Debris-Flow Model

Los Angeles Department of Public Works
Regional Sediment Management and
Water Supply Workshop
July 14, 2010

Presented by Sue Cannon

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- USGS approach/model for estimating debris-flow volumes
- How well the model did this winter
- What we might expect for the coming winter

Station fire, LA Times photos

Point 1. Multi-agency and -disciplinary effort

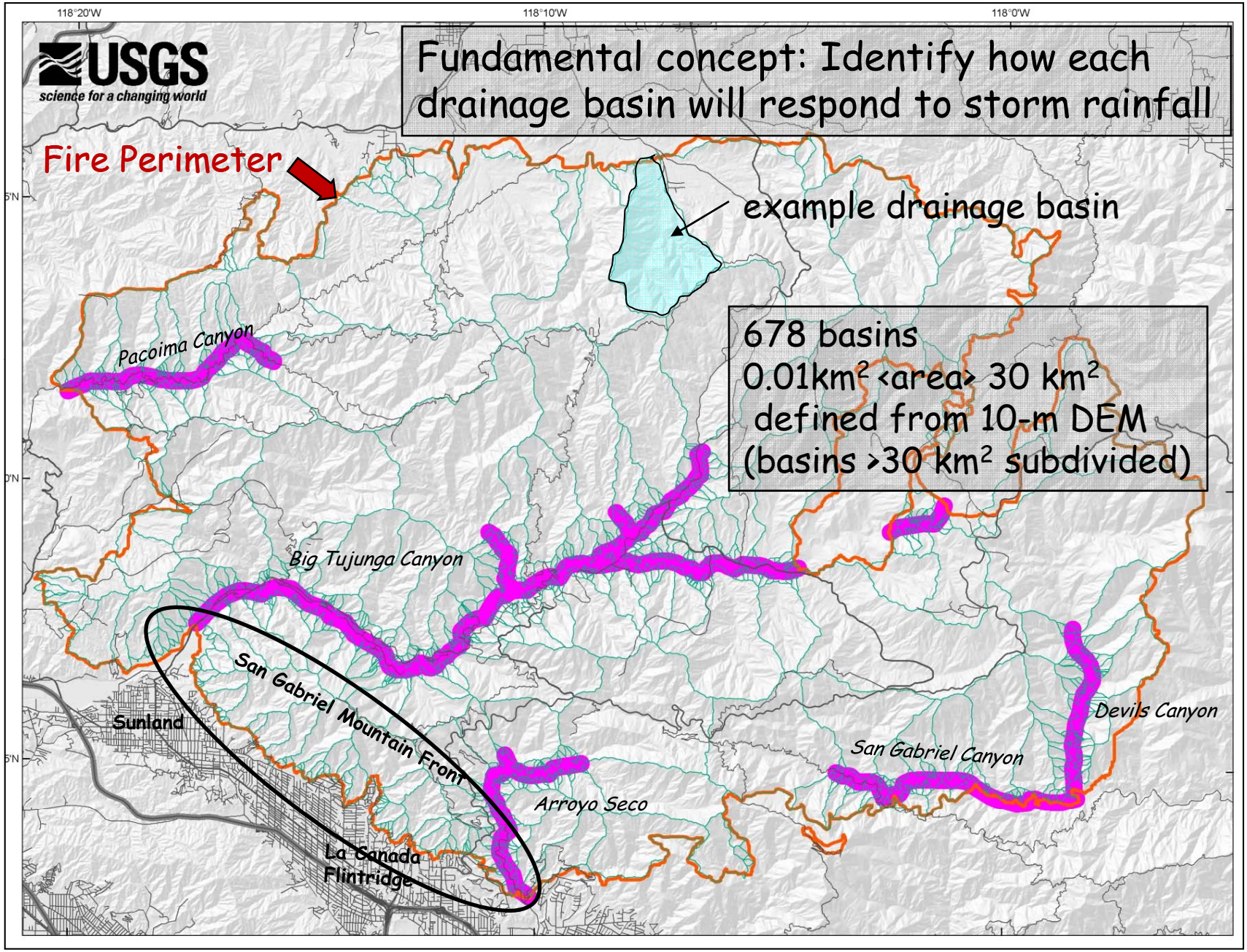
Angeles NF, Station fire BAER Team,
Riverside Fire Research Station, RSAC

Point 2. A work in progress:

Data deluge,
Winter of 2009,
Station fire

Post-fire debris-flow
researchers

Approach: Station Fire Debris-Flow Hazards Assessment

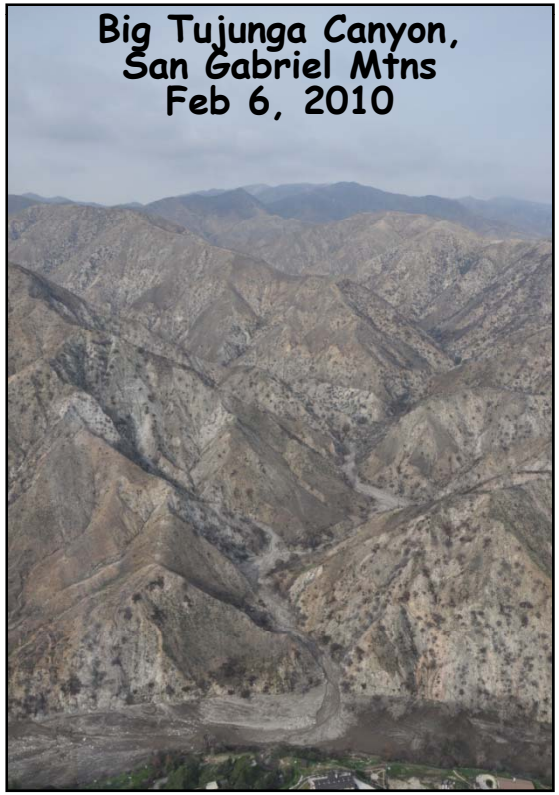


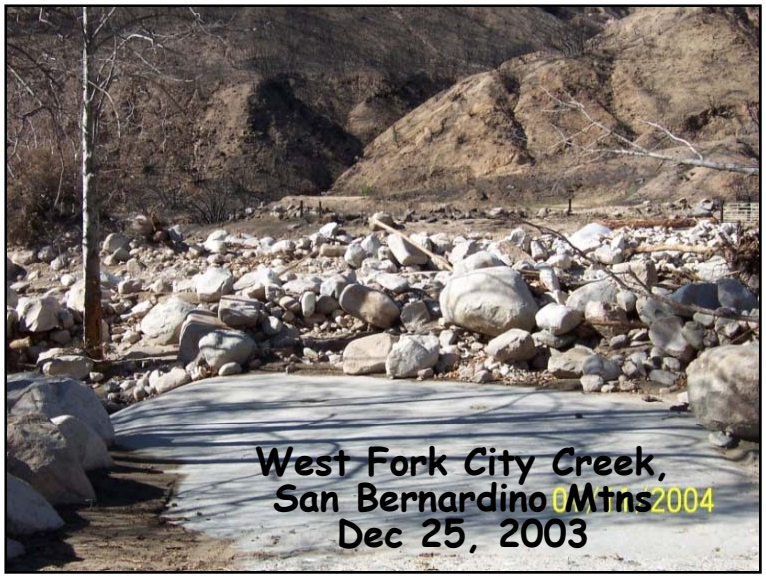
Approach for Characterizing Post-Fire Debris-Flow Hazards

- What basins are most prone to debris flow?
- How big will the response be?
- What areas will be impacted?

Empirical/Statistical Models

- Probability of debris flow
- **Debris-flow Volume**
- Inundation modeling





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Variables used to characterize debris-flow volume for each basin:

	Volume Model (n=40) (single storm/volume)
Burned extent:	Total area burned
Soil properties:	None
Basin gradients:	Length of the longest flow path
	Elevation change
Storm rainfall:	Total storm rainfall

Data sources for model development: and implementation

Volume	•Field measurements •Debris basin records
Total area burned	BAER BARC maps
Length of the longest flow path, elevation change	10-m DEMs
Total storm rainfall	Rain gages, NOAA Atlas 14, LADPW, Hirshfield, 1961

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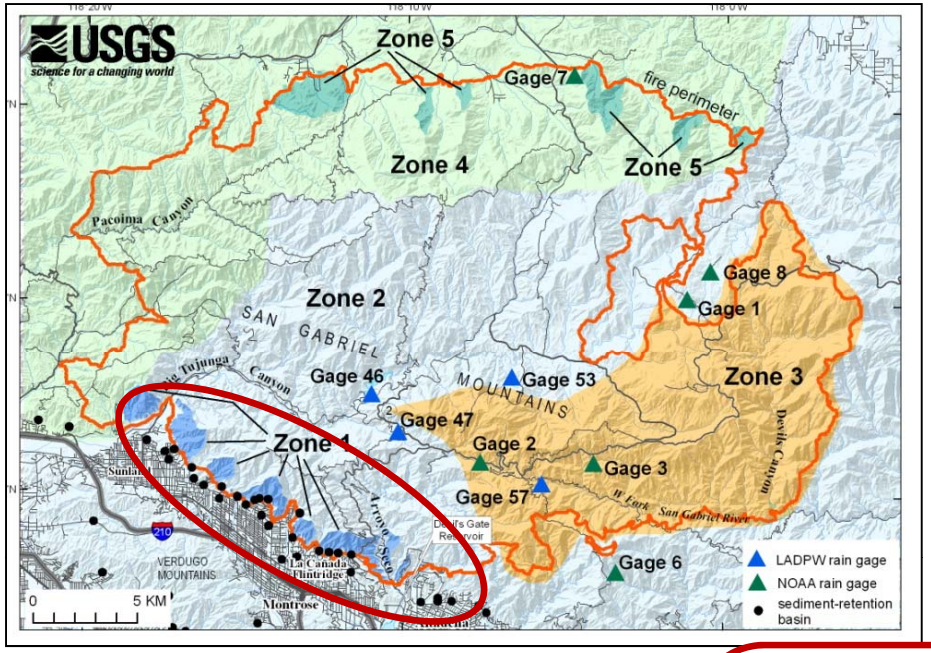
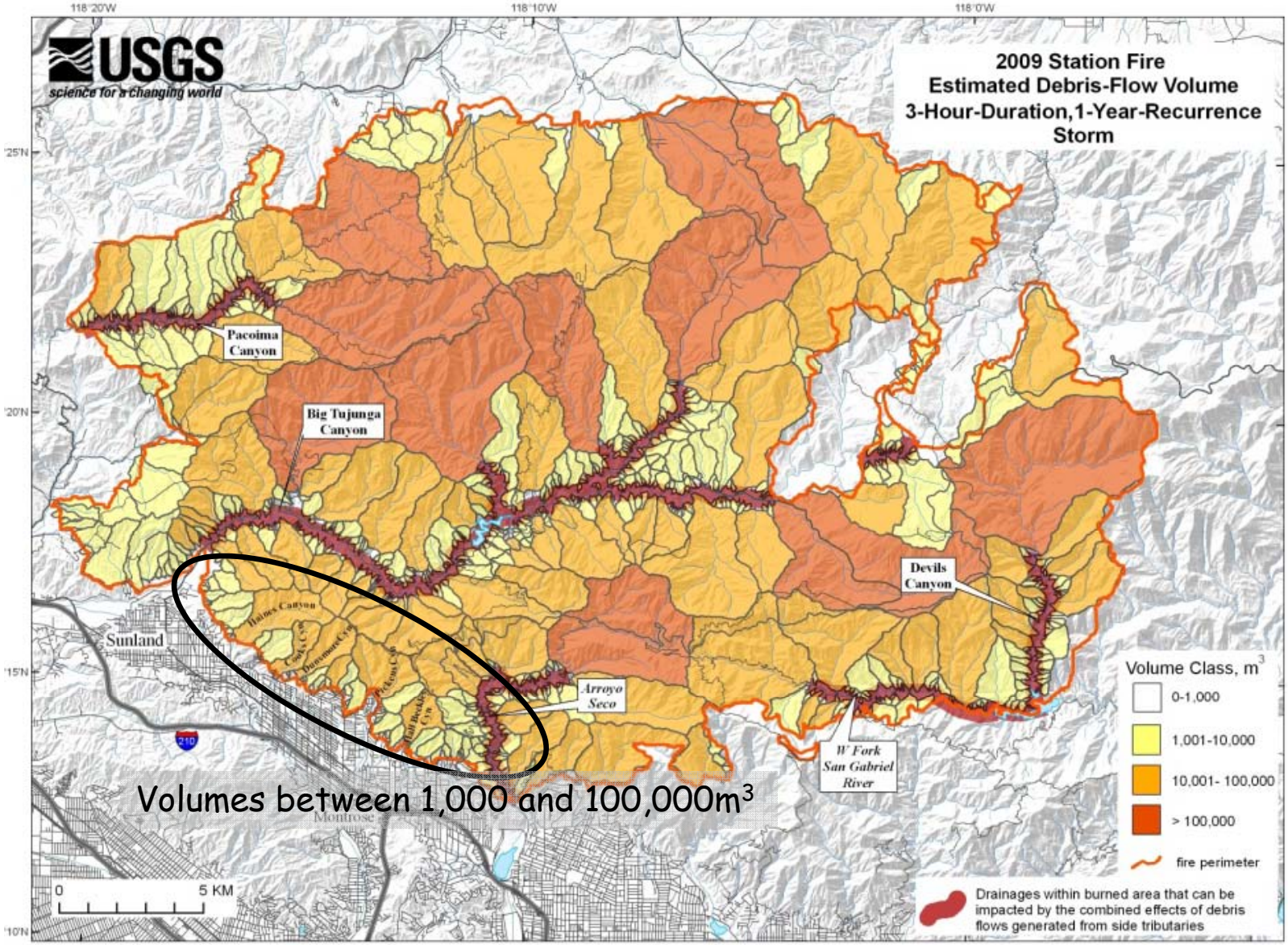


Approach: Storm rainfall used in hazard assessment

Zone	3-hour-duration, 1-year-recurrence storm		12-hour-duration, 2-year-recurrence storm	
	Total rainfall, (inches)	Average rainfall intensity, (inches/hour)	Total rainfall, (inches)	Average rainfall intensity, (inches/hour)
1	1.2	0.40	3.4	0.28
2	1.3	0.43	3.6	0.30
3	1.4	0.47	4.2	0.35
4	1.1	0.37	3.0	0.25
5	0.8	0.27	2.3	0.19

Projected debris flow volumes in response to a 3-hr-duration, 1-yr-recurrence thunderstorm



Winter of 2009-2010:

Date	*Storm Duration (hours)	*Storm Total (inches)	**Storm Recurrence Interval
Oct 13-14, 2009	29	2.3 to 2.5	1 year
Nov 12, 2009	1.0 to 1.3	0.75 to 1.1	Up to 5 year
Dec 7, 2009	16	0.8 to 1.4	<1 year
Dec 11-13, 2009	29 to 38	1.9 to 5.8	Up to 5 year??
Jan 18, 2010	23	2.1 to 4.3	Up to 2.5 year
Jan 19, 2010	7	0.4 to 0.7	<1 year
Jan 20, 2010	15	1.0 to 1.8	<1 year
Feb 6, 2010	25	3.1 to 4.4	Up to 2.5 year
Feb 9, 2010	6 to 7	0.4 to 0.9	<1year
April 11, 2010	6.5	0.9 to 1.3	<1 year

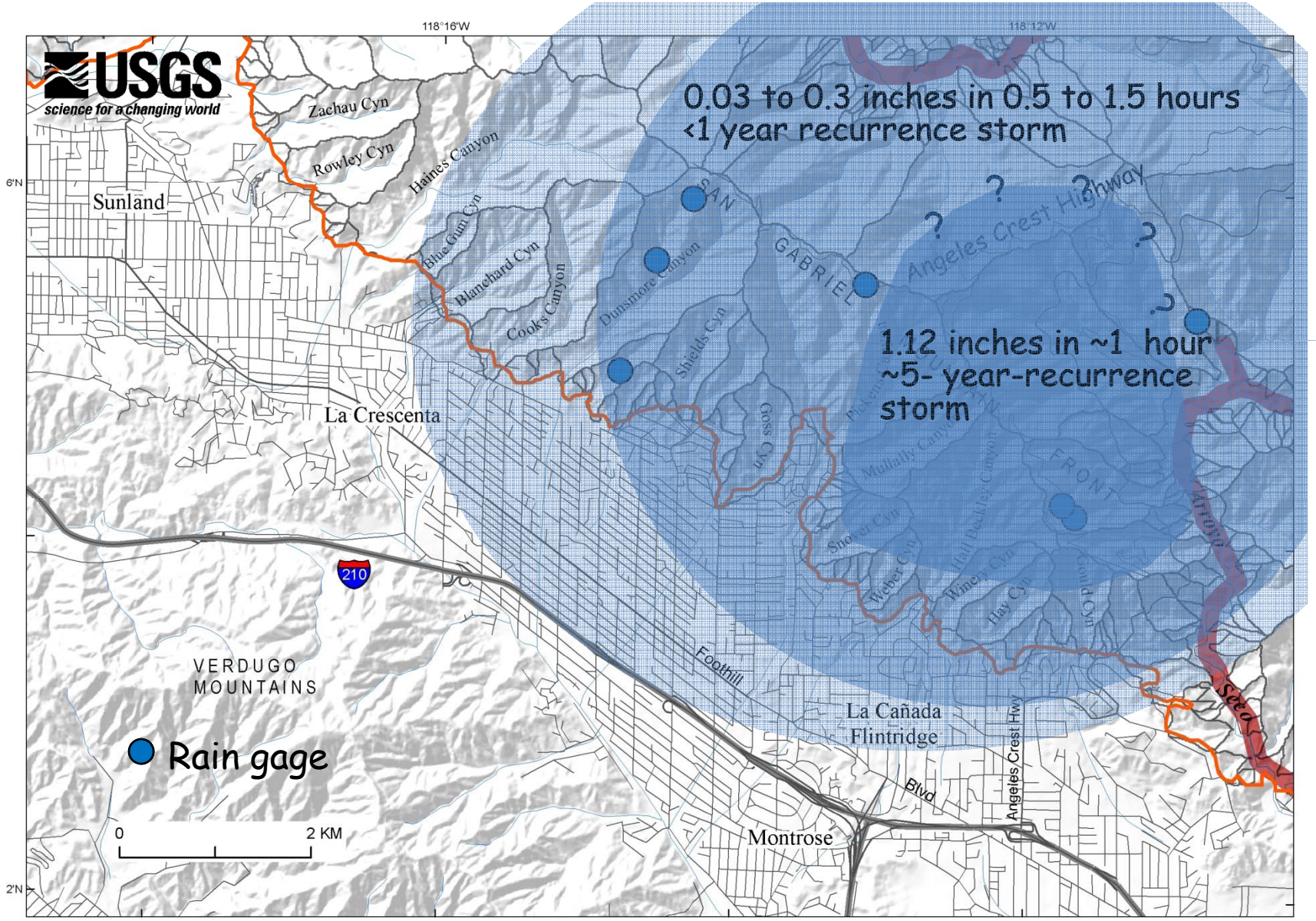
*Measured from gages along the San Gabriel Mountain Front.
**From Hershfield (1961), Los Angeles County Frequency Analyses Report, and NOAA (Bonnin et al., 2006).

Hydrologic Response

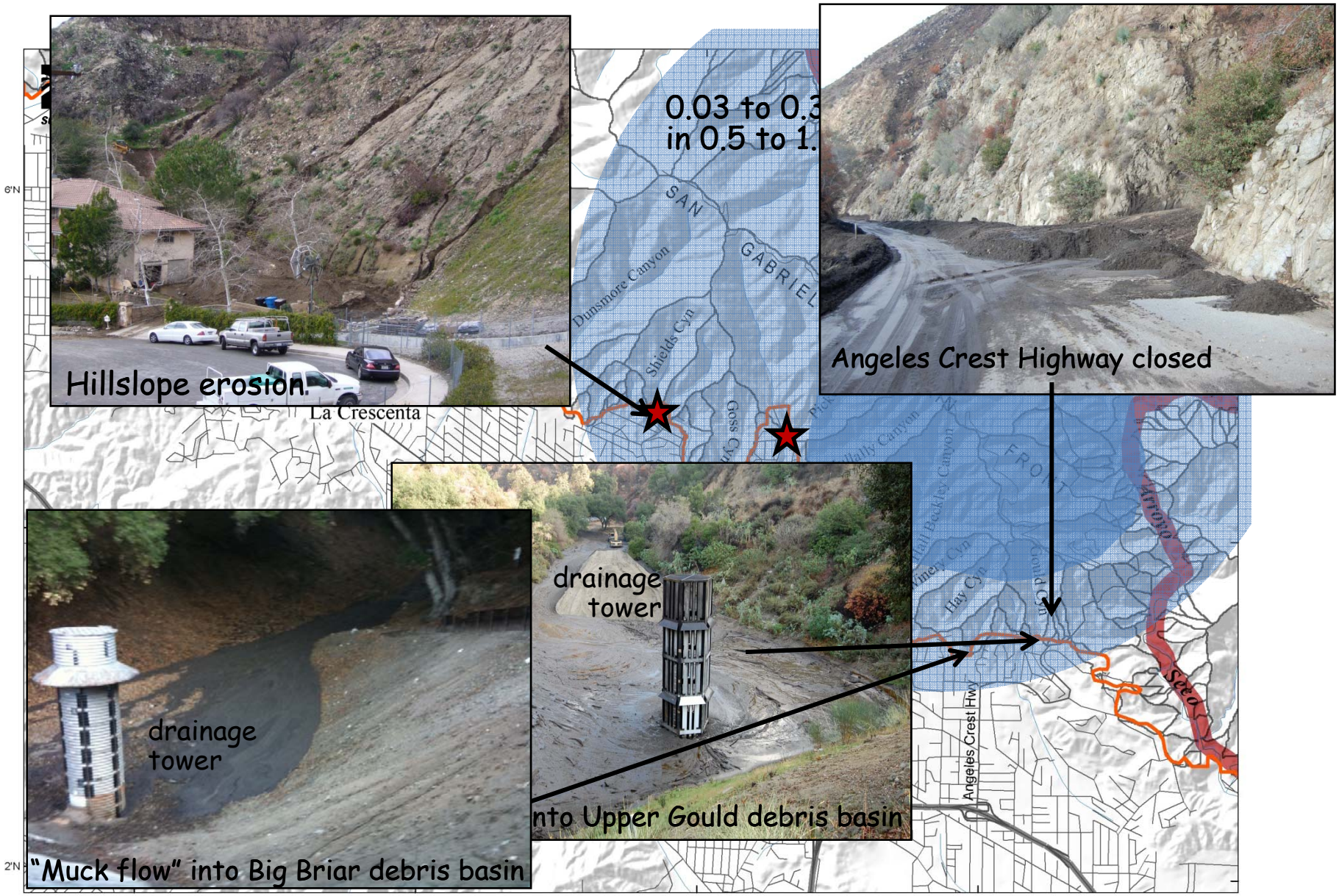
- negligible
- localized debris flows and flooding
- widespread debris flows and flooding

Modeled storm: 1.2 to 1.3 inches of rain in 3 hours

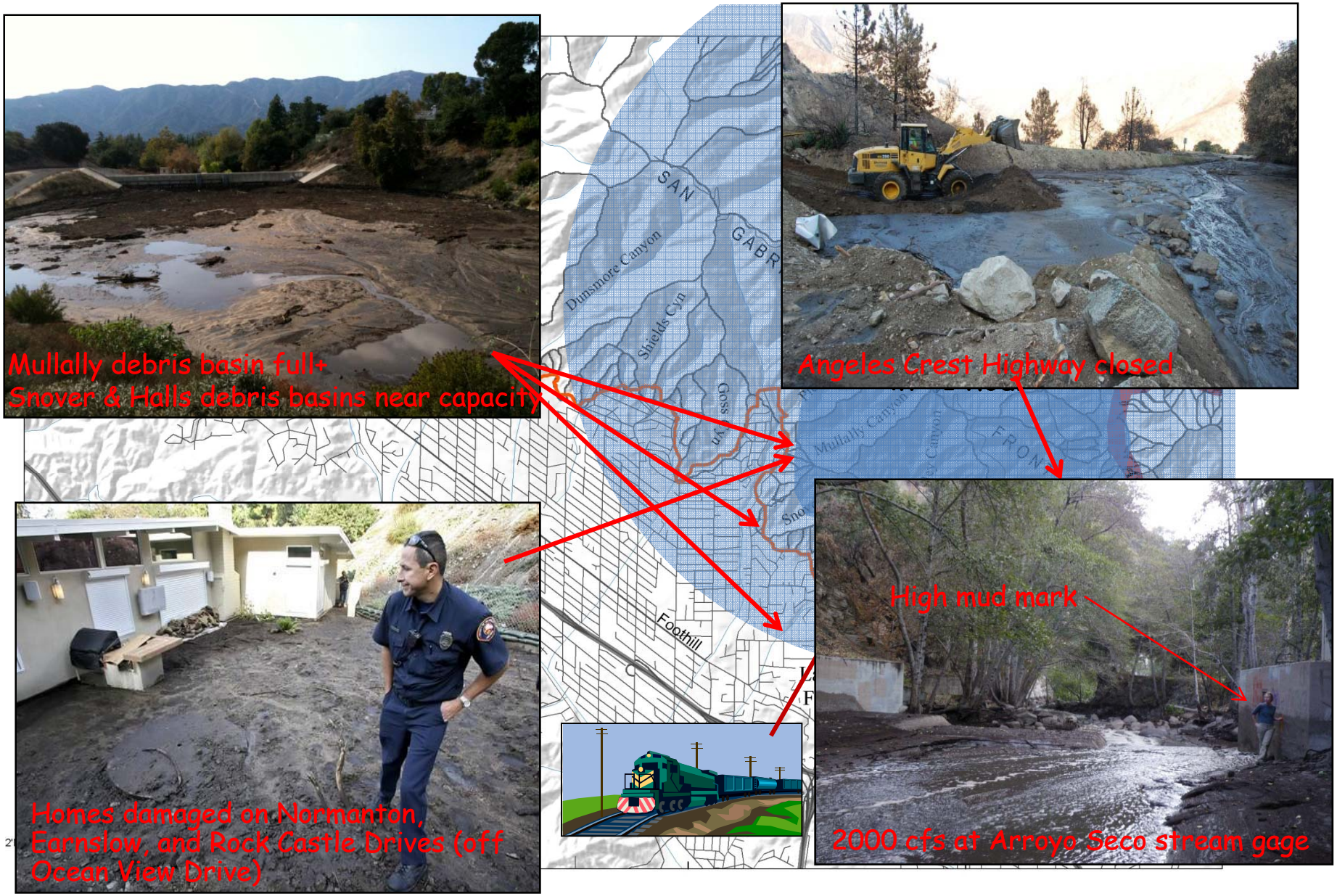
November 12, 2009 Storm: Approximate rainfall distribution



November 12, 2009 Storm: Response in low rainfall area



November 12, 2009 Storm: Response in high rainfall area

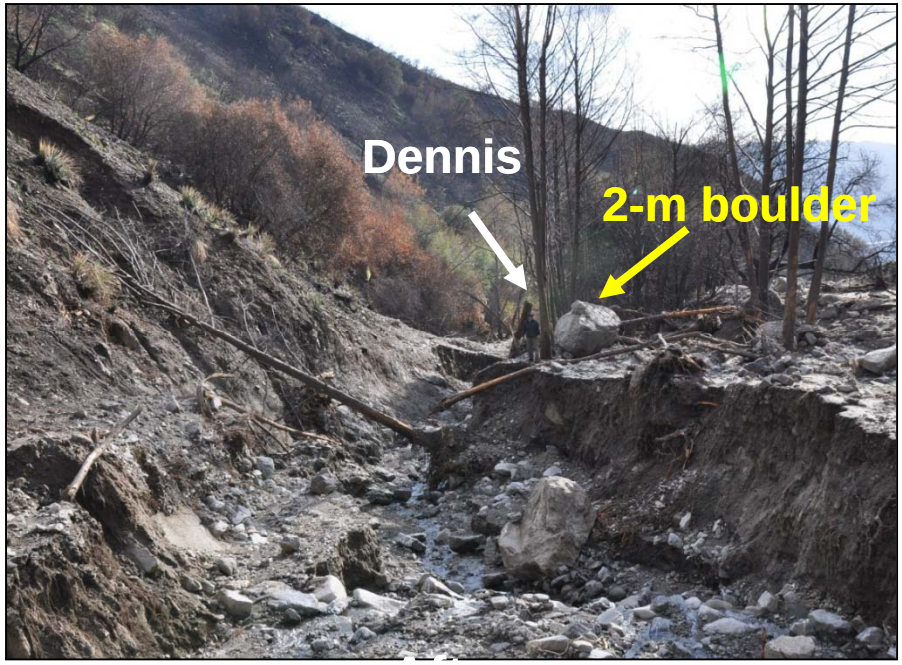


Jan.18 and Feb.6, 2010 Storms: THE BIG ONES

Dunsmore Canyon:

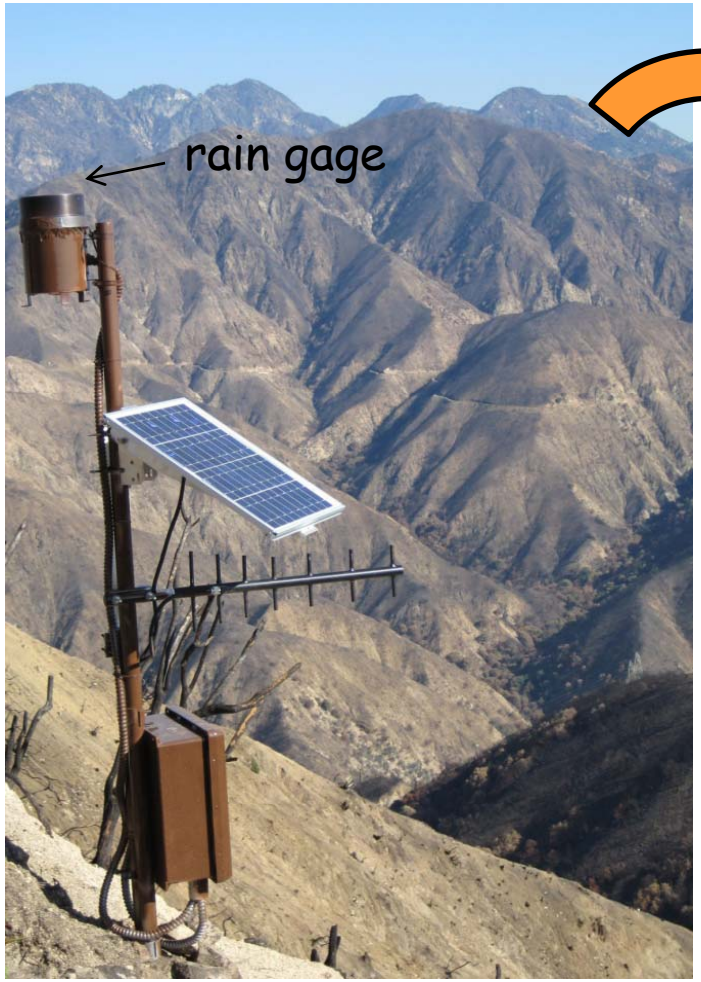
January 19, 2010

February 7, 2010

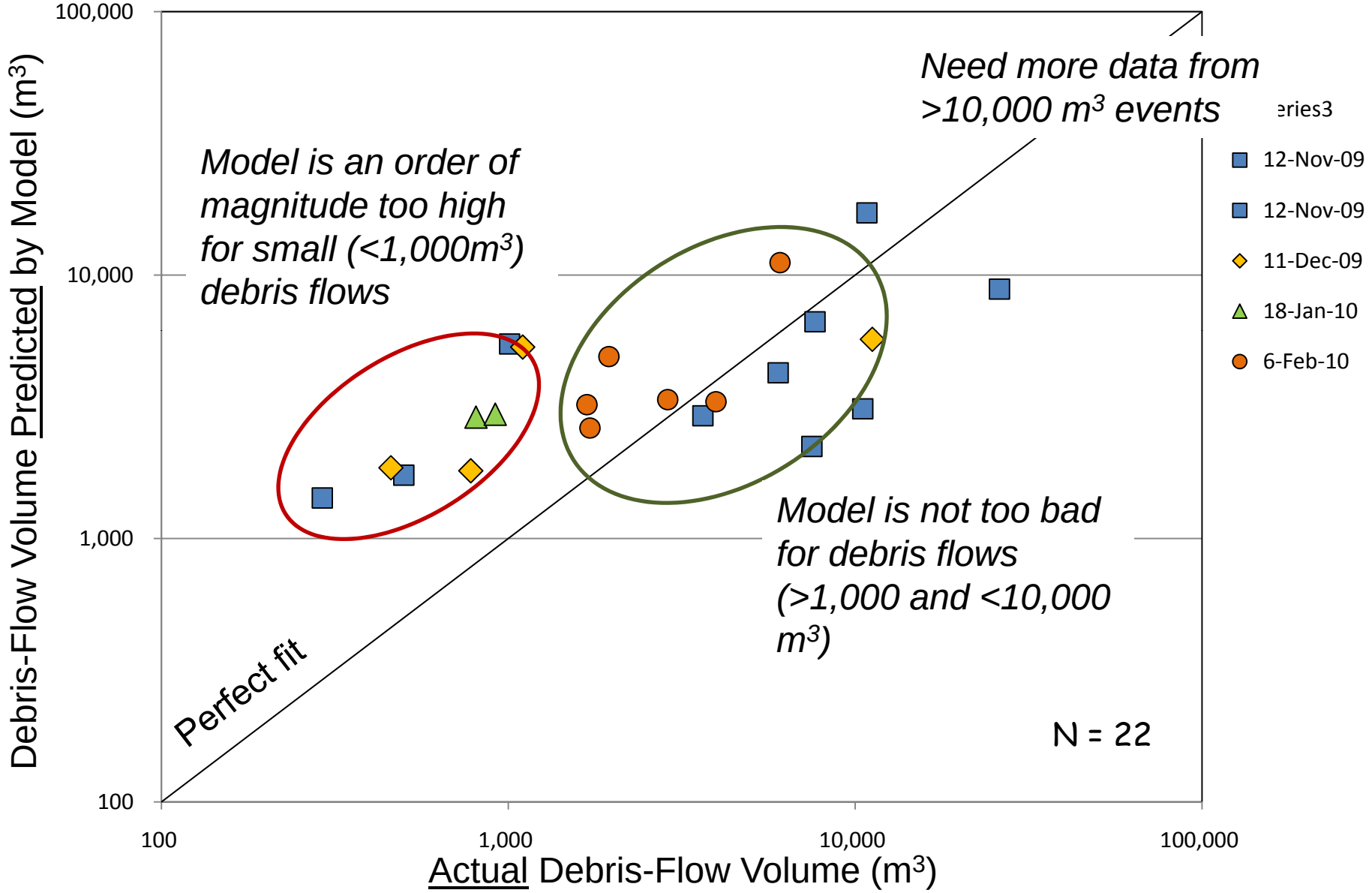


How well did the debris-flow volume do?

- Run the volume model with measured storm rainfall
- Compare predicted volumes with volumes of material collected in debris basins

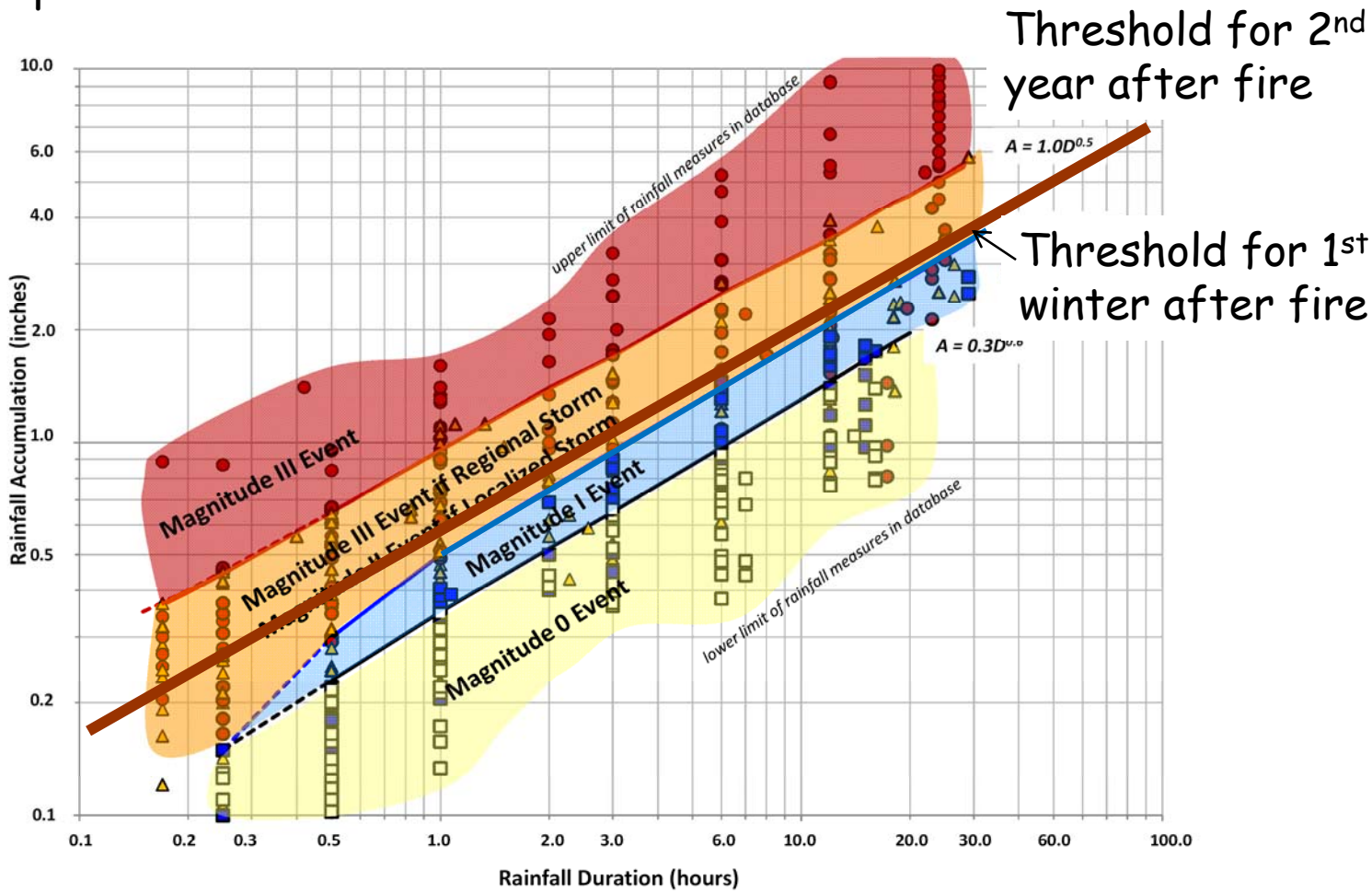


First cut: How well did the debris-flow volume do?



What might we expect for the coming winter?

1. It all depends on the rainfall……..
2. If get storms comparable to those in 2009:
   a. It will take just slightly higher rainfall rates to trigger an equivalent response



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1. It all depends on the rainfall……..
2. If get storms comparable to those of 2009:
   a. It will take just slightly higher rainfall rates to trigger an equivalent response
   b. Experience in southern CA indicates that the response of second winter can be comparable to the first
   c. Field observations in the Station fire indicate that although material has been flushed from many of the low-order channels, these bedrock-lined channels could now act as effective water flumes.

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   a. It will take just slightly higher rainfall rates to trigger an equivalent response
   a. Experience indicates that the response of second winter can be comparable to the first
   b. Field observations in the Station fire indicate that although material has been flushed from many of the low-order channels, these bedrock-lined channels could now act as effective water flumes.
3. **If storms are either more intense, longer duration, or closer together than 2009 storms – LARGER, MORE DESTRUCTIVE EVENTS**

But what about all that fantastic vegetation growth?

Can we quantify its effect on recovery and sediment yields?

Cumulative measure of vegetation change -

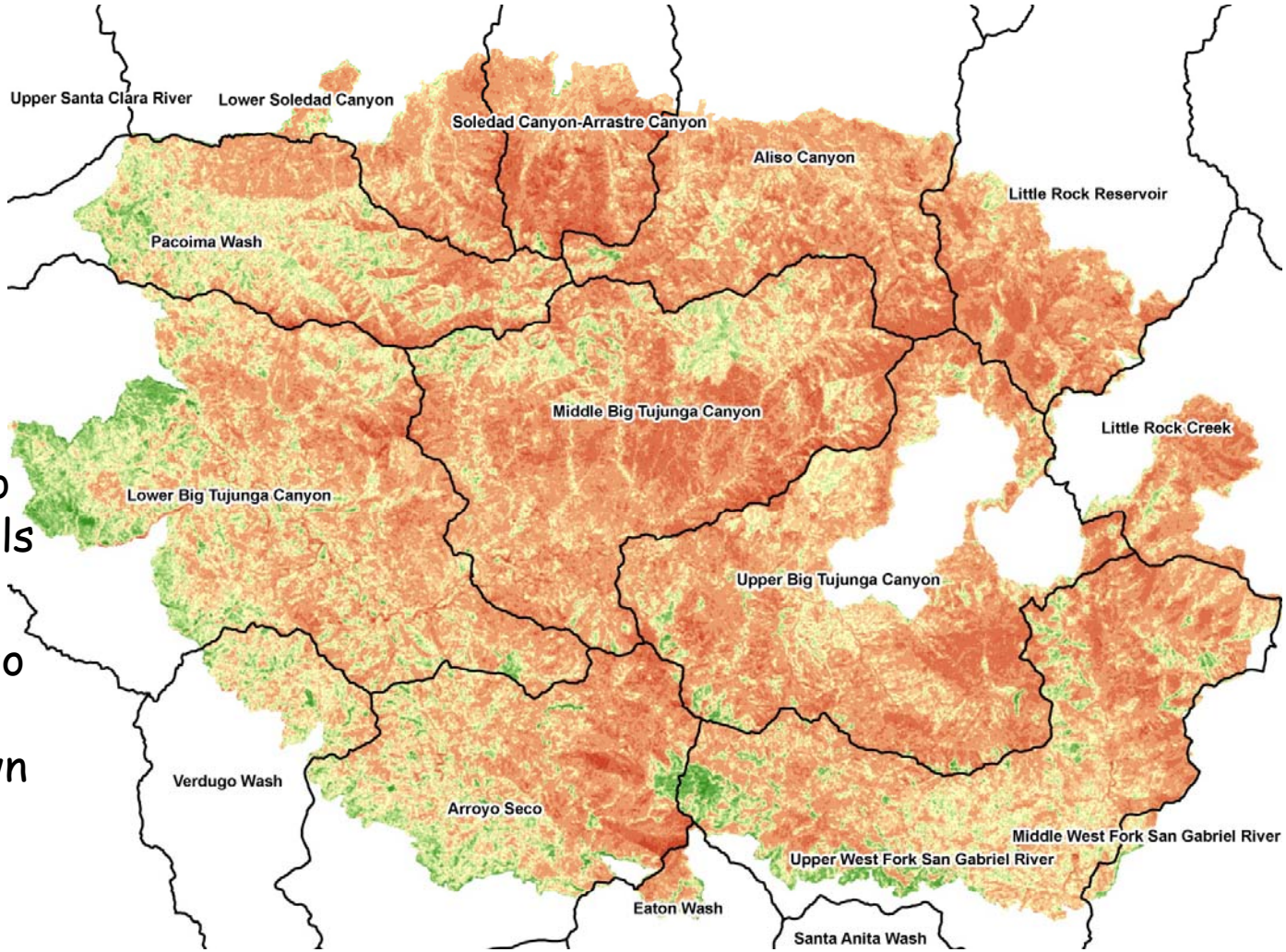
Feb to May 2010

Green = more veg during year

Red = less veg during year

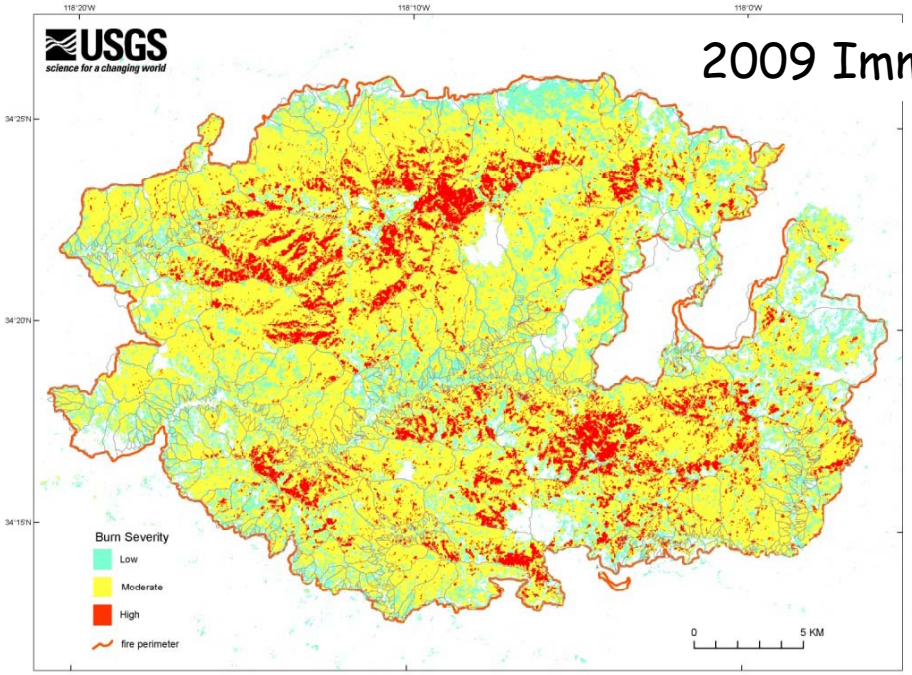
Most re-growth to date in low foothills

Effects will be also be lessened with drying and lay down



Jess Clark
USDA Forest Service, Remote Sensing Applications Center,
http://fsweb.rsac.fs.fed.us

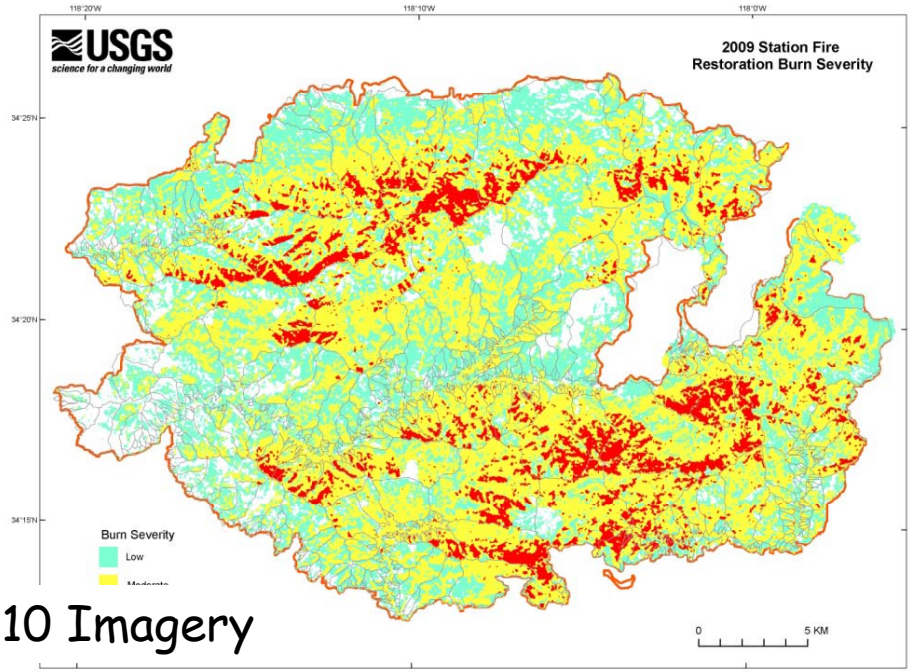
Effects of vegetative regrowth on burn severity map and debris flow volume model predictions



2009 Immediate Post-fire Burn Severity Map

Primary change: Areas of moderate burn severity are now classified as low severity

Average change in volume model predictions: -2%
Range 0% to 50%



Burn Severity Map from May, 2010 Imagery

What might we expect for the coming winter?

More of the same, or MORE

Questions??