Wildfires & Debris Flows, Oh my!

Mike Conway – Ann Youberg

2010 Schultz Fire (Flagstaff)

2012 Gladiator Fire (Crown King)

2011 Wallow Fire (Alpine)

2011 Monument Fire (Huachuca Mtns)

2011 Horseshoe 2 Fire (Chiricahua Mtn)

Photos courtesy of USFS

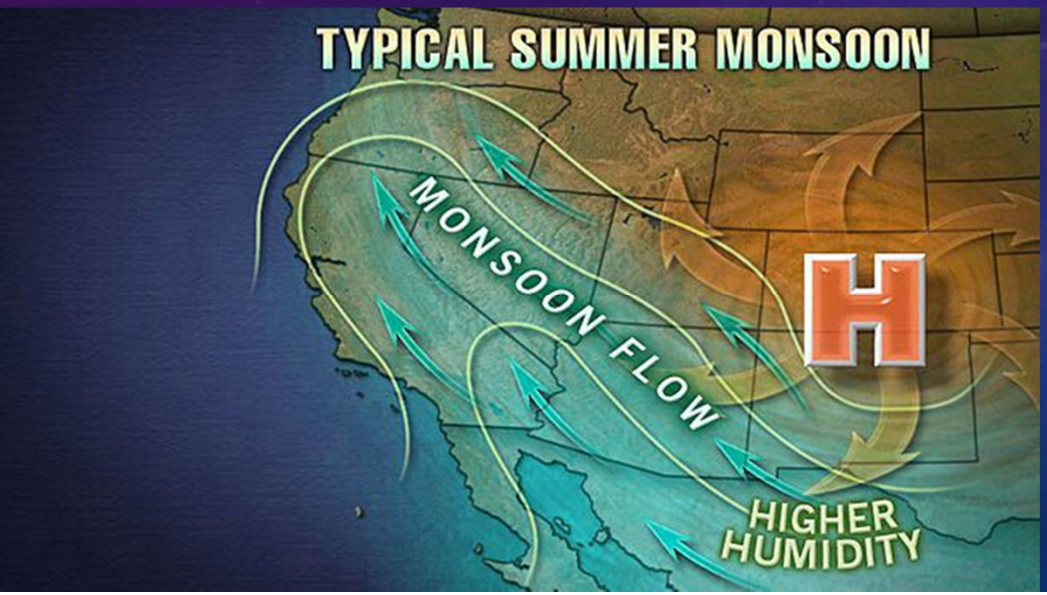
Debris flow – concrete slurry: the perfect analog

- 60%+ by volume - loose mud, sand, soil, & rock - water and air that travels downslope.
- solids > water (viscous slurry)
- > ½ solids in the mass larger than sand grains;
- Speed – slow to fast up to 100 mph

Fire and Rain

DEBRIS FLOWS

Horseshoe 2 Fire Intl Space Station 2011



Factors influencing how watersheds respond to wildfire:

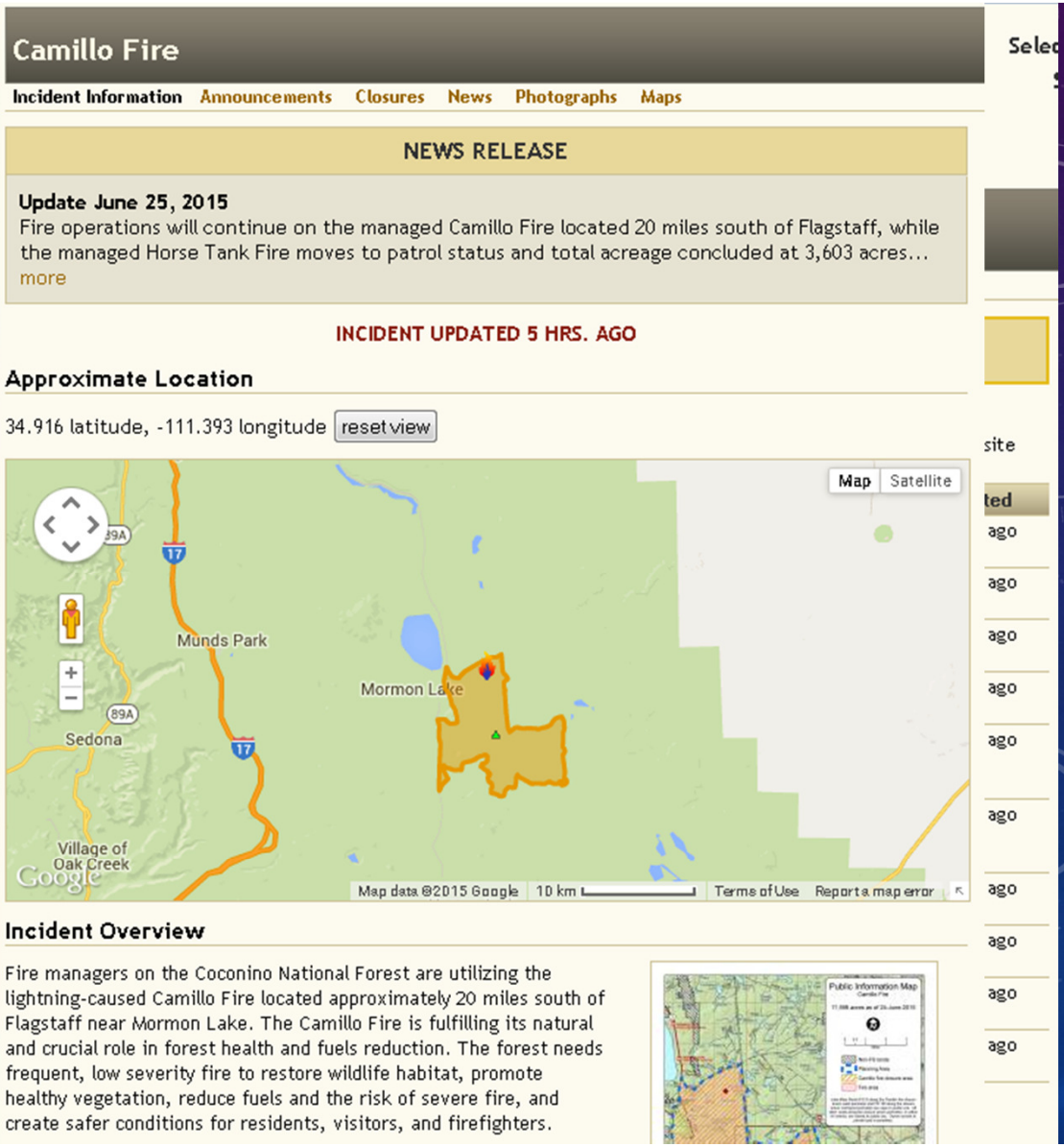
precipitation intensity, burn severity, availability of debris, slope

DROUGHT

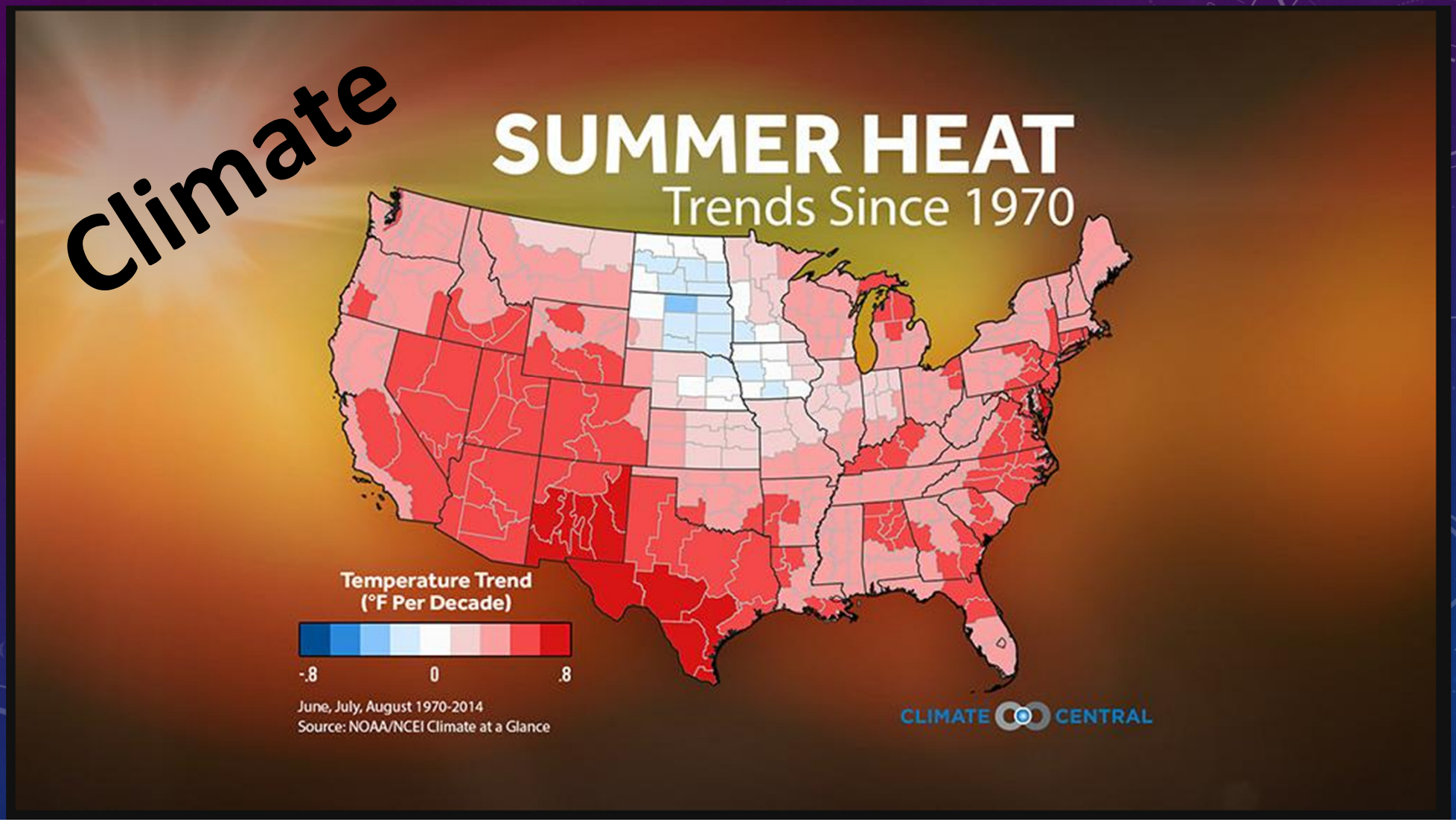
Tracking wildfires w/ InciWeb

Incident Info U.S.A.

http://inciweb.nwcg.gov/



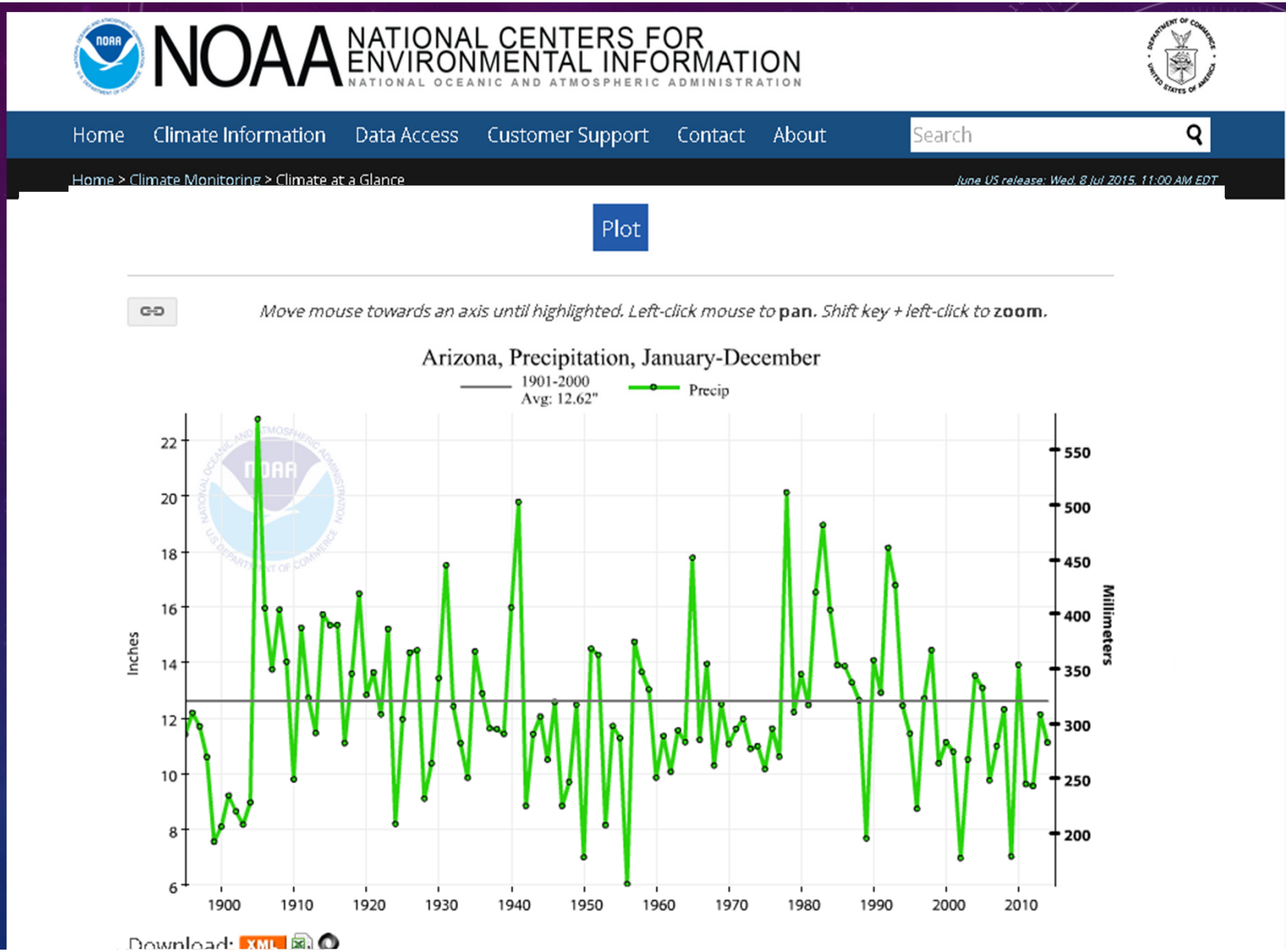
Climate


SUMMER HEAT
Trends Since 1970
Temperature Trend
(°F Per Decade)
-.8
0
.8
June, July, August 1970-2014
Source: NOAA/NCEI Climate at a Glance
CLIMATE CENTRAL

Climate at a glance

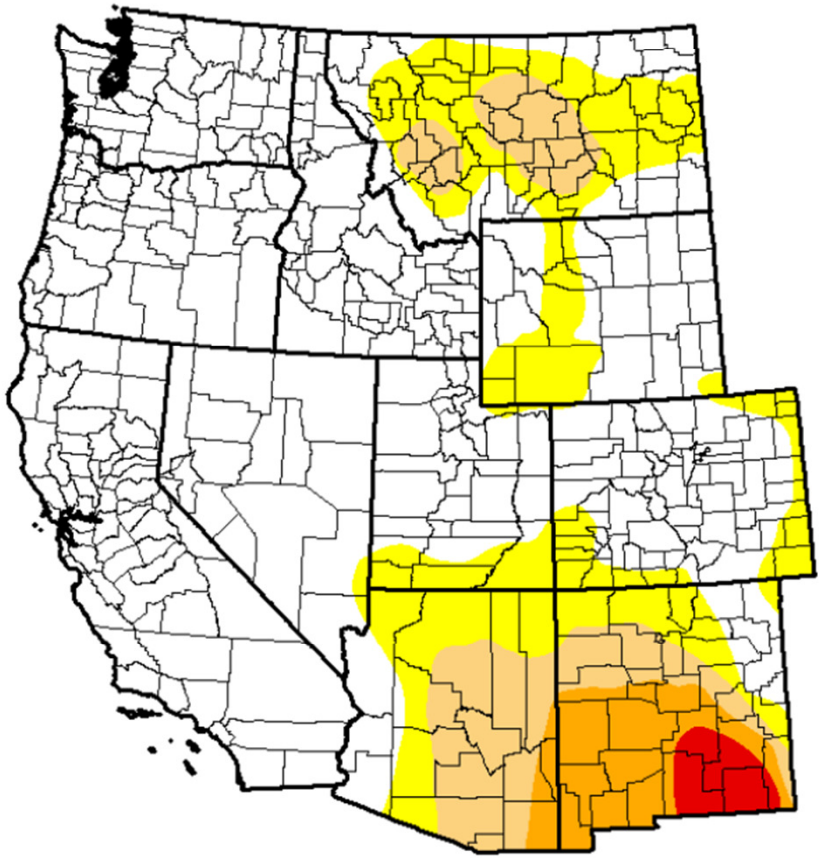
Got those climate change blues, again!

NOAA



U.S. Drought Monitor

West



June 6, 2000

(Released Thursday, Jun. 8, 2000)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	69.20	30.80	14.30	5.84	1.34	0.00
Last Week *5/30/2000*	73.80	26.20	16.04	5.93	1.36	0.00
3 Months Ago *3/7/2000*	76.08	23.92	7.90	0.60	0.00	0.00
Start of Calendar Year *1/4/2000*	80.42	19.58	0.18	0.01	0.00	0.00
Start of Water Year	-	-	-	-	-	-
One Year Ago	-	-	-	-	-	-

Intensity:

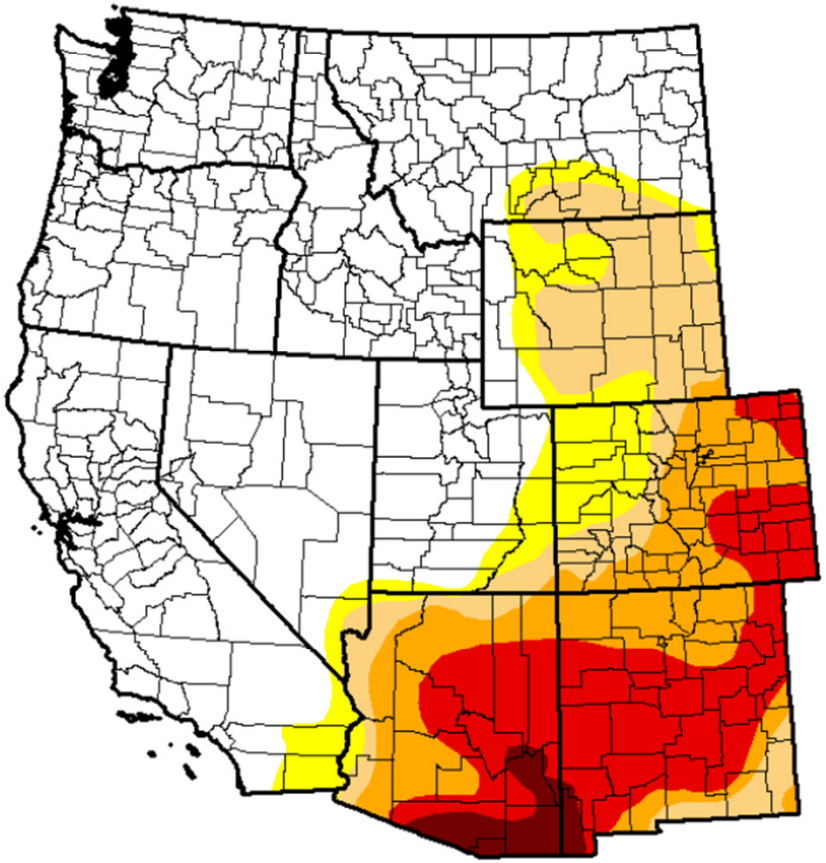
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Staff
National Drought Mitigation Center

http://droughtmonitor.unl.edu/

U.S. Drought Monitor
West



June 13, 2006

(Released Thursday, Jun. 15, 2006)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	59.74	40.26	32.81	23.10	13.37	1.66
Last Week 6/6/2006	59.97	40.03	30.75	22.85	12.34	1.68
3 Months Ago 3/14/2006	59.82	40.18	25.14	15.33	5.00	0.00
Start of Calendar Year 1/3/2006	57.59	42.41	14.39	0.00	0.00	0.00
Start of Water Year 9/27/2005	45.73	54.27	30.88	11.63	0.96	0.00
One Year Ago 6/14/2005	53.64	46.36	16.46	0.74	0.00	0.00

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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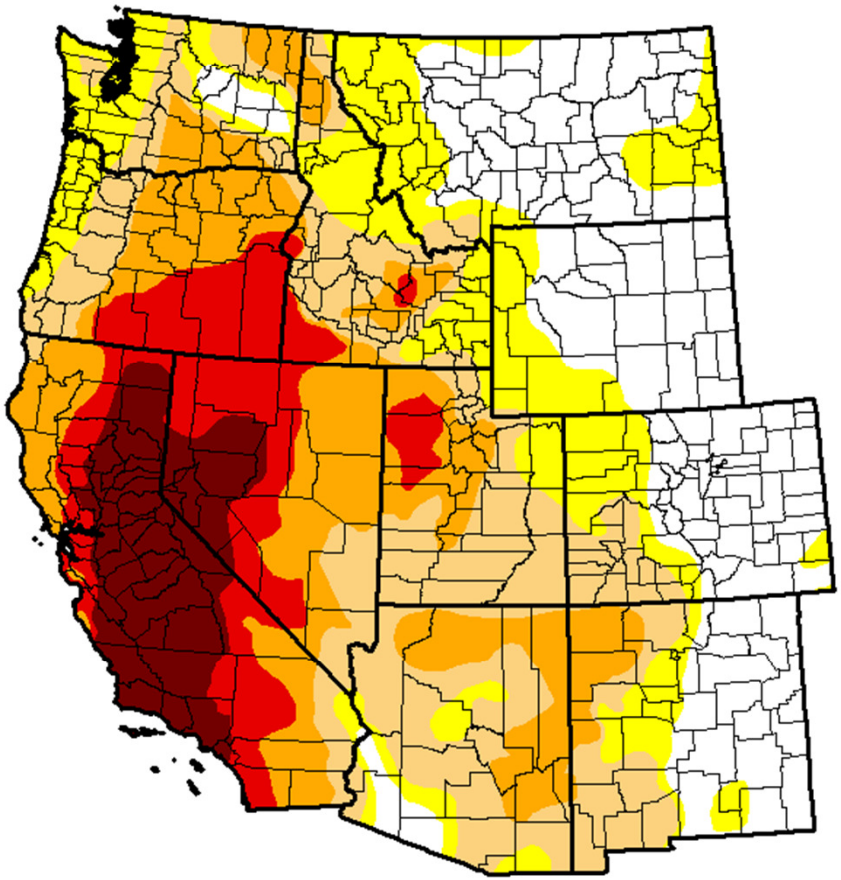
Author:
Richard Tinker
CPC/NOAA/NWS/NCEP

http://droughtmonitor.unl.edu/

U.S. Drought Monitor
West



June 2, 2015

(Released Thursday, Jun. 4, 2015)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	25.23	74.77	56.98	35.92	17.99	7.94
Last Week 5/26/2015	25.37	74.63	57.03	35.92	17.59	7.94
3 Months Ago 3/3/2015	29.95	70.05	59.79	29.48	16.62	7.04
Start of Calendar Year 12/30/2014	34.76	65.24	54.48	33.50	18.68	5.40
Start of Water Year 9/30/2014	31.48	68.52	55.57	35.65	19.95	8.90
One Year Ago 6/3/2014	31.84	68.16	60.32	47.21	20.20	4.31

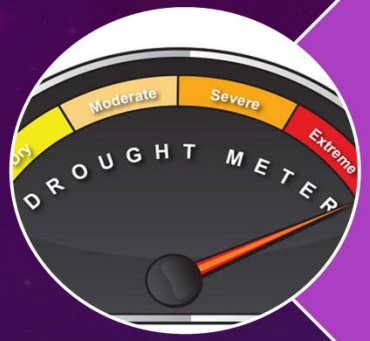
Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

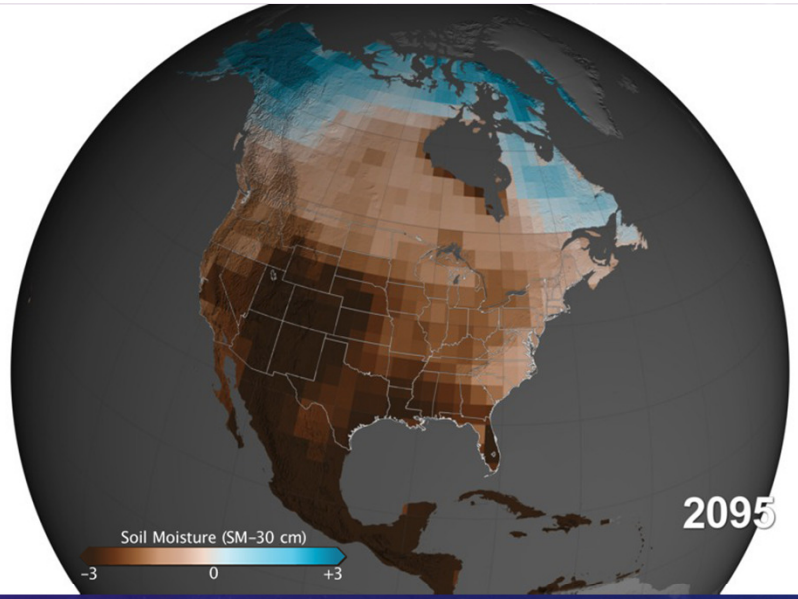
Author:
David Miskus
NOAA/NWS/NCEP/CPC

http://droughtmonitor.unl.edu/



Mega-Drought

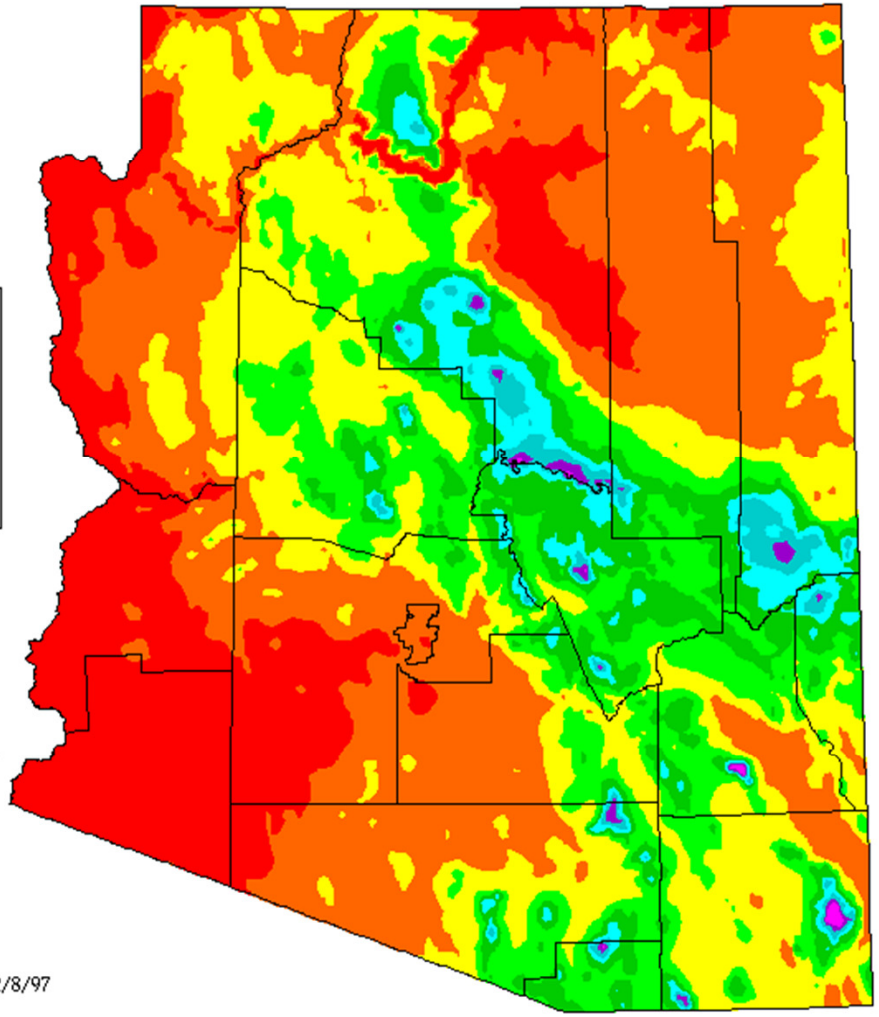
- Last SW MD ~ 1,000 yrs
- Climate models forecasting MD 2050-2099 (NASA, Cornell, Columbia)



Arizona Monsoon >> South to SE winds bringing moisture from Gulf of CA & Gulf of MX

Average Annual Precipitation

Arizona



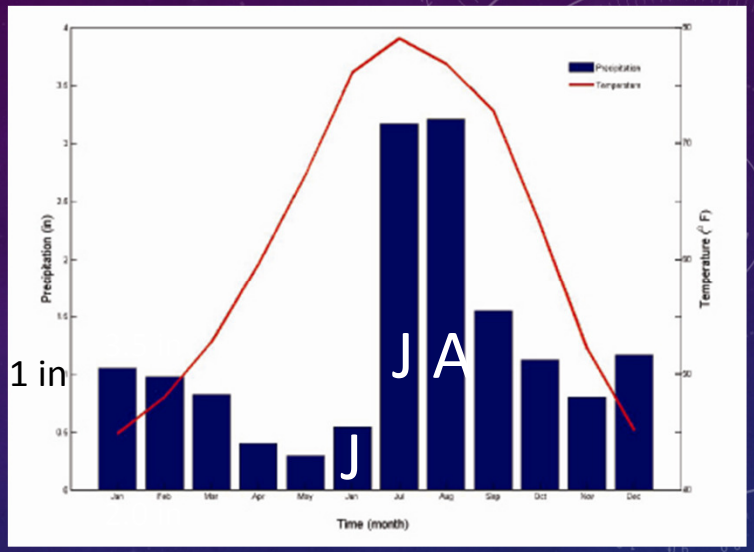
Legend (in inches)

Under 8	24 to 28
8 to 12	28 to 32
12 to 16	32 to 36
16 to 20	Above 36
20 to 24	

Period: 1961-1990

This map is a plot of 1961-1990 annual average precipitation contours from NOAA Cooperative stations and (where appropriate) USDA-NRCS SNOTEL stations. Christopher Daly used the PRISM model to generate the gridded estimates from which this map was derived; the modeled grid was approximately 4x4 km latitude/longitude, and was resampled to 2x2 km using a Gaussian filter. Mapping was performed by Jenny Weisburg. Funding was provided by USDA-NRCS National Water and Climate Center.

12/8/97

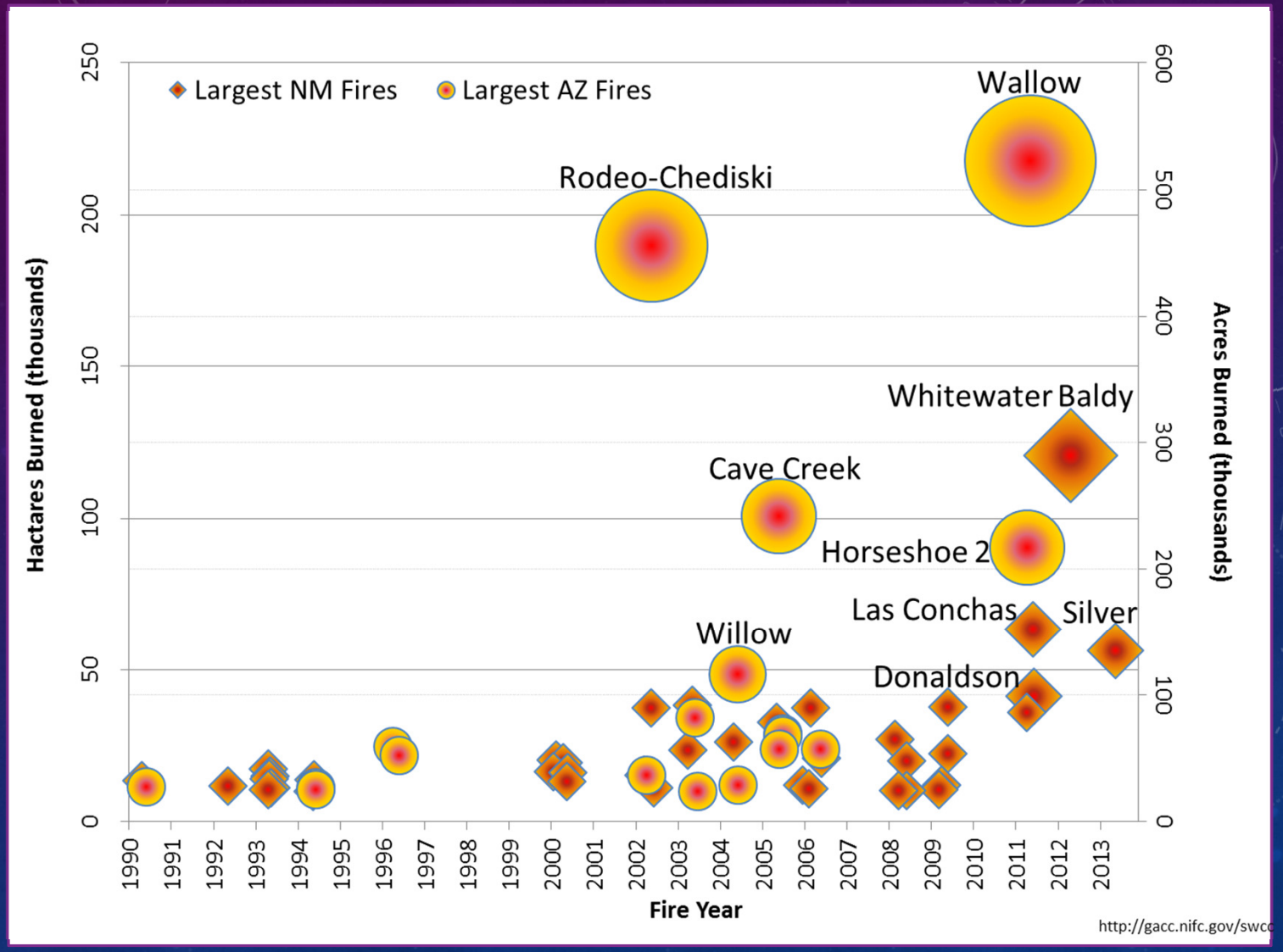


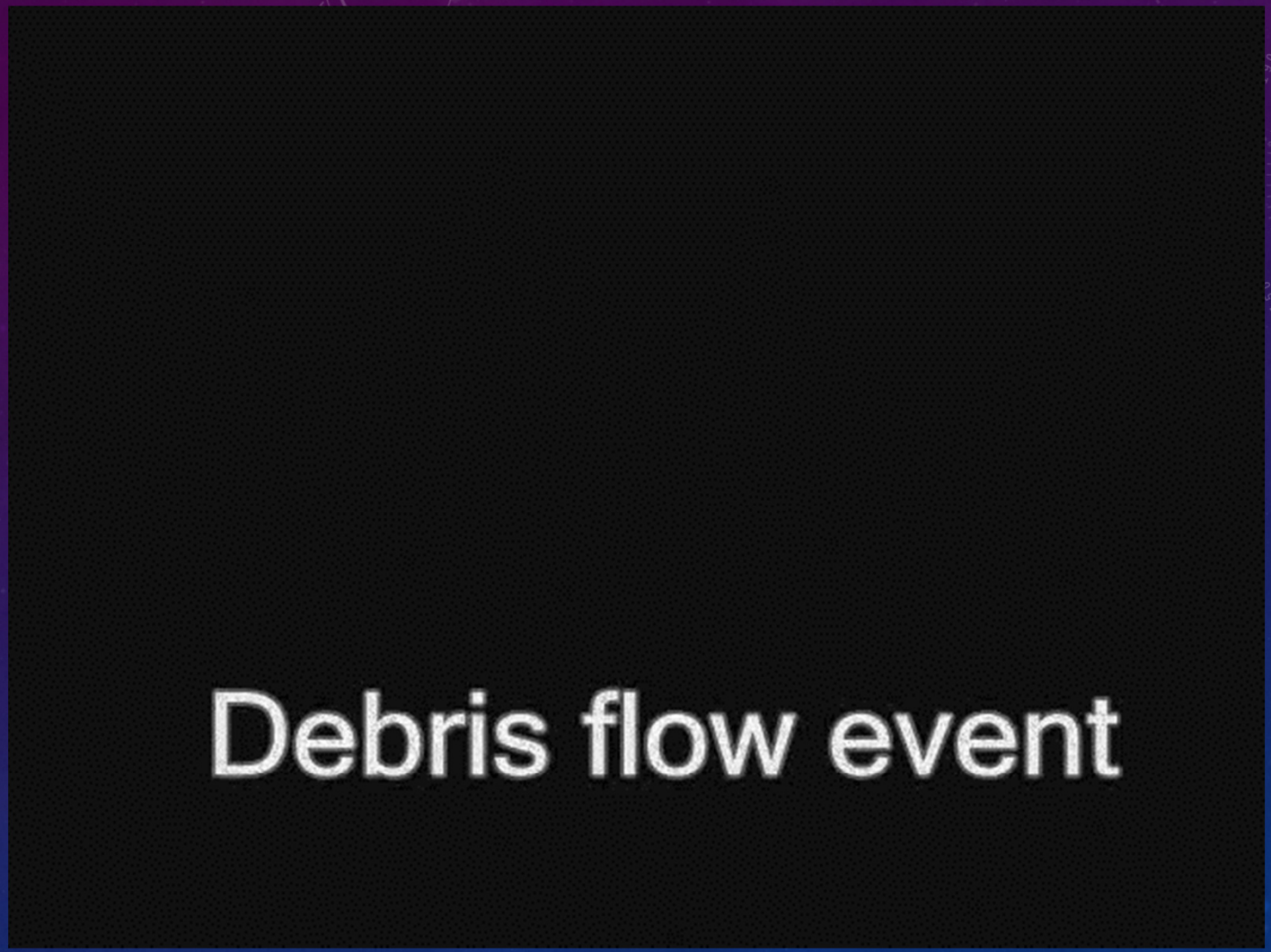
SE Arizona
Avg. monthly precipitation
1930-2022

AZ – NM Wildfires

Higher Temp + Drought

Bigger, badder & more frequent wildfires




Debris flow event

Debris flow
deposit
Grand Canyon, AZ

2005 Florida Fire
Madera Canyon
Santa Rita Mtns

2011 Monument Fire
Miller Canyon/Beatty's
Debris-flow deposits in
Foreground, flood damaged
Cabin in background.

2011 Monument Fire
Miller Canyon/Beatty's
Flood-damaged cabin.
2-yr 60-min storm

2011 Monument Fire
Miller Canyon/Beatty's
Grus from this tiny drainage put a slug of sediment in and around this cabin. Not clear if debris flow or hyperconcentrated.
2-yr 60-min storm

Sabino Canyon, July 2006
Debris flow event

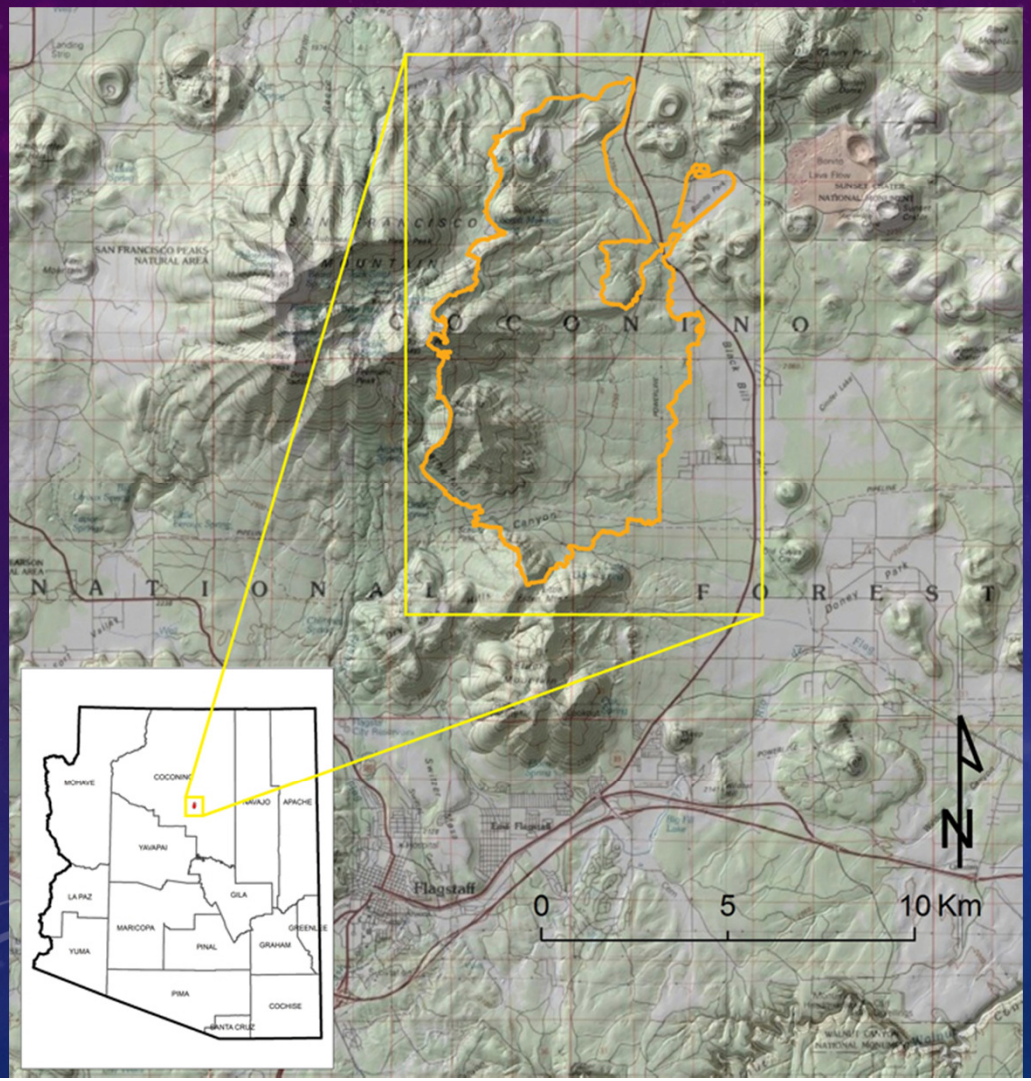
cisco Peaks 2010

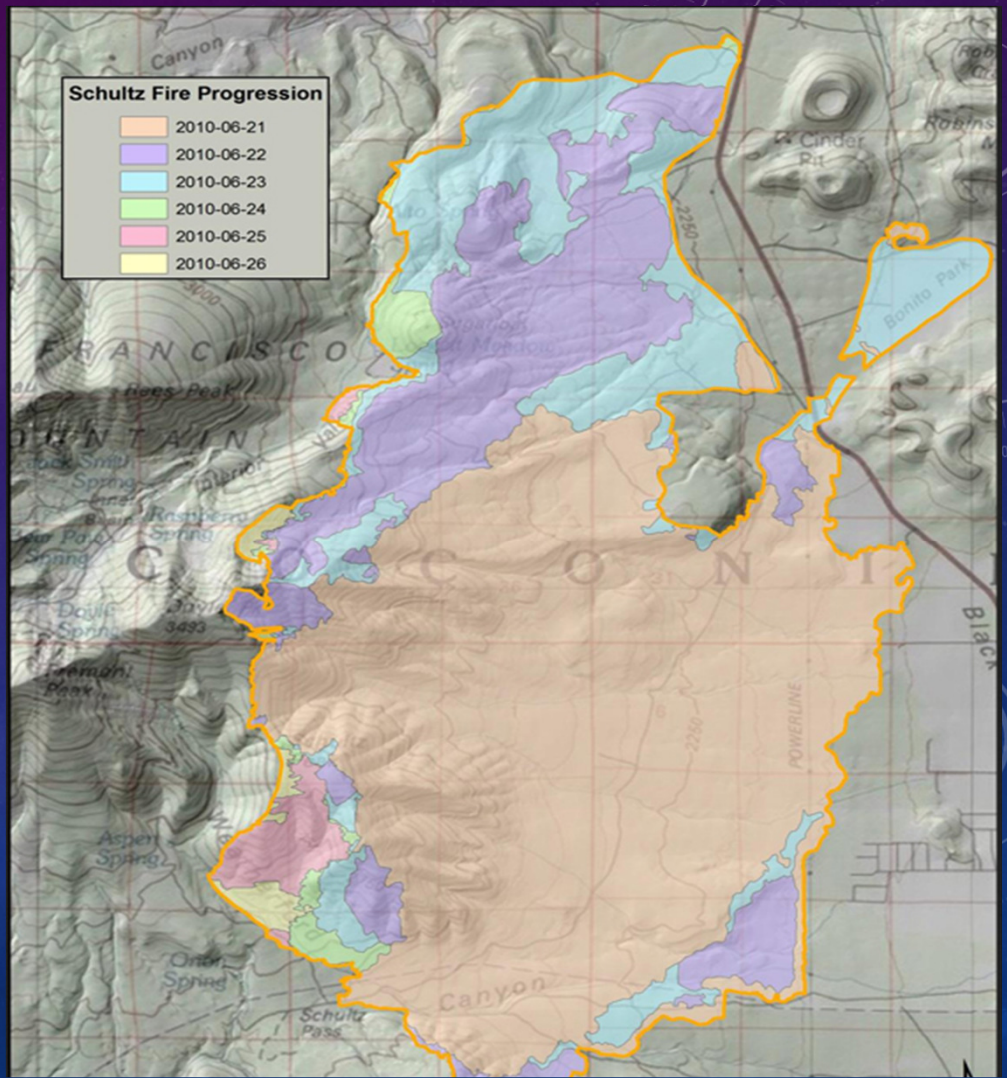
Geodatabase of Post-Wildfire Study Basins

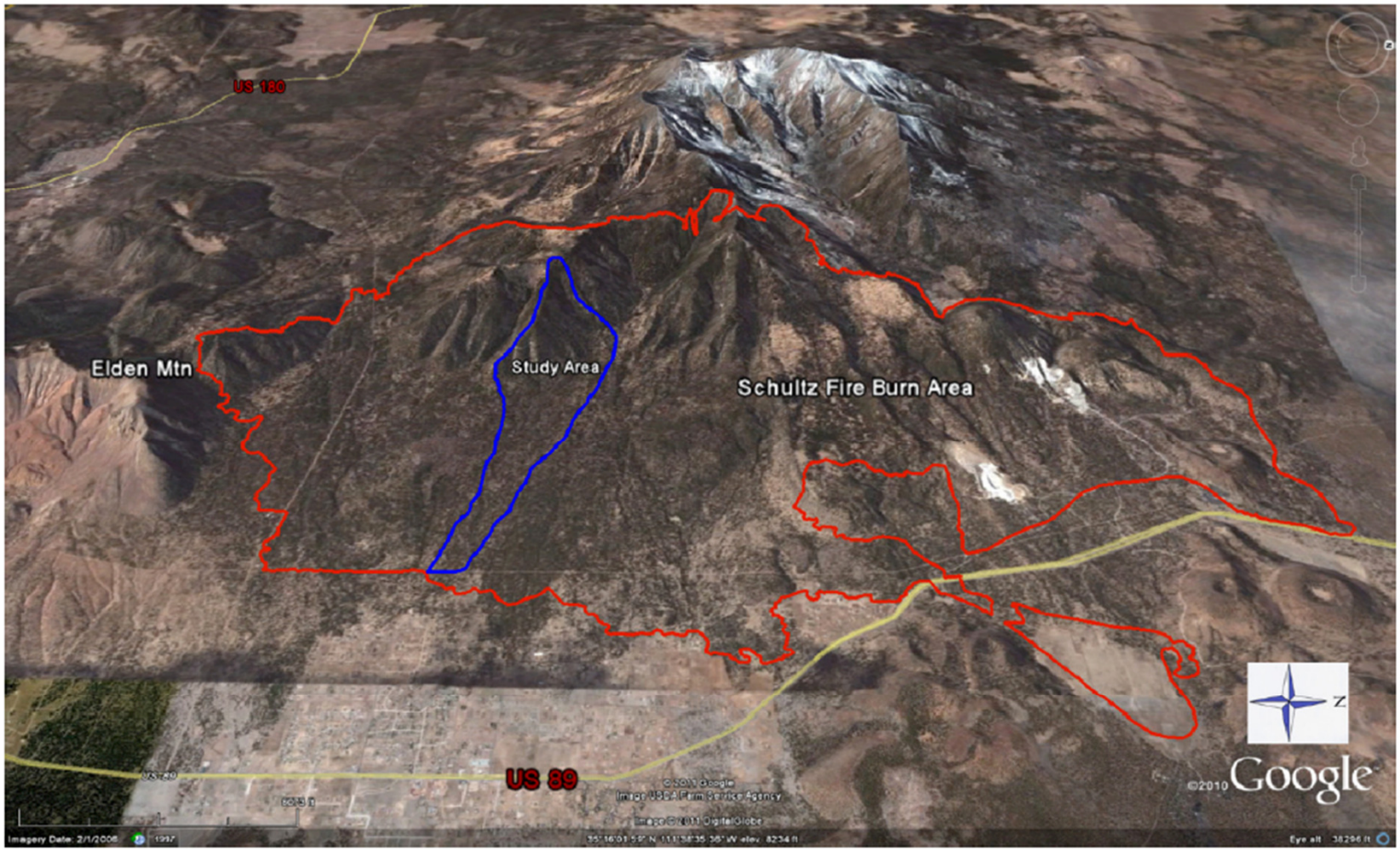
Assessing the predictive strengths of post-wildfire debris-flow models in Arizona and defining rainfall intensity-duration thresholds for initiation of post-fire debris flow

Ann Youberg

Schultz Fire 2010 – 15,070 acres Coconino NF

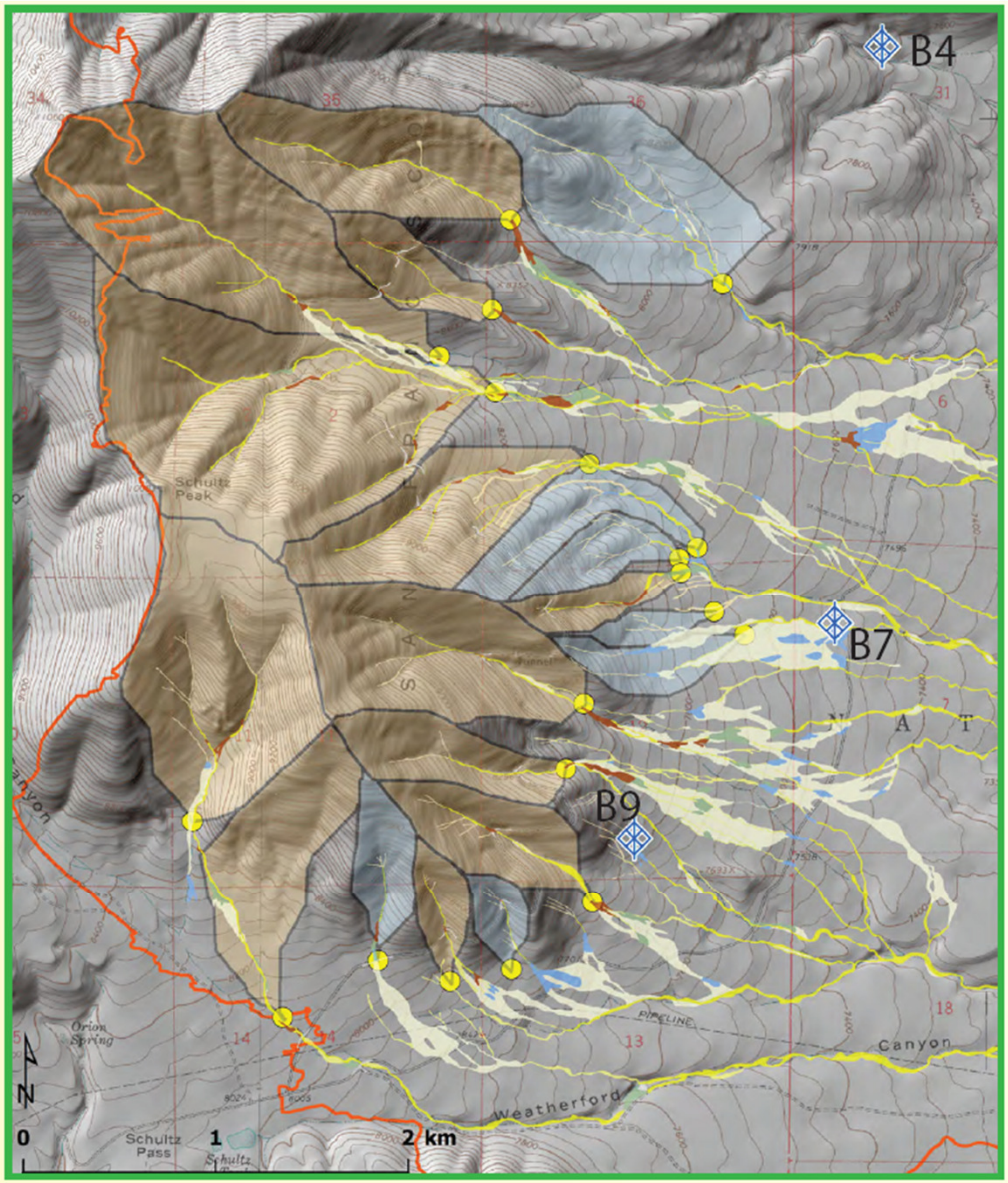





US 180
Elden Mtn
Study Area
Schultz Fire Burn Area
US 89
©2010 Google

San Francisco Peak, Arizona
Schultz Fire 2001

Opportunities for flooding & debris flows abound (basins n=19)



Schultz Fire Basins (n = 19) with outlets based on flood and debris flow deposit locations at or just below the base of the steep, upper slopes.

2011 Schultz Fire chars San Francisco Peaks

Burned slopes of the Schultz Fire. (D. Neary, RMRS)

Basin condition in the Schultz Fire burned area: post-fire, pre-storm (above), post-storms (right). (Numbers match trees between photos)

July 25, 2010:
San Francisco Peaks FR146 - drainage where the waterline was severed and removed by debris flows on July 20th.

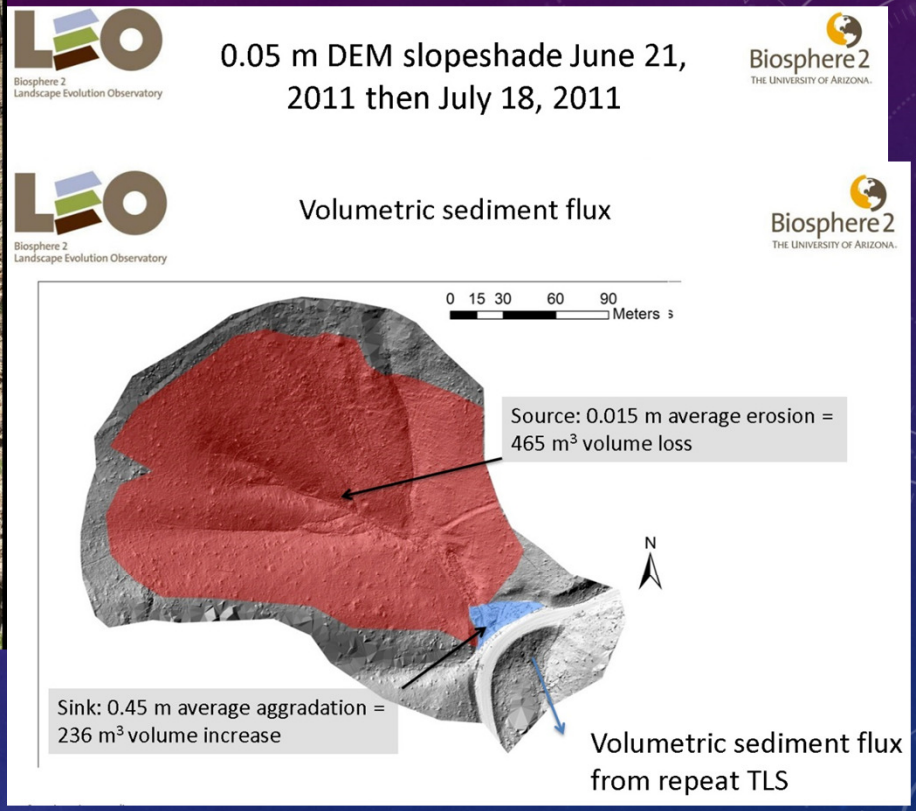
Roadbed demolished by the August 16th debris flows.
Photo: D. Fleishman, USFS.

'Watersheds subject to moderate to high severity burns are prone to much greater runoff – both in volume and velocity - due to decreased interception and infiltration.'

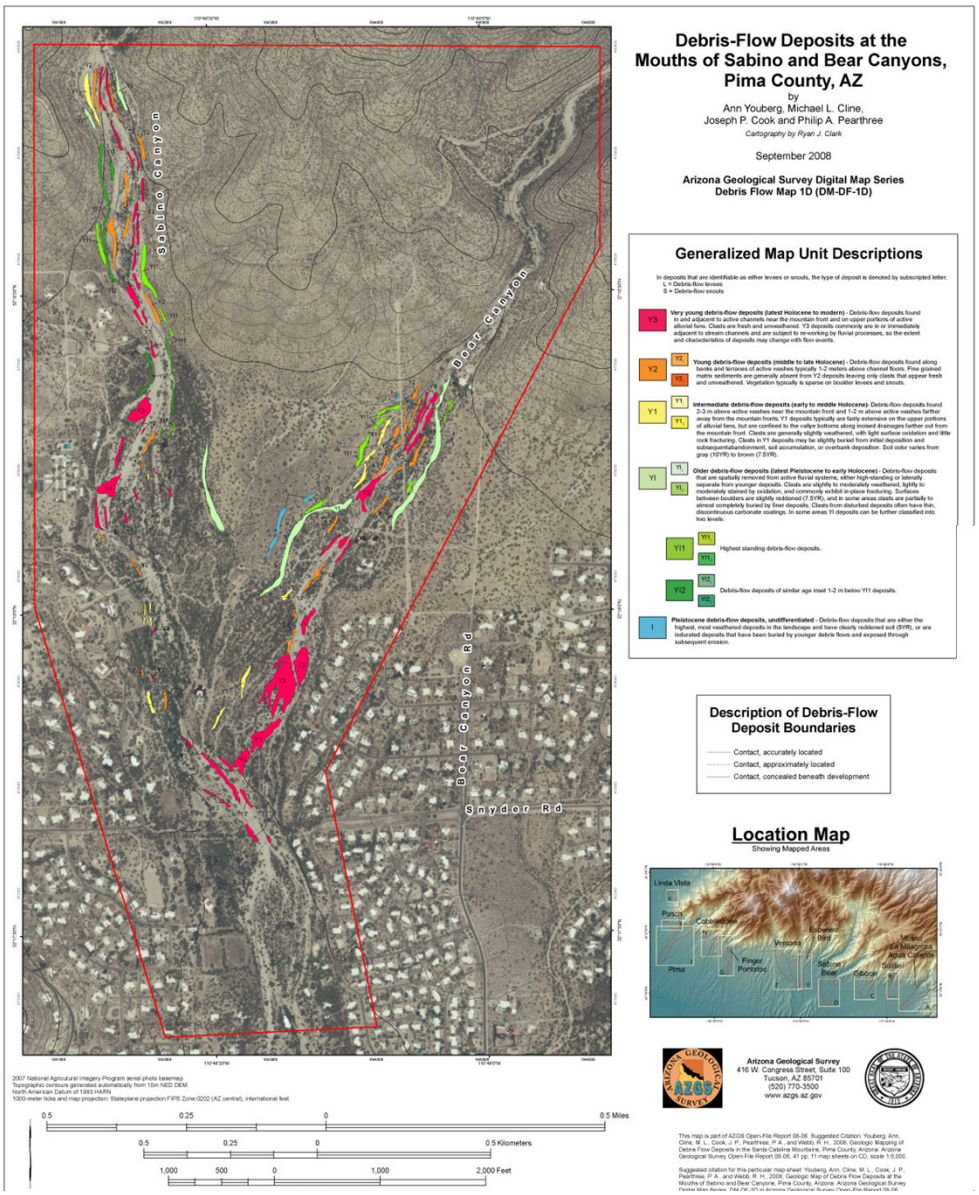
Hillslope erosion along FR146, San Francisco Peaks. August 17, 2010. Photo: A. Youberg, AZGS.

We can expect more wildfires in the future …

Over the past two decades, several communities throughout Arizona have dealt with post-wildfire flooding, rapid erosion, and sediment remobilization.
(Youberg, Koestner and Neary, 2011)



Terrestrial (lasar) Lidar Scanning - Monitoring landscape changes



Mapping Pleistocene debris flow deposits

Youberg and other , 2008

Ancient debris flow deposits in Santa Catalina Mtns.

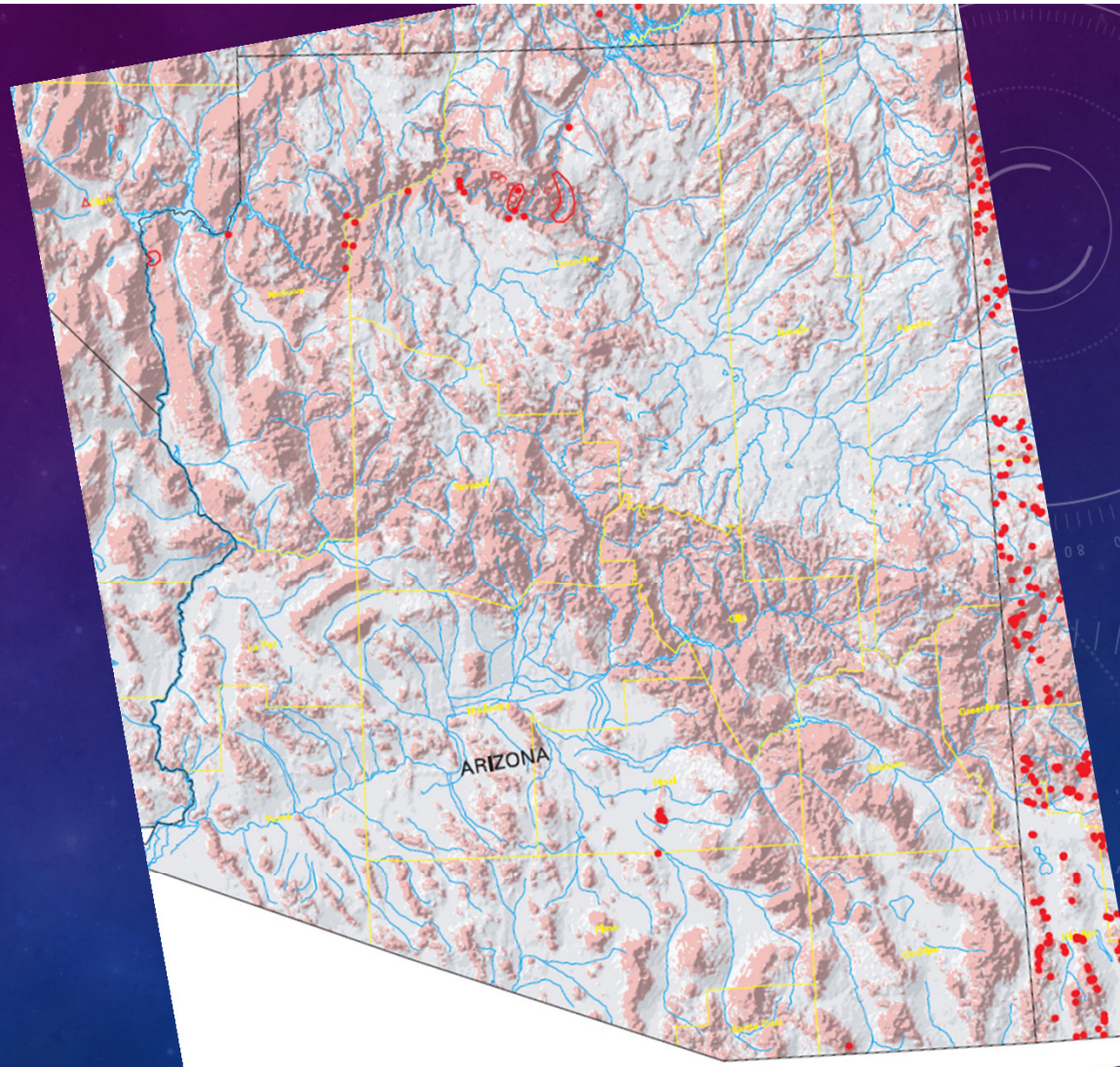
http://pubs.usgs.gov/mf/1999/2329/

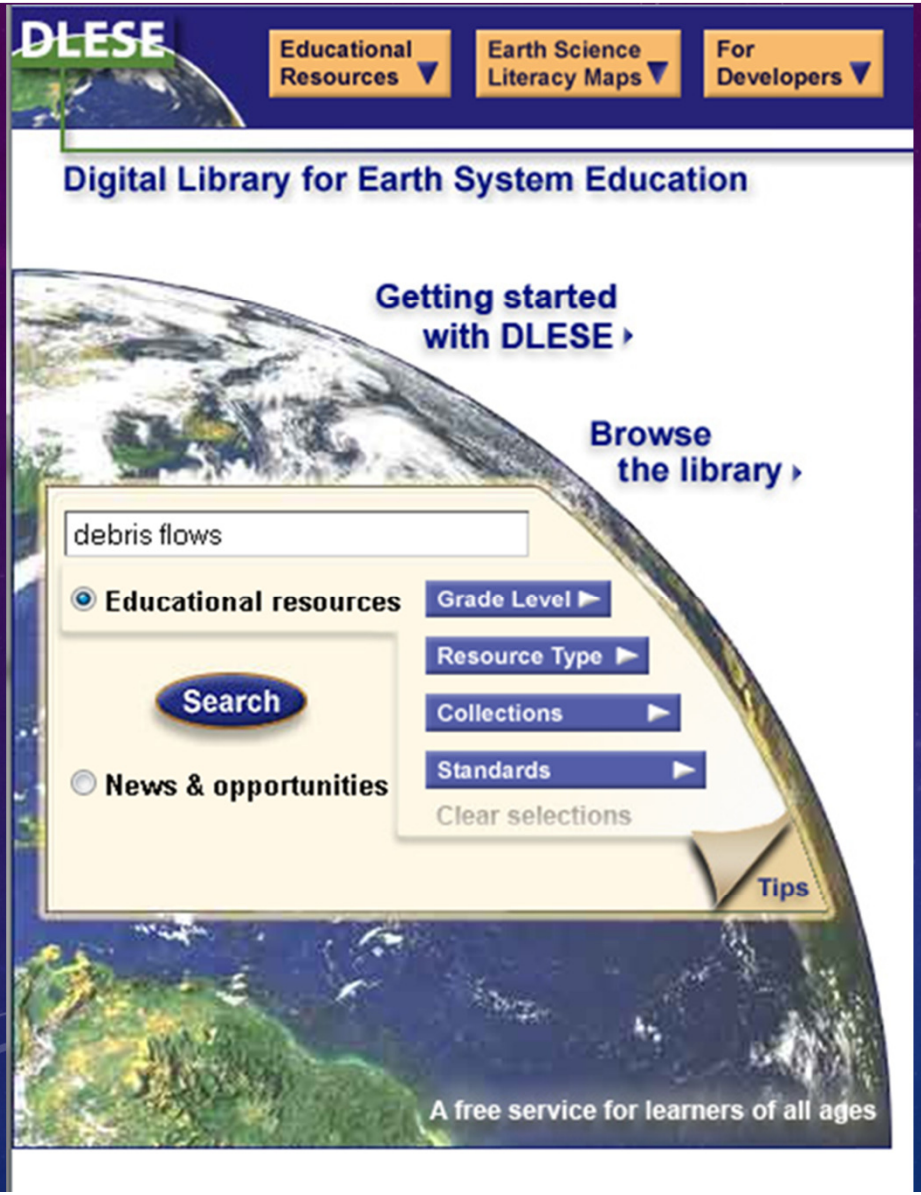
USGS Inventory of Holocene Debris Flows (1999): Arizona

● Debris flows

US Geological Survey National Landslide Program

~ $3.5 million annually





http://www.dlese.org/

- K to gray
- Classroom, field & lab activities
- Simple search & retrieval
- Free & no registration

Some online resources

InciWeb - http://inciweb.nwcg.gov/

Climate at a glance - http://www.ncdc.noaa.gov/cag/

AZGS Floods & Debris Flows - http://www.azgs.az.gov/hazards_floods.shtml

Michael Conway
Michael.Conway@azgs.az.gov

AZGS.AZ.GOV/map_services

- ✓ Geologic map of Arizona
- ✓ Geologic map of Grand Canyon
- ✓ Natural Hazards in Arizona viewer

Story maps

- ✓ Geologist in Grand Canyon
- ✓ Arizona's San Pedro River

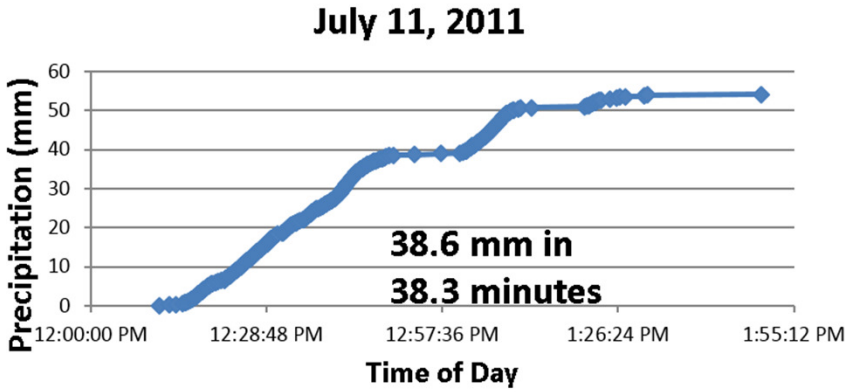
Schultz Fire 2010 – June 29 (top) Aug 9 (bottom)

Biosphere 2
Landscape Evolution Observatory

July 11 runoff

Biosphere 2
THE UNIVERSITY OF ARIZONA.

11:43 AM



3:43 PM

12:43 PM

facebook.co

Debris in channel near Visitor's Center looking downstream from well site and downstream at 9 ft culverts

Montezuma Creek – Coronado National forest
Disturbed by fire in 1988, 2006, 2011.

Stephanie Yard and Allen Haden (2011)