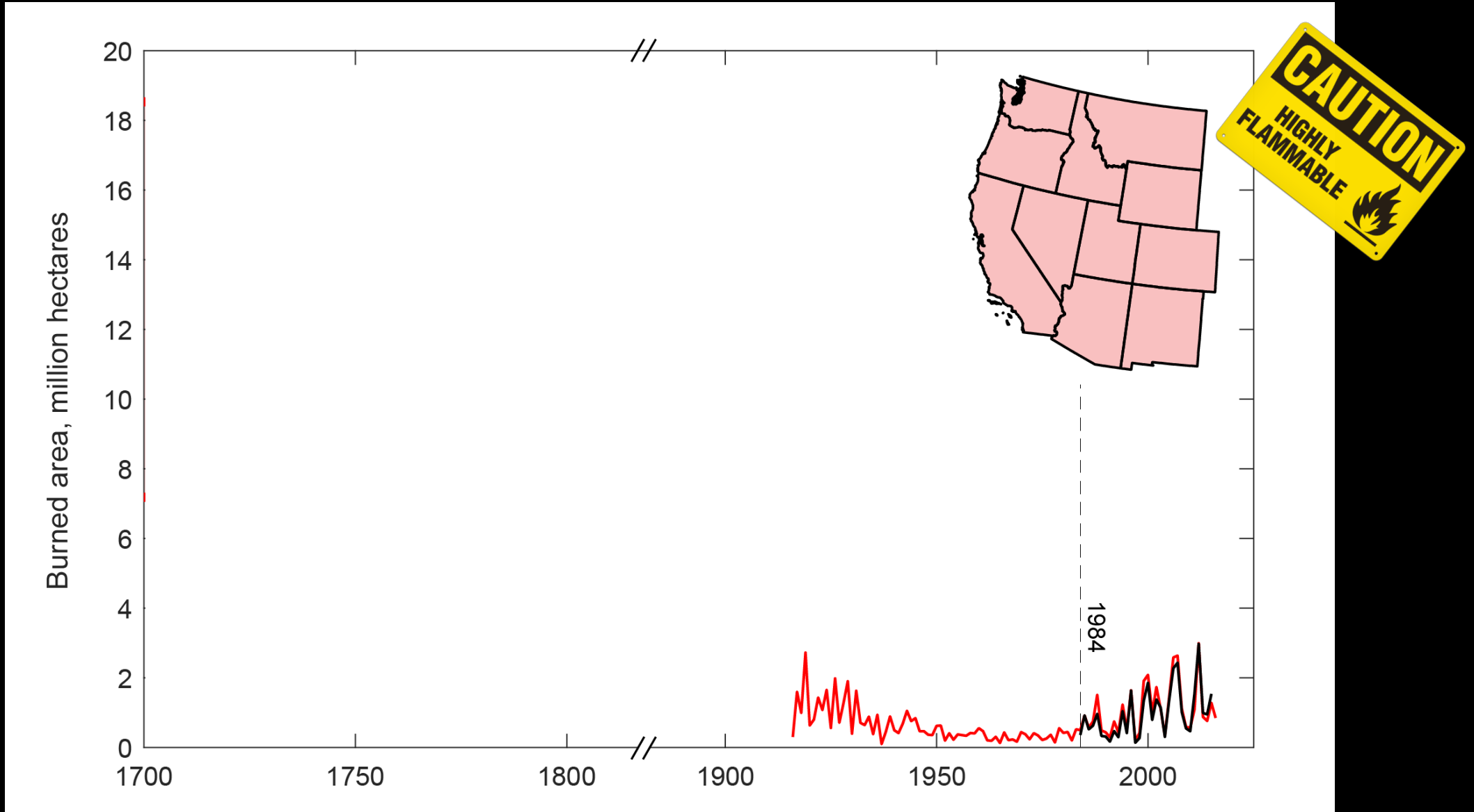
Wildfire is increasing throughout the western US



Fires	Acres
58,985	7,125,643
58,950	10,122,336
50,477	4,664,364
58,083	8,767,492
71,499	10,026,086
67,743	5,509,995
68,151	10,125,149

Source: NIFC

The western US is a highly flammable landscape



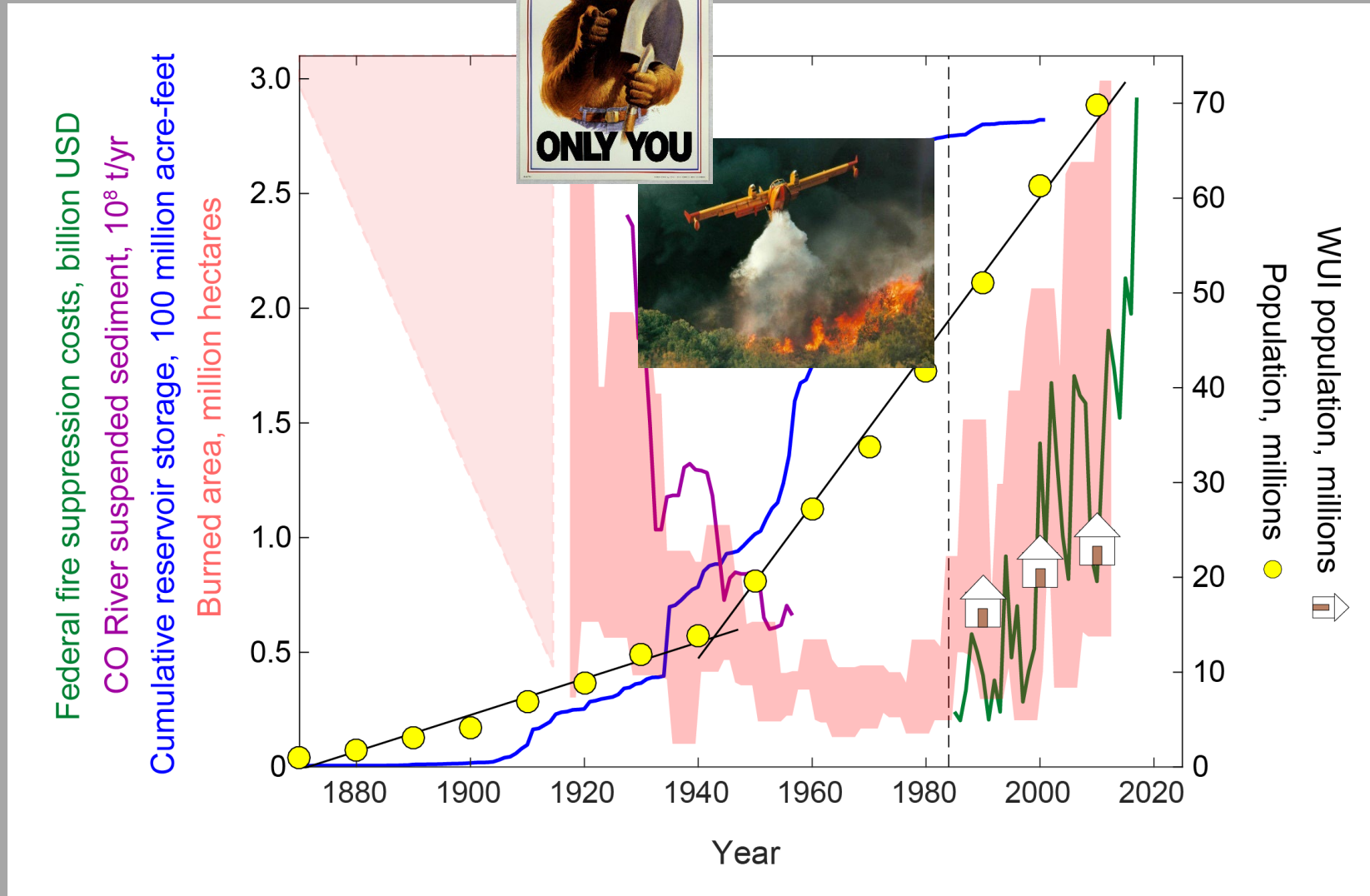
Data Sources: Leenhouts, 1998 (pre-settlement); Littell et al., 2009 (1916-2003); Littell personal communication (2004-2015); MTBS (1984 – 2015)

How it started (1940s):

Horray! We can control fire!

How it's going:

Bigger, more intense,
uncontrollable



Murphy et al., 2018



Stuart Johnson

Fire has been around as long as oxygen...420 Myr

Fire will be around as long as there is fuel, heat, and oxygen.

The real questions:

How do we want our fire?

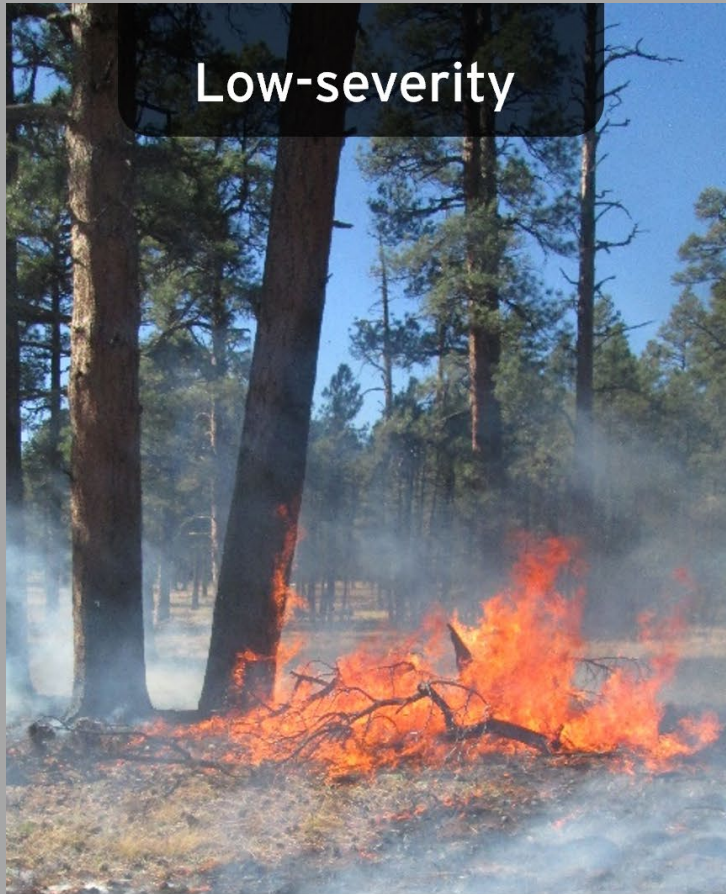
How do we want our smoke?



"Wildfire" by NPS Climate Change Response

Fire is inevitable. How can we improve fire outcomes?

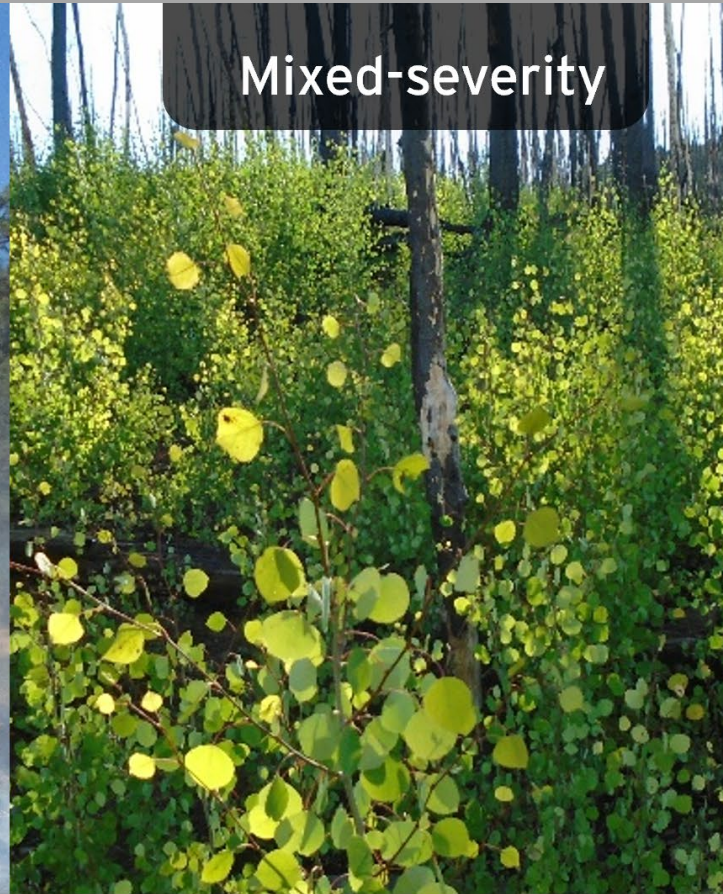
Low-severity



Ponderosa

- thick bark
- self pruning

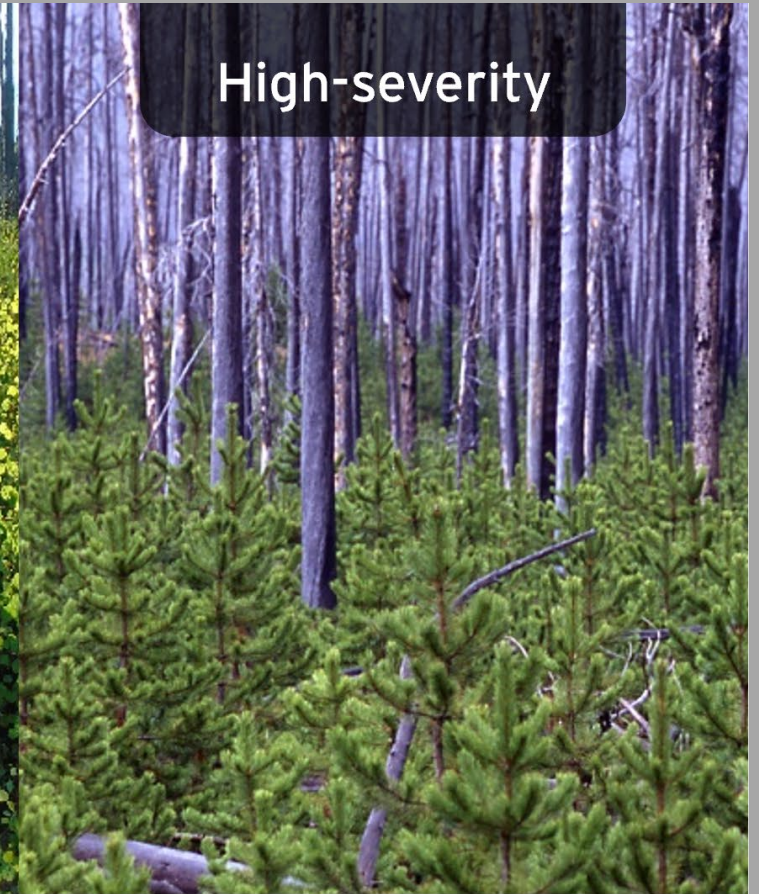
Mixed-severity



Aspen

- rapid regeneration

High-severity



Lodgepole

- serotinous cones

Wildfires pose many risks downstream

2002 Santaquin



https://ugspub.nr.utah.gov/publications/public_information/pi-90.pdf

2017 Highway 143



<https://www.sltrib.com/news/2017/08/08/flooding-takes-out-part-of-southern-utah-highway/>

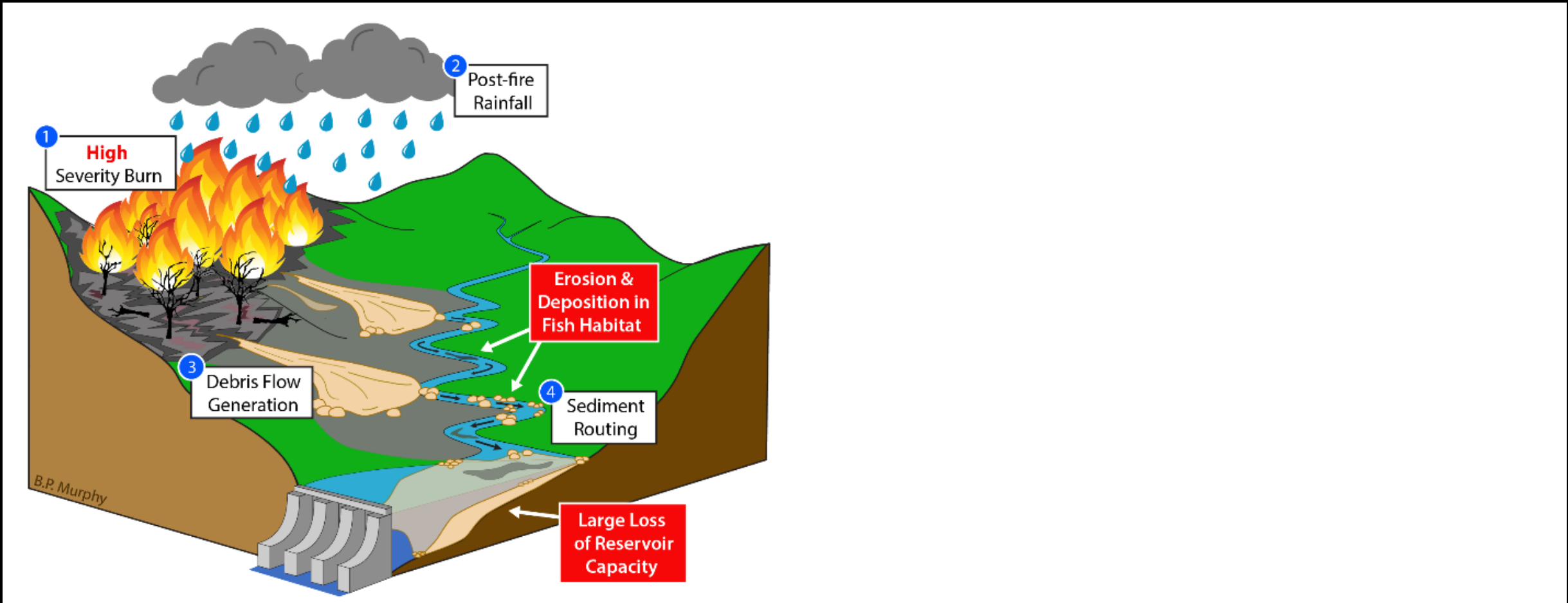
2019 US 89



<https://www.abc4.com/news/local-news/flash-flooding-forces-closure-of-us-89-in-utah-county/>

FIRE-water predicts

fire severity under current vegetation conditions
erosion under various possible fire and rainfall scenarios
delivery of sediment to the river network
sediment transport downstream, risk to downstream infrastructure



reduction in sedimentation under various fuel treatment options

FIRE-water model structure



Currently:

- Post-fire Erosion & Delivery
- Physics Based Sediment Routing
- Impacts on water resources, habitat, reservoirs

Proposed Additions:

- Add transportation infrastructure data
- Scenario-based simulations of potential transportation infrastructure impacts
- Results inform long-term planning and coordination with USFS, FFSL, land owners

USUAL: watershed delineation tools & calculations

Inputs

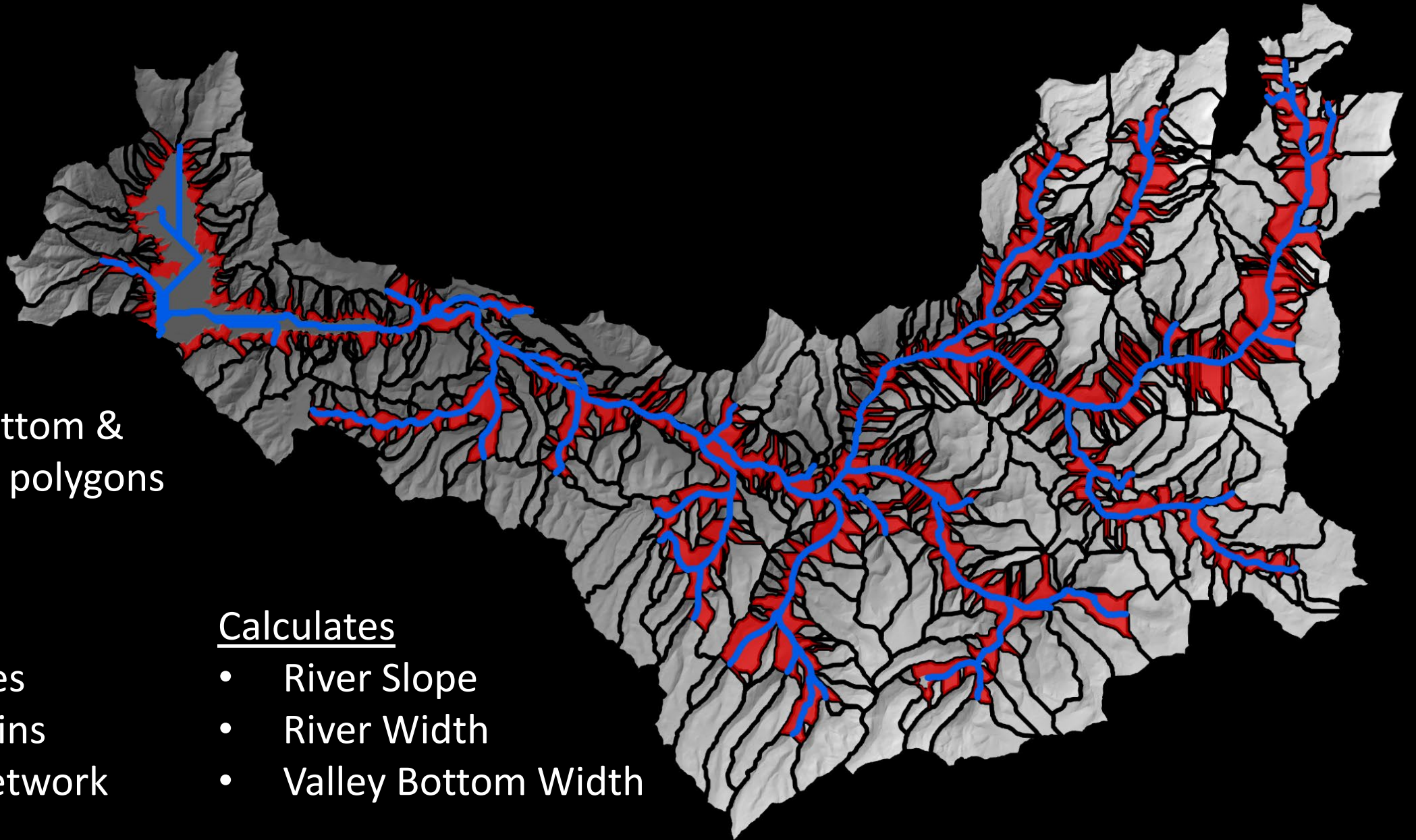
- DEM
- Outlet
- Valley bottom & reservoir polygons

Delineates

- Hillslopes
- Sub-basins
- River Network

Calculates

- River Slope
- River Width
- Valley Bottom Width



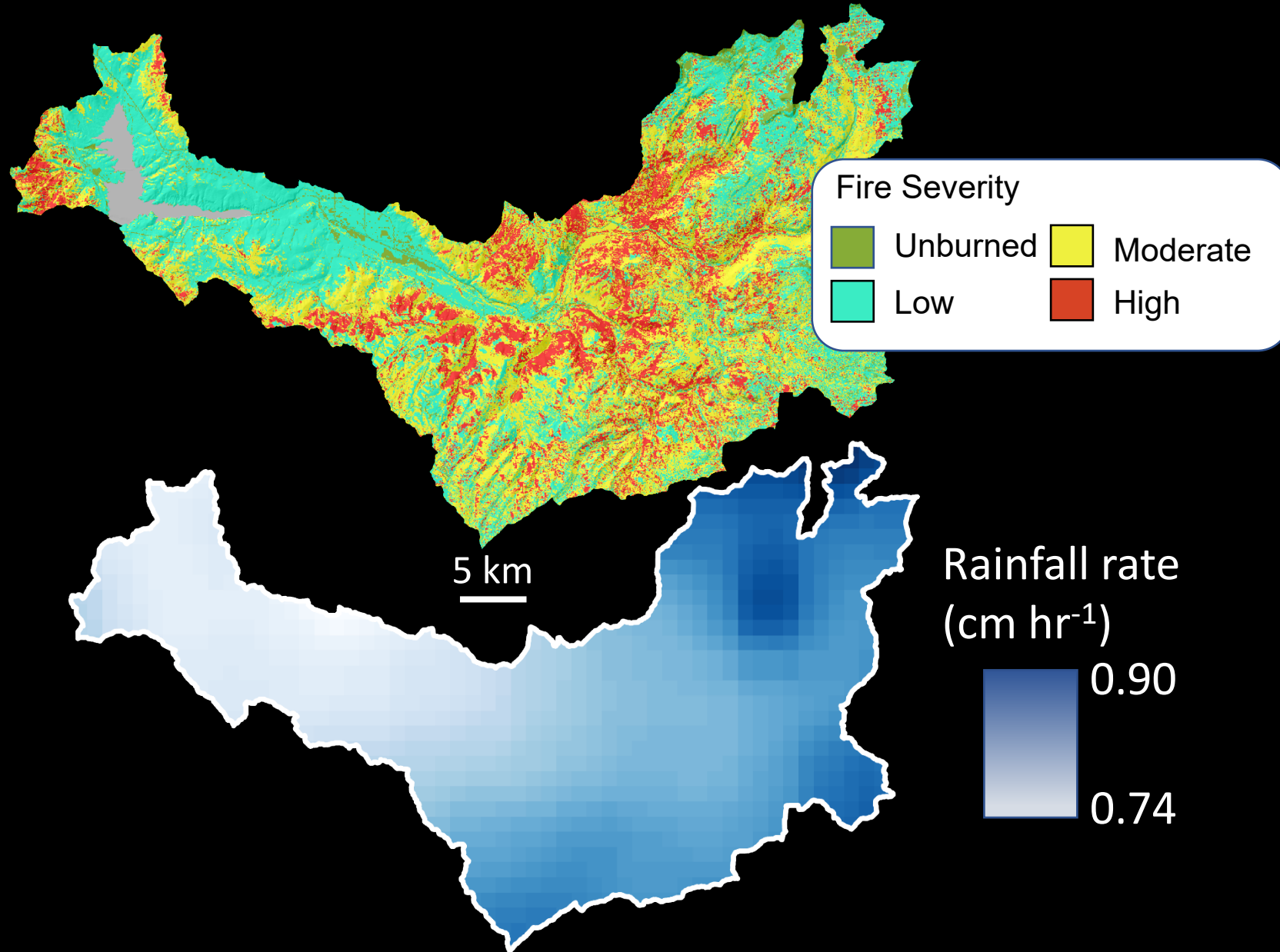
WEST: Inputs

Post-fire assessment

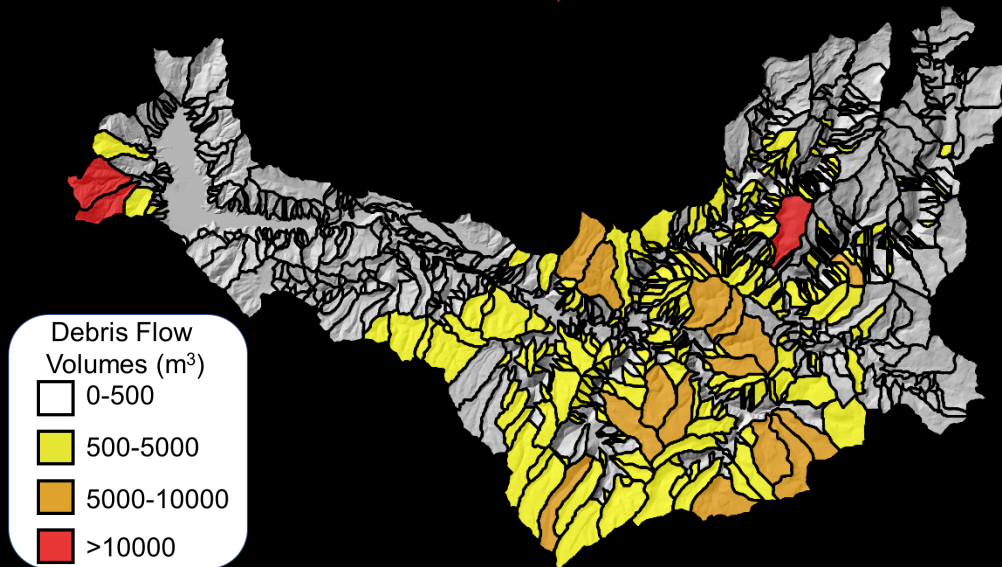
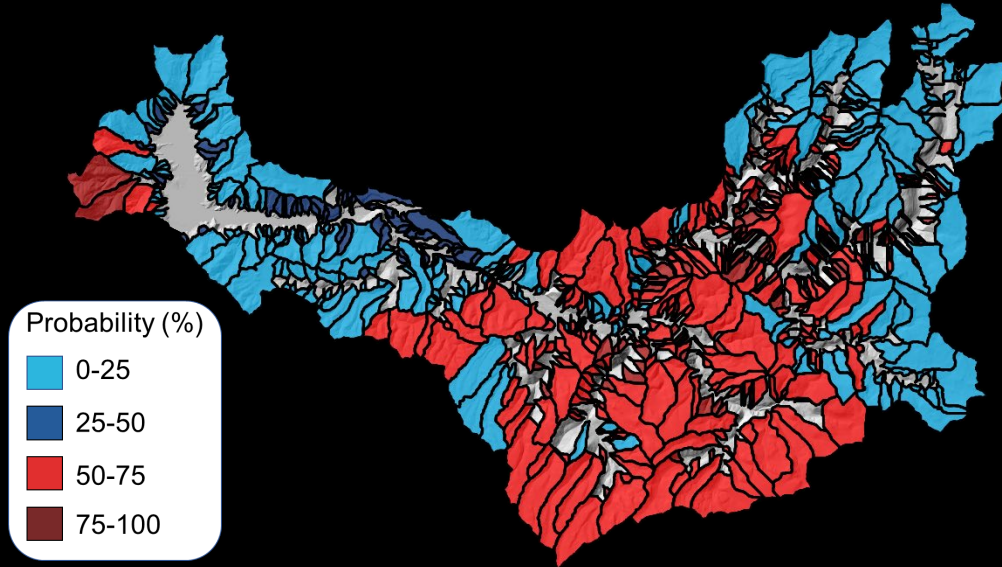
- Burn severity
- Slope
- Soil erodibility

NOAA PFDS

- 15-min intensity raster
- Select recurrence interval
 - 2-year RI shown



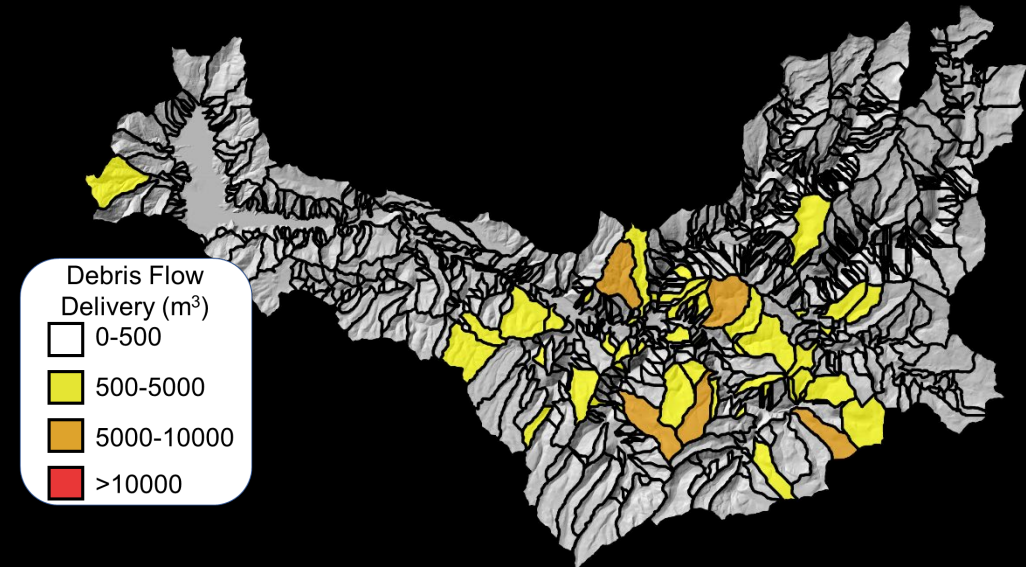
WEST: Debris flow probability, volumes, & delivery



Same methodology as used in BAER Assessments

- Probability (Staley et al., 2017)
- Volume (Gartner et al., 2014)

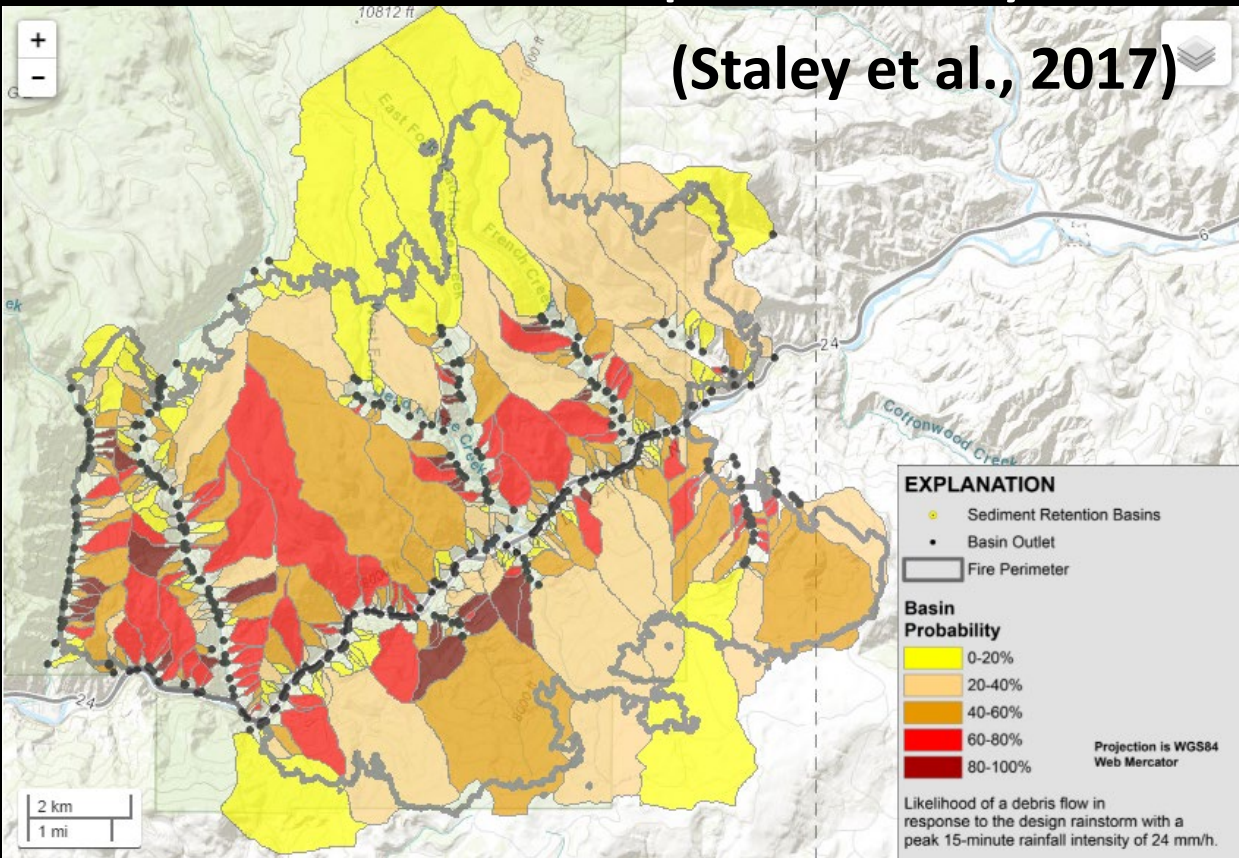
Geometric model based on valley bottom morphology (Murphy et al. 2019)



WEST: standard USGS debris flow hazard model

Debris flow probability

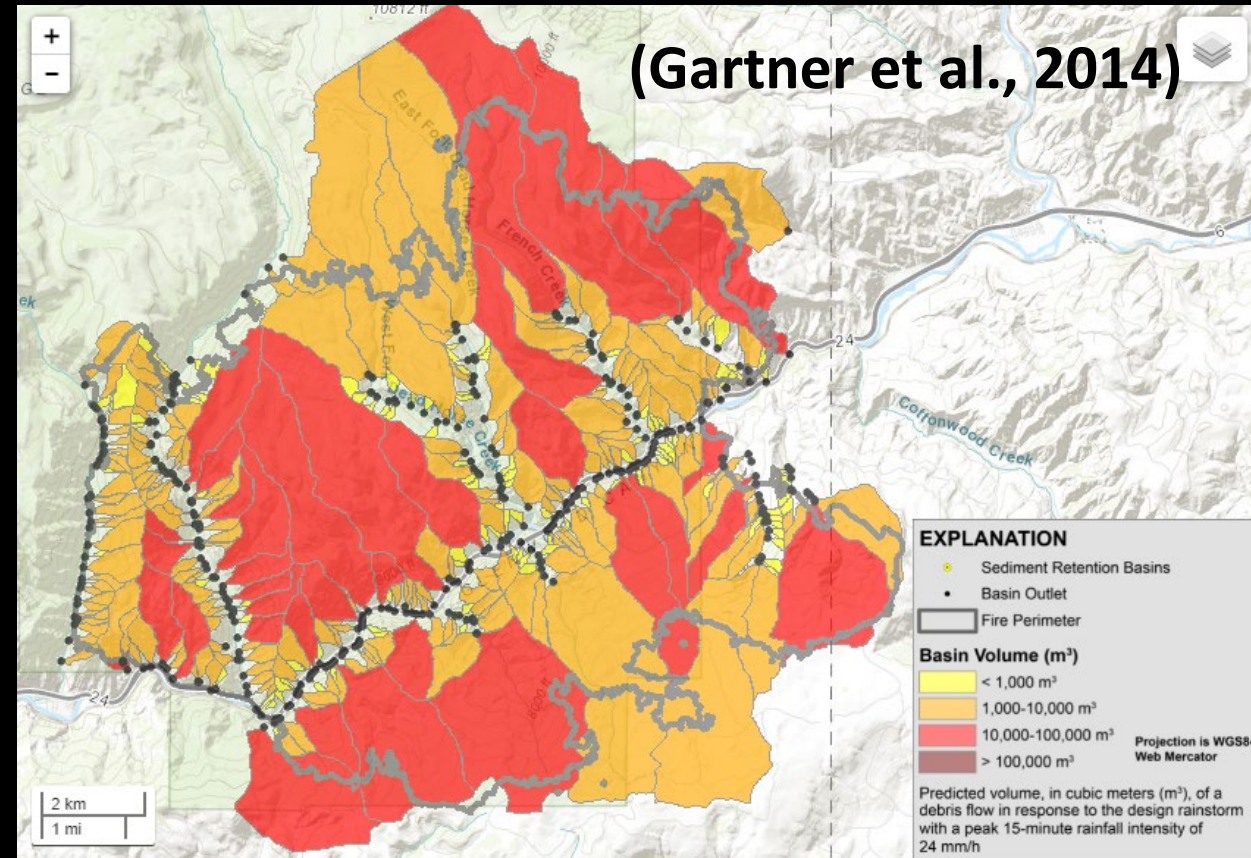
(Staley et al., 2017)



$$P=f(i_{15}, dNBR, K\text{-factor, area burned M-H } S>23^{\circ})$$

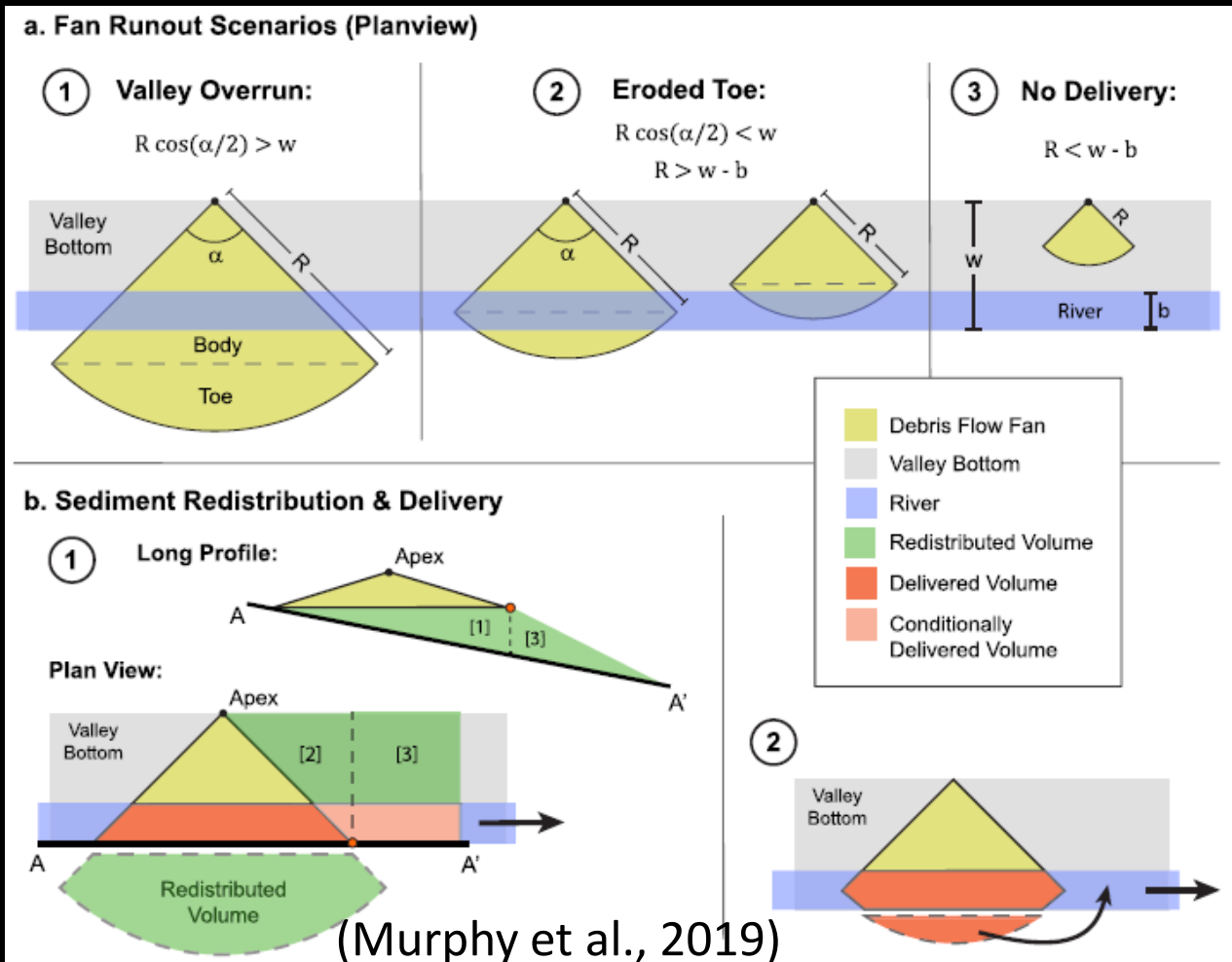
Debris flow volume

(Gartner et al., 2014)

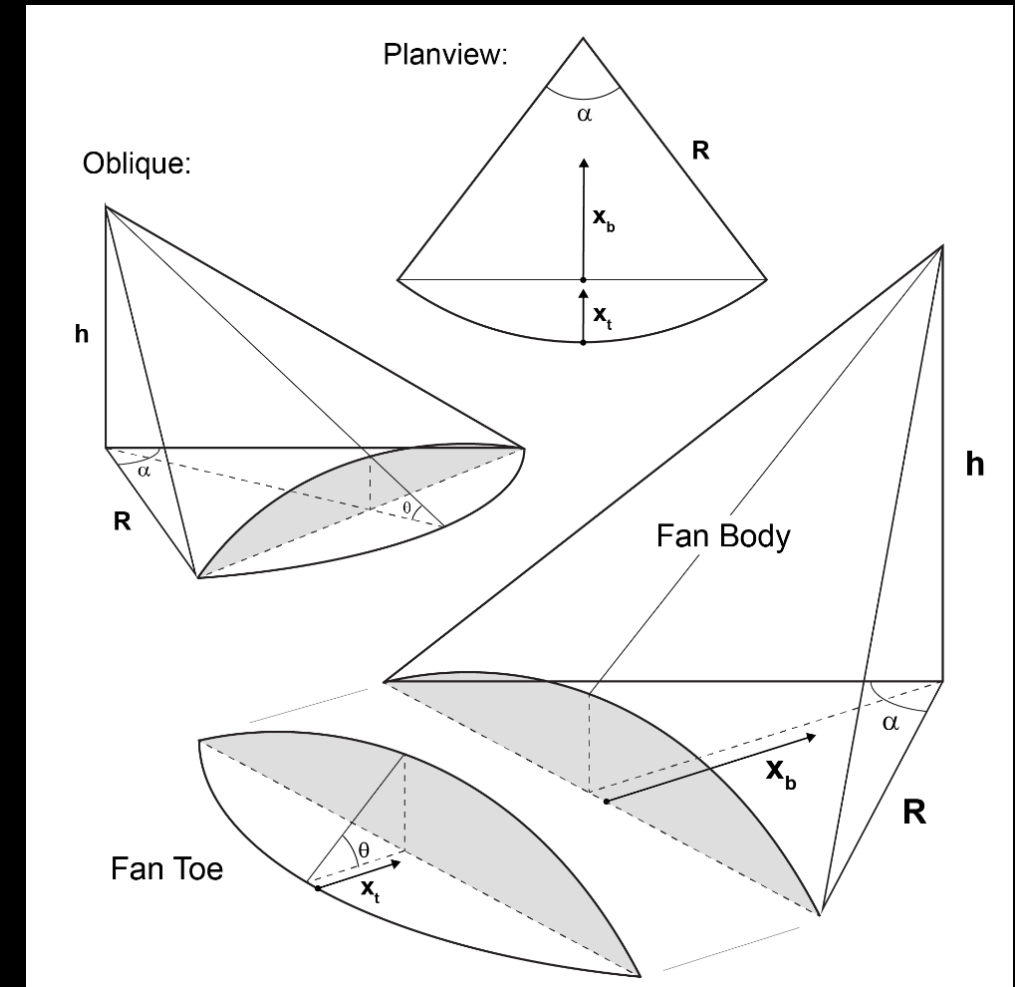


$$Vol=f(i_{15}, \text{area burned M-H, relief})$$

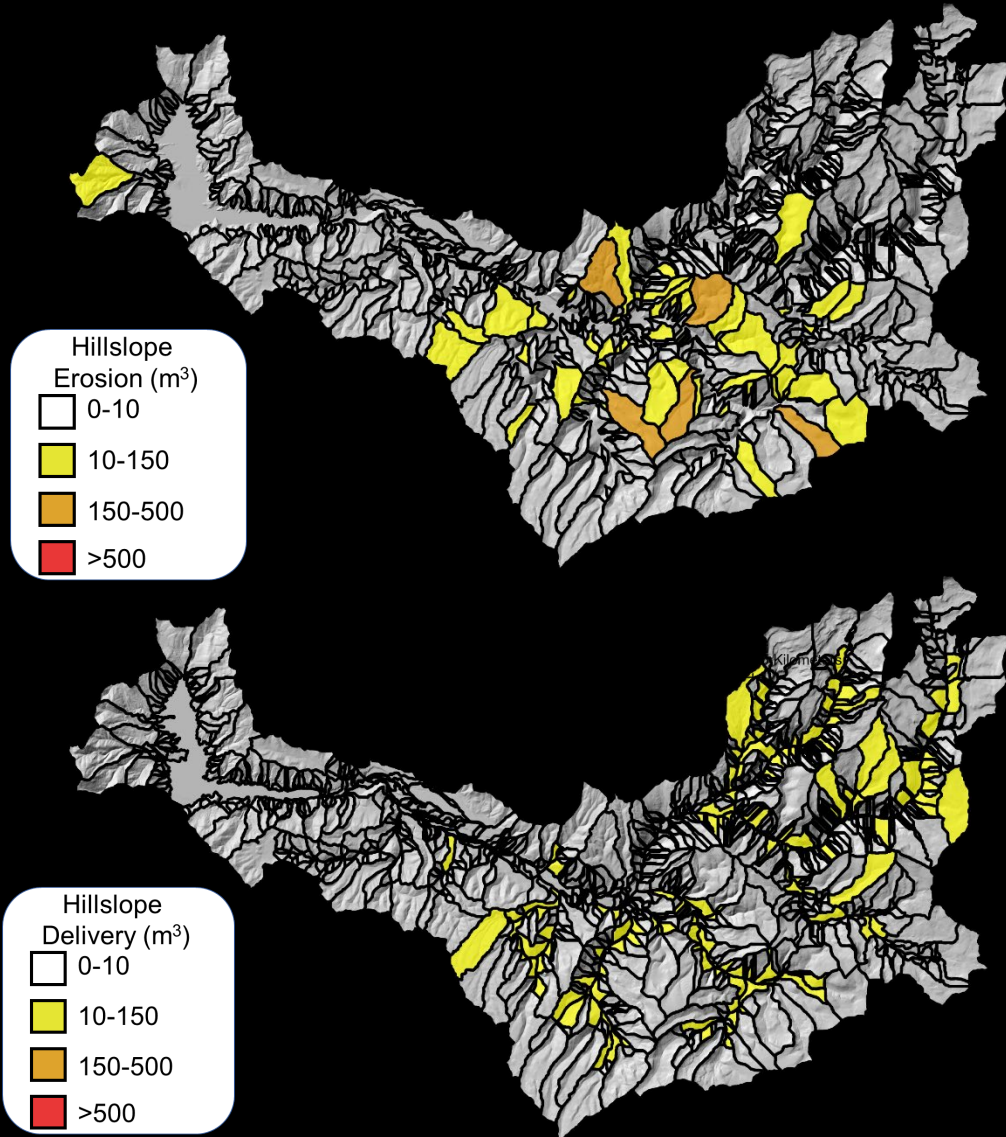
WEST: debris flow delivery to rivers



f(valley bottom width & slope, DF volume)



WEST: Hillslope Erosion & Delivery



Modified RUSLE post-fire erosion and delivery model (Gannon et al. 2019)

No debris flow → apply RUSLE

Total hillslope erosion found << total debris flow erosion

NST: Network sediment routing



- WEST outputs integrate seamlessly
- LANDLAB component
- Lagrangian model
- Physics based mixed-grain transport (Wilcock & Crowe, 2003)
- Runs with unsteady flow



FIRE-water limitations

- Numerous processes over-simplified (precip, df, RUSLE, delivery, channel-fp exchange)
- No reliable basis for hydrologic change post-fire
- Minimal constraints on grain size distributions contributed
- Channel slopes adjust, but width and depth static, simple scaling