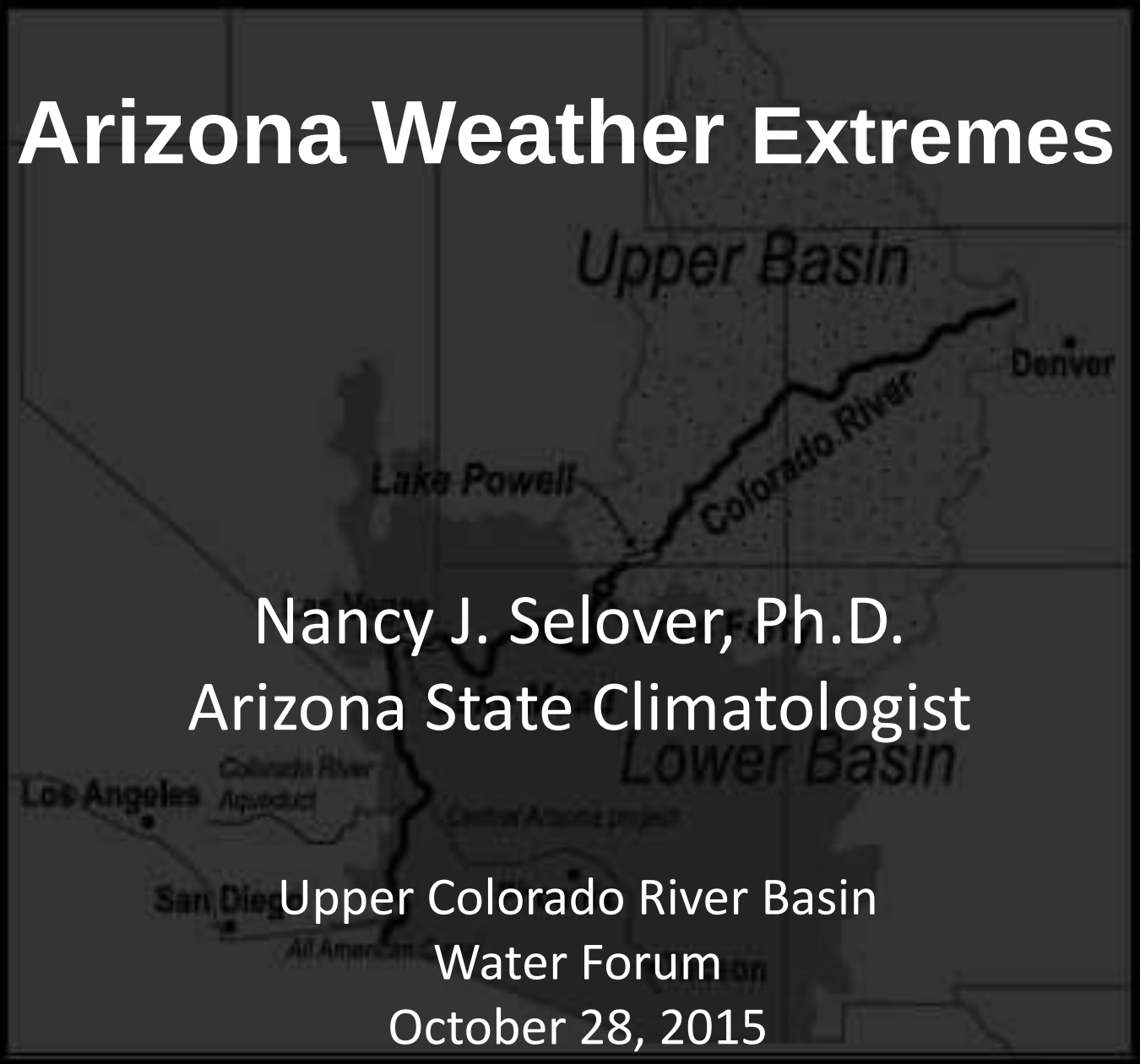
Arizona Weather Extremes



Nancy J. Selover, Ph.D.
Arizona State Climatologist

Upper Colorado River Basin
Water Forum
October 28, 2015

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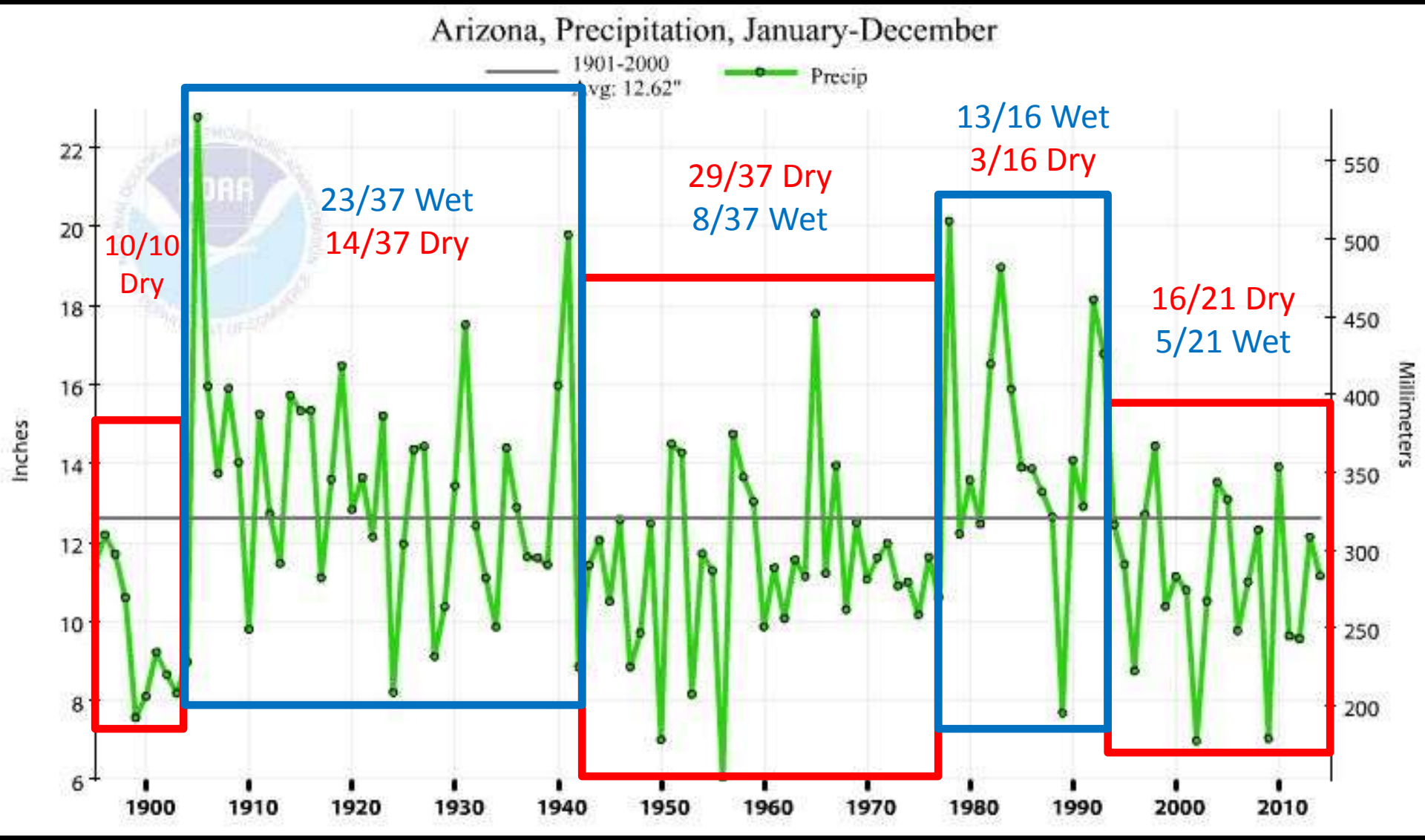

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Las Vegas
ARIZONA
NEW MEXICO
Flagstaff
Verde
Colorado
Agua Fria
Salt
Phoenix
Gila
Gila
San Francisco
Yuma
Tucson
Santa Cruz
San Pedro
FLAGSTAFF
SRP WATER
SRP WATER
C. C. CRAGIN DAM
PRESCOTT
SHOW LOW
PAYSON
HORSESHOE DAM
BARTLETT DAM
GRANITE REEF DAM
PHOENIX
ROOSEVELT DAM
STEWART MOUNTAIN DAM
HORSE MESA DAM
MORMON FLAT DAM

Salt River flow through Tempe December 30, 2004 through April 2005 satisfied Colorado River obligation to Mexico

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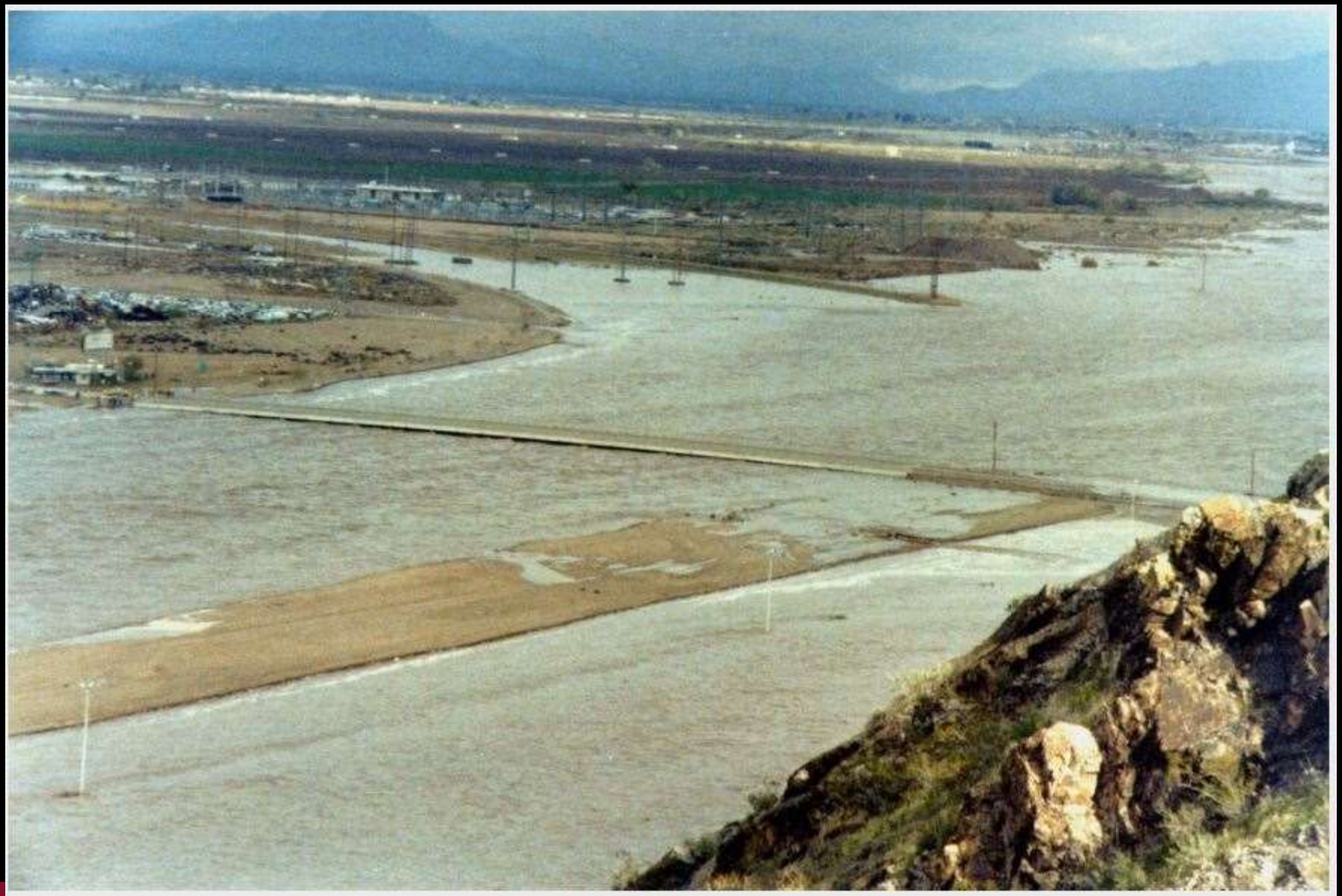

Salt River in flood, 1980; view east from Tempe Butte

3331 views

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http://www.panoramio.com/photo/7405300

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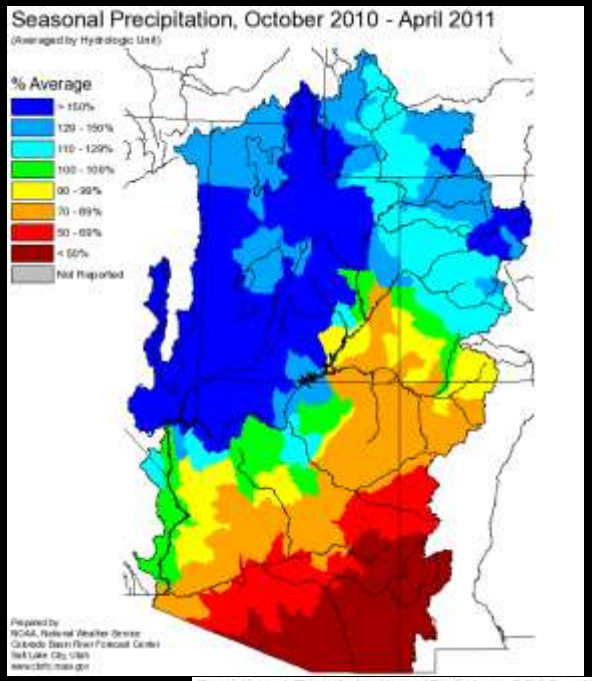
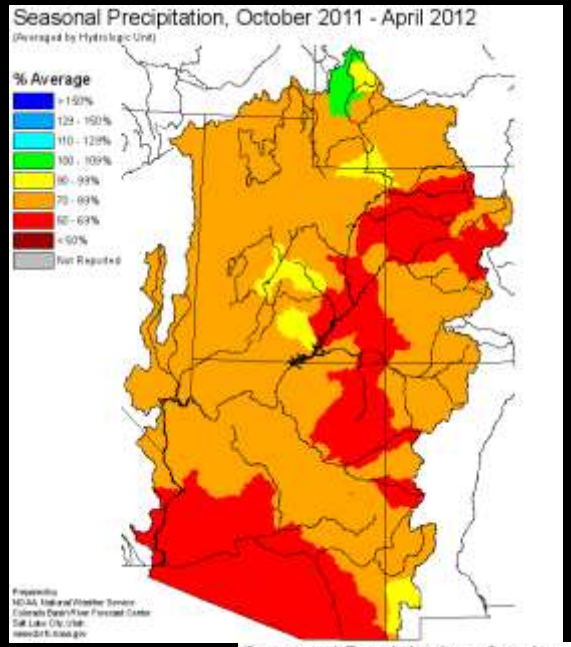
Winter Precipitation Comparison Colorado River Basin

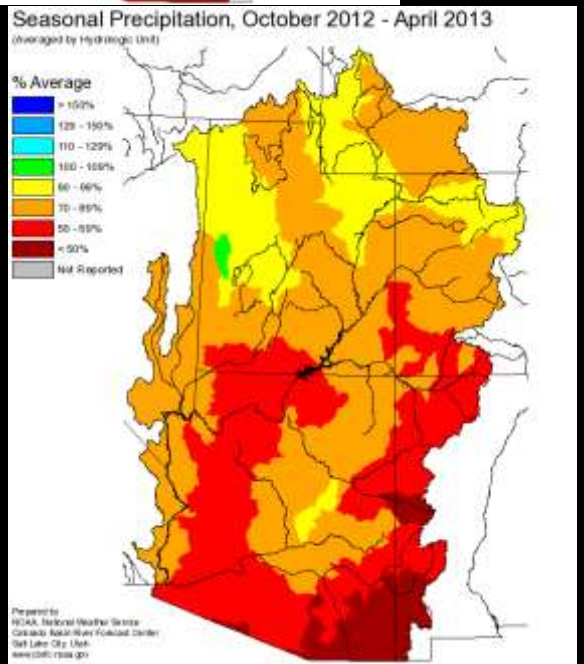
WY 2011



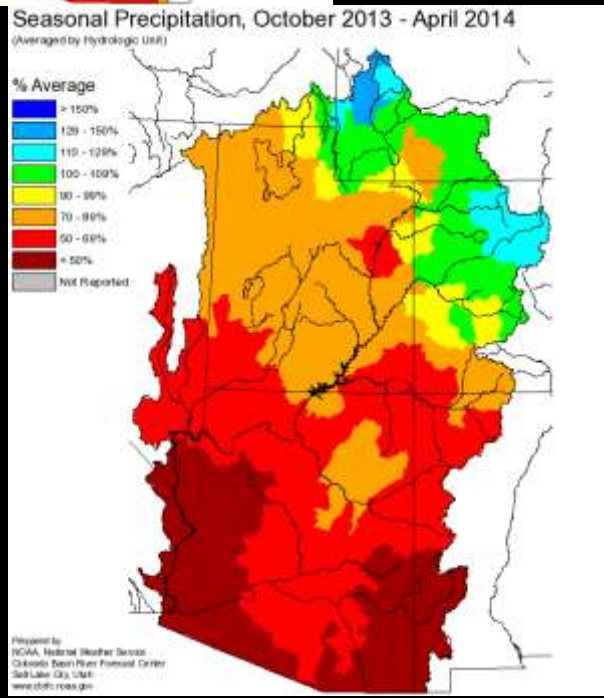
WY 2012



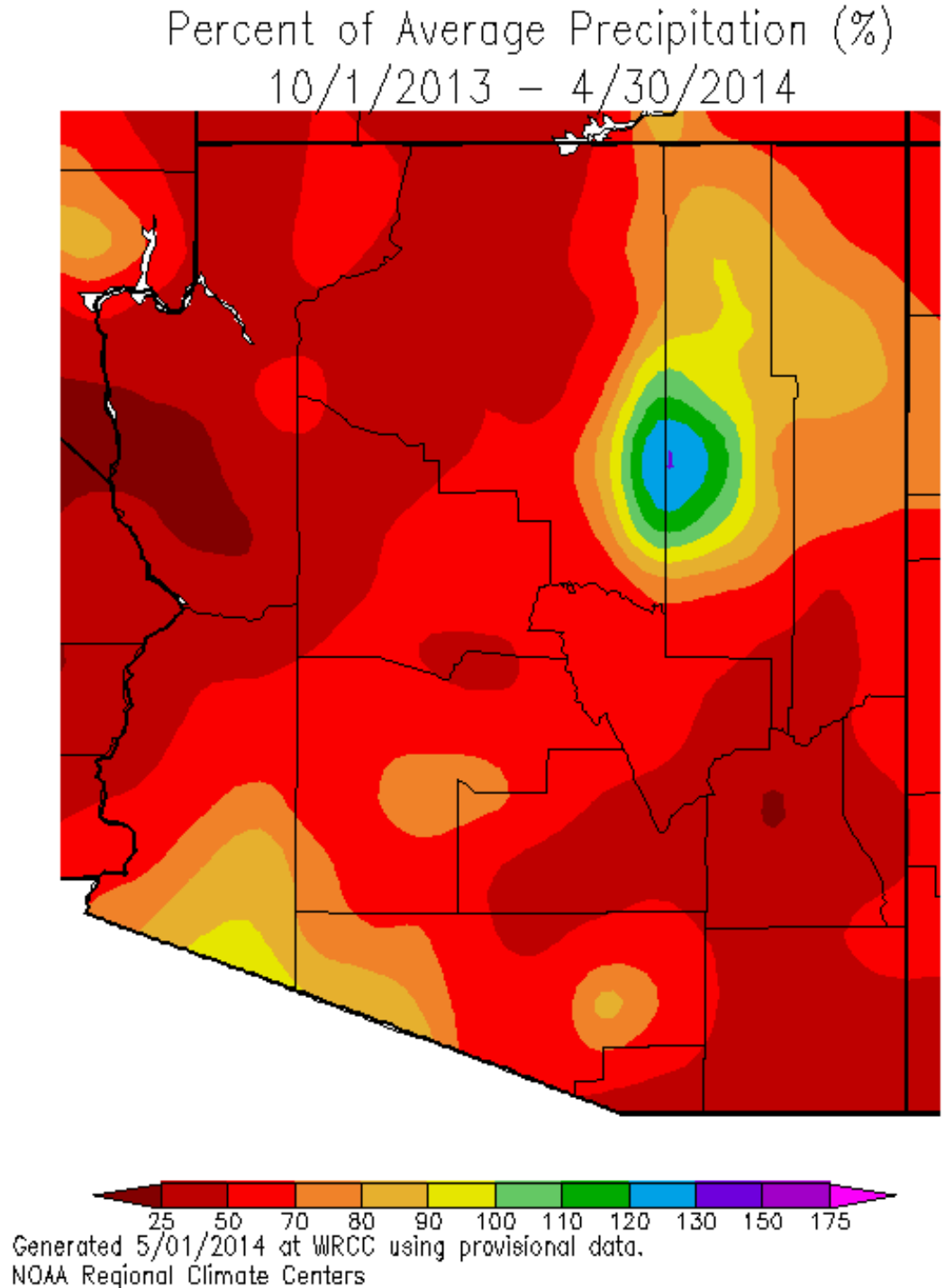
WY 2013



WY 2014



Winter Drought



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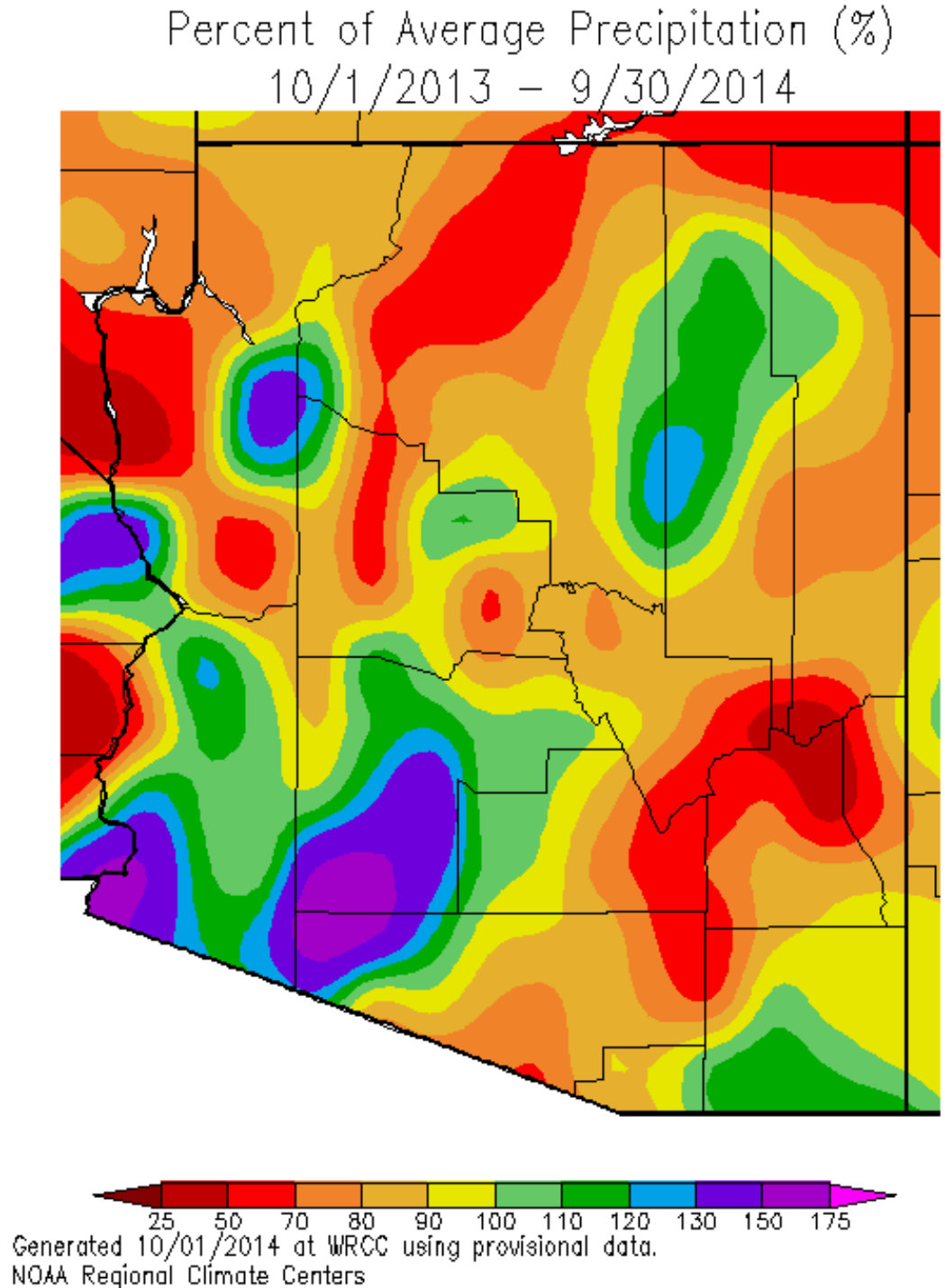
2014 Water Year



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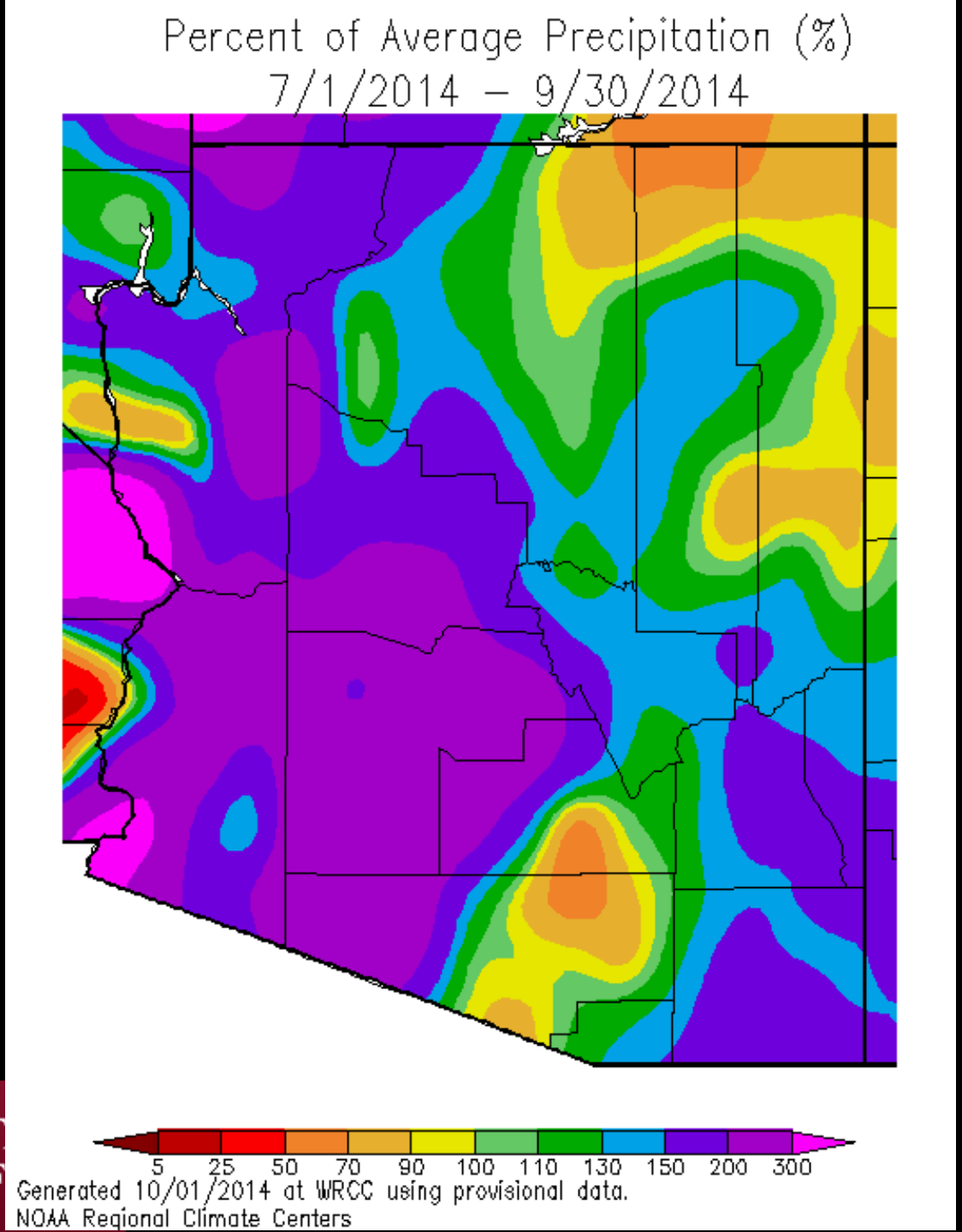
Summer Monsoon



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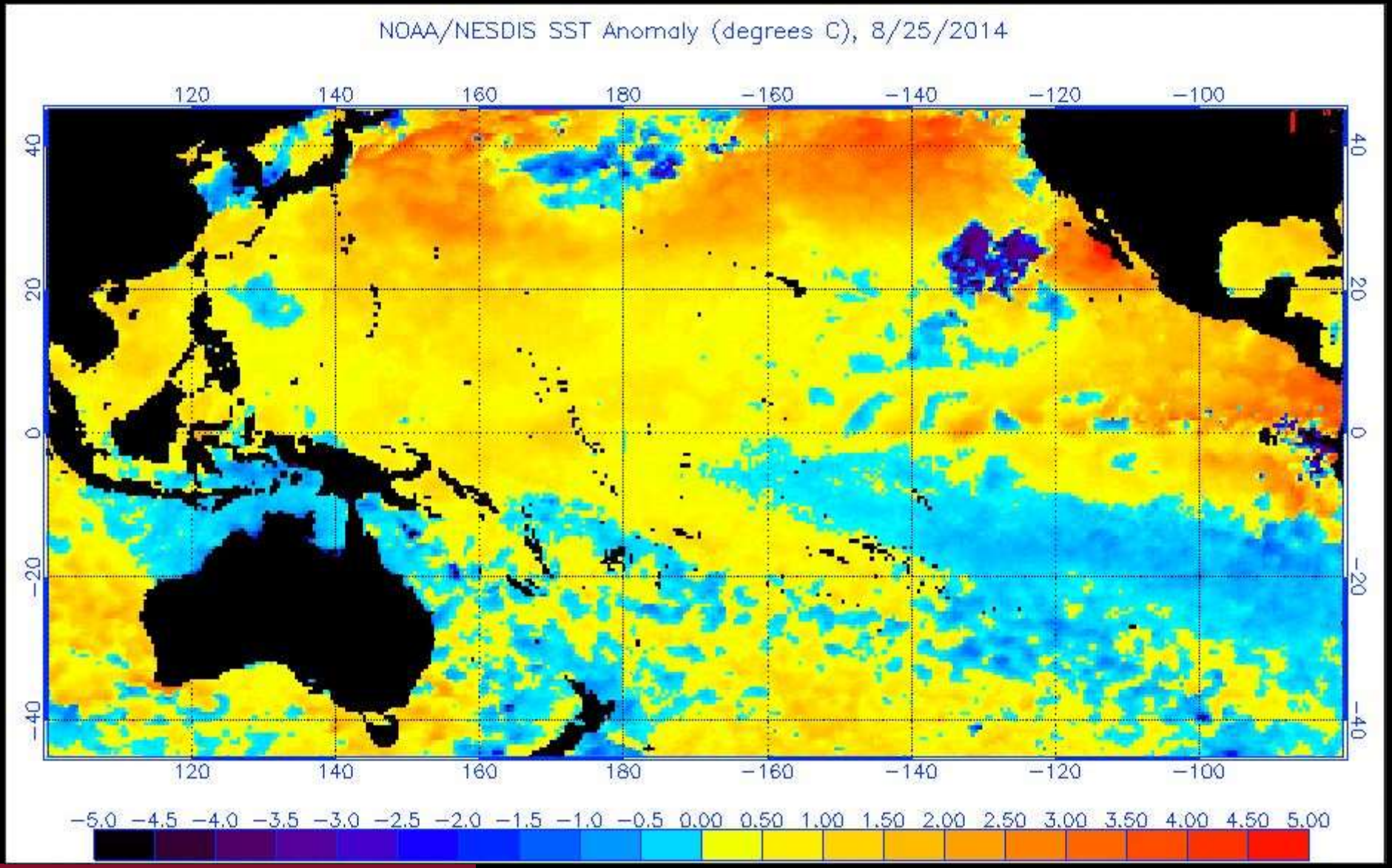
Pacific Sea Surface Temperature Anomalies



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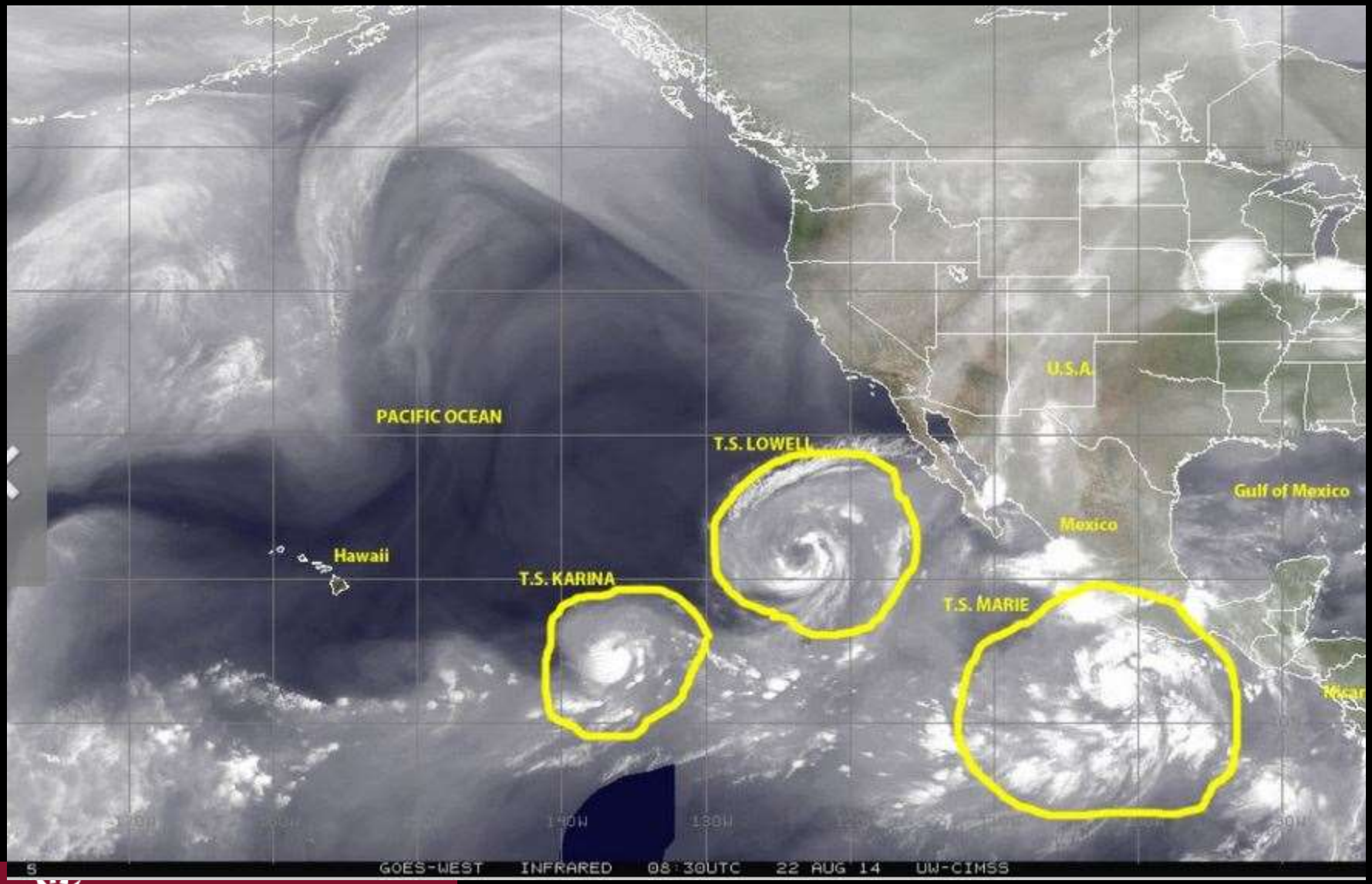
September 2014 Eastern Pacific Hurricanes



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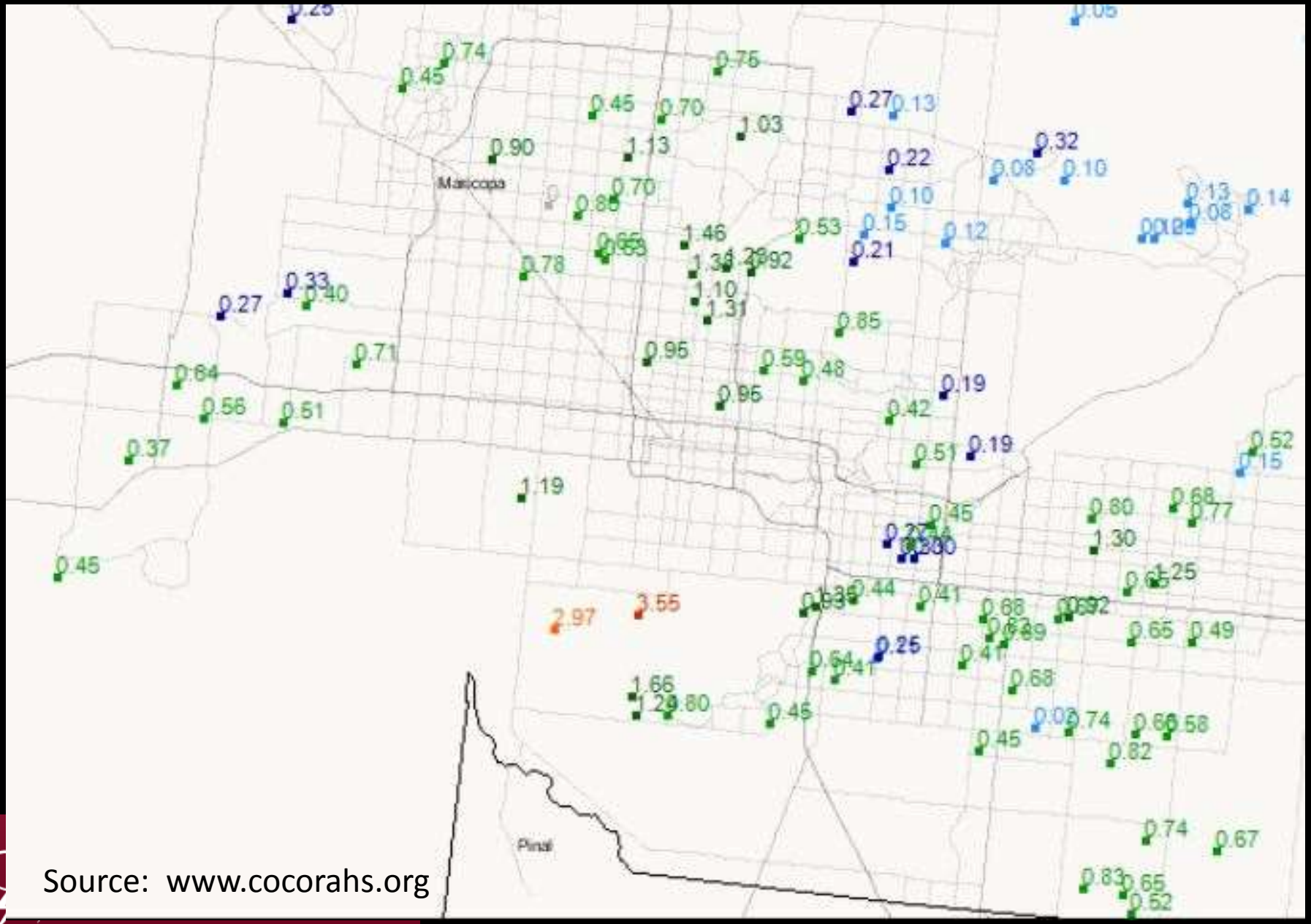
Monsoon 2014

Storm over South Mountain, Tuesday afternoon, 8/12/2014
(Photo: Scott Dalton)

August 12, 2014 Storm rain totals (less than 2 hours)



Source: www.cocorahs.org

Figure 1: Radar base reflectivity image from National Climatic Data Center archive - Aug. 12, 2014 at 6:00 PM MST.

* 90-minute values interpolated, not provided in NOAA 14.									AEP is Annual Exceedance Probability
1	0.47	0.89	1.16	1.64	2.35	2.43	2.48		Recorded period rainfall from Gage No. 6525 (in)
	20	60	81	108	285	214*	179		Return periods (years) - DDF for 6525
2	0.57	1.09	1.58	1.91	2.76	2.85	2.94		Recorded period rainfall from CoCoRaHS Station No. AZ-MR-326; 2/3 mi. NW of Gage No. 6525 (in)
	50	213	673	293	970	743*	630		Return periods (years) - DDF for 6525
3	0.43	0.75	1.06	1.46	1.81	1.97	1.97		Recorded period rainfall from Gage No. 4500 (in)
	12	22	11	48	49	49*	45		Return periods (years) - DDF for 4500

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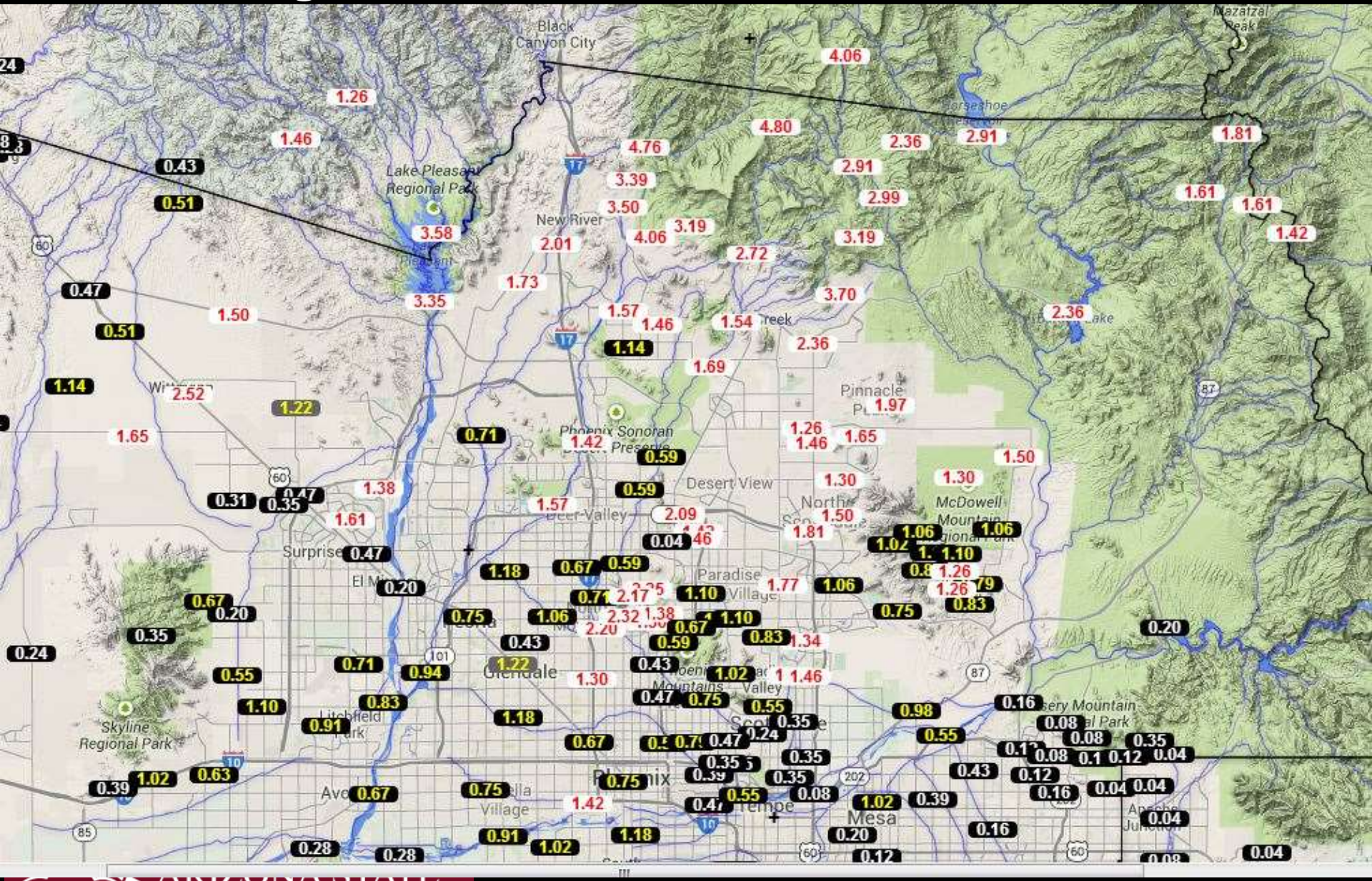
Source: FCDMC Stormrpt_08122014.pdf

August 19th Storm 24-hour rain totals



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August 19, 2014 North Valley – I-17

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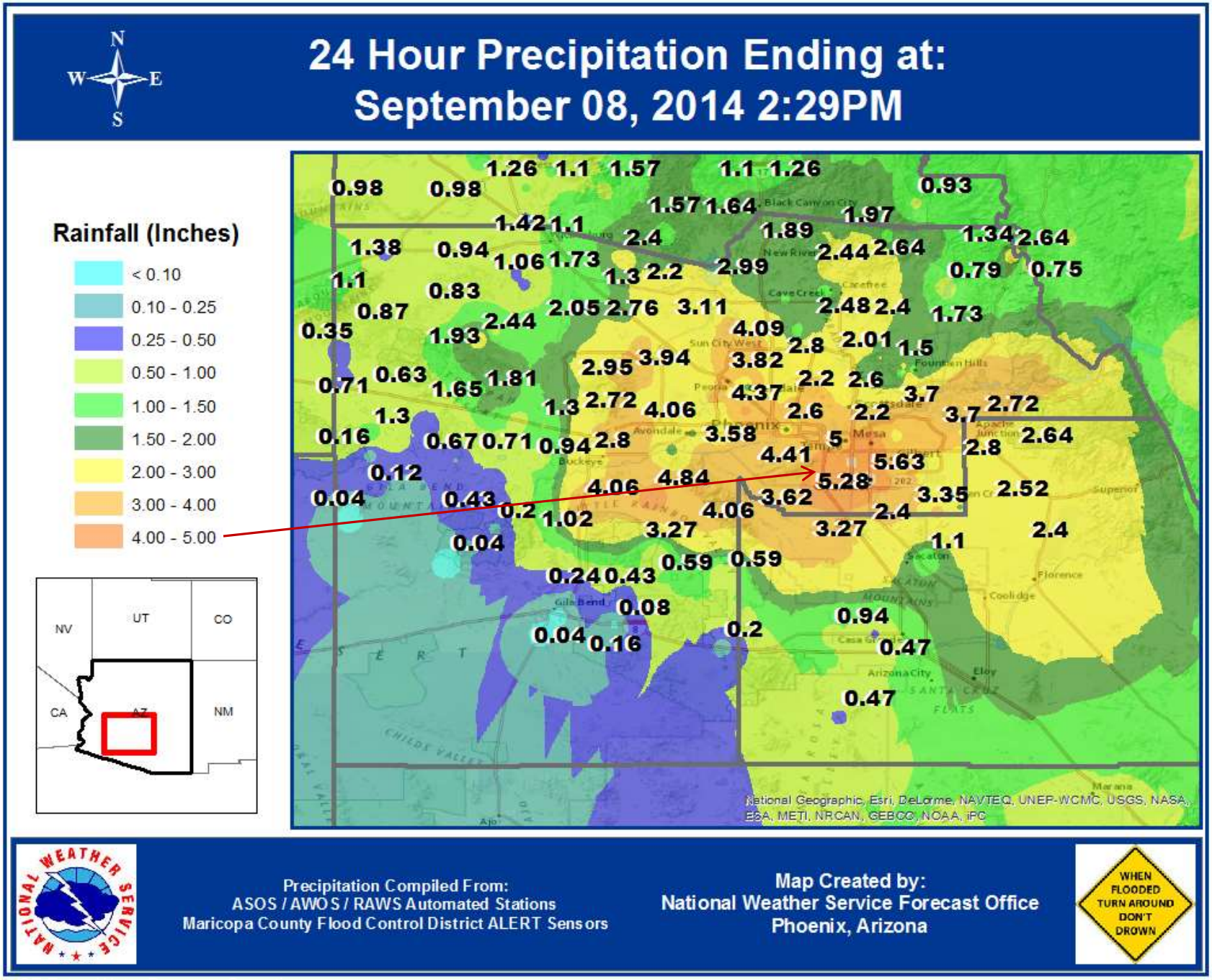
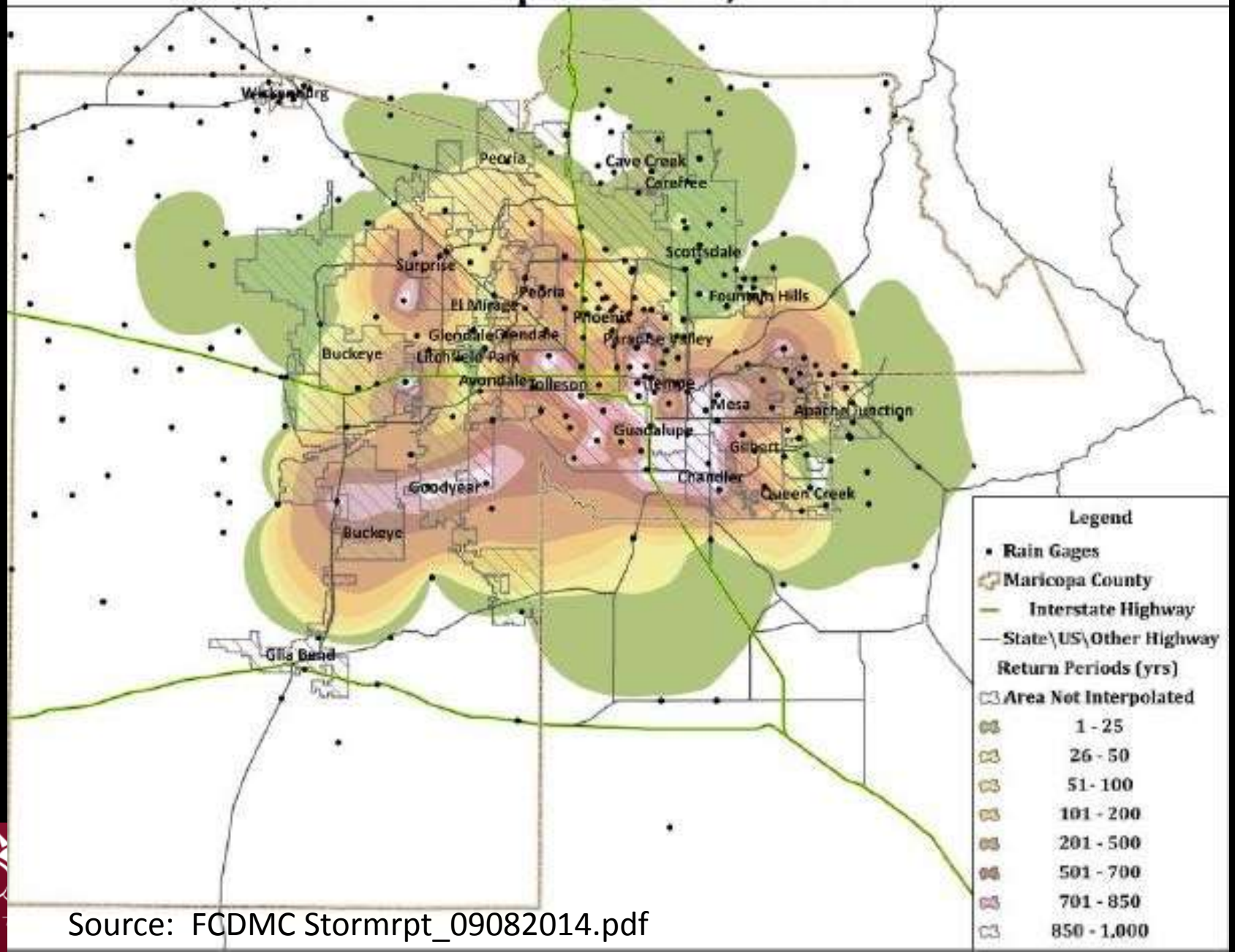
Source: Maricopa County Flood Control District

24 Hour Precipitation Ending at: September 08, 2014 2:29PM



http://www.wrh.noaa.gov/psr/pns/2014/September/Sep8Flooding.php

6 Hour Rainfall Return Periods
Storm of September 8, 2014



Source: FCDMC Stormrpt_09082014.pdf

Record rainfall & widespread flooding across Phoenix Metro Area

Updated: 7pm Tue Sep 9 2014

Major flooding along Interstate 10 at 43rd Ave. Image courtesy Arizona Dept of Transportation

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FEMA Requirement:

- Hazard Mitigation Plans must be updated every five years.
- Must include Climate Change in the Hazard Mitigation Plans
- What does this mean???

In the West: Non-Hurricane/Non-Tornadic Extreme Weather

- Is much more difficult to mitigate against.
- Currently we prepare for the 100-year event.
- The 100-year precipitation event and 100-year flood is the design standard for infrastructure including all bridges, dams, culverts, levees, foundations, grading, and drainages virtually nationwide.

200-year event??

- Economically, few cities, counties or states can afford to upgrade their entire infrastructure to withstand the 200-year precipitation and flood event, much less the 500 or 1000-year event.
- Is preparing for the 200-year event sufficient?
- But, if the 200-year event is going to become the norm, then infrastructure changes will be necessary. California has already decided to change the design standard to the 200-year event, due to their extreme vulnerability to flooding.

Economic Reality

- Most states don’t have the money to move to a 200-year flood standard on the basis of a “possibility” that these events could become the norm.

- Public infrastructure is much more difficult to replace or retrofit than adjusting building codes that put the burden on the builders and homeowners.

So what do we plan for?

- We had interviews with the Coconino County and Flagstaff, Arizona Hazard Mitigation Planners, followed by a workshop.
- Our purpose was to determine what extreme weather hazards they experience, what impacts those events have, and what information they need to plan mitigation strategies to reduce losses from those events.

Extreme Weather Events
Coconino County & Flagstaff, AZ

- **Winter storms**
  - Snow storms – blizzards - multi-day events
  - Rain on snow
- **Drought – leads to wildfires**
- **Monsoon – heavy rain events**
  - Local context: heavy rain on burn areas

Extreme Weather Impacts

- Flooding
- Flash flooding
- Transportation shutdown - roads blocked, closed, washed out, cut-off (erosion/debris flows)
- Loss of supply lines – food, manufacturing
- Loss of power – and water
- Medical emergencies
- Economic losses - tourism

What do they do now?

- Currently they plan for imminent extreme weather events as forecast out 3-7 days by the NWS.
- That’s enough time to manage a response to the immediate threat.
- It is not enough time to prevent the losses.

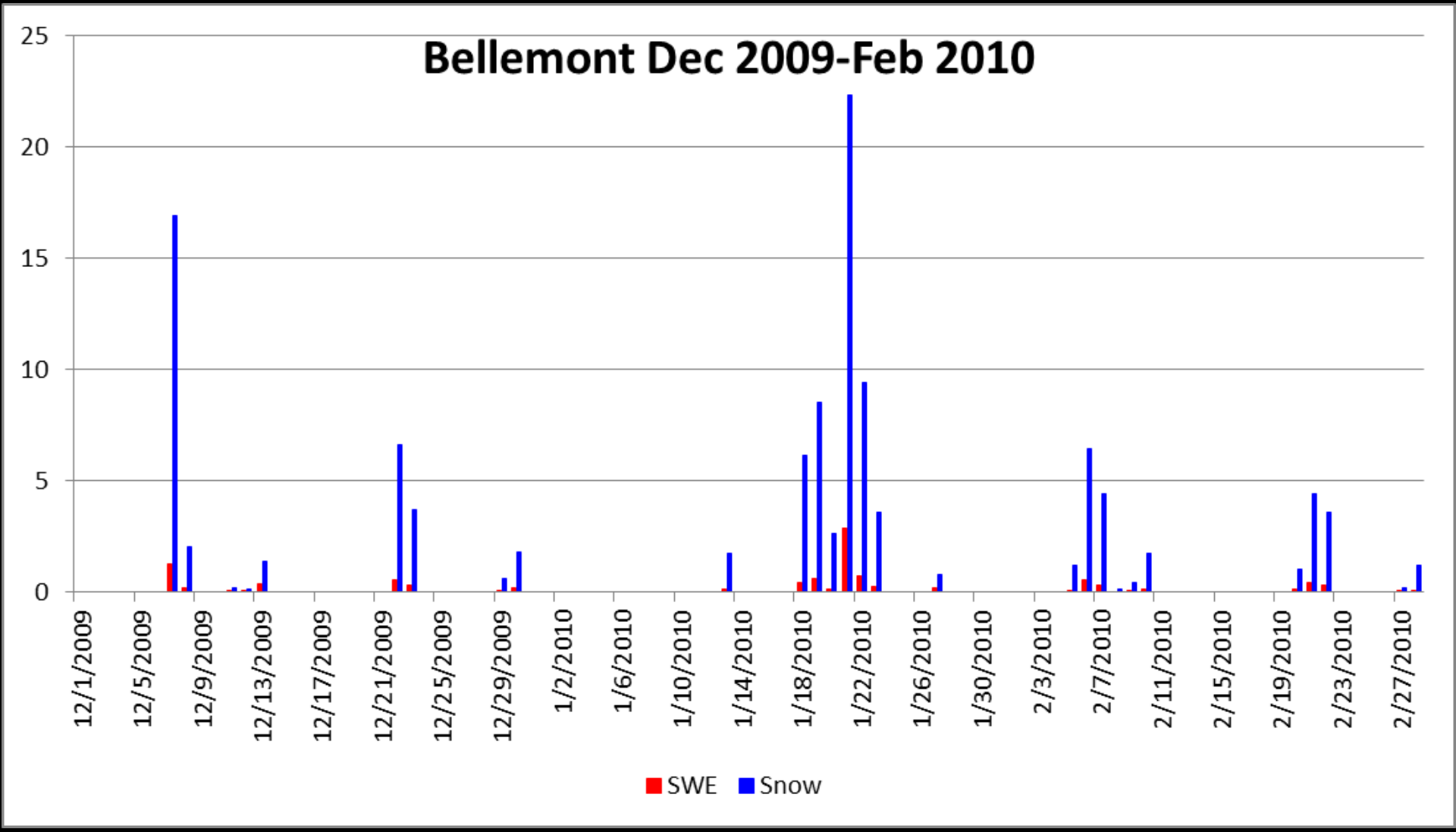
What information do they use now?

- For planning, they have the historical climate records of how much rain or snow fell.
- Current planning is based on the most extreme event that has occurred in the past.
- The number of extreme events is relatively small, and there is **no significant trend** toward increasing intensity or increasing frequency.

What information do they use now?

- Each planner has their own perception of how bad those historical extreme events were, partly based on how long they have lived in the jurisdiction.
- Few of the planners or first responders can equate the amount of rain or snowfall to the impacts of the event.

January 2010 Northern AZ Blizzard

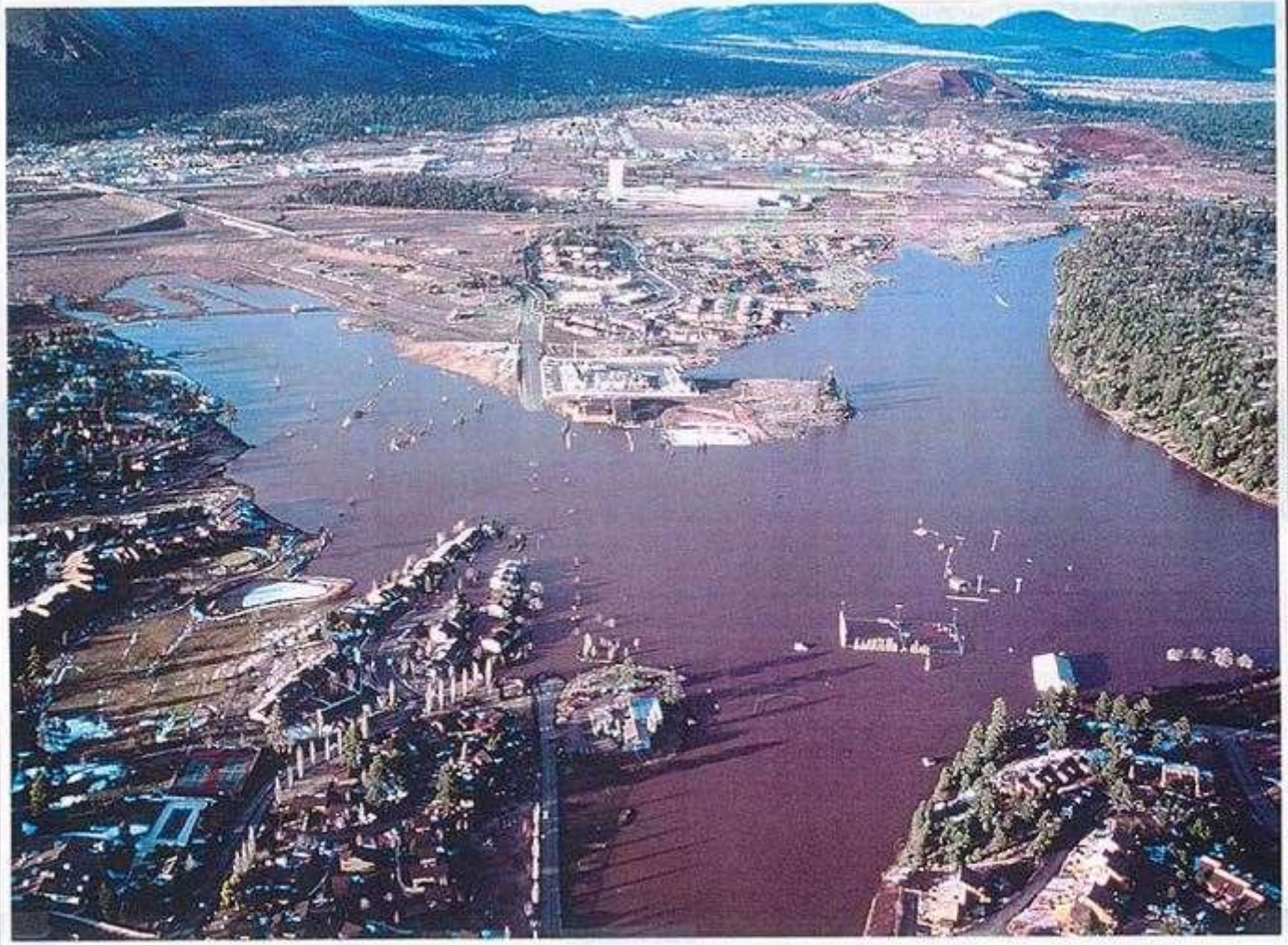


inches				Flagstaff	Current Snow					
	Average Recurrence Interval (years)									
Duration	1	2	5	10	25	50	100	200	500	1000
5-min	1.0	1.3	1.8	2.2	2.7	3.2	3.7	4.2	5.0	5.7
10-min	1.6	2.0	2.7	3.3	4.1	4.8	5.6	6.4	7.6	8.6
15-min	1.9	2.5	3.4	4.1	5.1	6.0	7.0	8.0	9.4	10.7
30-min	2.6	3.4	4.5	5.5	6.9	8.1	9.3	10.7	12.7	14.4
60-min	3.2	4.2	5.6	6.8	8.6	10.0	11.6	13.3	15.7	17.8
2-hr	5.6	7.1	9.5	11.3	14.1	16.4	19.0	21.8	25.8	29.3
3-hr	6.2	7.8	10.1	11.9	14.7	17.0	19.5	22.2	26.3	29.8
6-hr	7.6	9.4	11.6	13.7	16.5	18.8	21.4	24.2	28.1	31.4
12-hr	12.9	16.0	19.6	22.5	26.5	29.6	32.9	36.3	41.1	45.0
24-hr	16.9	21.1	26.2	30.4	36.2	40.7	45.5	50.3	57.0	62.2
2-day	20.1	25.1	31.3	36.3	43.2	48.7	54.4	60.2	68.3	74.6
3-day	21.7	27.1	33.8	39.4	47.1	53.2	59.7	66.4	75.7	83.1
4-day	23.3	29.0	36.4	42.4	50.9	57.8	65.0	72.5	83.1	91.5

The 2010 winter storm that paralyzed Flagstaff was less than a 100-year event

U.S. Army Engineer District

Corps of Engineers



Continental Estates Area - Post Peak Photo

Figure 4.5 1993 Flood Photos - Continental Area

Flooding in Continental Estates 1993 More

www2.nau.edu

Why don't they just use the extremes from the past?

- One reason FEMA is requiring climate change to be included in the plans is that NOAA says climate change will cause more intense and more frequent extreme events.
- So we need to base our planning on what we expect to occur in the future, not what occurred in the past.
- But that information does not exist for extreme weather events.

So what do we plan for?

- The time horizon for mitigation is within the 2-, 5-, and 10-year window that coincides with both the Hazard Mitigation Plan Update and the election and budgeting cycles for the jurisdictions.
- Planners need actionable information on what severe weather to expect in that time horizon.

The Information Gap

- Currently no forecasts, predictions, outlooks, projections or other guidance exists in the 2-10 year window.

- In the absence of information from NOAA, the planners will make their own best guess, which is an **uneducated guess**.

We need to provide our stakeholders with actionable guidance on extreme weather events.

Thank you.

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