

Regional post-fire debris flow risk for Water Year 2017

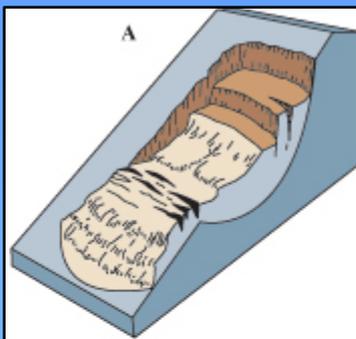
Mark Strudley, PhD
Hydrologist/Geomorphologist
NOAA/NWS

We heavy help and credit due to... *science for a changing world*

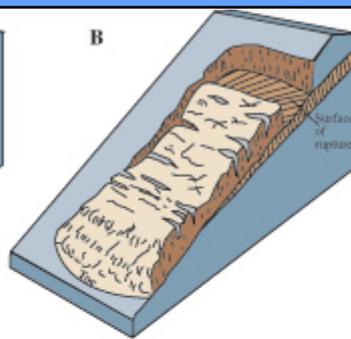
National Weather Service

*SF/Monterey Bay Area
Weather Forecast Office
Monterey, CA*

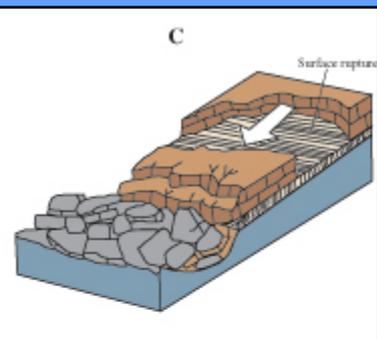




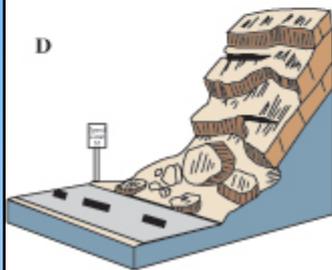
Rotational landslide



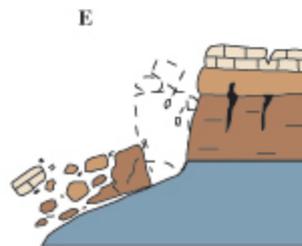
Translational landslide



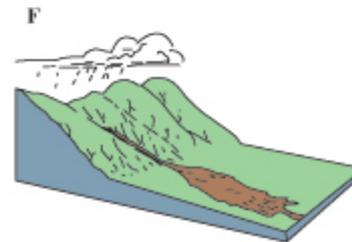
Block slide



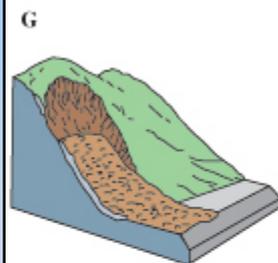
Rockfall



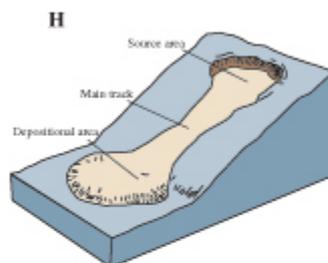
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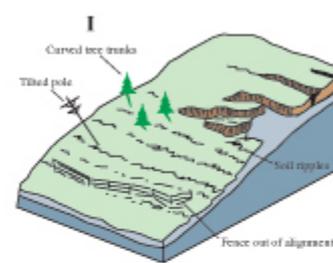
Debris flow



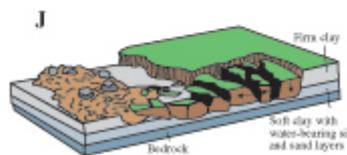
Debris avalanche



Earthflow



Creep



Lateral spread

What Are Post-Fire Debris-Flows?

- Initiate from surface runoff and erosion processes.
- Progressive entrainment of sediment.
- Often exhibit evidence of both debris-flow and flood processes.



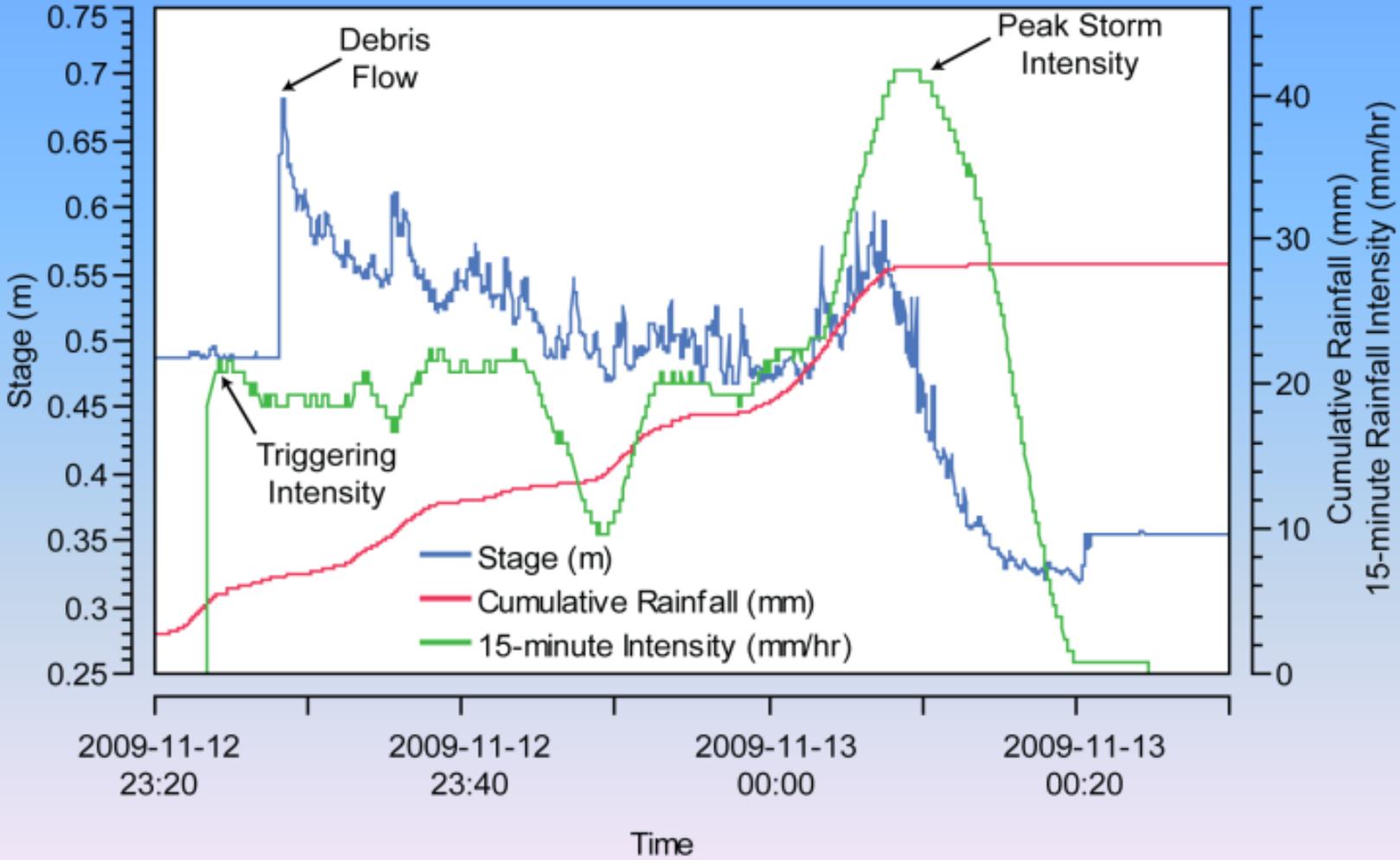
What Are Post-Fire Debris-Flows?

- Do not require a discrete source of material (e.g. landslide), with a significant percentage of material originating from shallow erosion.
- Impact constrained to gullies, stream channels and immediately adjacent areas.
- Probability of occurrence **not** empirically related to antecedent moisture conditions.
- Volume and velocity have been experimentally linked via flume studies to antecedent moisture conditions, but not yet empirically demonstrated.



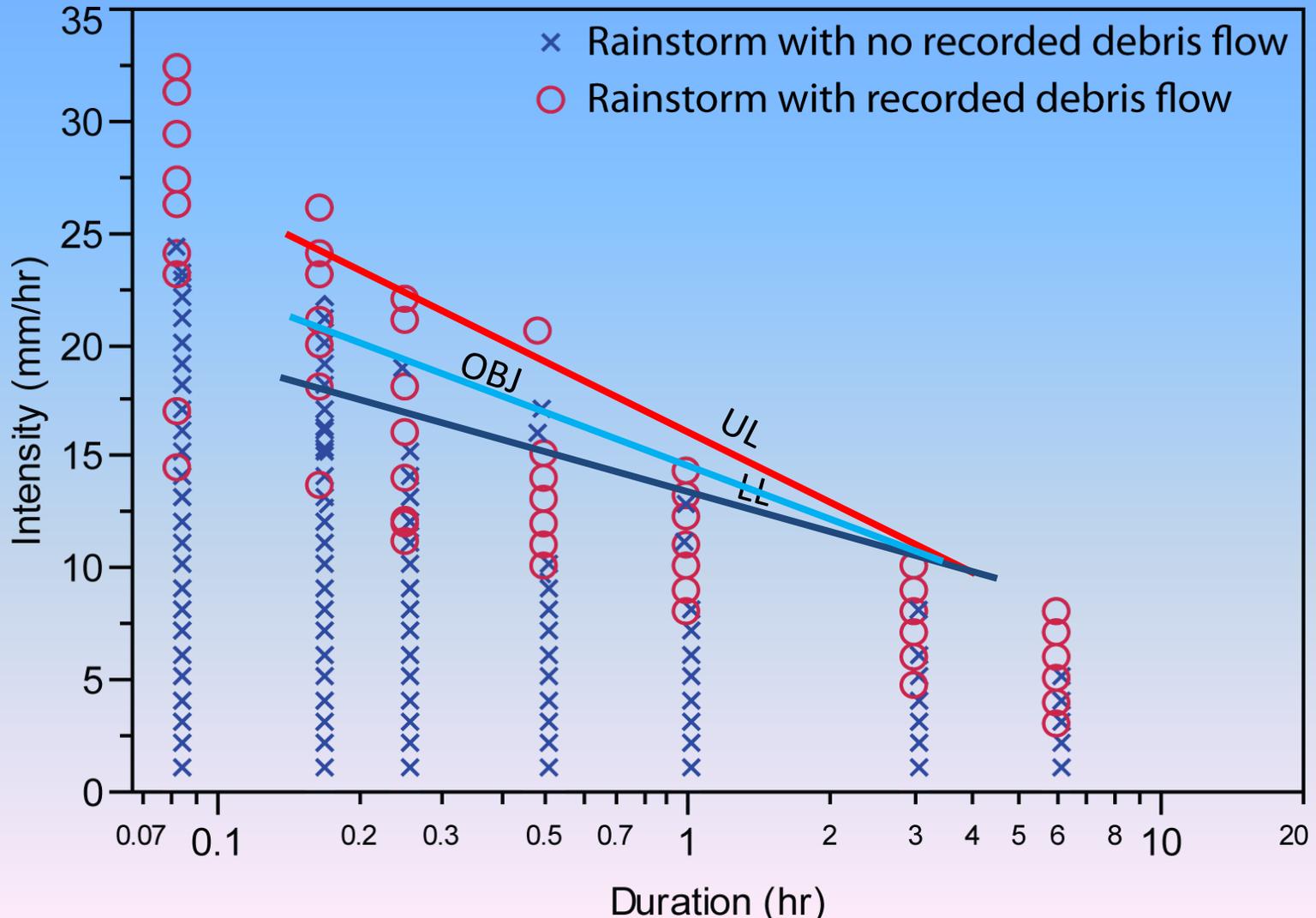
What Are Post-Fire Debris-Flows?

Debris-flows initiate during high-intensity rainfall.



How Do We Predict Post-Fire Debris-Flows?

Post-fire debris-flows are well-characterized by rainfall intensity-duration thresholds.



New Approach

Logistic Framework:

$$p = \frac{e^x}{1 + e^x} \quad x = b + c_1cX_1 + c_2cX_2 + \dots + +c_n cX_n$$

Updated Link Function:

$$x = -3.63 + 0.41(T * R) + 0.67(F * R) + 0.70(S * R)$$

Terrain Steepness (T)	Fire Severity (F)	Soil Properties (S)	Rainfall (R)
Proportion of upslope area with moderate to high burn severity and gradients $\geq 23^\circ$	Average dNBR of upslope pixels / 1000	Average KF-Factor of upslope area	Peak rainfall accumulation, in mm (15 minute durations)

Staley, D.M., Negri, J.A., Kean, J.W., Tillery, A.C., and Youberg, A.M., 2016, *Updated Logistic Regression Equations for the Calculation of Post-Fire Debris-Flow Likelihood in the Western United States*, U.S. Geological Survey Open-File Report 2016-1106, 20 p.

Available online at: <https://pubs.er.usgs.gov/publication/ofr20161106>

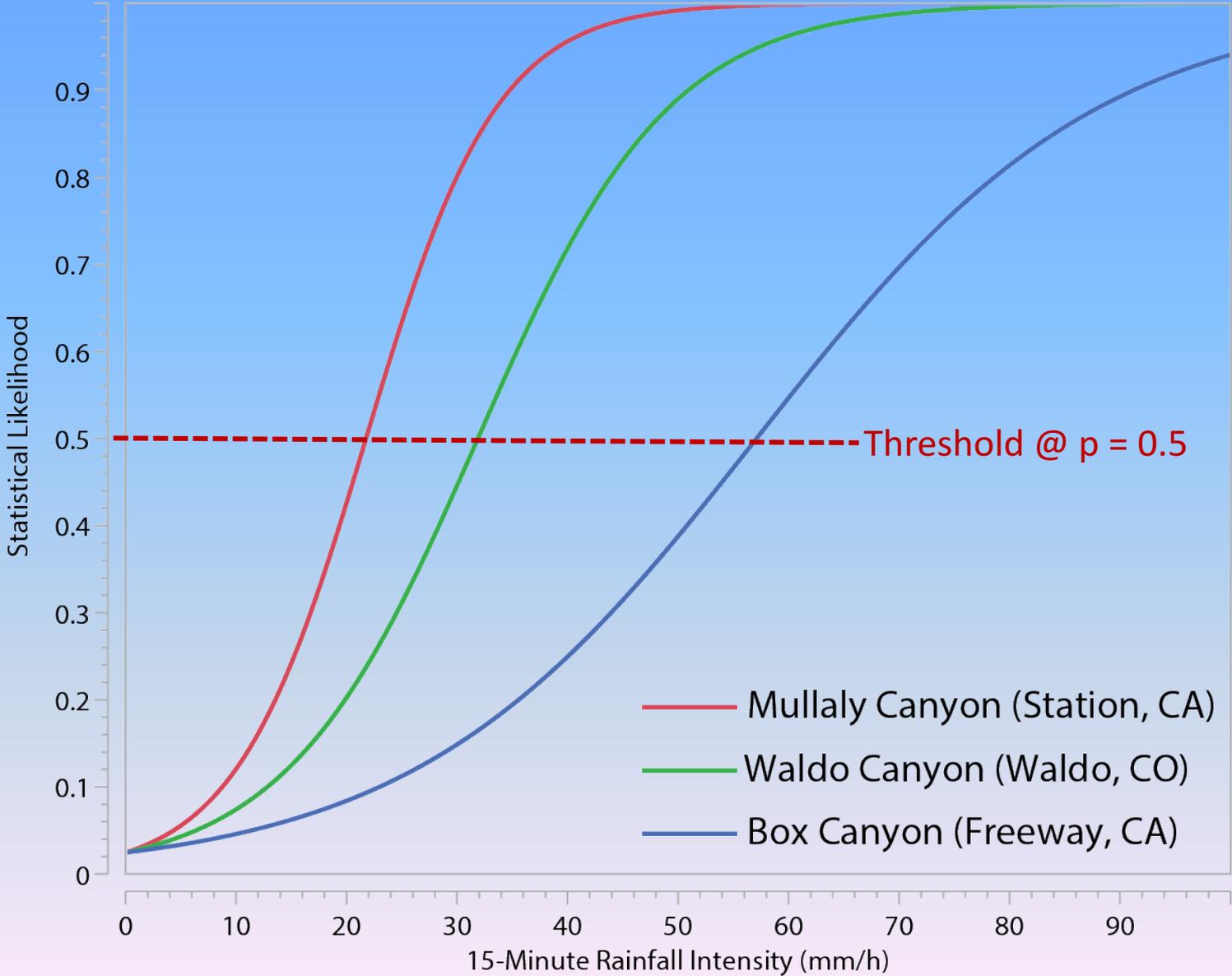
New Approach

Solving for the rainfall rate at any P value:

$$R_{(p)} = \frac{\ln\left(\frac{p}{1-p}\right) - b}{c_1 T + c_2 F + c_3 S}$$

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New Approach



Experimental Post Wildfire Debris Flow and Flash Flood

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Soberanes Fire
Flash Flood/Debris Flow Threat Information

Downloads: [KML File](#) [USGS Debris Flow Information](#)

[Permalink](#)

Burn Area Safety information [Share](#)

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Why Are Burn Scars Susceptible to Flash Floods/Debris Flows?

Flash floods and debris flows in areas recently burned by wildfire present a unique hazard to people and property in the path of these events. While some floods develop over time, flash floods and debris flows in burned areas with steep terrain can occur within minutes of the onset of a rainstorm. The increase in runoff is mostly due to the fact that there is much less, or no vegetation to intercept rainfall and slow the flow of runoff over the ground. The problem may be worsened by the effect that wildfire can have of reducing the ability of water to infiltrate into the soil.

Areas that are not traditionally flood-prone are also at risk. This is due to changes to both the landscape and stream channels caused by wildfire and the debris carried in the flood. In the event of moderate to heavy rainfall, do not wait for a flash flood warning in order to take steps to protect life and property. Thunderstorms that develop over the burned area may produce flash flooding and debris flows before a warning can be issued. If you are in an area vulnerable to flooding and debris flows, plan in advance so you know how you will stay safe once the storms or flooding begin.

USGS Post-Wildfire Landslide Hazards



Other Impacts

- Debris flow hazards (see USGS Debris Flow link above).
- Flooding in local drainages due to reduced rainfall infiltration on burned slopes and reduced conveyance of runoff in channels from accelerated sediment input from burn scar erosion.
- Accelerated erosion of burned hillslopes, causing sedimentation and debris built-up downslope or downstream.
- Accelerated erosion and rilling of unpaved rural roads and paths.
- An initial phase of post-fire gunk and ash in drainage ways and reservoirs following the first several rains, and associated "boiling" of water supply systems.

Populated Areas Affected: Big Sur, Palo Colorado, Tassajara Zen Center, Posts, San Clemente Rancho, Pfeiffer Big Sur State Park
Major Roads Affected: Rural roadways interior to the Santa Lucias generally north of Arroyo Seco, Highway 1
Rivers and Streams Affected: Areas of highest flooding and debris flow potential: Pfeiffer Redwood Creek, Juan Higuera Creek, Palo Colorado Upper Road Crossing, Doud Creek, Soberanes Creek
Bridges Affected: Rural bridge crossings within and adjacent to the burn scar

<http://www.wrh.noaa.gov/>

NWS Layers: Current NWS Warnings [KML](#) and Hazards [KML](#)

Burn Scar Flash Flood Safety Information

Each wildfire burn area poses its own unique risk of Flash Flooding due to many factors including proximity to population centers, burn severity, steepness of terrain, and size of the burned area. Impacts can occur down slope and/or downstream of any burn area, big or small. Contact your local officials to determine if you are at risk for flash floods and debris flows.

What should people who live near burn areas do to protect themselves from potential Flash Flooding and Debris Flows?

Before a flood event:

- Have an evacuation/escape route planned that is least likely to be impacted by Flash Flooding or Debris Flows.
- Have a 72-hour kit ready to go in case you need to evacuate - Remember the 6 P's in your planning - papers, pills (medicine), phone, pets, purse (money) and photos.
- Have a battery operated radio.
- Stay informed before and during any potential event; knowing where to obtain National Weather Service (NWS) Outlooks, Watches and Warnings via the [NWS website](#), [Facebook](#), [Twitter](#), or NOAA Weather Radio.
- Contact local officials for additional risk information and potential mitigation efforts.
- For more information about flood insurance, go the link [here](#)

During a flood event:

- Be alert as precipitation develops. Do not wait for a warning and take appropriate action to protect yourself from potential floodwaters.
- Utilize information from local emergency officials for the appropriate action for your location (Evacuation or Shelter in Place).
- Do not attempt to walk across flowing streams, drive through flooded roadways or allow children to play in drainage areas (just 6 inches of moving water can knock an adult off their feet).
- Call 911 if you are caught in a Flash Flood or Debris Flow.
- If water rises in your home before you can evacuate, move to the top floor, attic or roof.
- Stay aware of local flash flood warnings through local radio, TV and on www.weather.gov
- If you come in contact with floodwaters, wash your hands with soap and disinfected water.



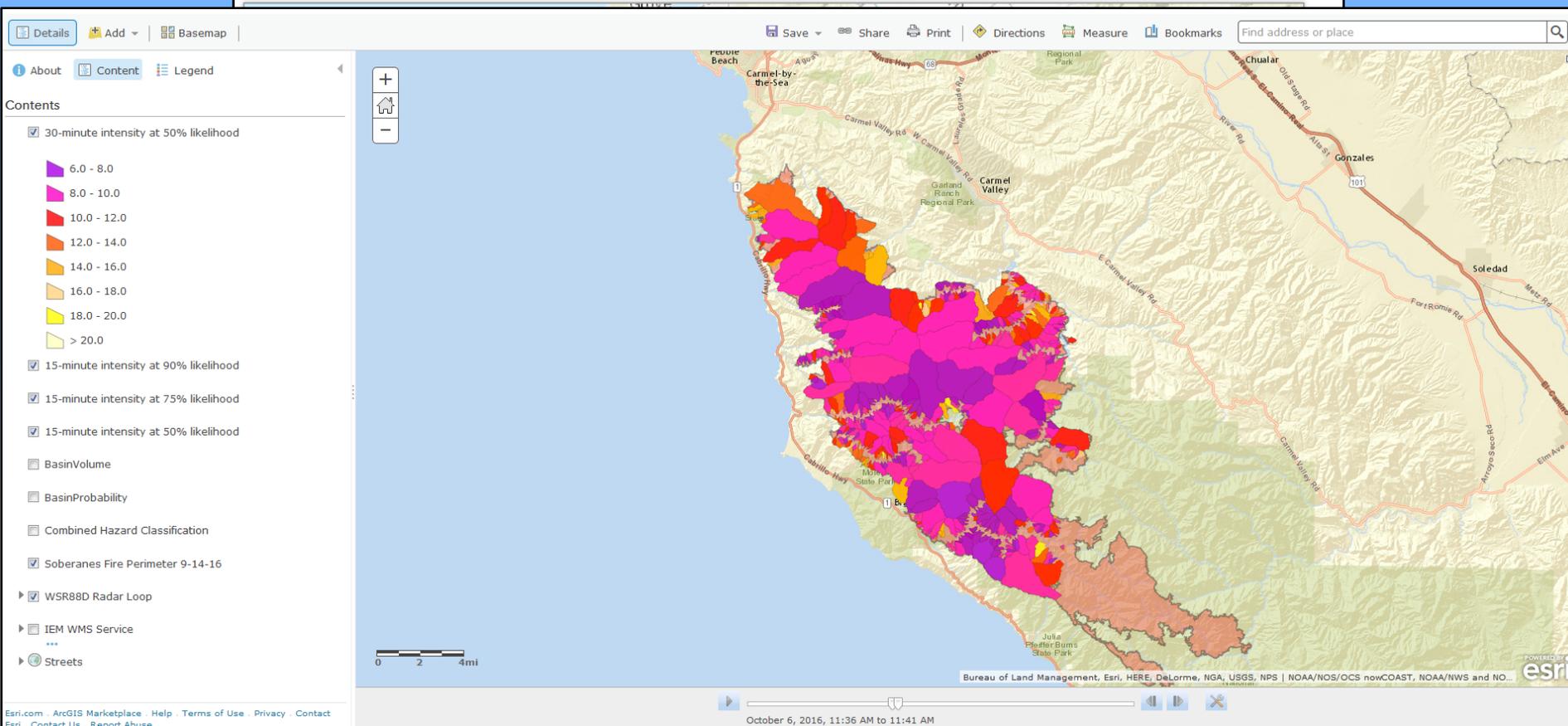
NOAA Flood Safety
Property Protection Information from NRCS



2016 Soberanes, BAER Phase 1 Fire - Los Padres National Forest

Date of origin: July 22, 2016
Location: 36.35,-121.77
Total Area Burned: 379 km²

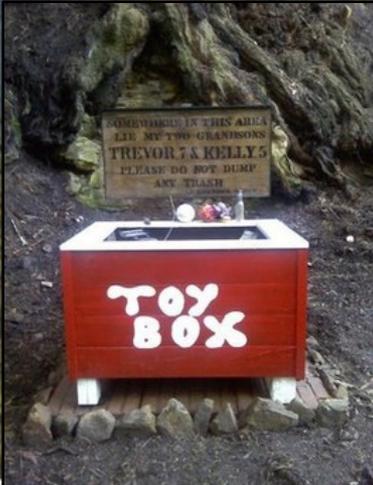
Preliminary Hazard Assessment



Combined relative debris flow hazard. These predictions are made at the scale of the drainage basin, and at the scale of the individual stream segment. Estimates of probability, volume, and combined hazard are based upon a design storm with a peak 15-minute rainfall intensity of 24 millimeters per hour (mm/h). Predictions may be viewed interactively by clicking on the button at the top right corner of the map displayed above. Visit the [Scientific Background](#) page for more information on how the predictions are calculated. For more information about what to do in case you live in an area where debris flows are possible, please visit [If you live in a recently burned area, and there is a rainstorm...](#)

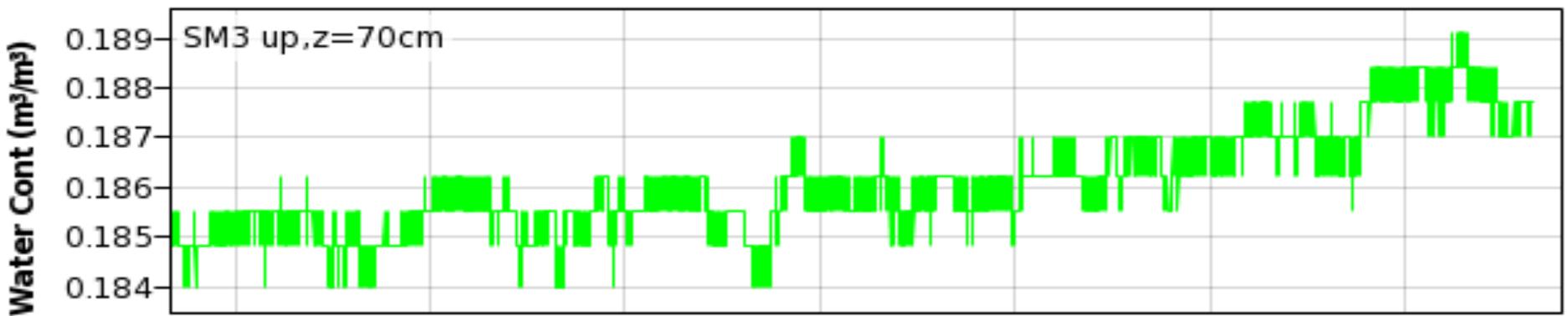
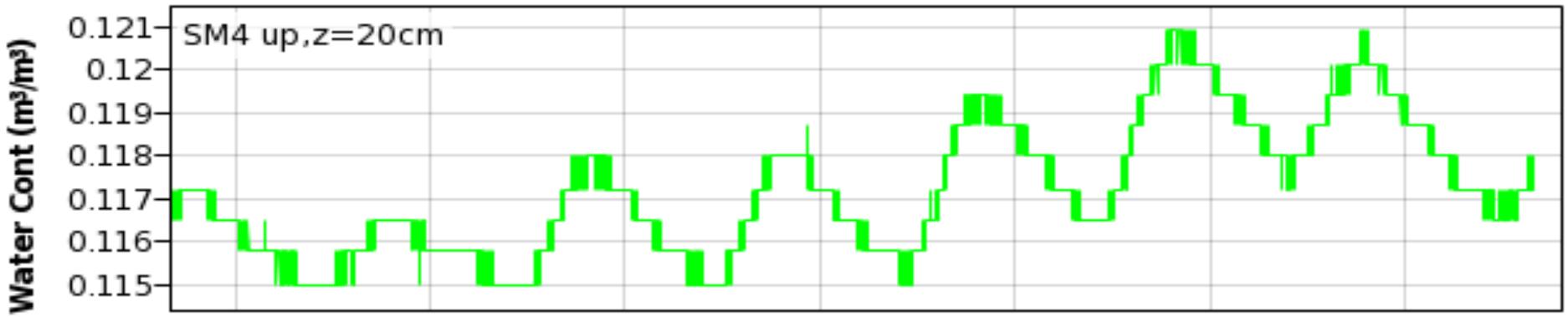
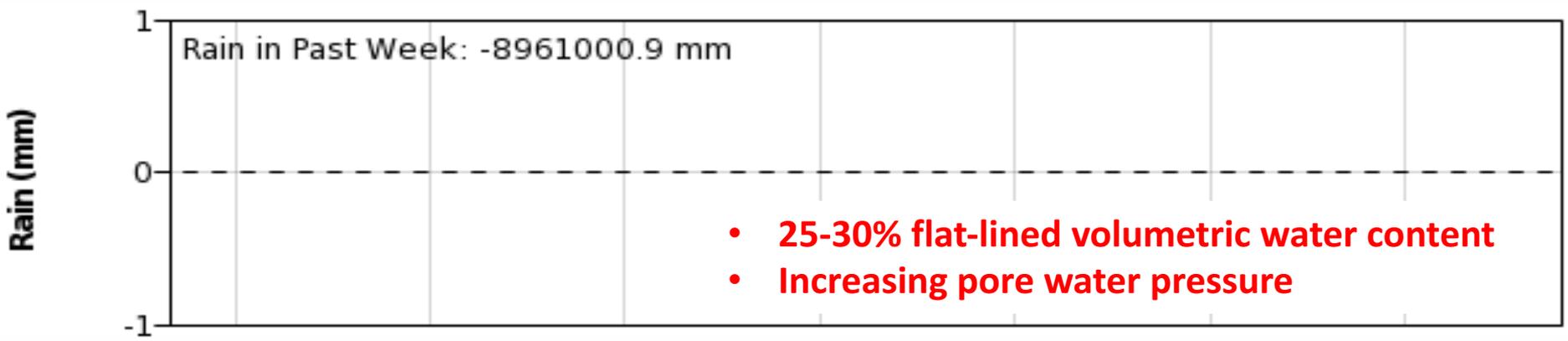




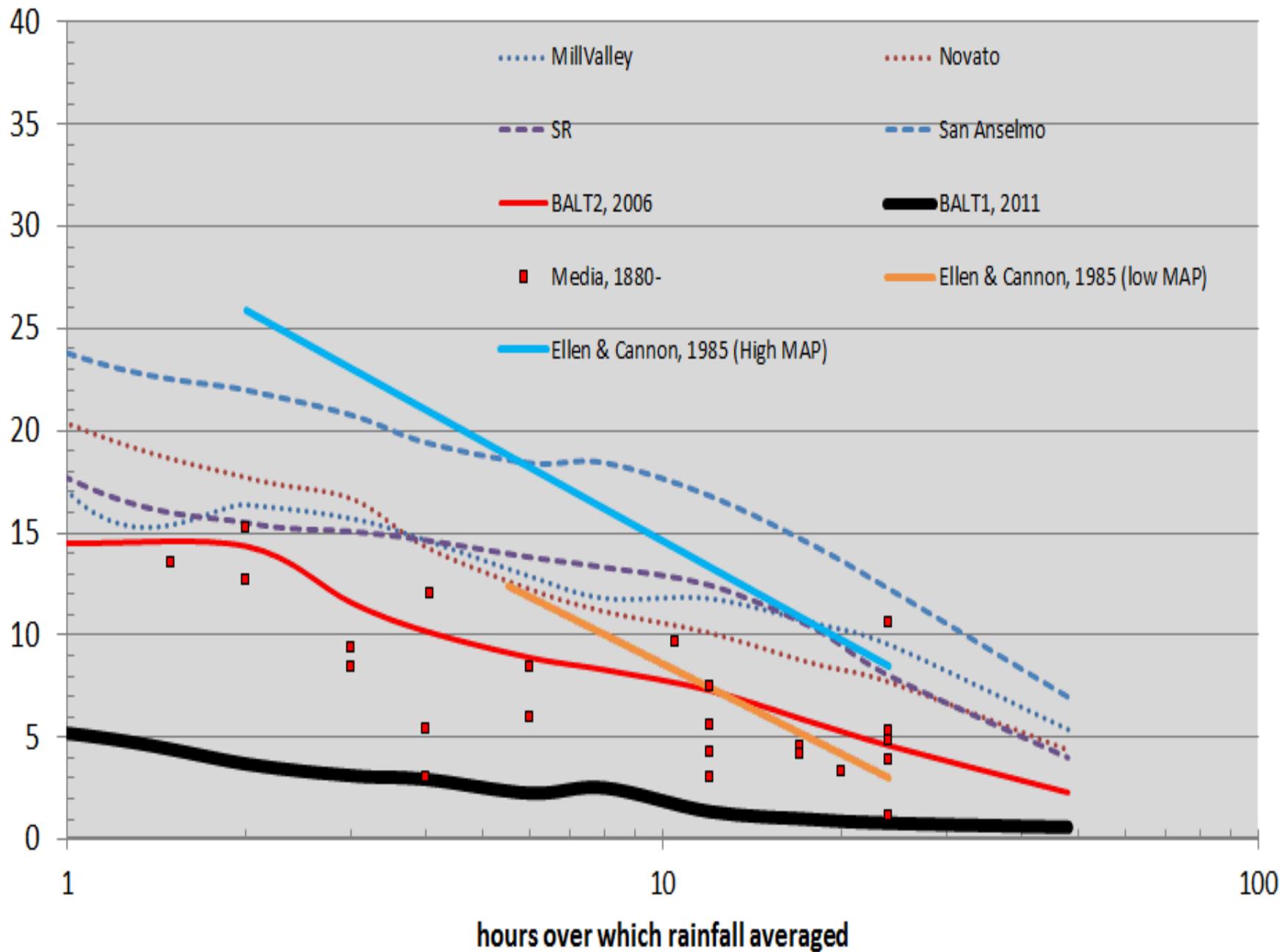


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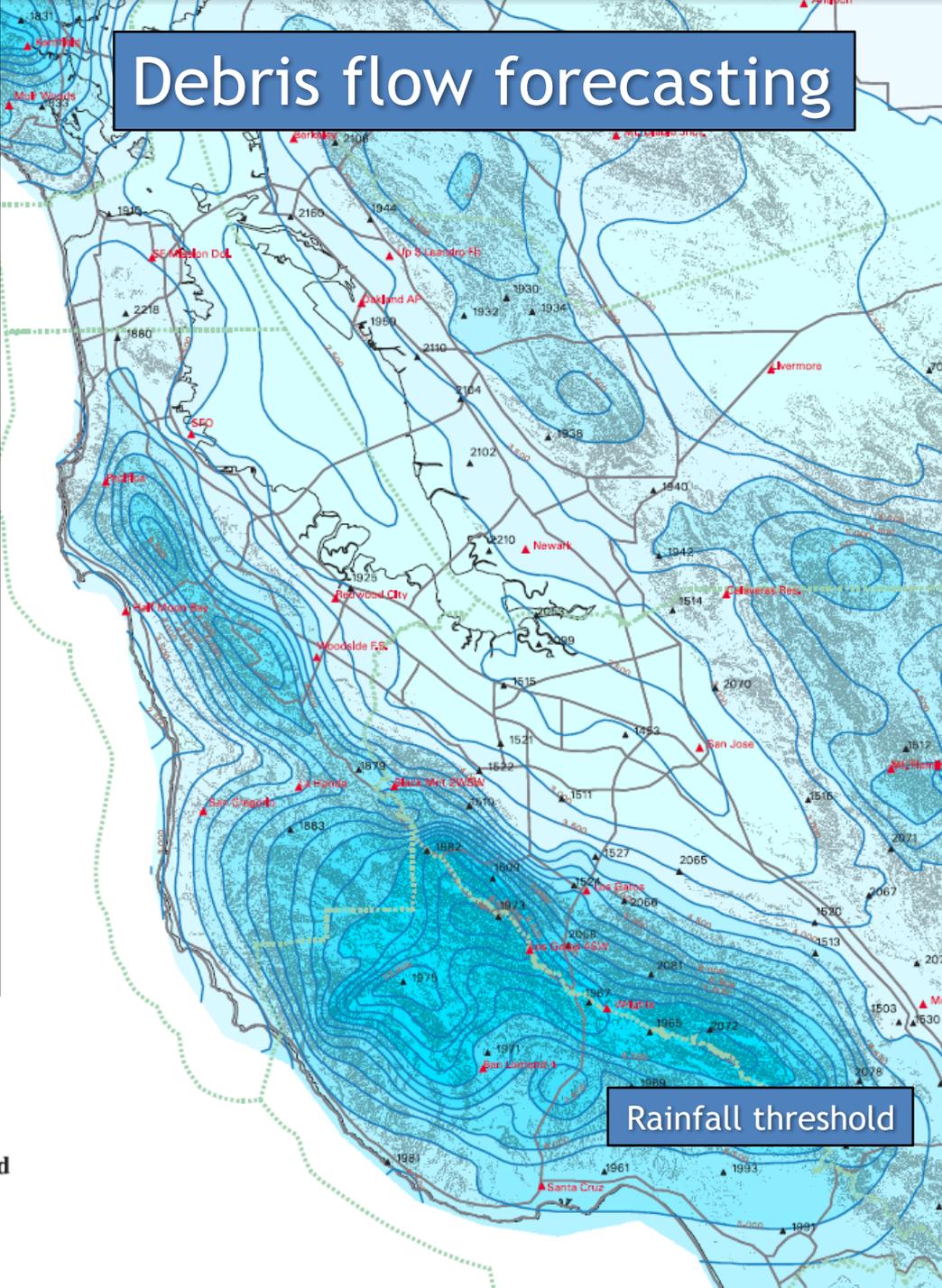
08/23 08/24 08/25 08/26 08/27 08/28 08/29



equivalent hourly rainfall rate
(mm/hr)



Debris flow forecasting



SAN FRANCISCO BAY REGION – 24 Hour Rainfall Threshold

By
R.C. Wilson and A.S. Jayko
1997

Warning Dissemination:

Flash Flood Watch (1-2 days out)

Flood Watch



- Urban/Small Stream Advisory
- Flash Flood Warning
- Flood Warning (forecast points)



Flash Flood Emergency

We are a resource for you!

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