USDA United States Department of Agriculture
Southwest Climate Hub

Arizona Climate Conversation:

Climate Informed Agriculture

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Adapted from a Climate Smart Agriculture training developed by Elizabeth Marks, NRCS

Today's Conversation

Climate

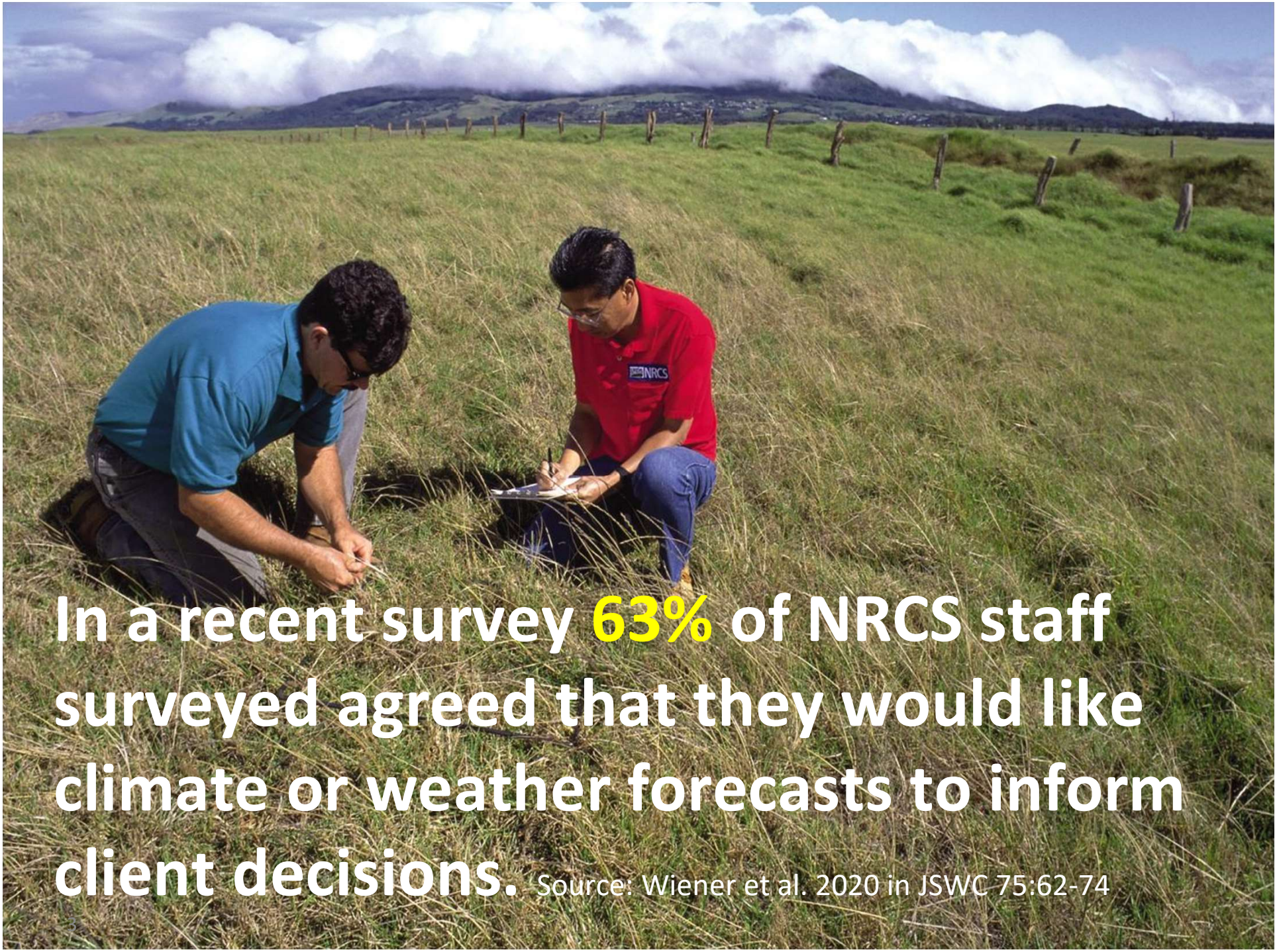
- Terminology
- U.S. Climate Changes
- Why these changes are occurring
- Local Climate Information
  - **Yuma Valley and Saltwater Basin update**

Climate Smart Agriculture

- Adaptation and Transformation
- Available Resources
- How to start the conversation

Discussion/Feedback

- Survey



In a recent survey 63% of NRCS staff surveyed agreed that they would like climate or weather forecasts to inform client decisions. Source: Wiener et al. 2020 in JSWC 75:62-74

What words come to mind when you think of Climate Adaptation/Resiliency?

Click on link in the Chat box

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Terminology

Weather vs. Climate (Source: NOAA)

Weather reflects short-term conditions of the **atmosphere**

Climate is the average daily **weather** for an extended period at a certain location

Weather can change from minute-to-minute, hour-to-hour, day-to-day, and season-to-season. **Climate**, is the average of **weather** over time and space.

Climate is what you expect, weather is what you get.

Photo Credit: Travi

Climate Smart Agriculture

Definition: **Agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes GHGs (mitigation), and enhances achievement of national food security and development goals. (Source: Food and Agriculture Organization)**

Other terms:

- Climate Informed Agriculture
- Climate Smart Farming
- Natural Climate Solutions
- Engineering with Nature
- Weather/Drought Resiliency

Photo: Robert Wilson

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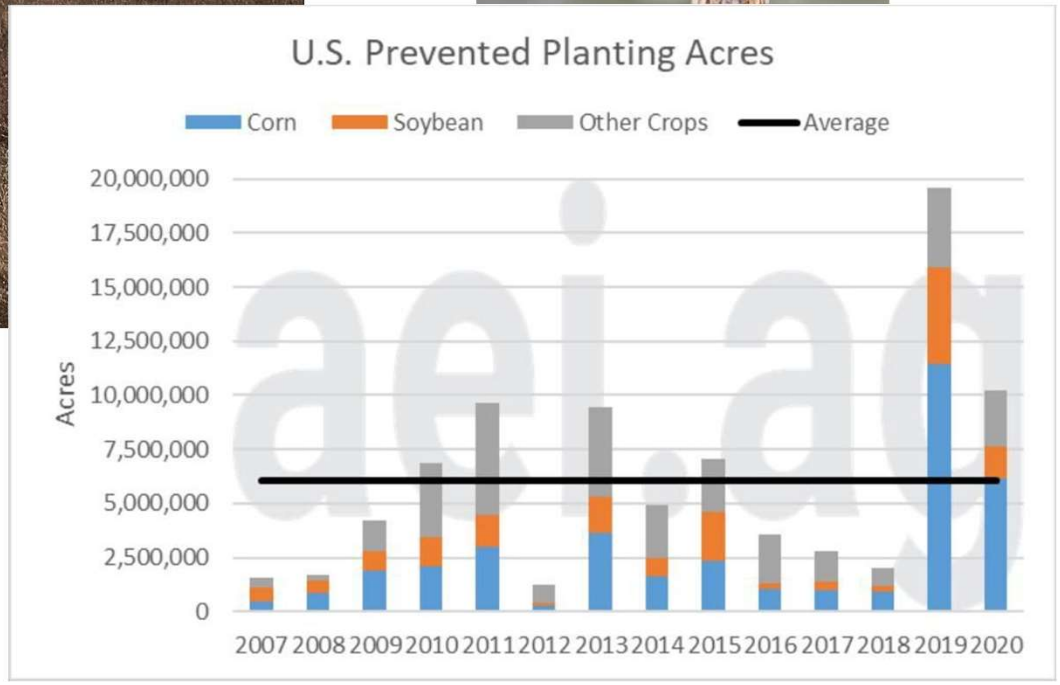
National Climate Changes

Natural

Natural Resources Conservation Service

nrcs.usda.gov/

What changes in weather have you noticed in your lifetime?



Natural Resources Conservation Service

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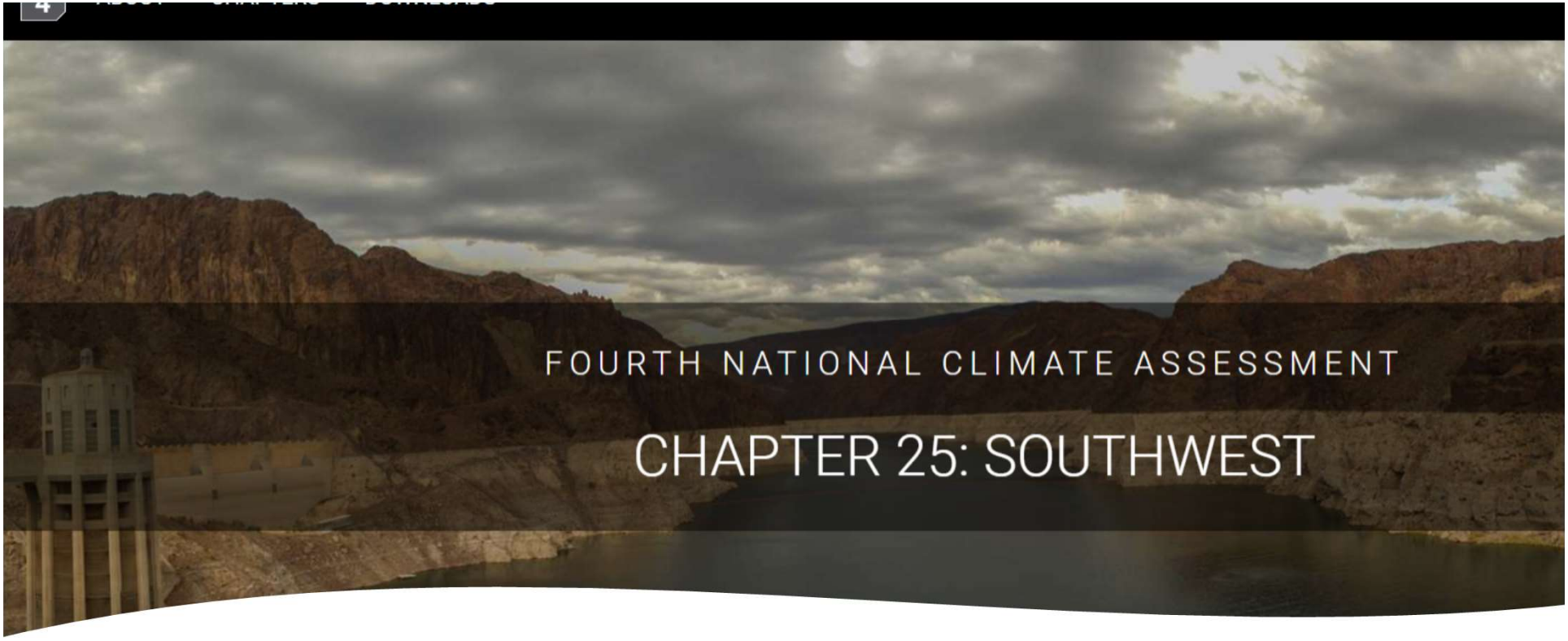
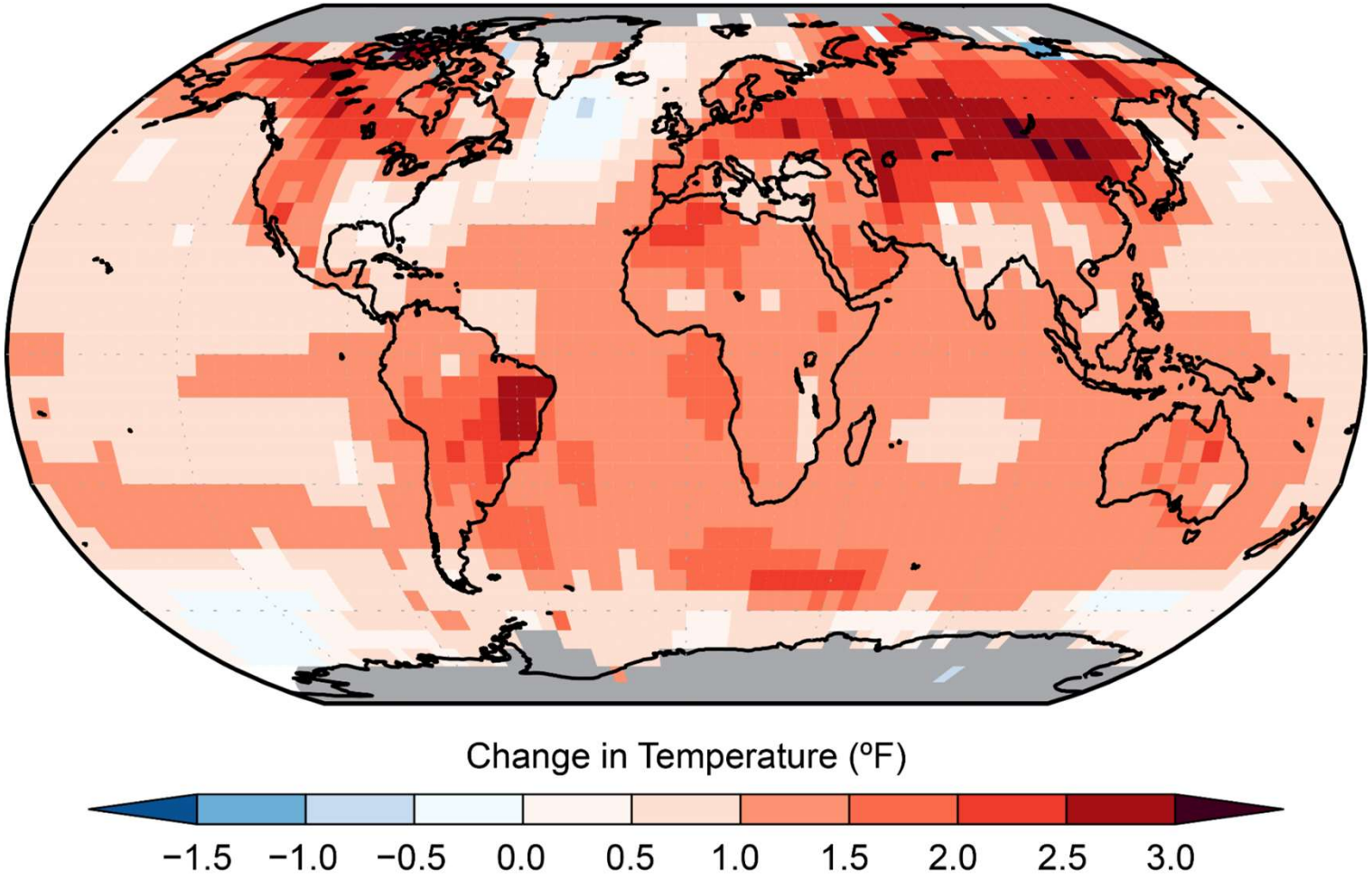


Fourth National Climate Assessment 2018

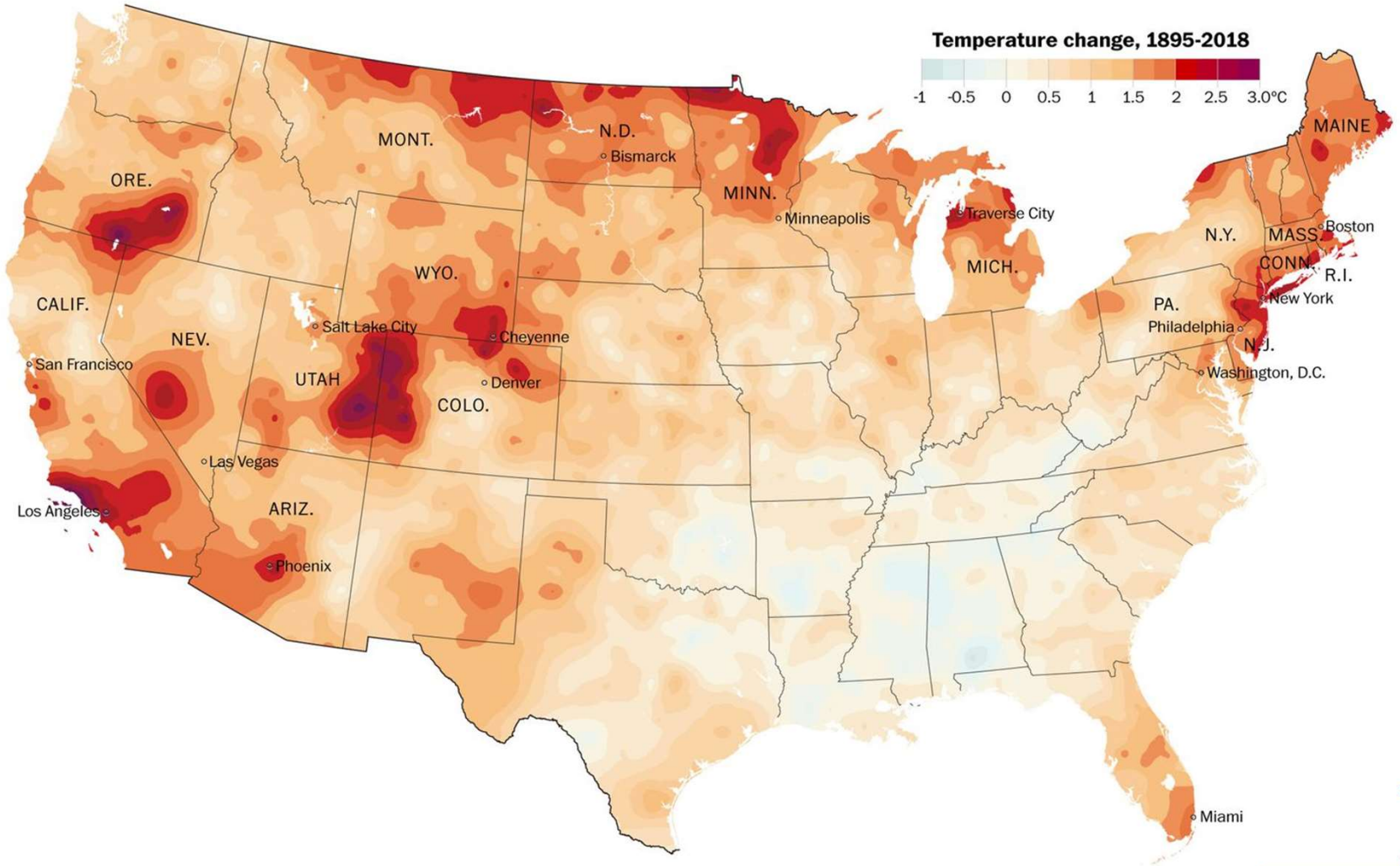
- 1,500 page congressionally mandated report done every four years by the US Global Change Research Program (federally funded).
- Lead agency: National Oceanic and Atmospheric Association (NOAA), many other partner contributors including USDA
- Official data source for USDA climate change information

Observed: Average Global Rise in Temperature of 2°F
(1880 – 2012)



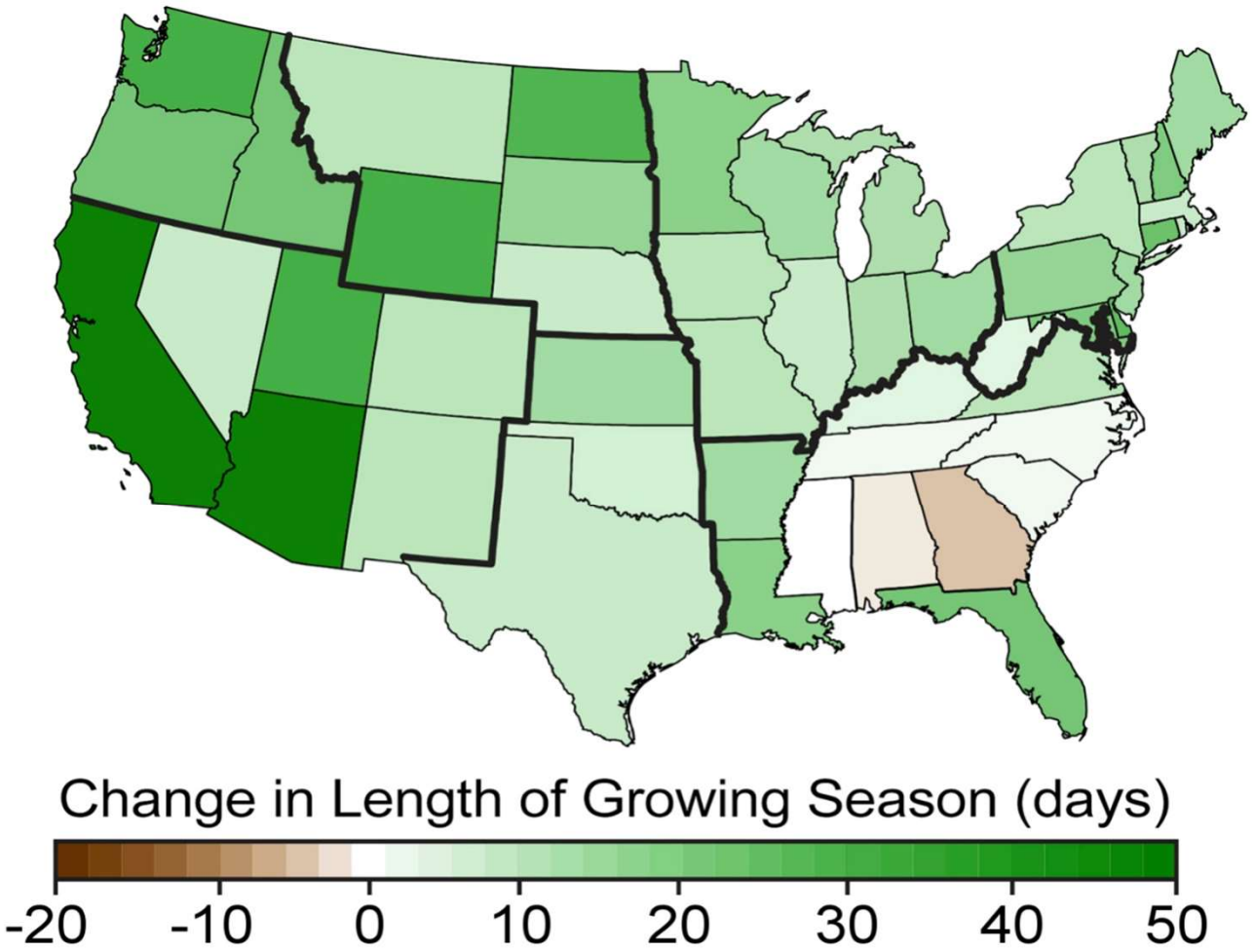
Source: Fourth National Climate Assessment 2018

Observed: U.S. Change in Temperature
(1880 – 2012)



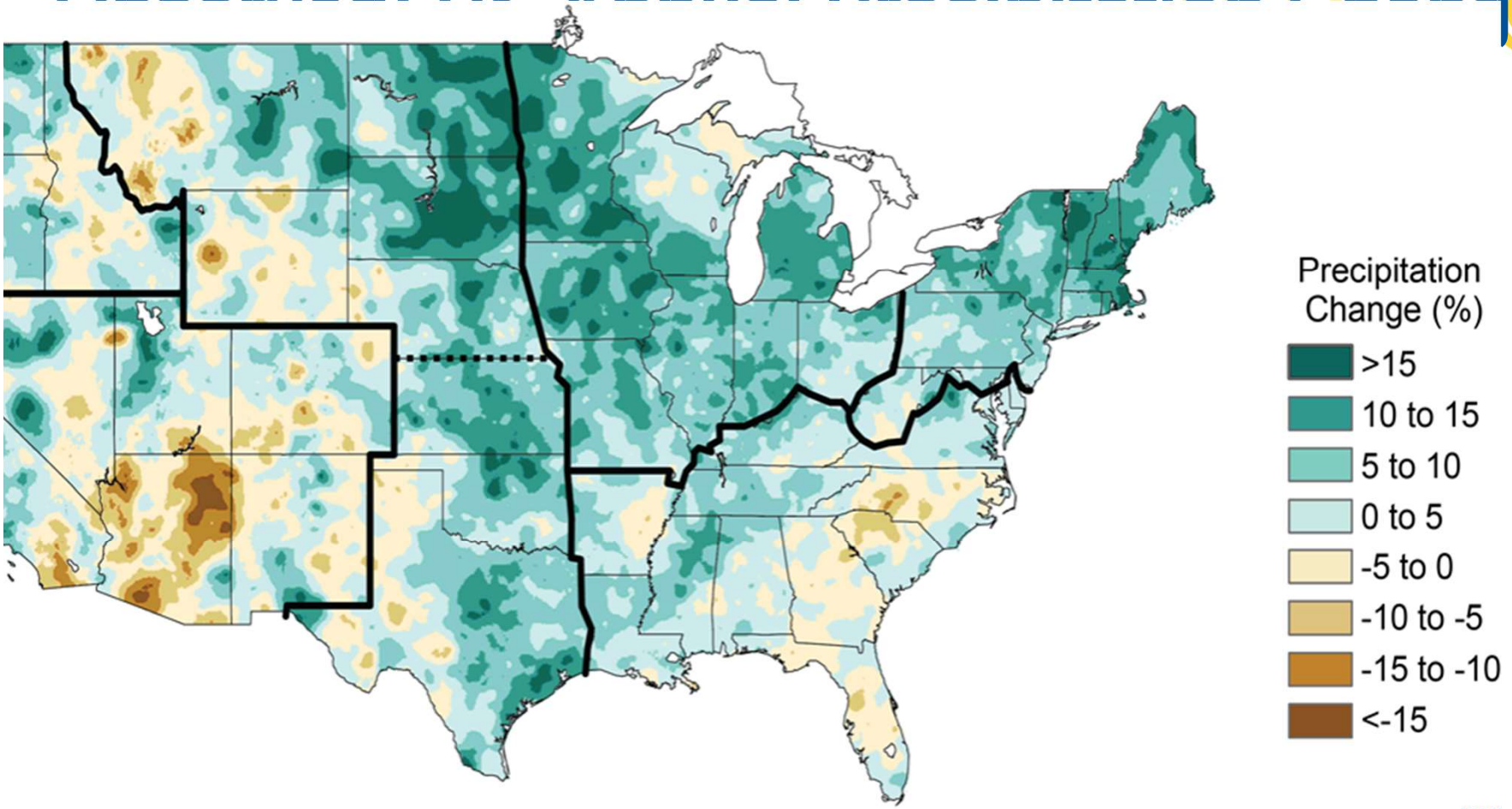
Source: Fourth National Climate Assessment 2018

Observed: Change in Growing Season Length
(1895 – 2012)



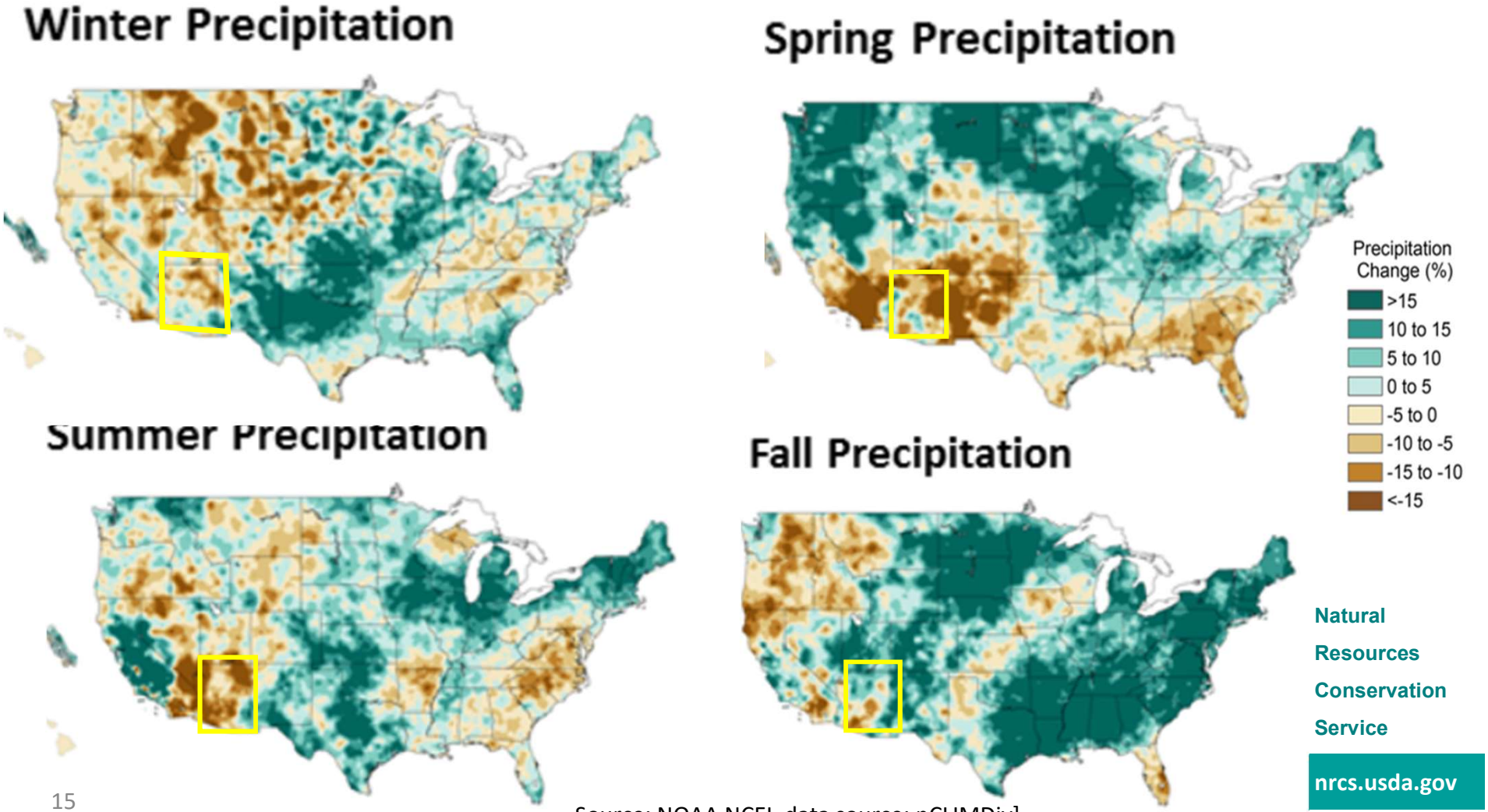
Source: Fourth National Climate Assessment 2018

Observed US Annual Precipitation Change



Source: Fourth National Climate Assessment 2018

Observed: Precipitation Timing Changes (1986-2018 to 1901-1960)



Source: NOAA NCEI, data source: nCLIMDiv].

Natural Resources Conservation Service

nrcs.usda.gov

How does this climate information factor into understanding specific Agricultural production systems in Arizona?

- Alfalfa
- Pasture
- Rangeland
- Livestock
- Corn
- Olives
- Pecans
- Greens

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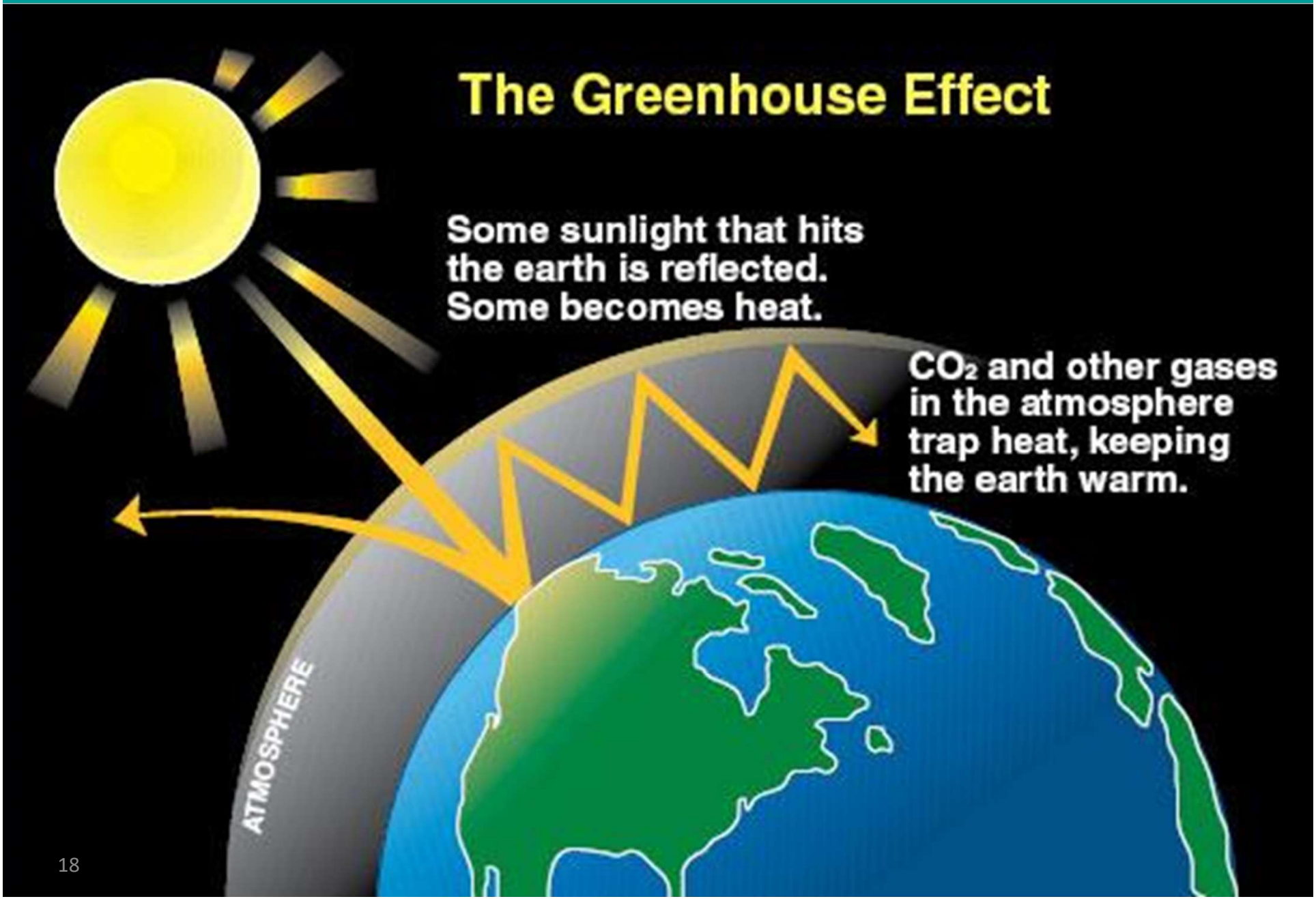
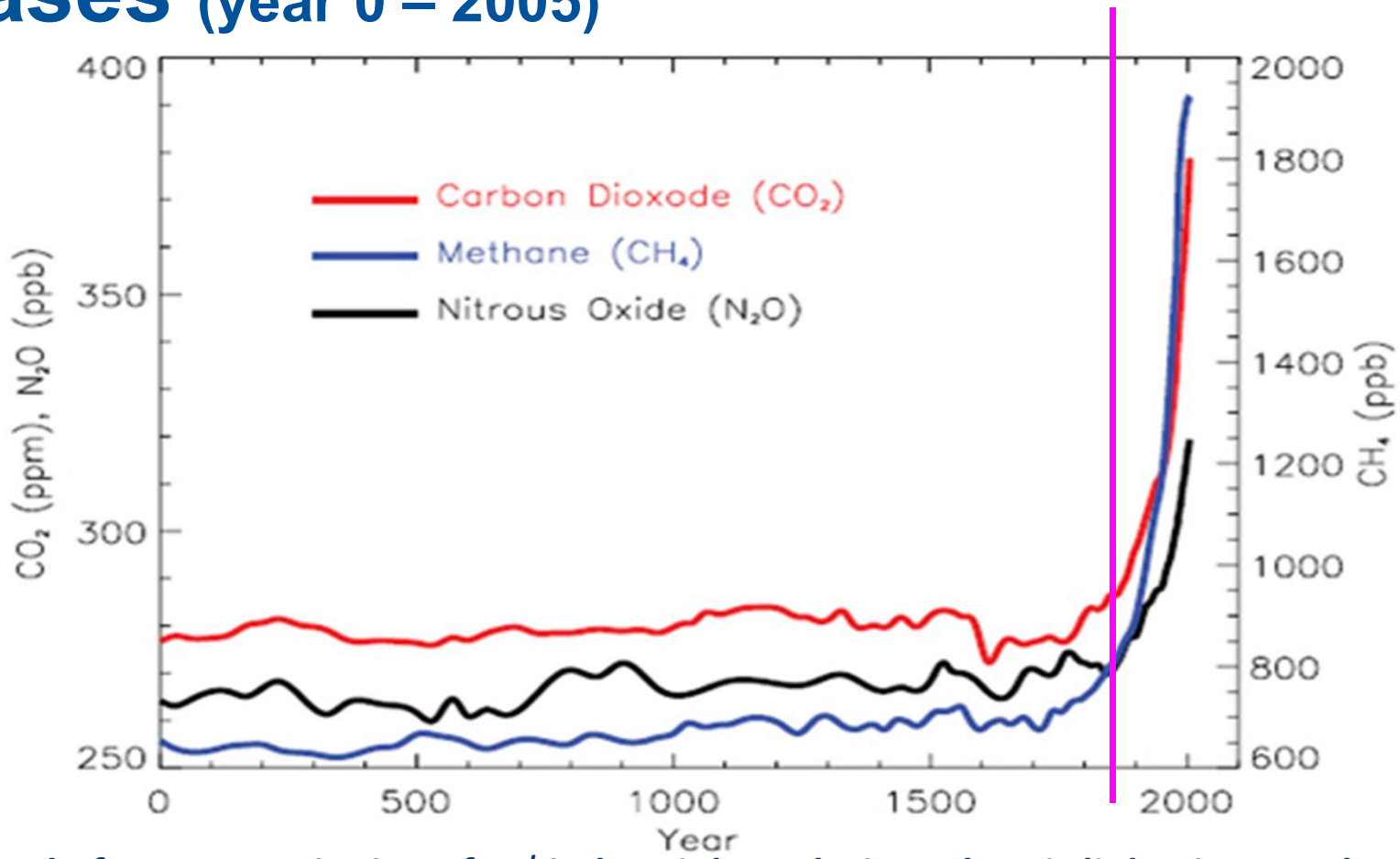
Why Are These Changes Happening?


Photo: Scott Woodall


Photo: Scott Woodall


The Greenhouse Effect
Some sunlight that hits the earth is reflected. Some becomes heat.
CO_2 and other gases in the atmosphere trap heat, keeping the earth warm.
ATMOSPHERE

Concentrations of Greenhouse Gases (year 0 – 2005)



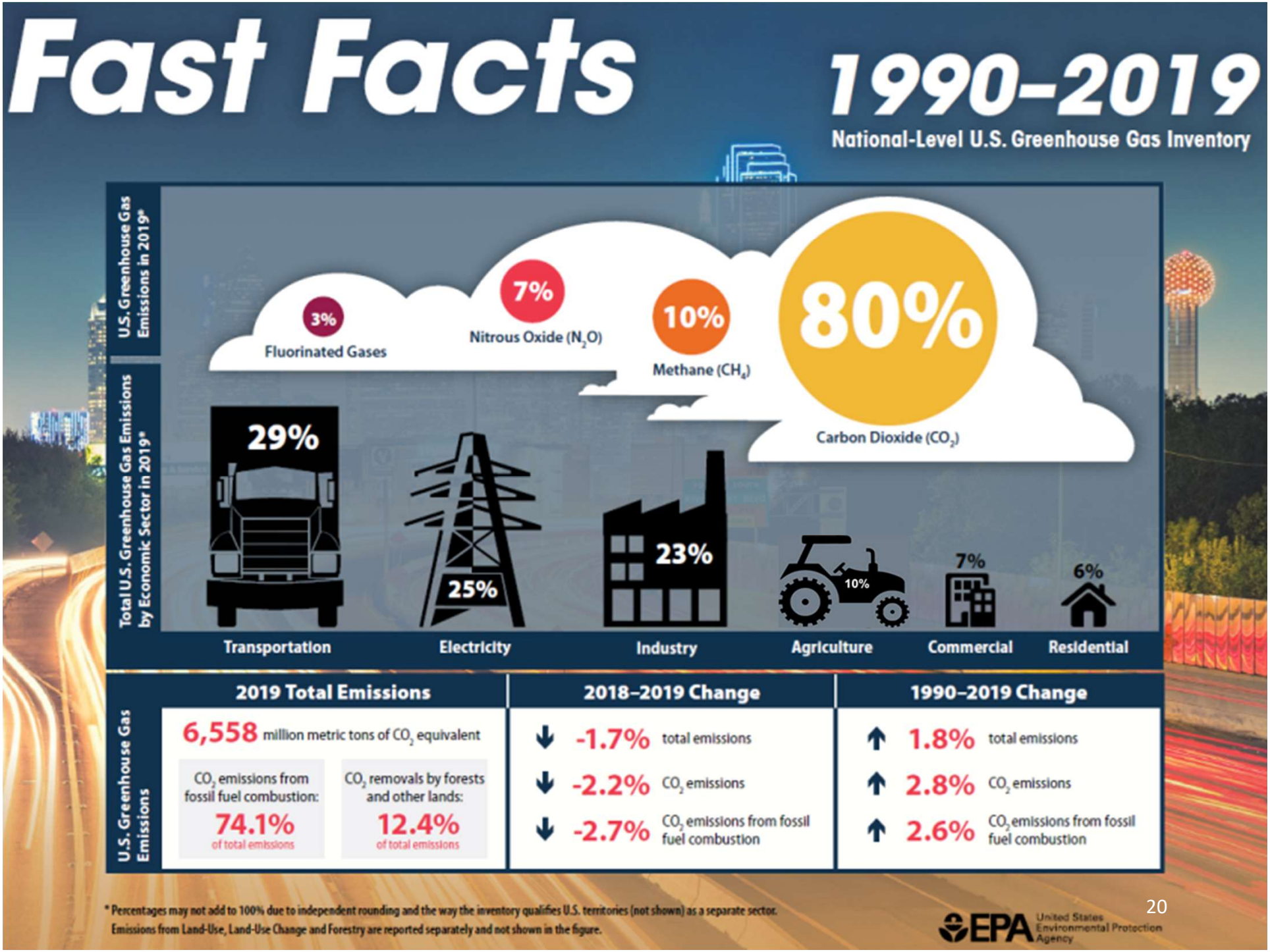
End of 1800s: Beginning of 2nd industrial revolution, electric lights invented, and introduction of the automobile.

Source: Intergovernmental Panel on Climate Change Fourth Assessment Report 2007

Fast Facts

1990–2019

National-Level U.S. Greenhouse Gas Inventory



U.S. Greenhouse Gas Emissions

2019 Total Emissions	2018–2019 Change	1990–2019 Change
6,558 million metric tons of CO_2 equivalent	↓ **-1.7%** total emissions	↑ **1.8%** total emissions
CO_2 emissions from fossil fuel combustion: **74.1%** of total emissions	↓ **-2.2%** CO_2 emissions	↑ **2.8%** CO_2 emissions
CO_2 removals by forests and other lands: **12.4%** of total emissions	↓ **-2.7%** CO_2 emissions from fossil fuel combustion	↑ **2.6%** CO_2 emissions from fossil fuel combustion

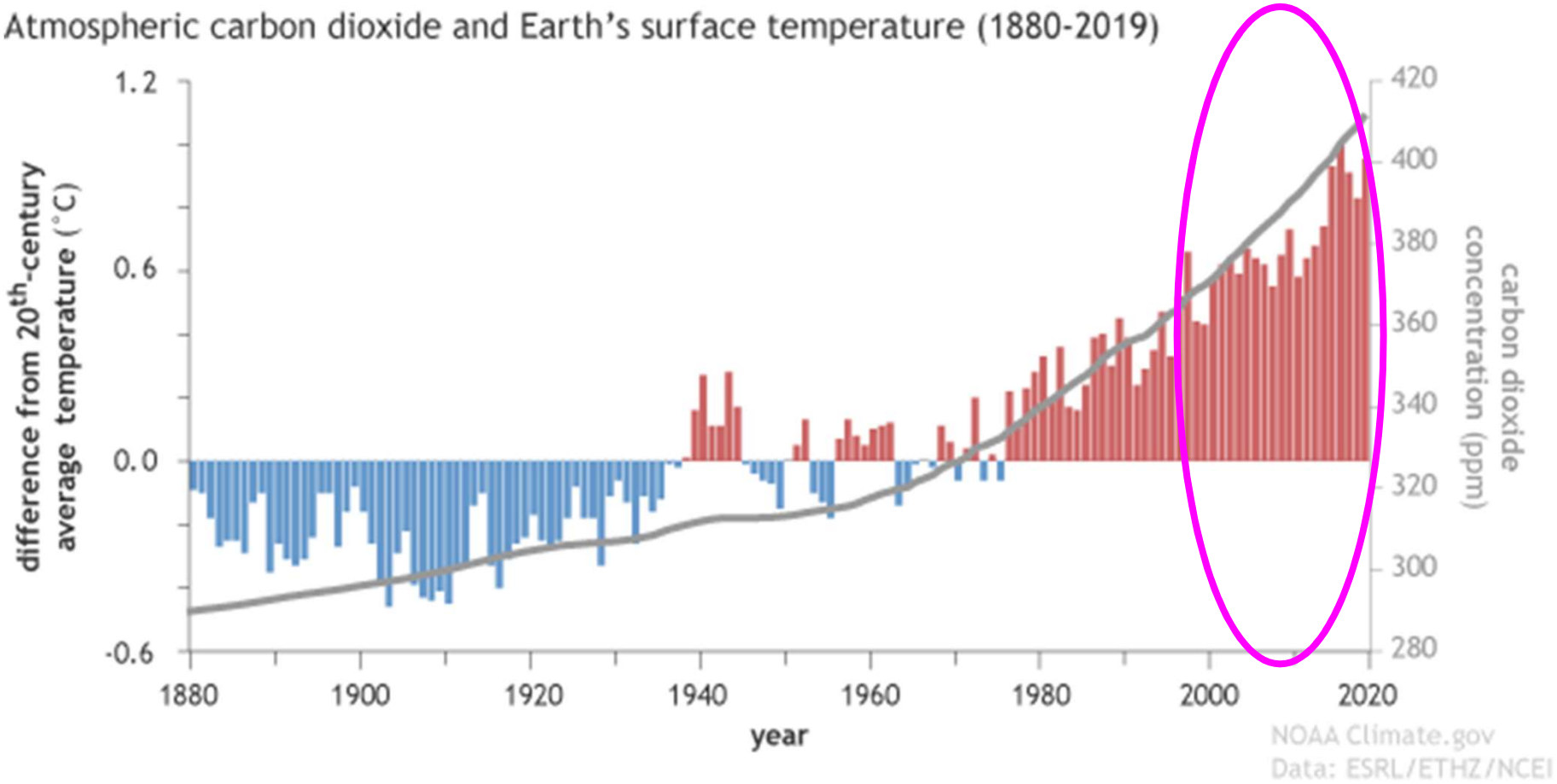
* Percentages may not add to 100% due to independent rounding and the way the inventory qualifies U.S. territories (not shown) as a separate sector. Emissions from Land-Use, Land-Use Change and Forestry are reported separately and not shown in the figure.

EPA United States Environmental Protection Agency

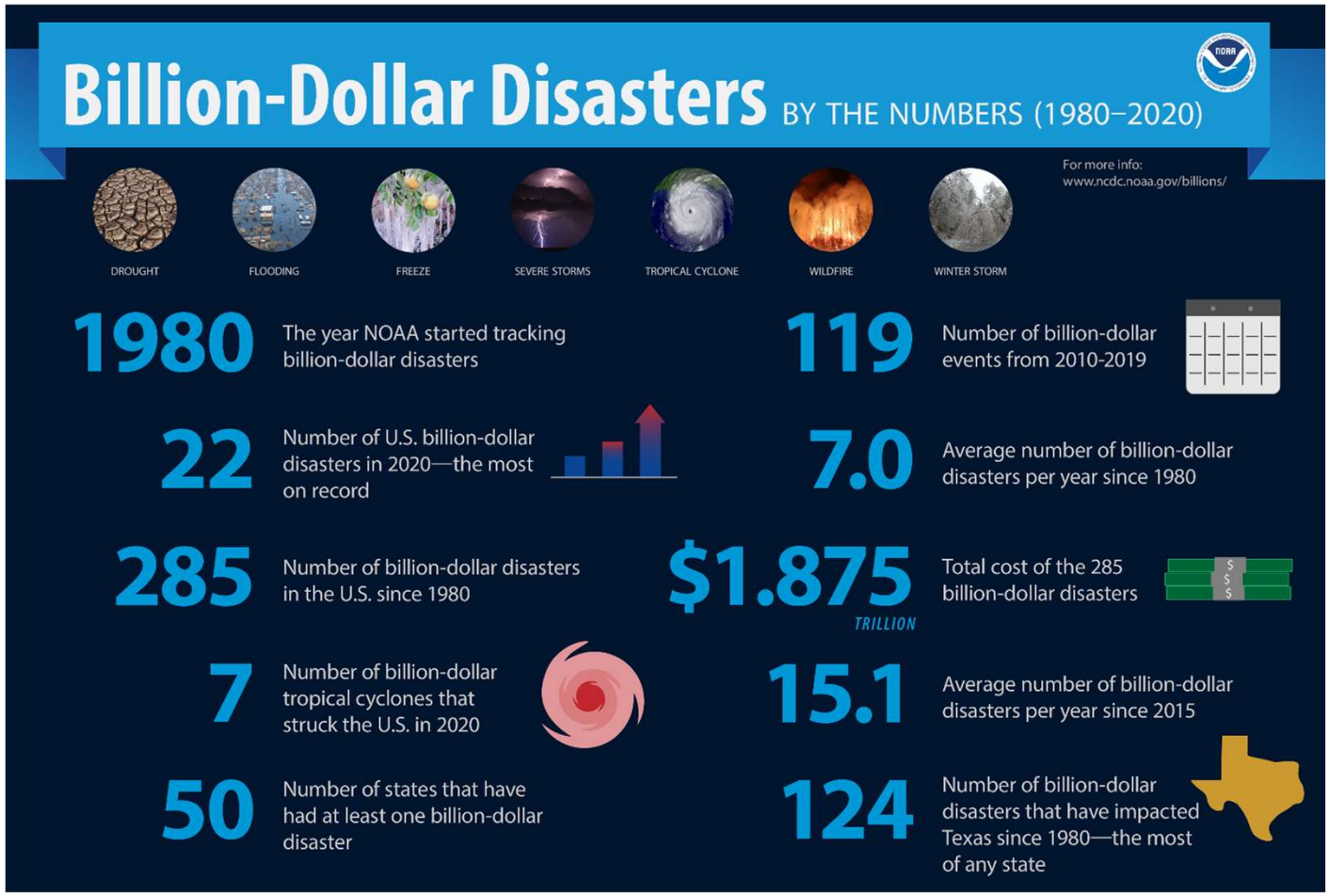
Half of human-related CO_2 emissions has occurred only in the last 40 years.

Source: Data: Luthi, D., et al.. 2008; Etheridge, D.M., et al. 2010; Vostok ice core data/J.R. Petit et al.; NOAA Mauna Loa CO_2 record.

Temperature Has Risen Along With Levels of Greenhouse Gases



US Billion Dollar Disaster Events 1980 - 2020



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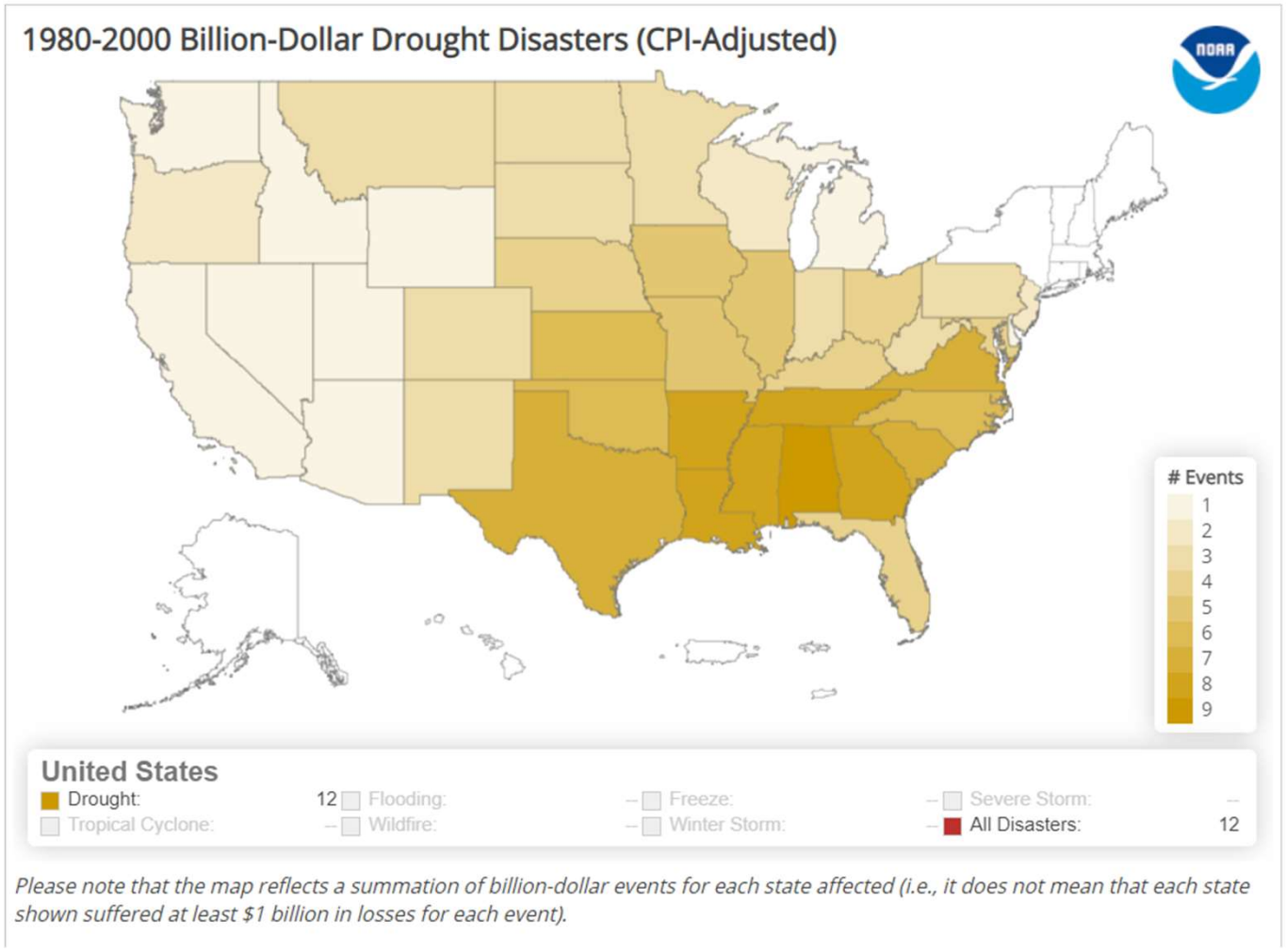
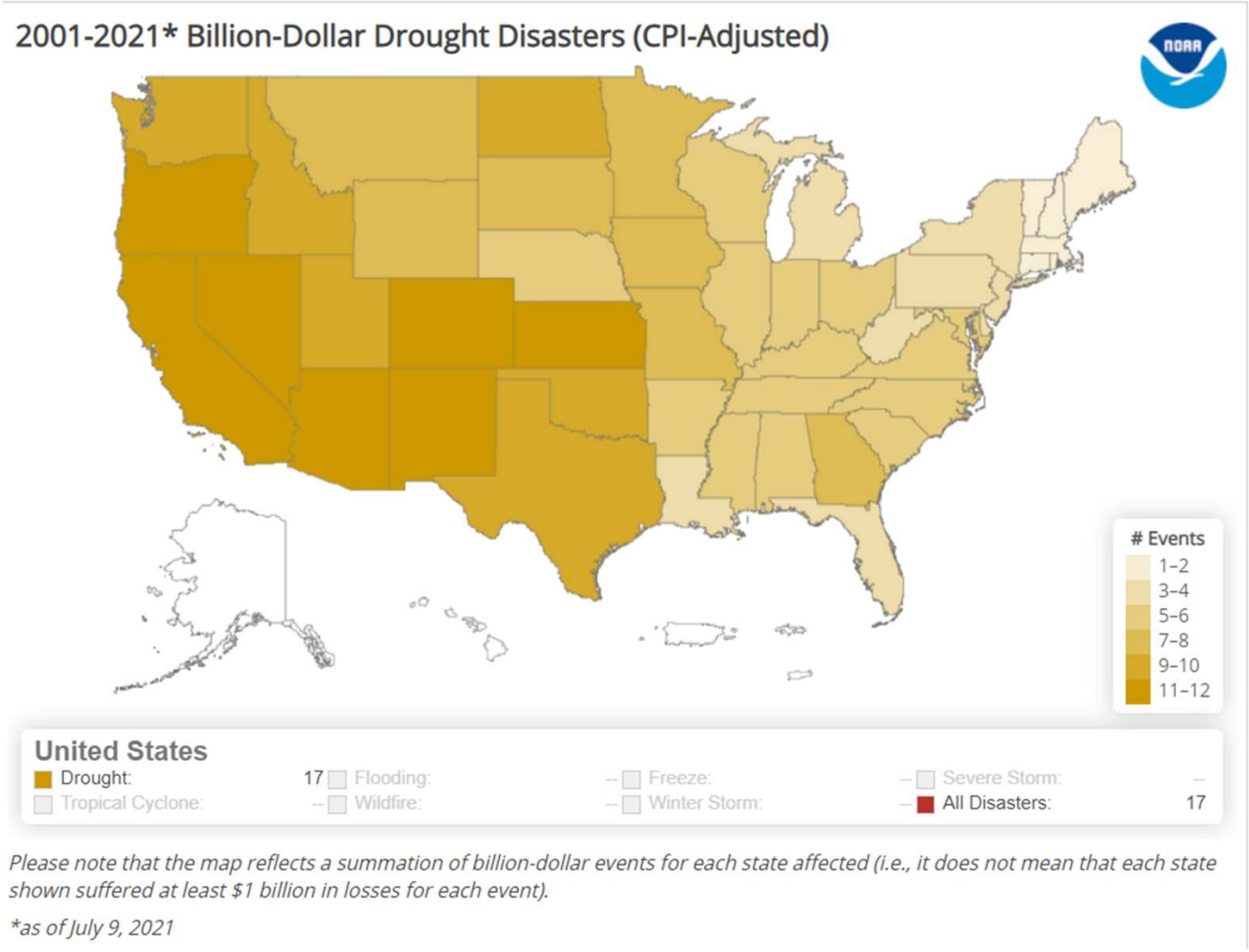
Source: NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2021).

Drought in Dollars – 1980-2000



Please note that the map reflects a summation of billion-dollar events for each state affected (i.e., it does not mean that each state shown suffered at least $1 billion in losses for each event).

Drought in Dollars – 2001-2021



Please note that the map reflects a summation of billion-dollar events for each state affected (i.e., it does not mean that each state shown suffered at least $1 billion in losses for each event).

**as of July 9, 2021*

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Local Climate Changes and Trends

Caiti Steele, Southwest Climate Hub Coordinator

Natural Resources Conservation Service

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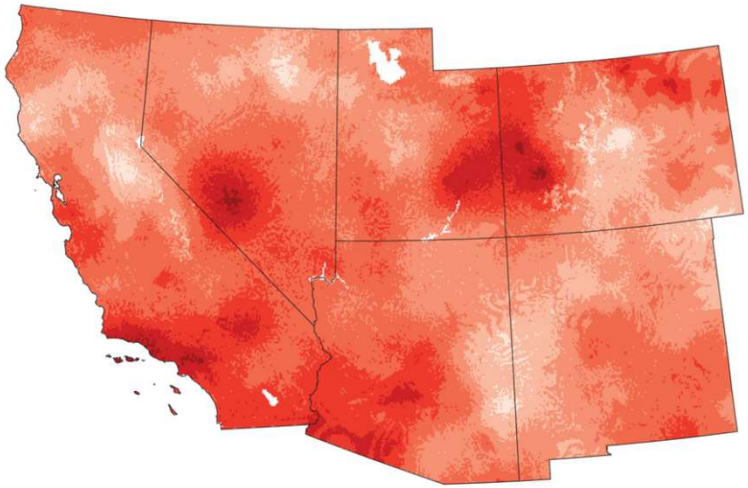
Southwest Things to Think About

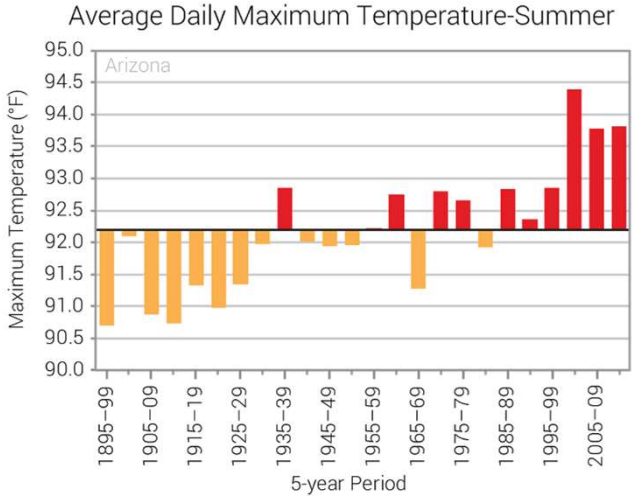
- Direct impacts
  - Heat
  - Mega Drought
  - Extreme rainfall events, shifting rainfall patterns?
- Indirect impacts
  - Water quantity and quality, water table compactions
  - Flooding
  - Wildfire and post-fire flooding
  - Woody and herbaceous invasive species
- Historically underserved communities are among the most at risk from climate change – new USDA commitment to "*equity, inclusion and equal opportunity*"

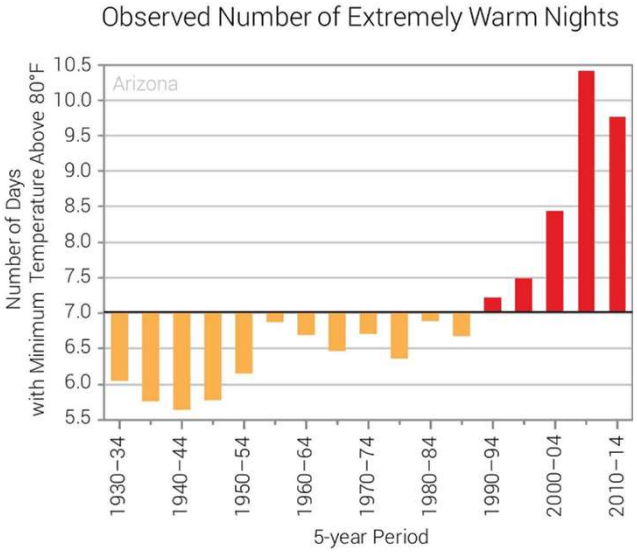
A century of change in Arizona



Annual temperatures increased across almost all of the Southwest region from 1901 to 2016

https://nca2018.globalchange.gov/chapter/25/





https://statesummaries.ncics.org/chapter/az/

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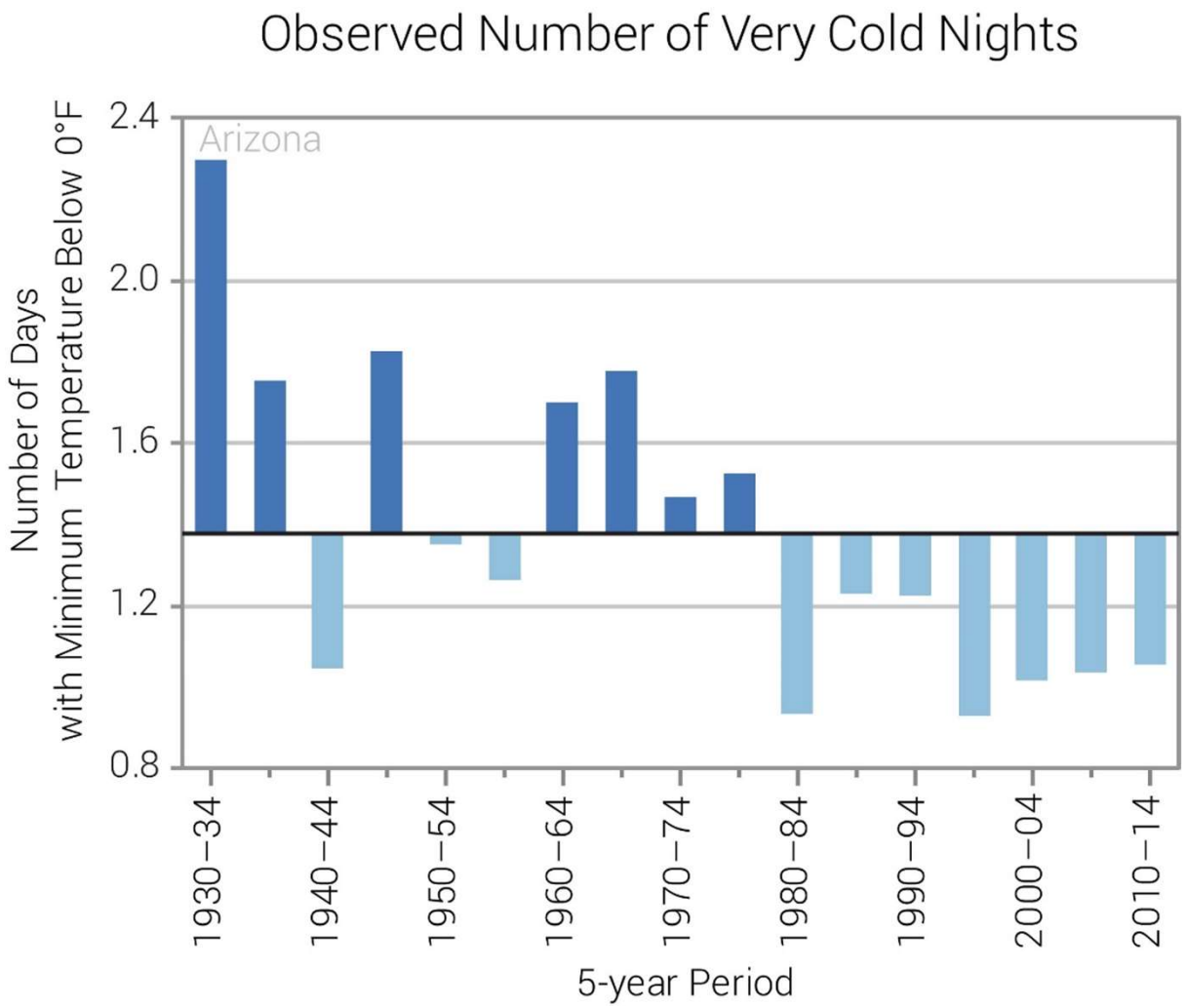
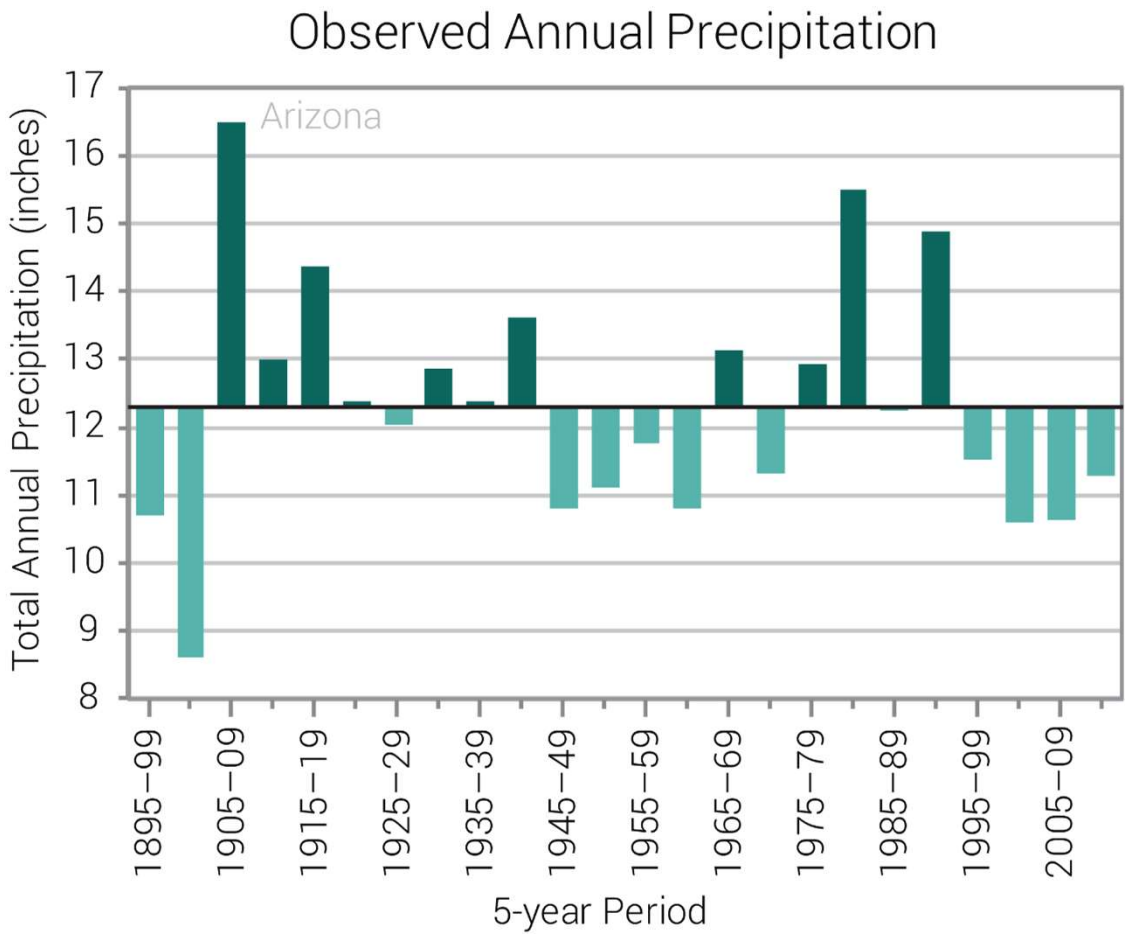
A century of change in Arizona



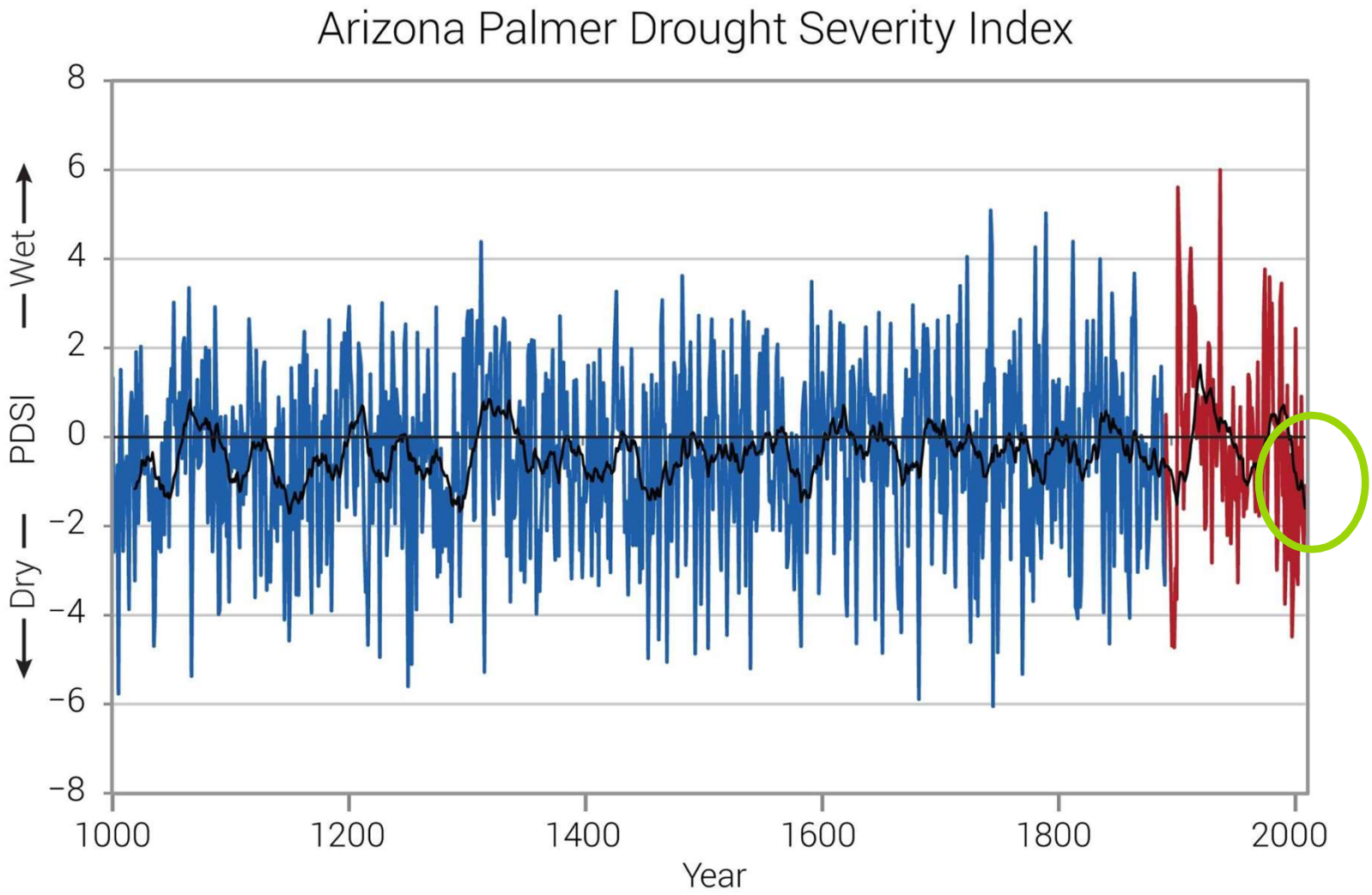
https://statesummaries.ncics.org/chapter/az/

A century of change in Arizona

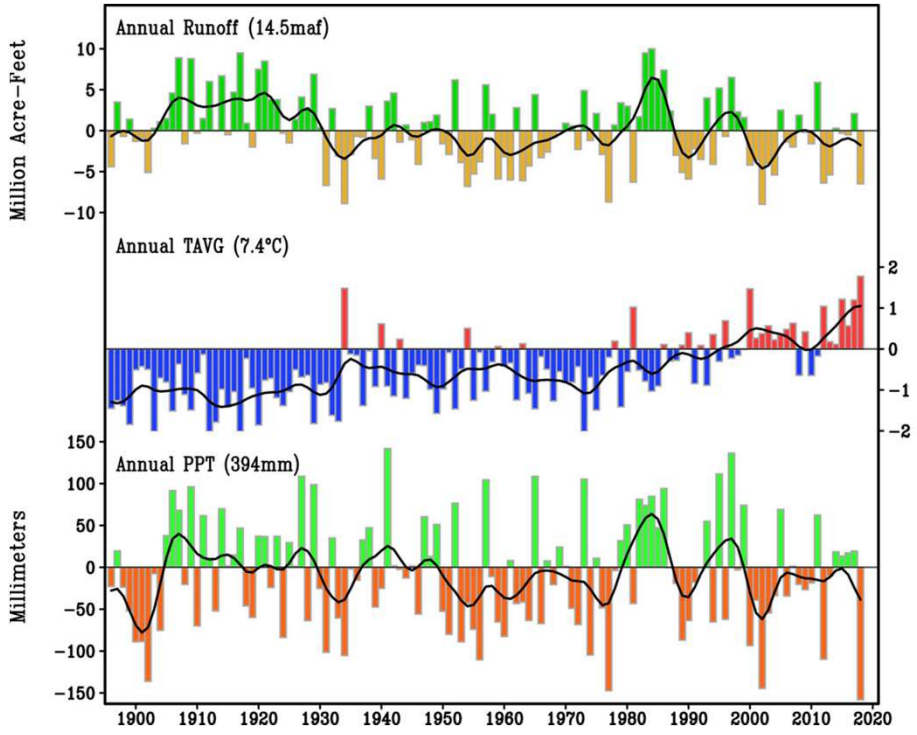


https://statesummaries.ncics.org/chapter/az/

Drought

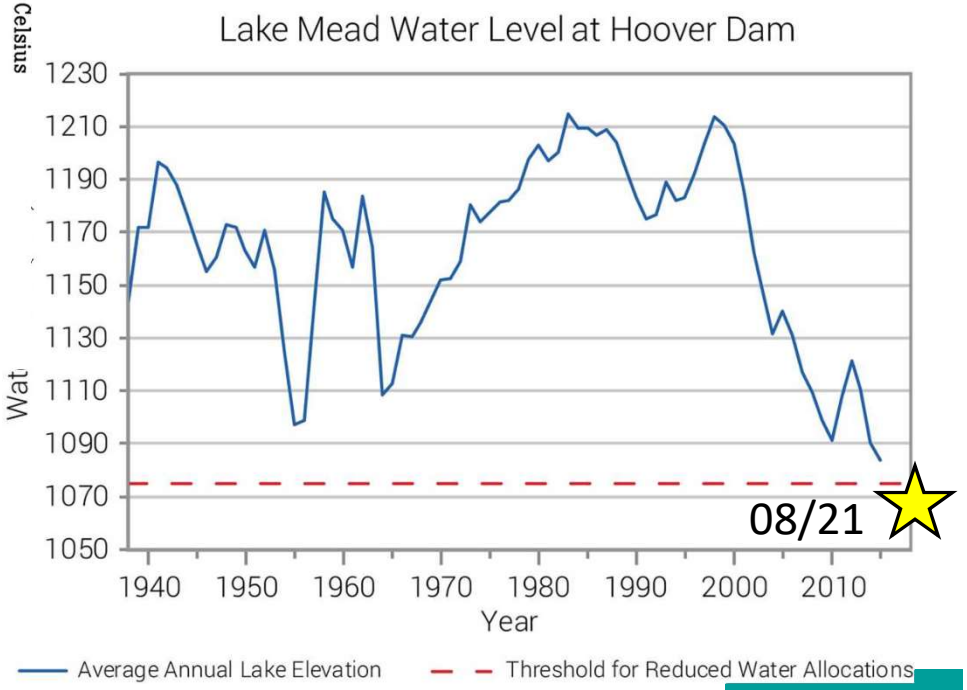

Arizona Palmer Drought Severity Index
8
6
4
2
0
−2
−4
−6
−8
Wet
PDSI
Dry
1000
1200
1400
1600
1800
2000
Year

Water quantity: surface water



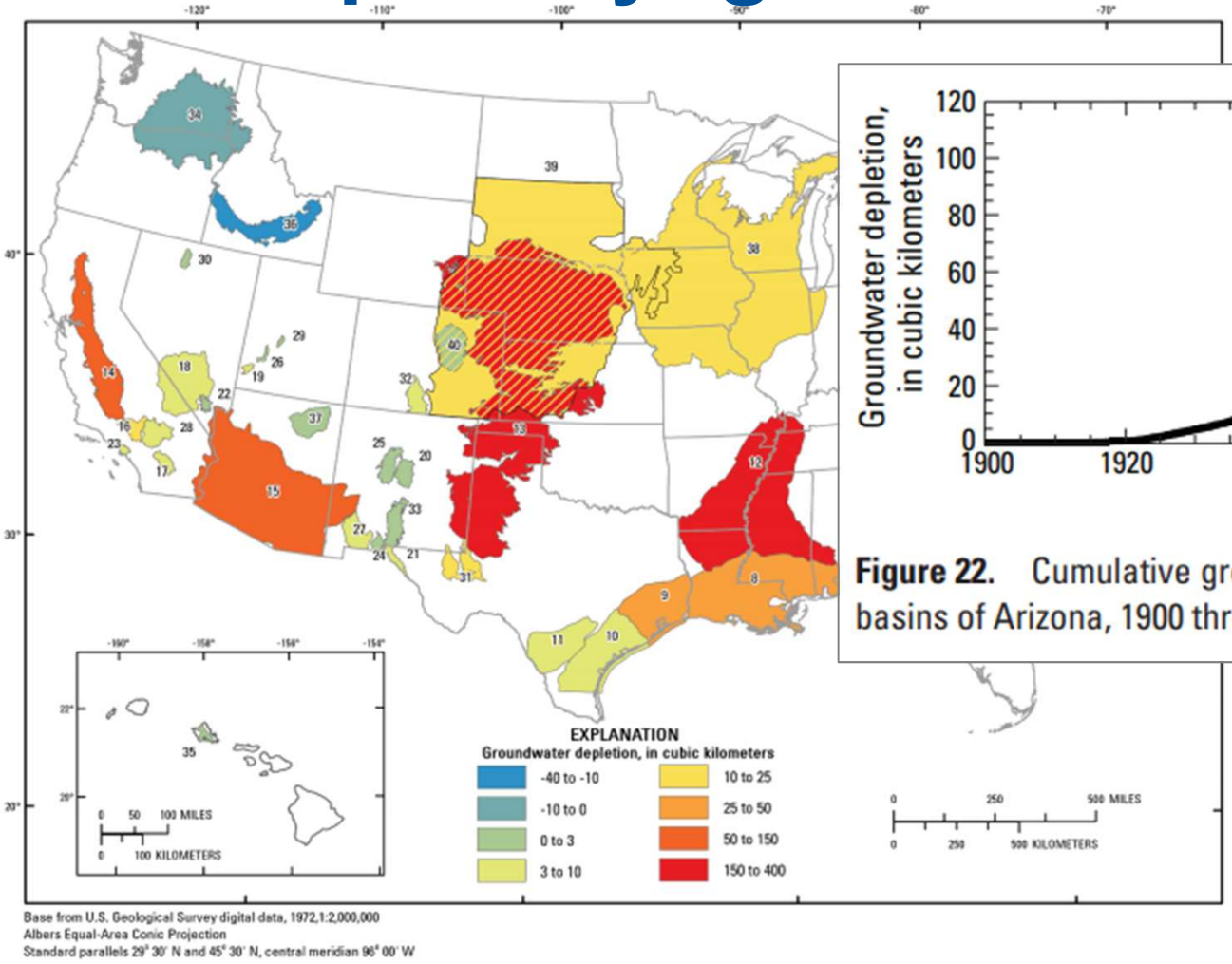
https://journals.ametsoc.org/view/journals/clim/32/23/jcli-d-19-0207.1.xml

Upper Colorado River 1896 - 2018:
Naturalized Lees Ferry streamflow; UCRB-averaged surface air temperature; UCRB-averaged precipitation; 1981–2010 climatological means are in the upper-left portion of each plot (Hoerling et al., 2019)



https://statesummaries.ncics.org/chapter/az/

Water quantity: groundwater



Base from U.S. Geological Survey digital data, 1972,1:2,000,000
Albers Equal-Area Conic Projection
Standard parallels 29° 30′ N and 45° 30′ N, central meridian 96° 00′ W

Figure 2. Map of the United States (excluding Alaska) showing cumulative groundwater depletion, 1900 through 2008, in 40 assessed aquifer systems or subareas. Index numbers are defined in table 1. Colors are hatched in the Dakota aquifer (area 39) where the aquifer overlaps with other aquifers having different values of depletion.

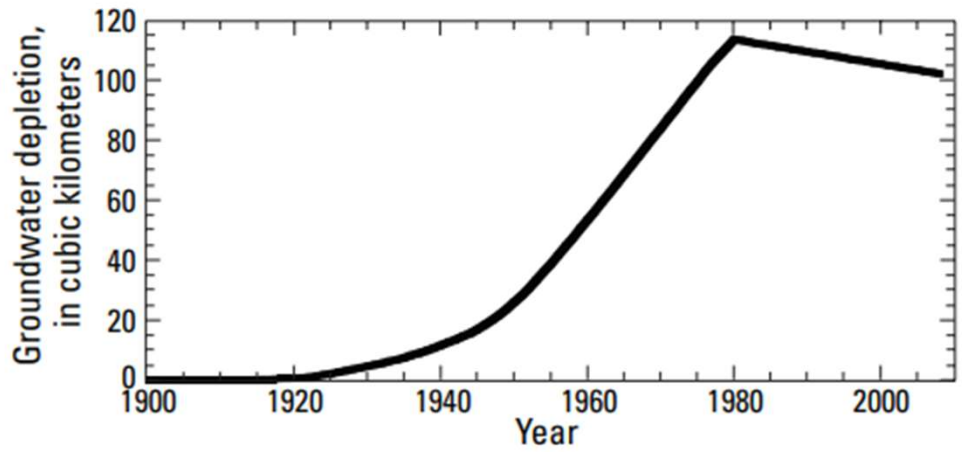
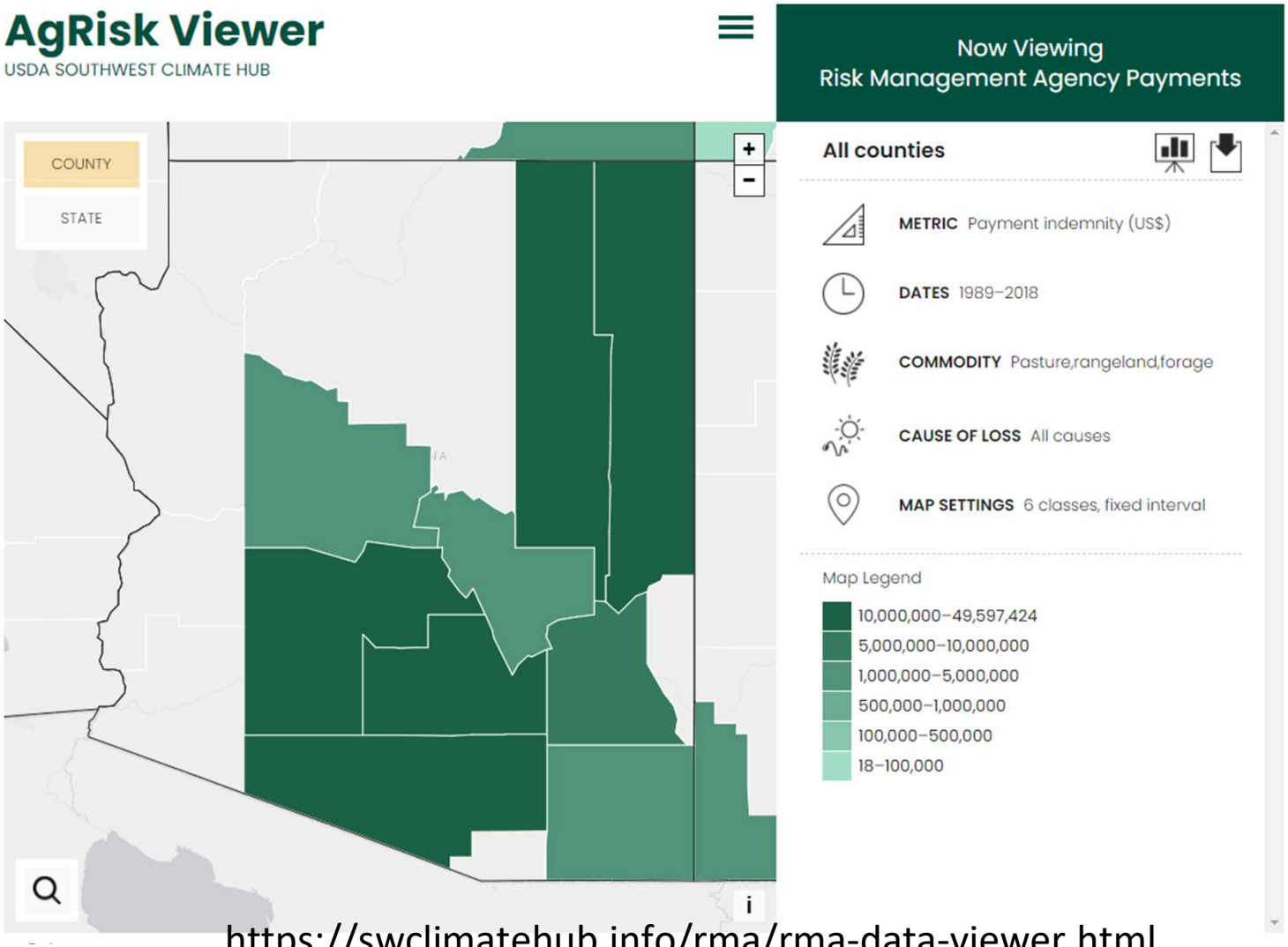


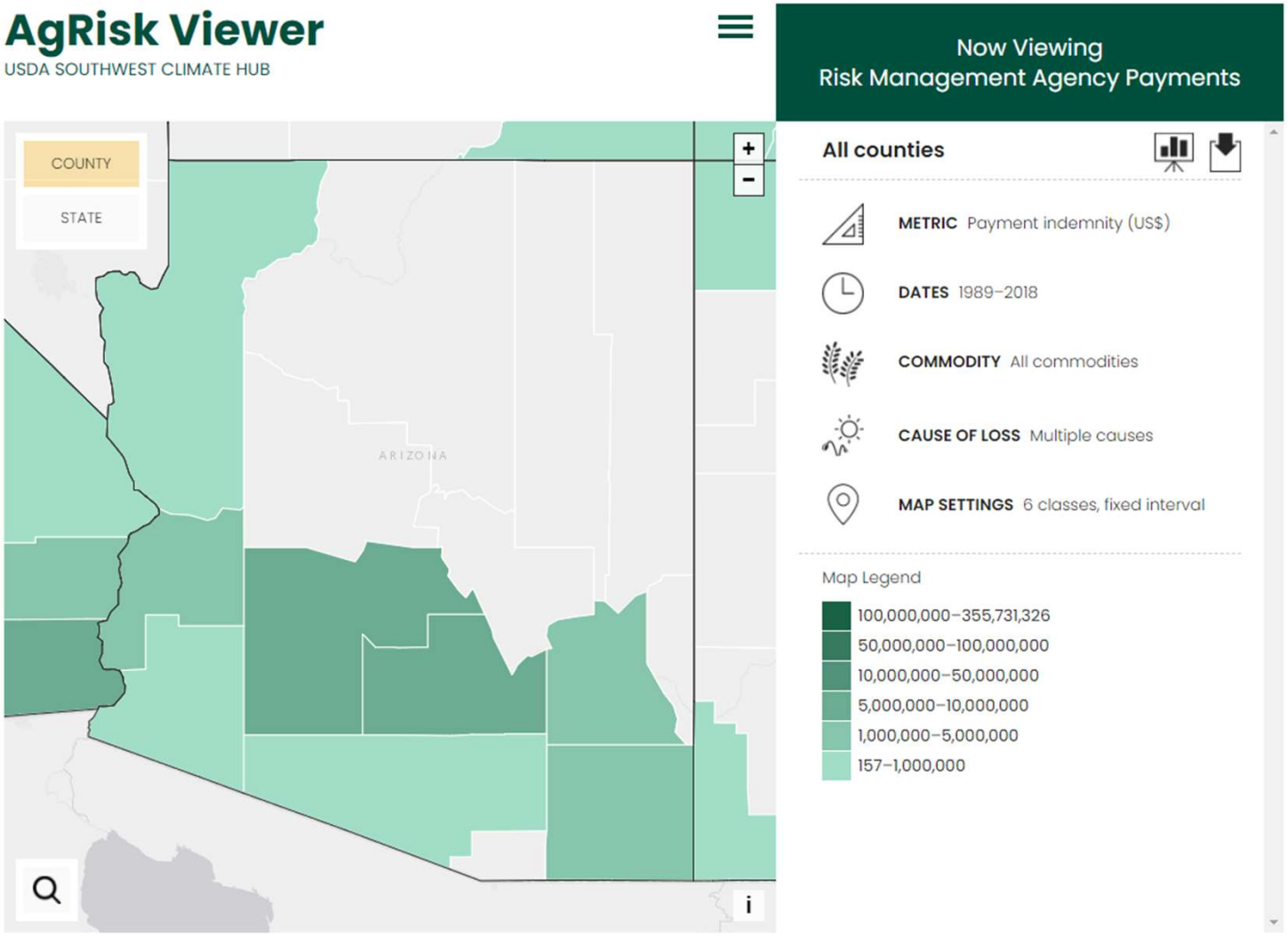
Figure 22. Cumulative groundwater depletion in the alluvial basins of Arizona, 1900 through 2008.

Pasture, range and forage



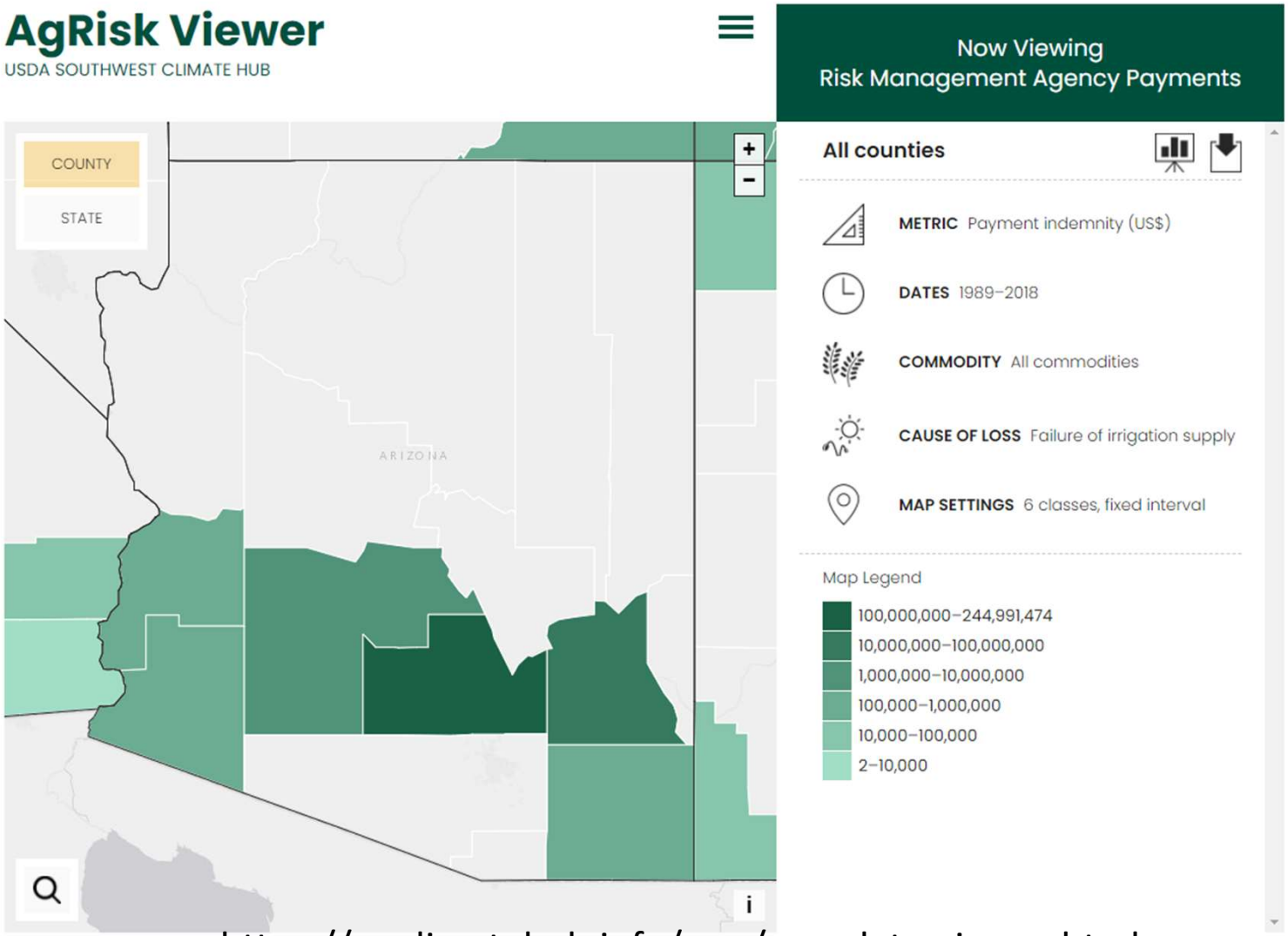
https://swclimatehub.info/rma/rma-data-viewer.html

Excess precipitation / flooding



https://swclimatehub.info/rma/rma-data-viewer.html

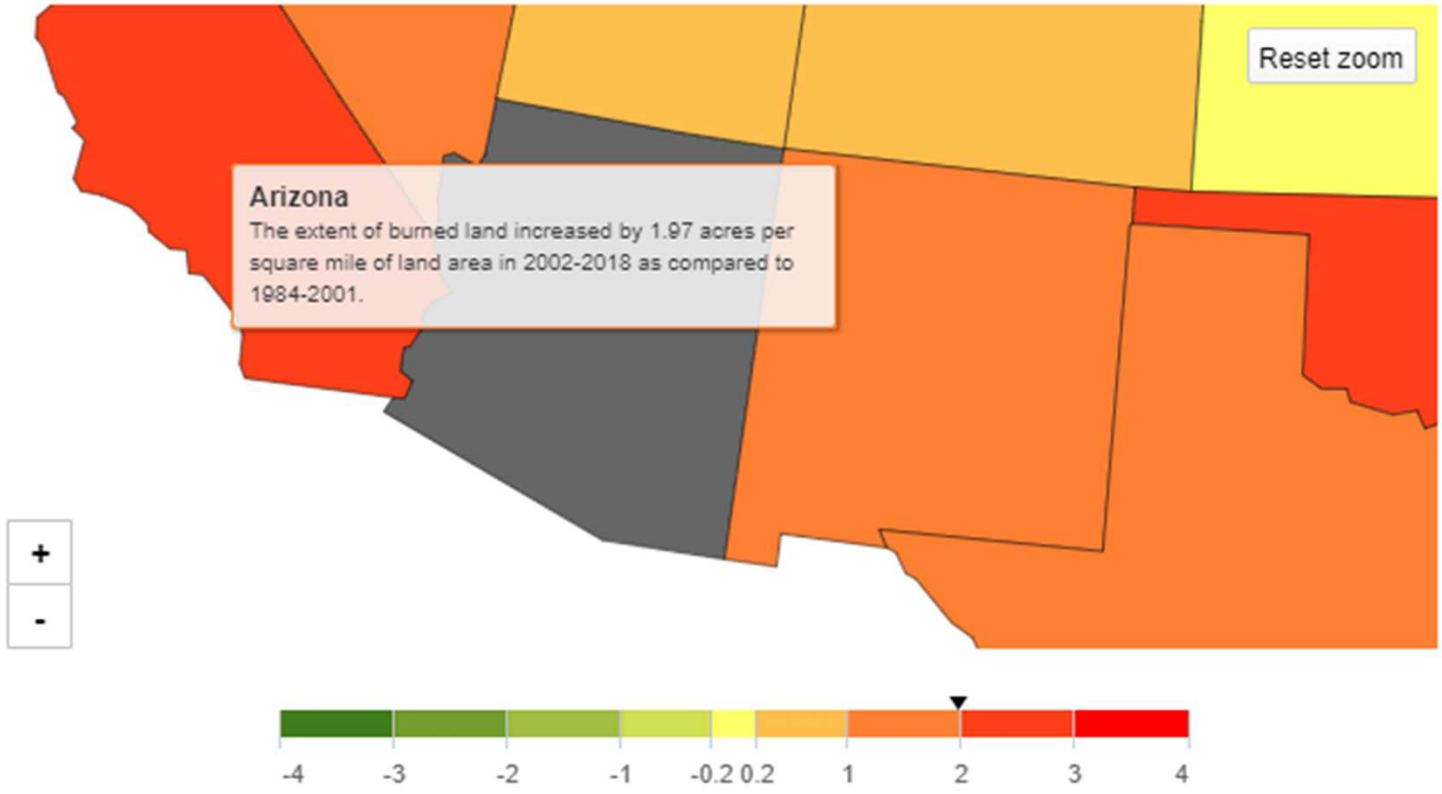
Failure of irrigation supply



https://swclimatehub.info/rma/rma-data-viewer.html

Wildfire

Figure 5. Change in Annual Burned Acreage by State Between 1984-2001 and 2002-2018



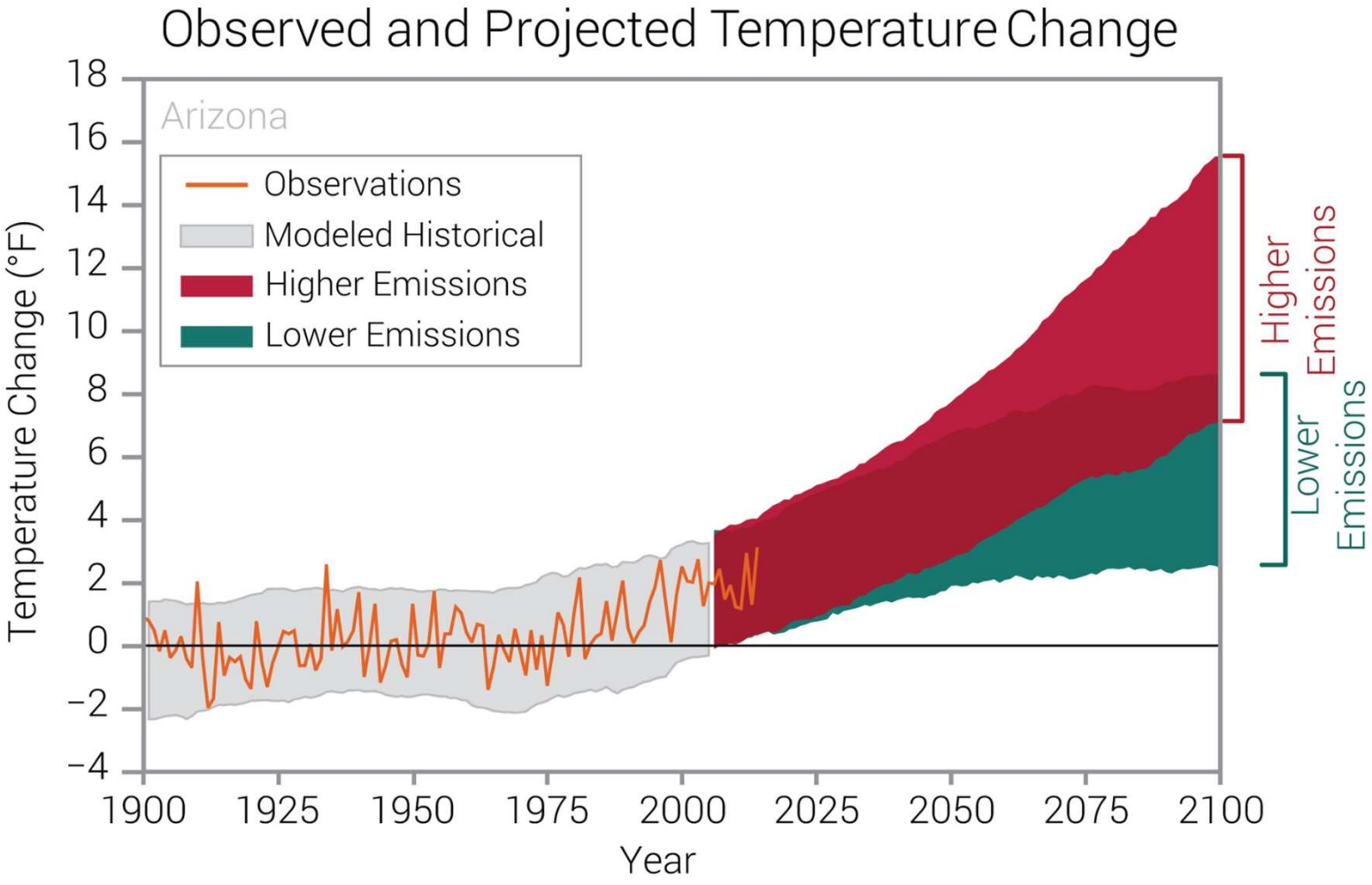
Increase in annual burned acreage of ~225,000 acres

https://www.epa.gov/climate-indicators/climate-change-indicators-wildfires

What management changes have you seen producers adopting to adjust to changing weather/climate conditions and associated impacts on their operations?

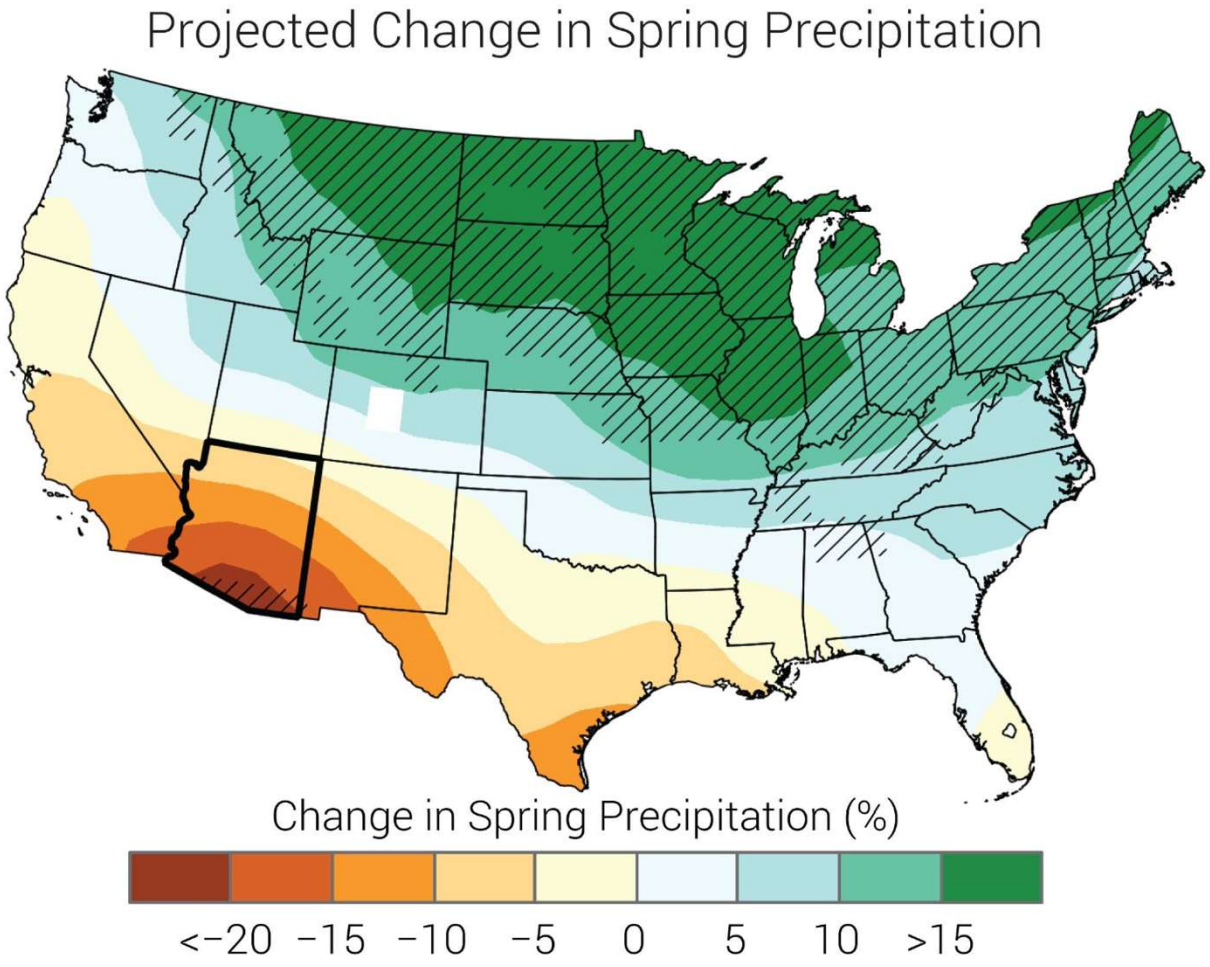
enter in chat box

The next 80 years?

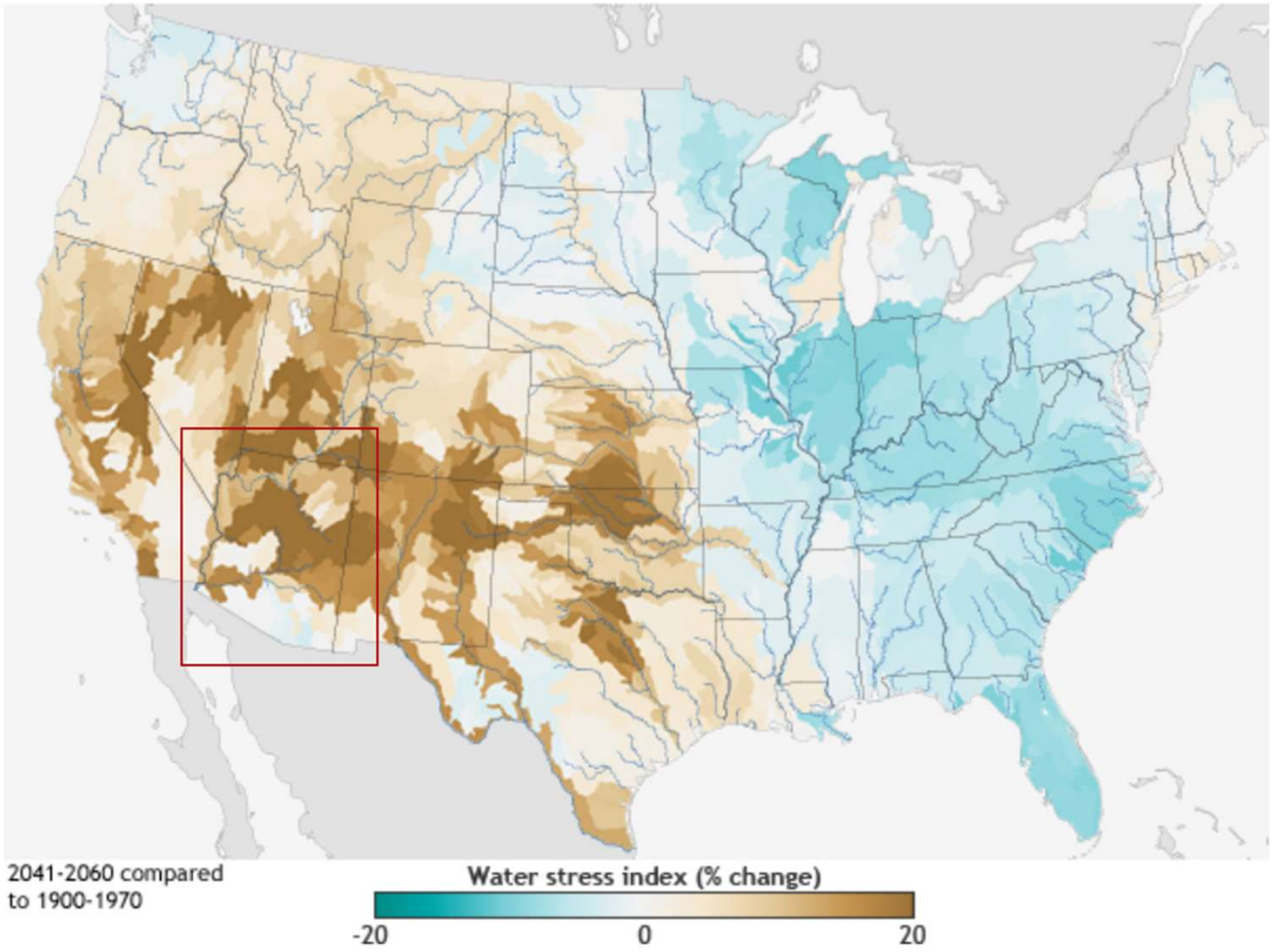


https://statesummaries.ncics.org/chapter/az/

The next 80 years?

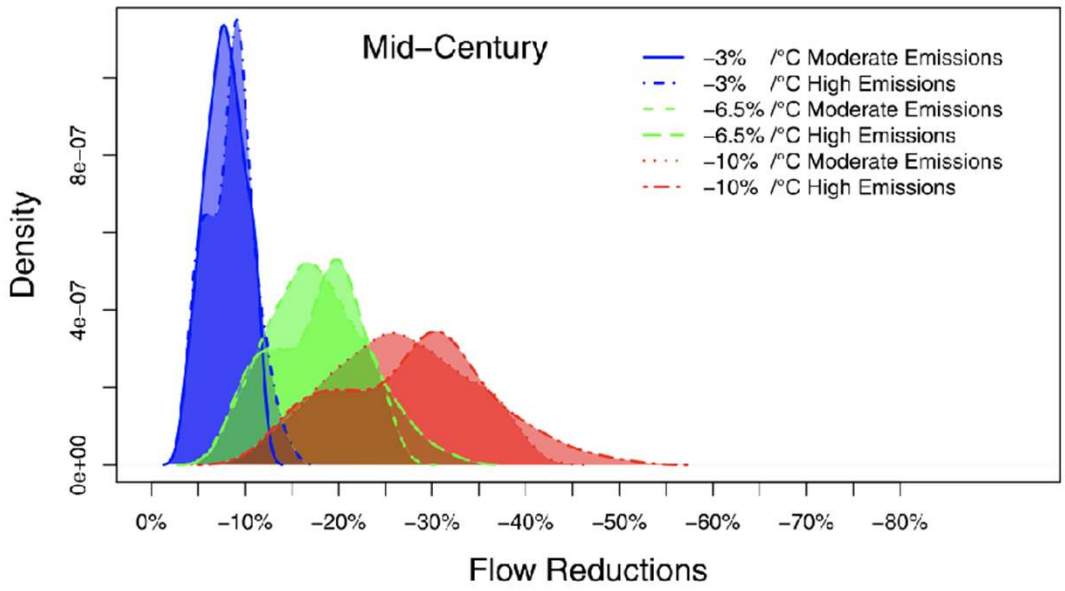


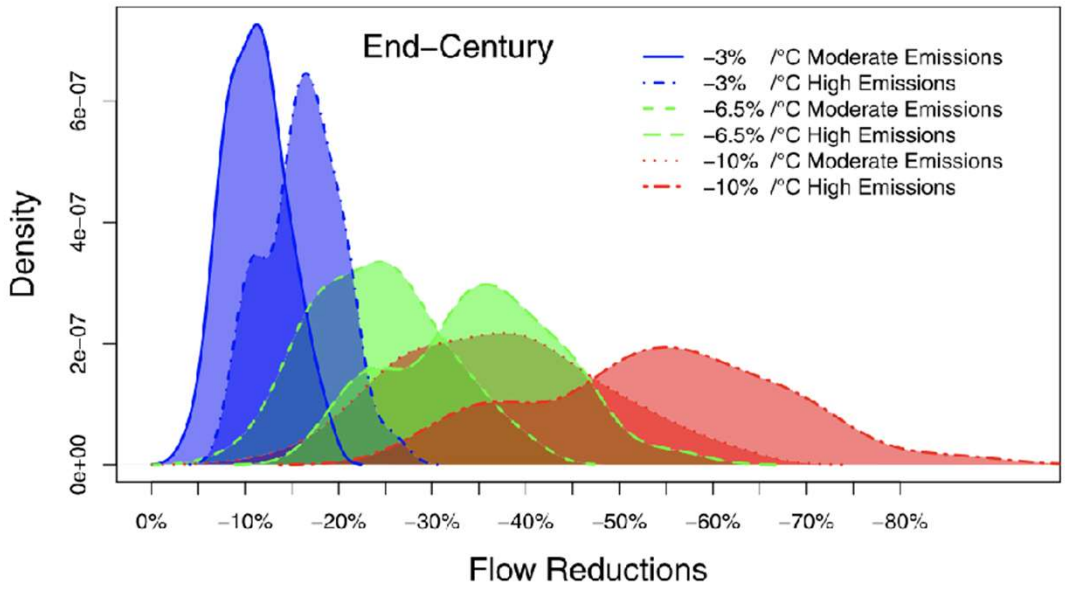
https://statesummaries.ncics.org



Mid-century (2040-2061) change in water stress compared to historical average (1900-1970)

https://www.climate.gov/news-features/featured-images/climate-change-increase-water-stress-many-parts-us





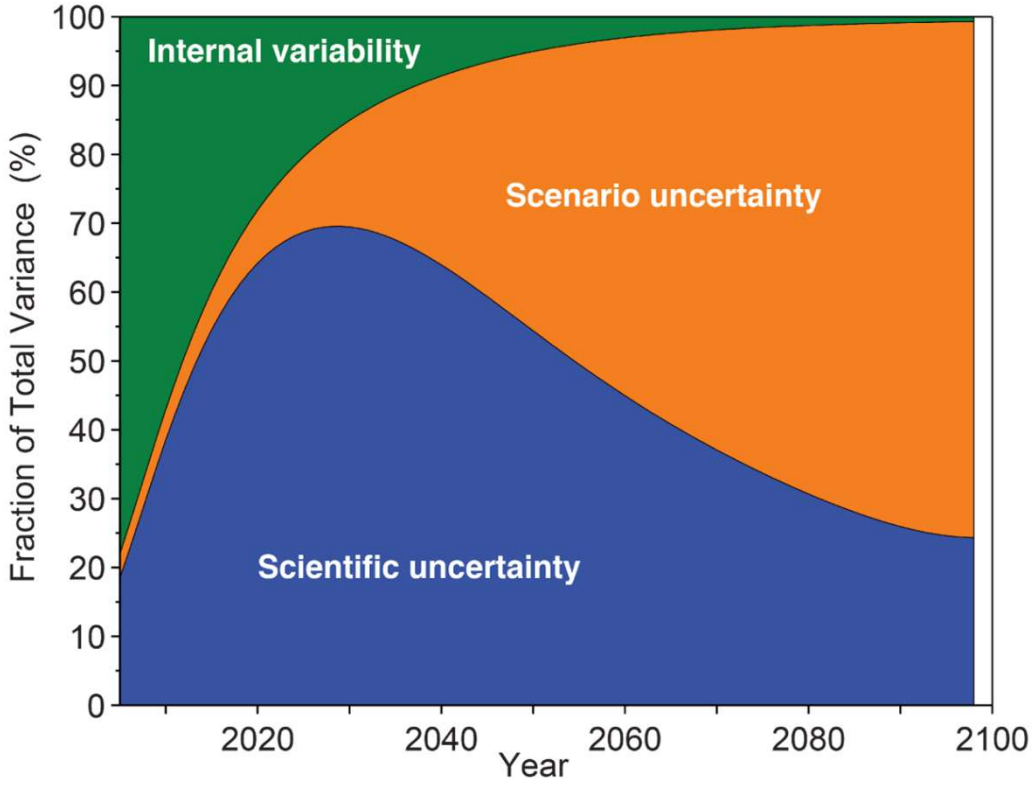
Bleak future for the Upper Colorado?

Probability of change in the flow in the UCR for different emissions scenarios and associated changes in temperature (Udall and Overpeck, 2017).

Arizona – the next 10 years?

"Climate models don't work so well in this timescale, because natural variability arising from modes/oscillations (like ENSO) dominate the precipitation patterns over the Southwest…

ENSO variability will be the biggest determinant of winter precipitation variability and natural variations (as best as we can tell) in the monsoon…



…on average, temperatures will likely rise over the next years but, will rise/fall in concert with wet periods and we can still expect cool/dry winters which can happen during La Niña winters (like winter 20-21).

Pers. Comm. Mike Crimmins – U of A, Associate Specialist & Associate Professor, Climate Science

SRP Watershed and Reservoir Update

Andrew Volkmer, Hydrologist

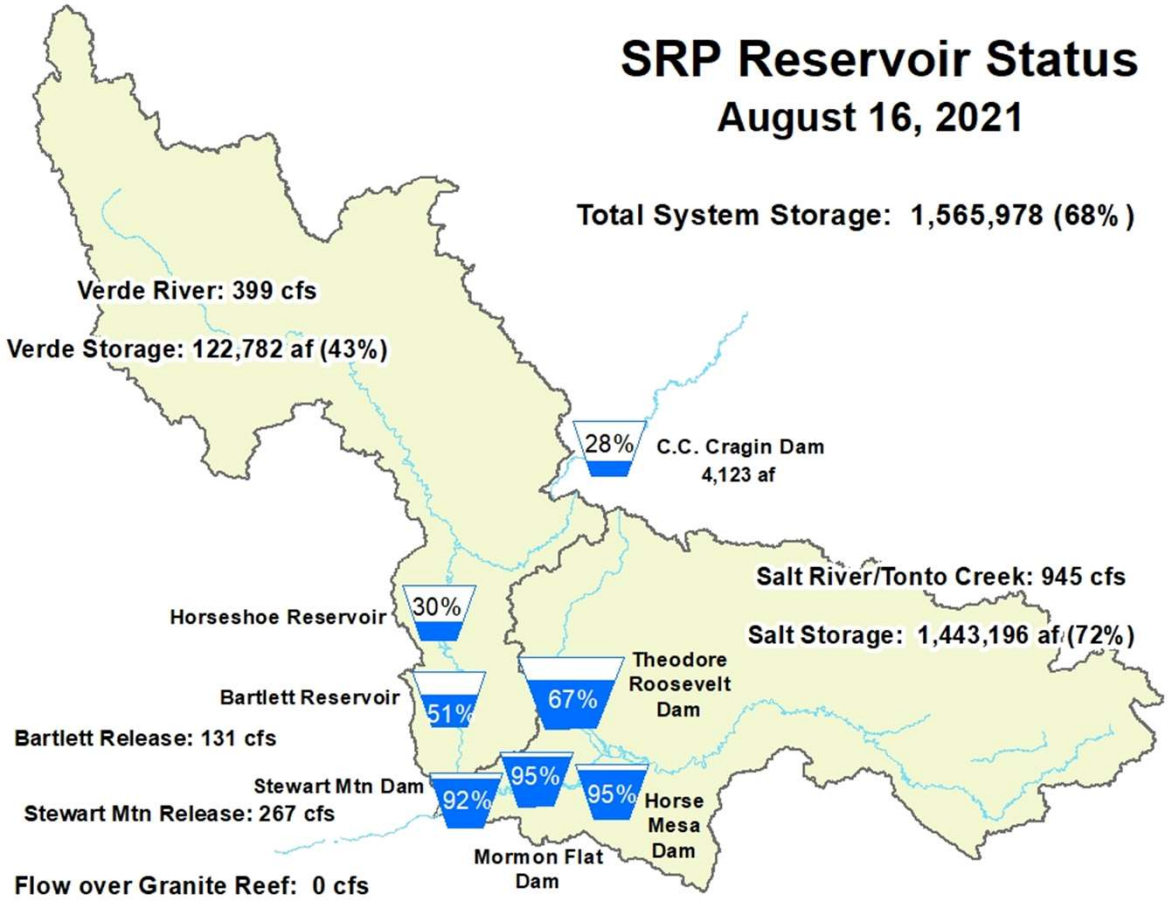
8/18/2021

Delivering water and power™

Reservoir and Watershed Status

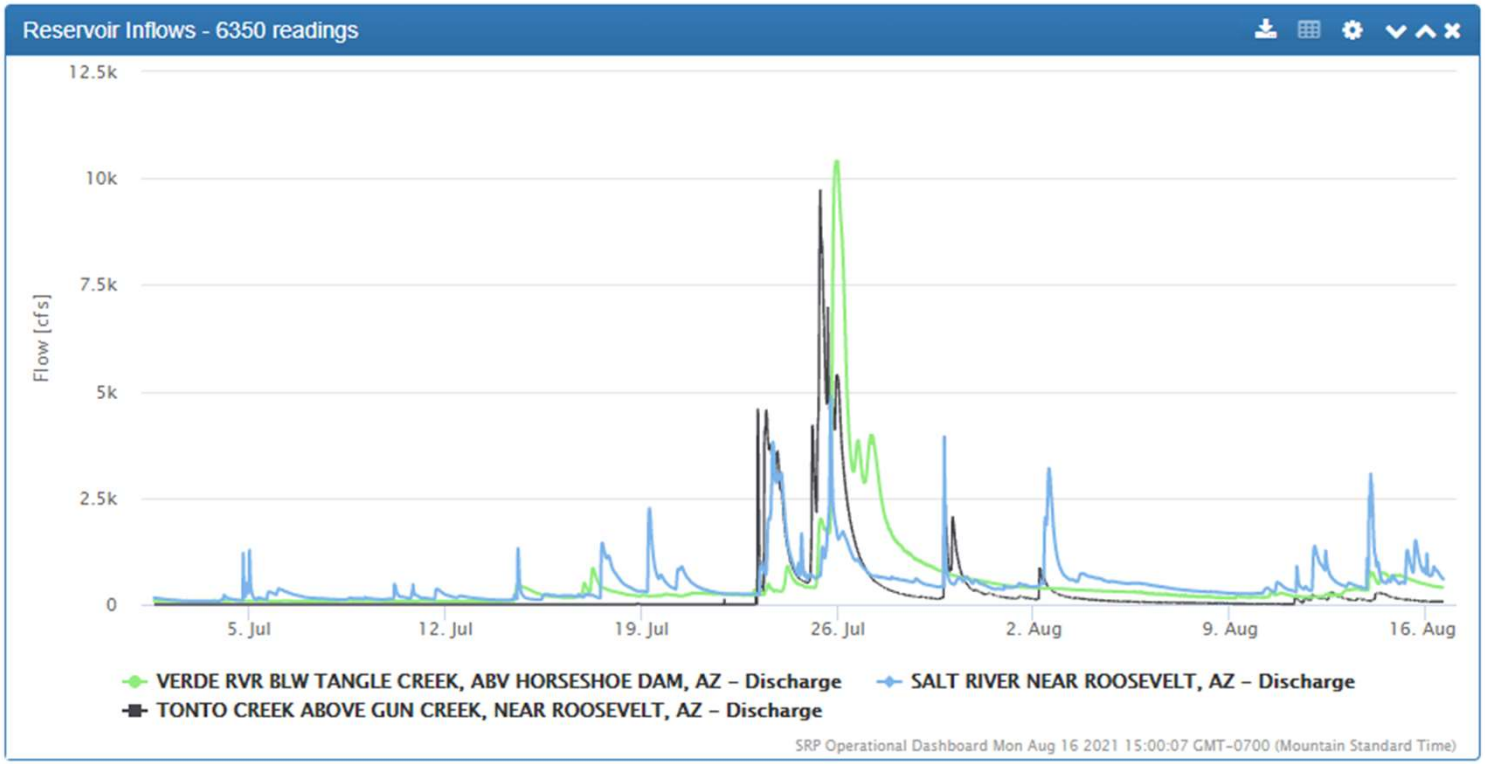
Reservoir Total Storage
1,565,978 AF – 68%
(Last year – 87%)

Current Inflow – 1,344 cfs
Current Outflow – 398 cfs



Delivering water and power™

Salt, Tonto, Verde Streamflow

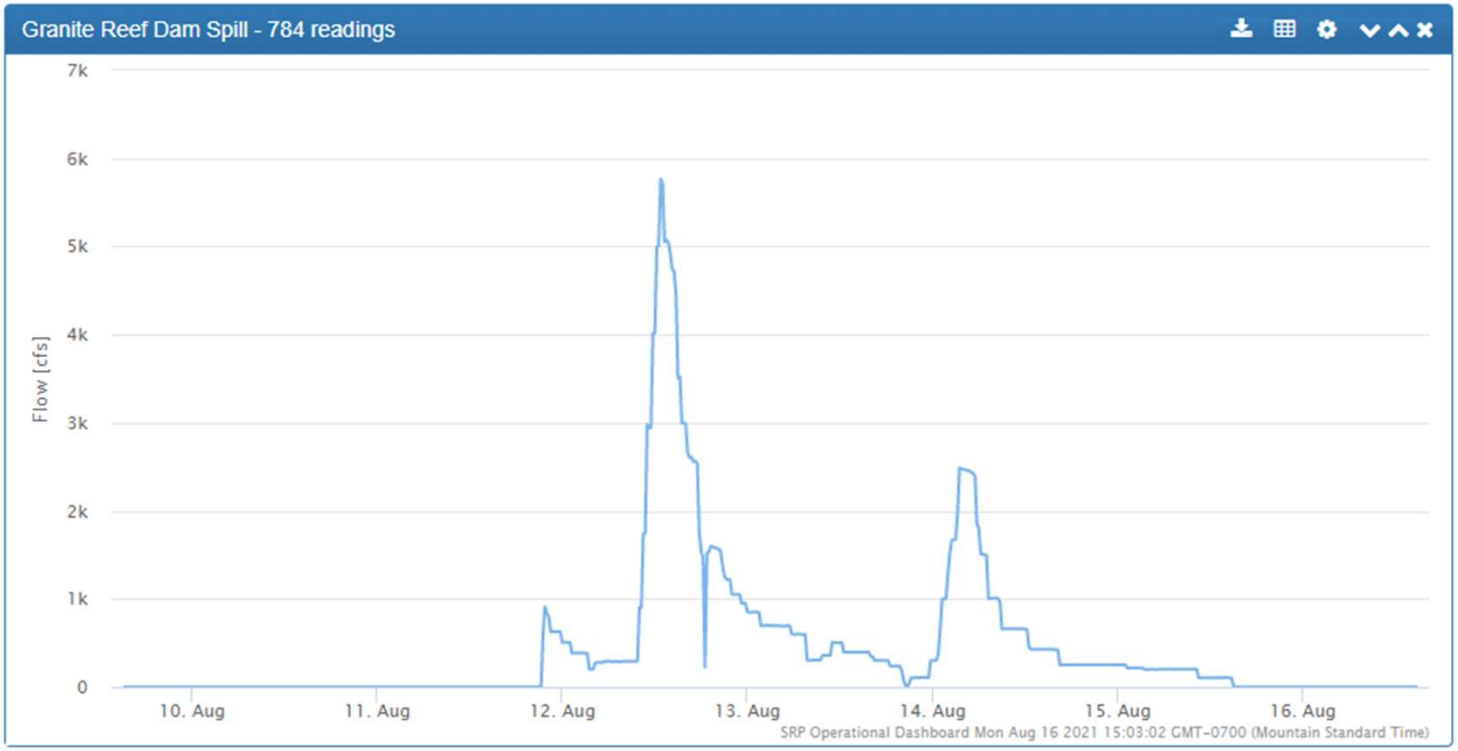


Salt, Tonto, Verde Inflows: Winter 2021 vs July 2021

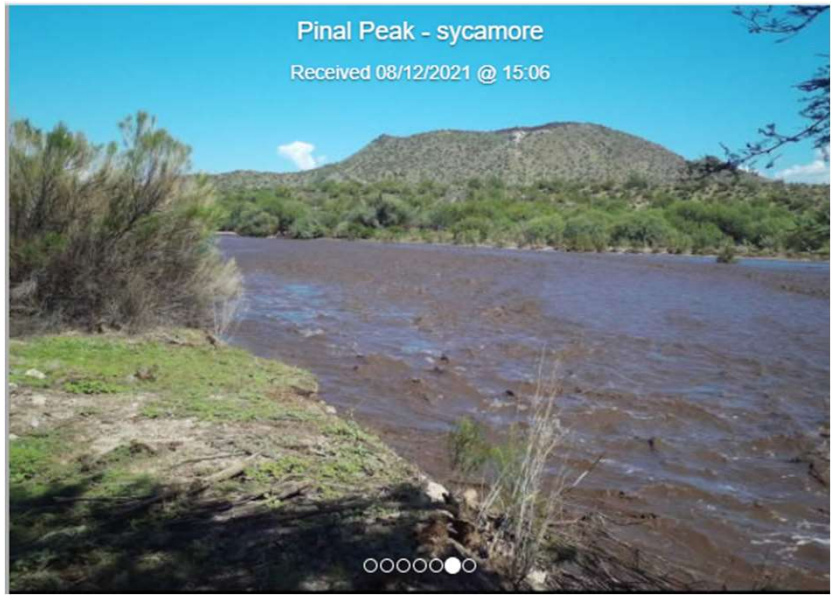
	Winter 2021 Inflows (AF) Jan 1 – May 31	July 2021 Inflows (AF)	July % median
Salt River near Roosevelt	43,089*	28,323	185%
Tonto Creek above Gun Creek	4,311	26,213^	3,248%
Verde River below Tangle Creek	56,466***	36,503	412%
Total (SRP reservoir inflow)	103,866**	91,039^^	355%

** lowest on record, ** 2nd lowest on record (behind 2018), *** 3rd lowest on record (behind 2018 and 2002)*
^ Highest on record, ^^3rd highest on record (behind 1919 and 1915)

Spill over Granite Reef Dam

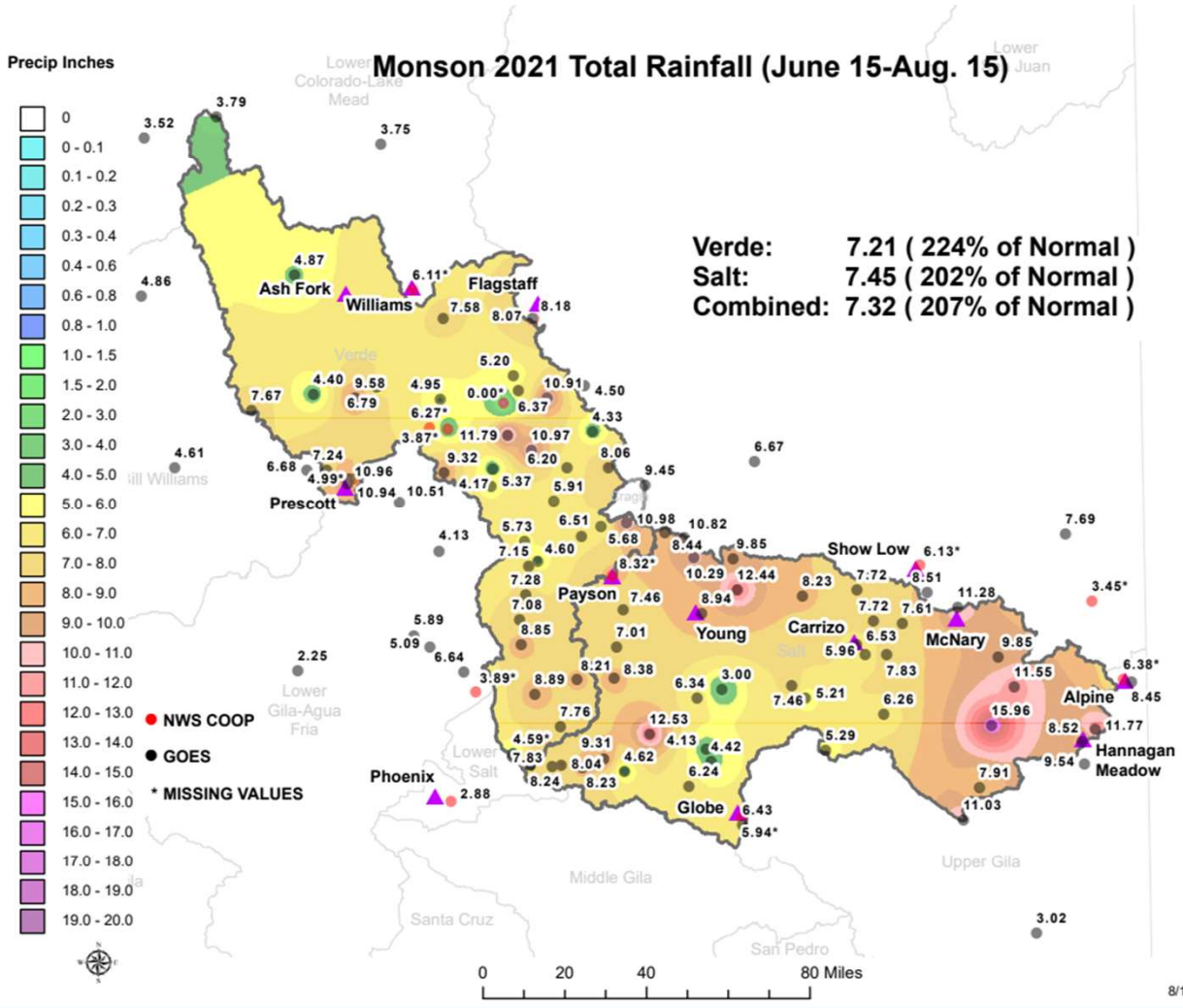


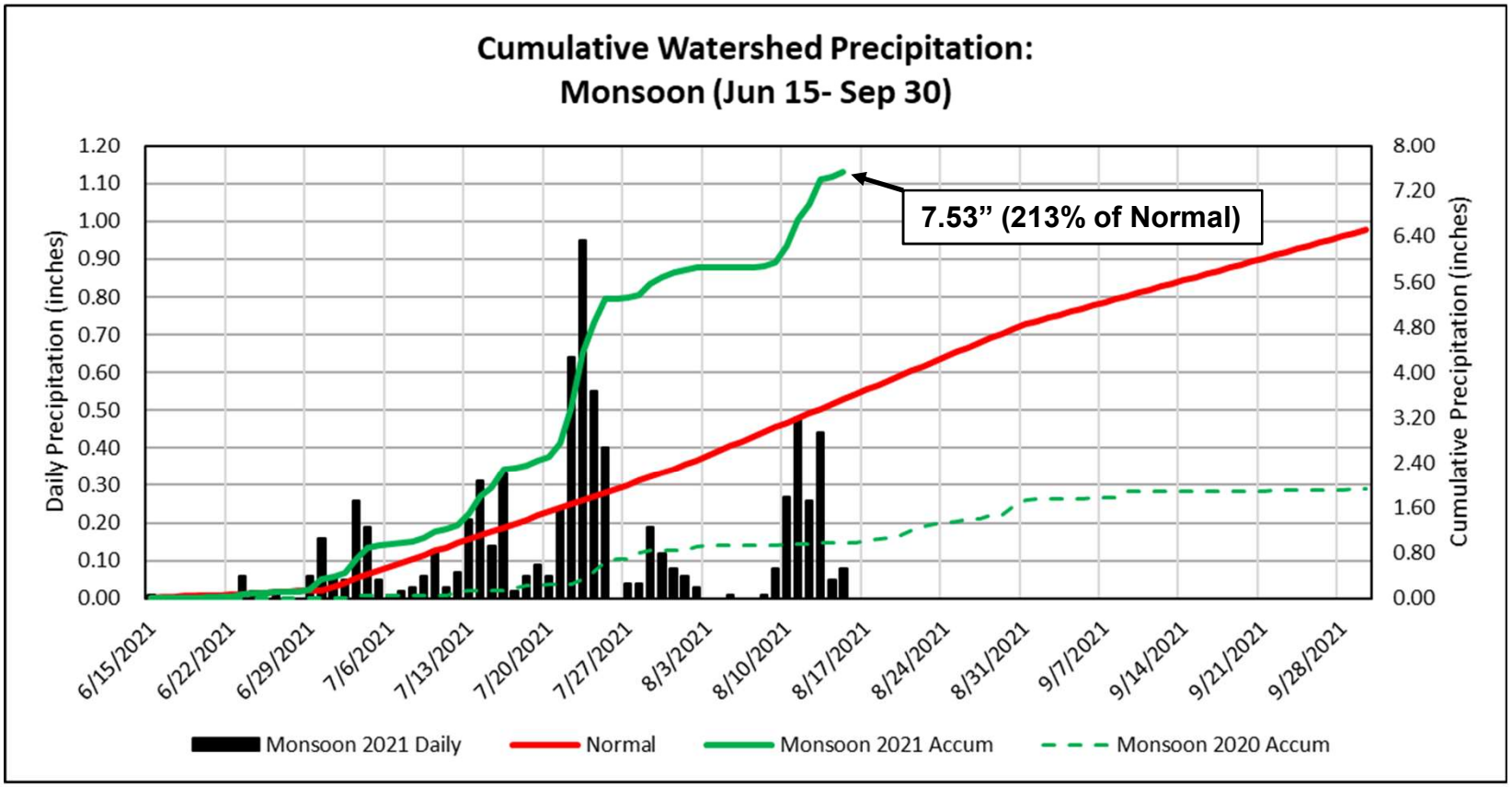
Lower Sycamore Creek



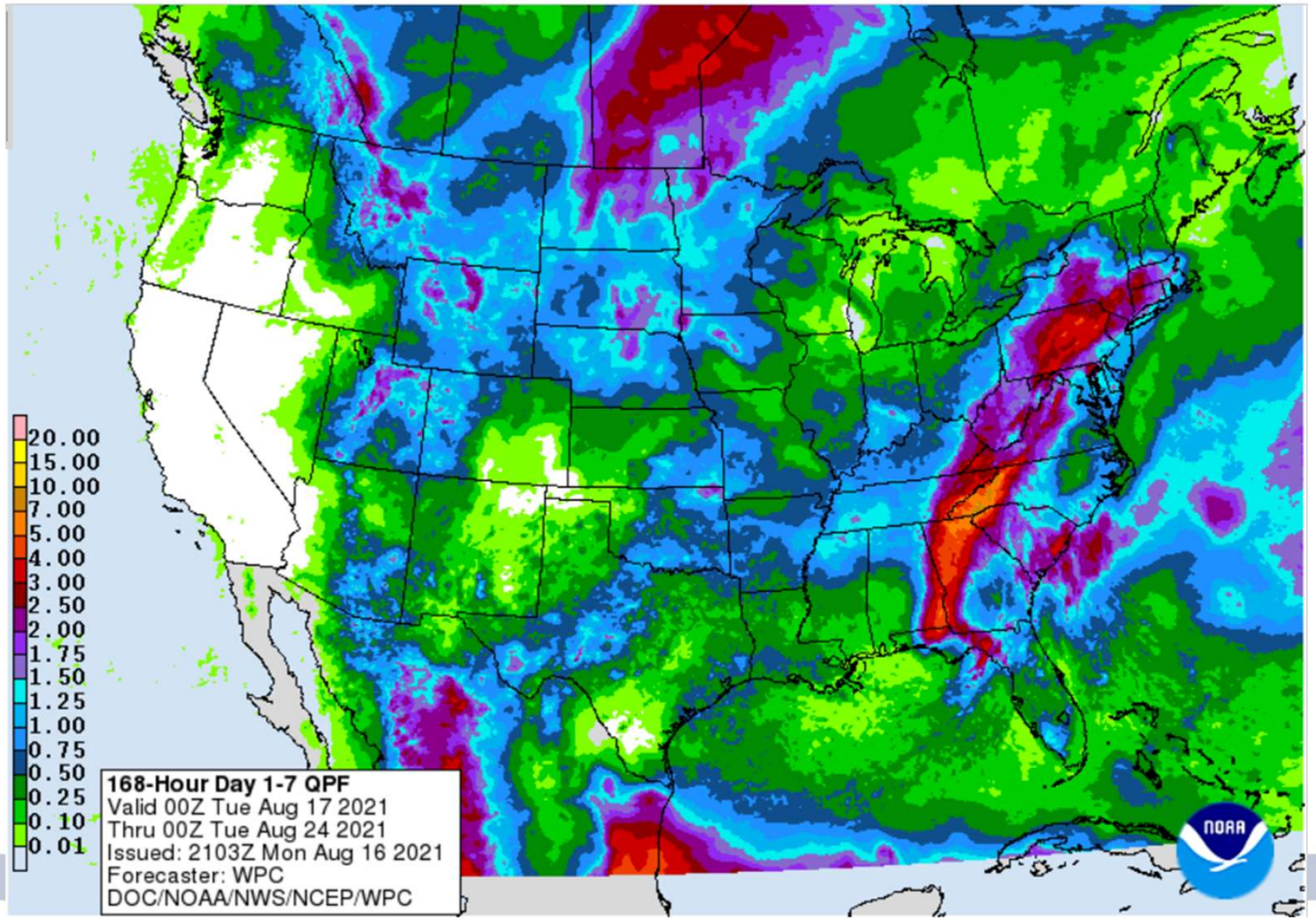
Cottonwood Creek

Delivering water and power™


Monson 2021 Total Rainfall (June 15-Aug. 15)
Precip Inches
0
0 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.6
0.6 - 0.8
0.8 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 3.0
3.0 - 4.0
4.0 - 5.0
5.0 - 6.0
6.0 - 7.0
7.0 - 8.0
8.0 - 9.0
9.0 - 10.0
10.0 - 11.0
11.0 - 12.0
12.0 - 13.0
13.0 - 14.0
14.0 - 15.0
15.0 - 16.0
16.0 - 17.0
17.0 - 18.0
18.0 - 19.0
19.0 - 20.0
NWS COOP
GOES
* MISSING VALUES
Verde: 7.21 (224% of Normal)
Salt: 7.45 (202% of Normal)
Combined: 7.32 (207% of Normal)
Ash Fork
Williams
Flagstaff
Prescott
Payson
Show Low
Young
Carrizo
McNary
Alpine
Hannagan Meadow
Phoenix
Globe
Lower Colorado-Lake Mead
Lower Juan
Verde
Lower Gila-Agua Fria
Lower Salt
Middle Gila
Upper Gila
Santa Cruz
San Pedro
0 20 40 80 Miles
8/16/2021

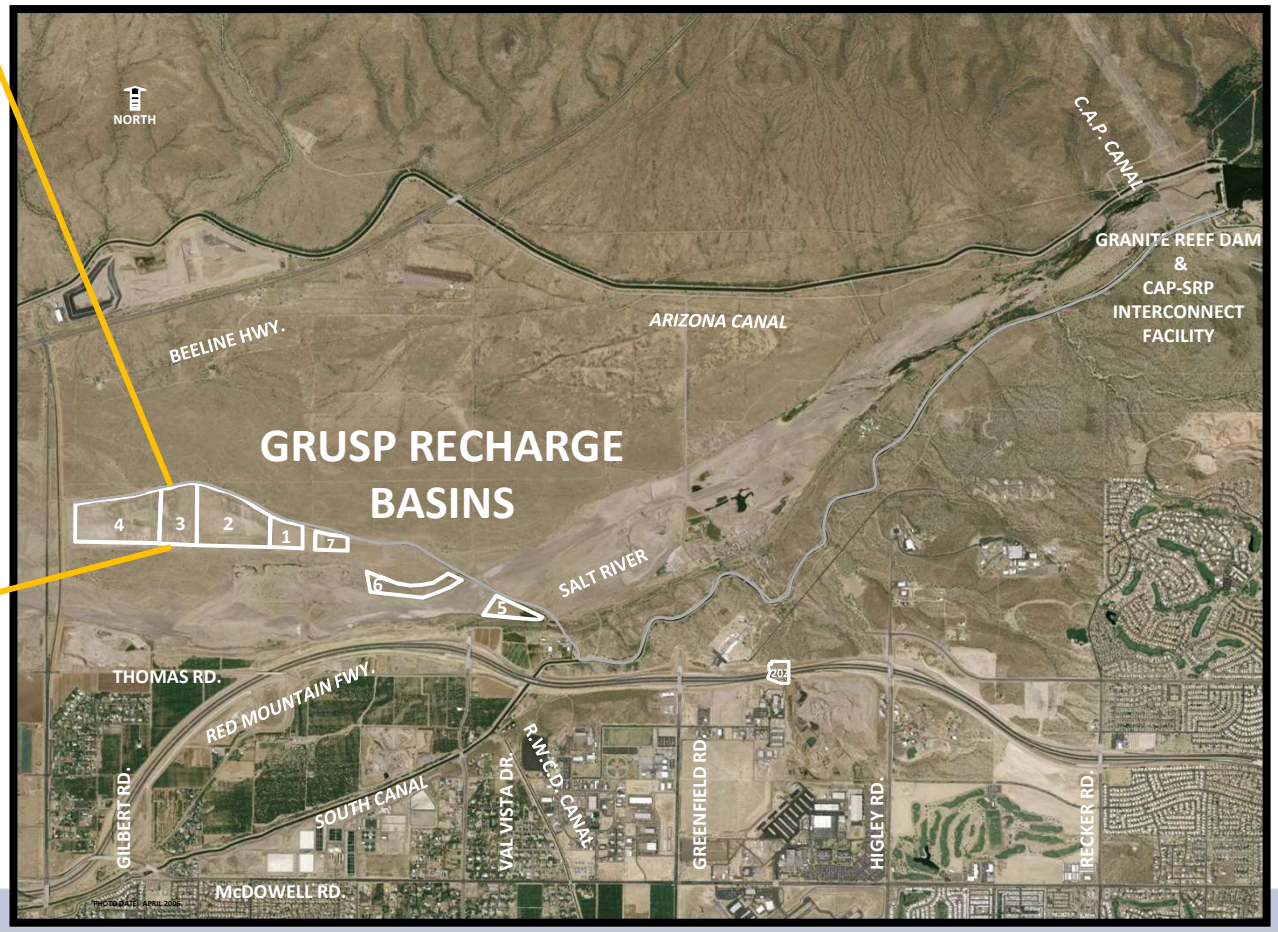

Cumulative Watershed Precipitation:
Monsoon (Jun 15- Sep 30)
Daily Precipitation (inches)
Cumulative Precipitation (inches)
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
8.00
7.20
6.40
5.60
4.80
4.00
3.20
2.40
1.60
0.80
0.00
7.53" (213% of Normal)
6/15/2021
6/22/2021
6/29/2021
7/6/2021
7/13/2021
7/20/2021
7/27/2021
8/3/2021
8/10/2021
8/17/2021
8/24/2021
8/31/2021
9/7/2021
9/14/2021
9/21/2021
9/28/2021
Monsoon 2021 Daily
Normal
Monsoon 2021 Accum
Monsoon 2020 Accum

8/16/2021 – Days 1-7 QPF

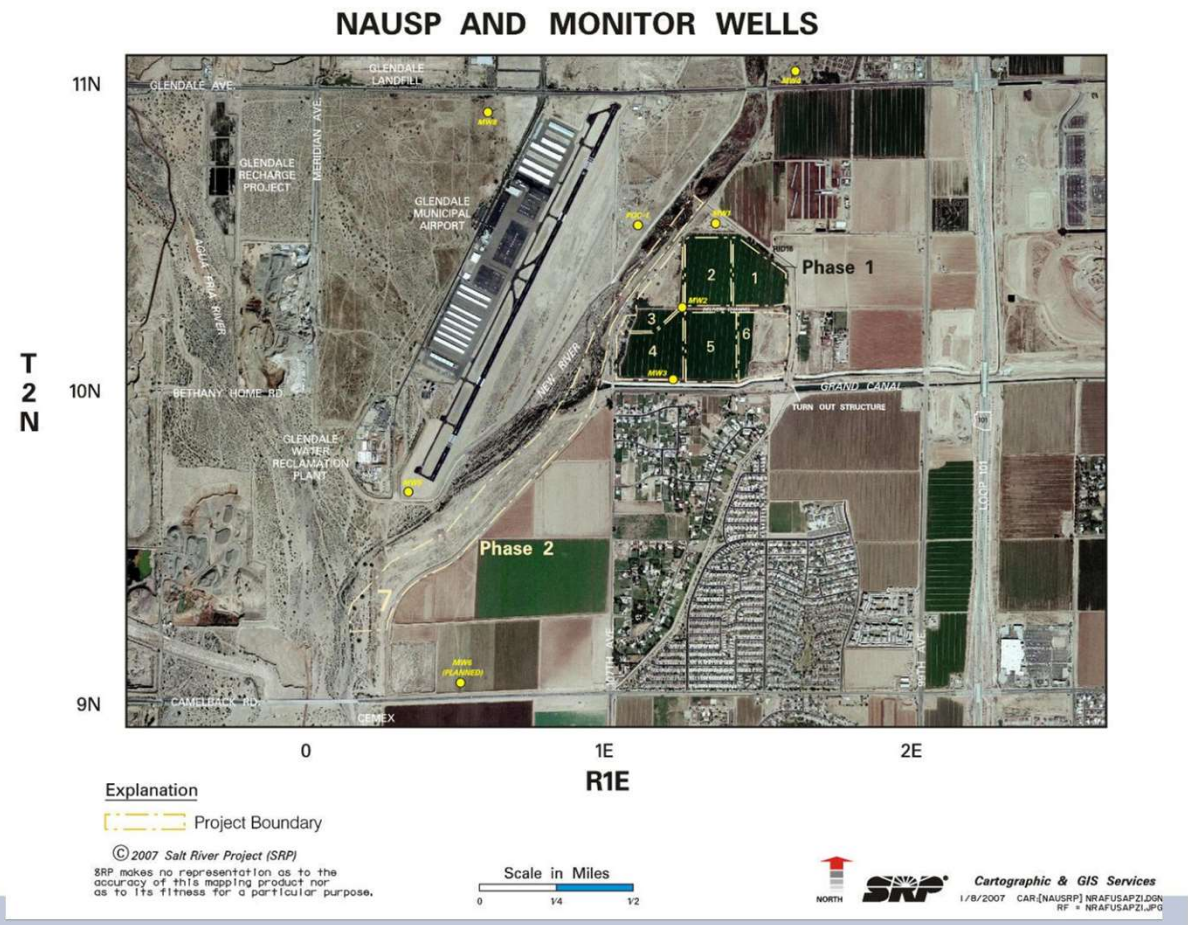


Delivering water and power™

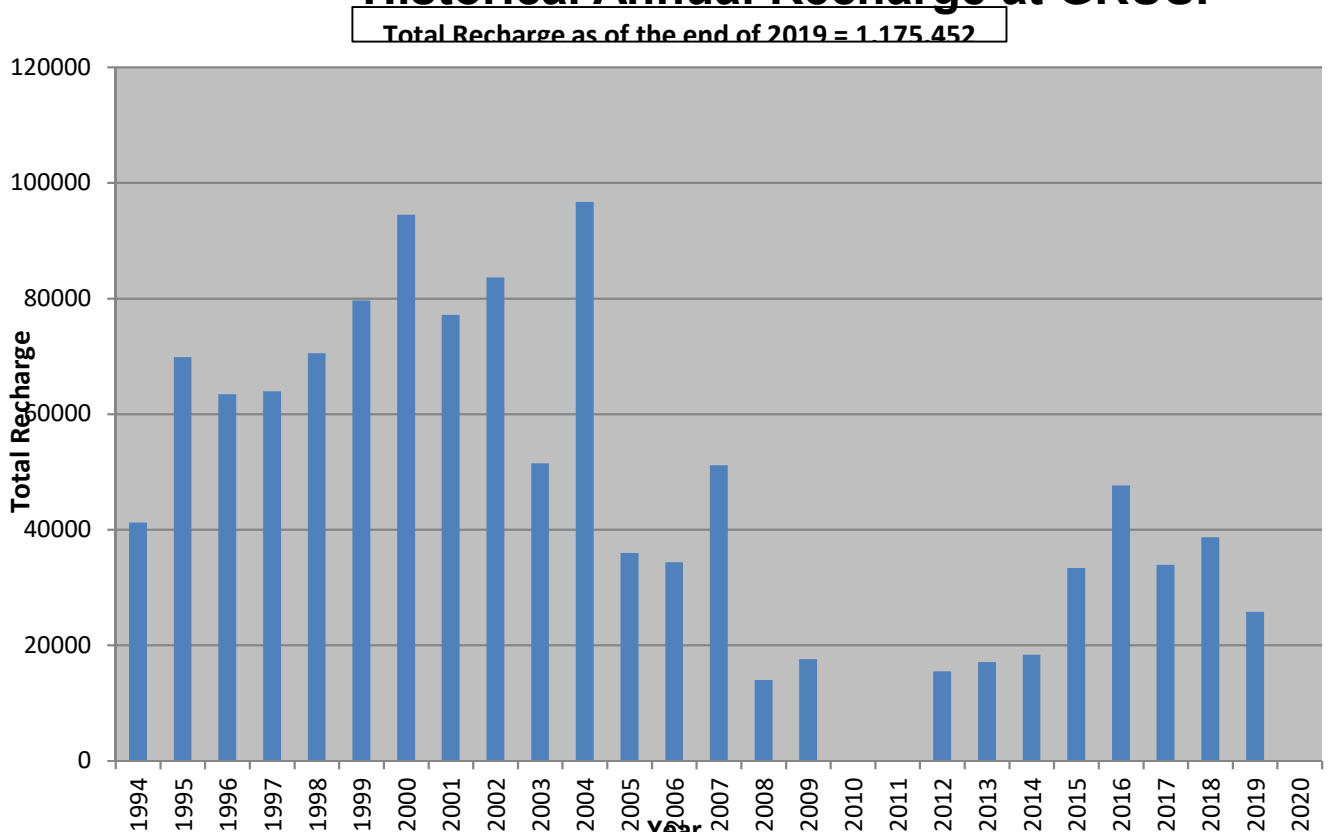
Granite Reef Underground Storage Project



New River-Agua Fria River Underground Storage Project (NAUSP)

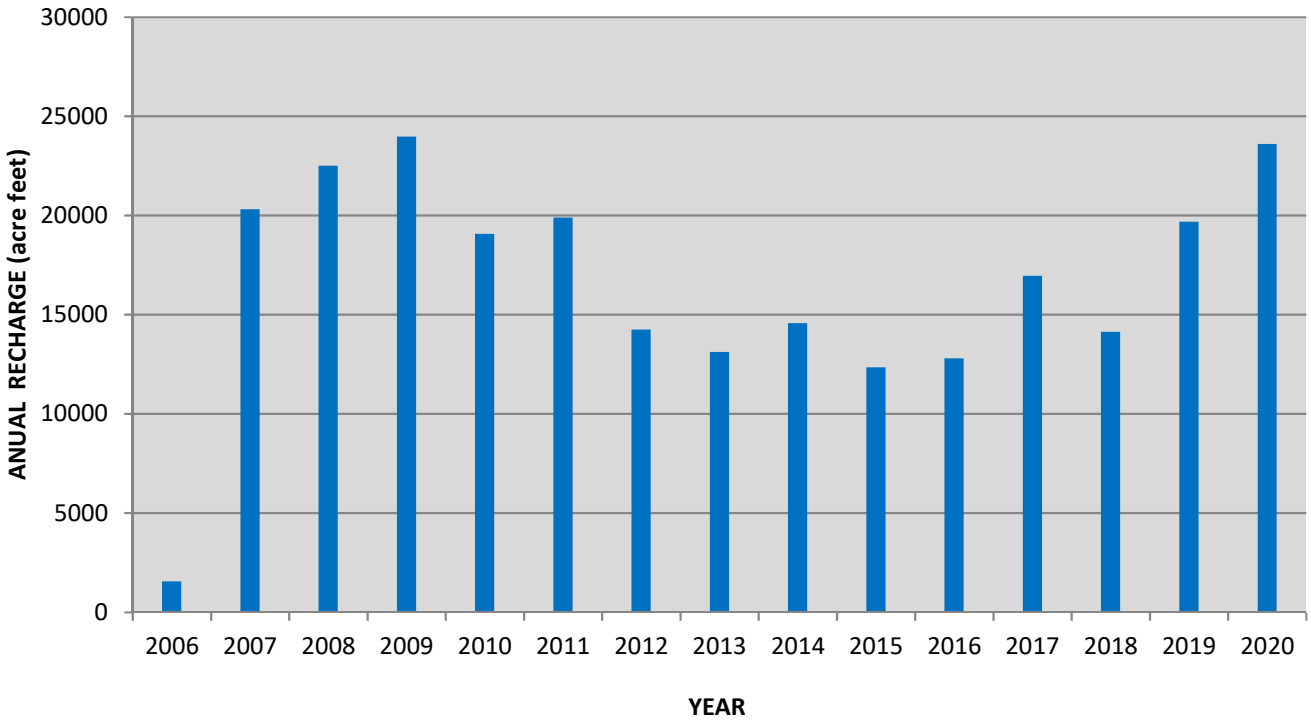


Historical Annual Recharge at GRUSP



ANNUAL RECHARGE at NAUSP

(Total Historical Facility Recharge at end of 2020 = 248,755 acre feet)



Delivering water and power™

Thanks! Any questions?

Andrew Volkmer

Andrew.Volkmer@srpnet.com

(602) 236 - 0402

USDA United States Department of Agriculture
Southwest Climate Hub

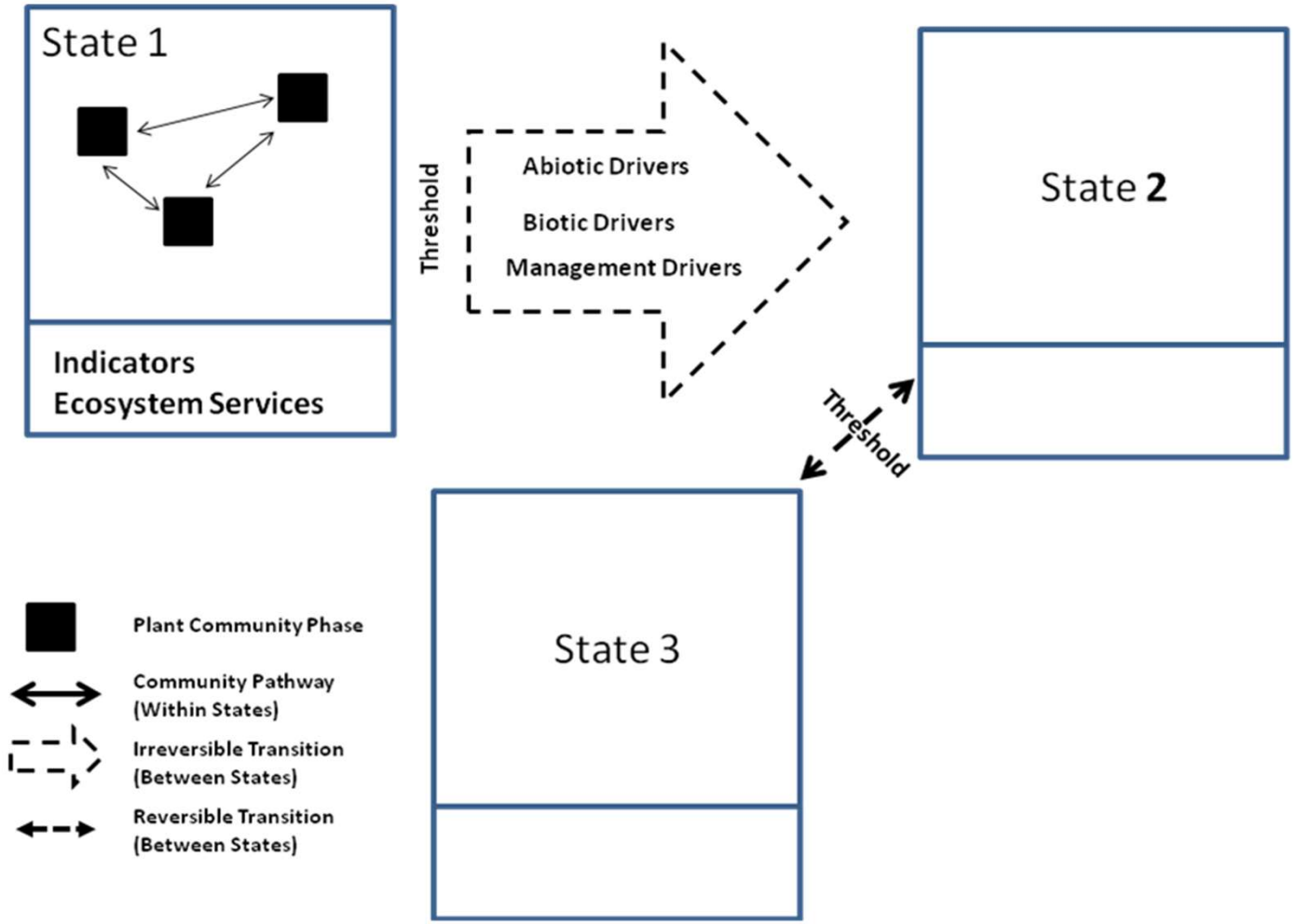
When Adaptation Fails – Transformation

Joel Brown, NRCS, SW Climate Hub Co-director

Adaptation or Transformation

- Adaptation-doing more of the same thing or modifying actions
- Transformation-substantial changes to actions in response to climate change
  - *new-products, services, management systems*
  - *changes in scale and intensity*
  - *changes in locations*
- Responsive or Anticipatory
- Technological or Behavioral

Conceptualizing Transformation



Transformation in Arizona Granitic Hills 16-20”pz R038XB204AZ

1. Reference -Chaparral

2. Shrub-Pinyon Juniper

3. Manzanita Turbinella

4. Manzanita

Transformation in Arizona

Other Examples

Loss of irrigation water
Grassland – Shrubland conversion
?

Add other examples in the chat box

What do we need to do help Arizona adapt to climate change?

- Ranchers
- Irrigated/Dryland Farmers
- Rural/Urban water needs
- Agricultural survival strategies

Place thoughts in the chat box

Available Resources

USDA Climate Hubs

Natural Resources Conservation Service

nrcs.usda.gov

Southwest USDA Climate Hub

- Headquartered at the USDA-ARS Jornada Experimental Range on the New Mexico State University campus in Las Cruces, NM

- Provide information and technology to guide climate-informed decision making by farmers, ranchers, forest landowners, Native American tribes, natural resource managers and technology transfer specialists

- Science driven, stakeholder centered, efficient, cooperative partnerships with federal, state and local organizations

Southwest USDA Climate Hub

Climate Hubs Supporting NRCS

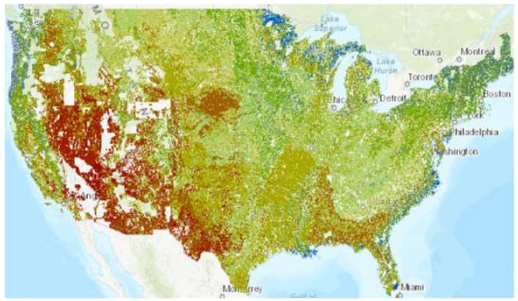
Increase partnership reach and science connections

- Drought Learning Network (focus on how not what)
- Peer-to-peer knowledge transfer
- Tribal Engagement
- SW Beef Project
- ARID Project

Provide Tools to inform Decision-making

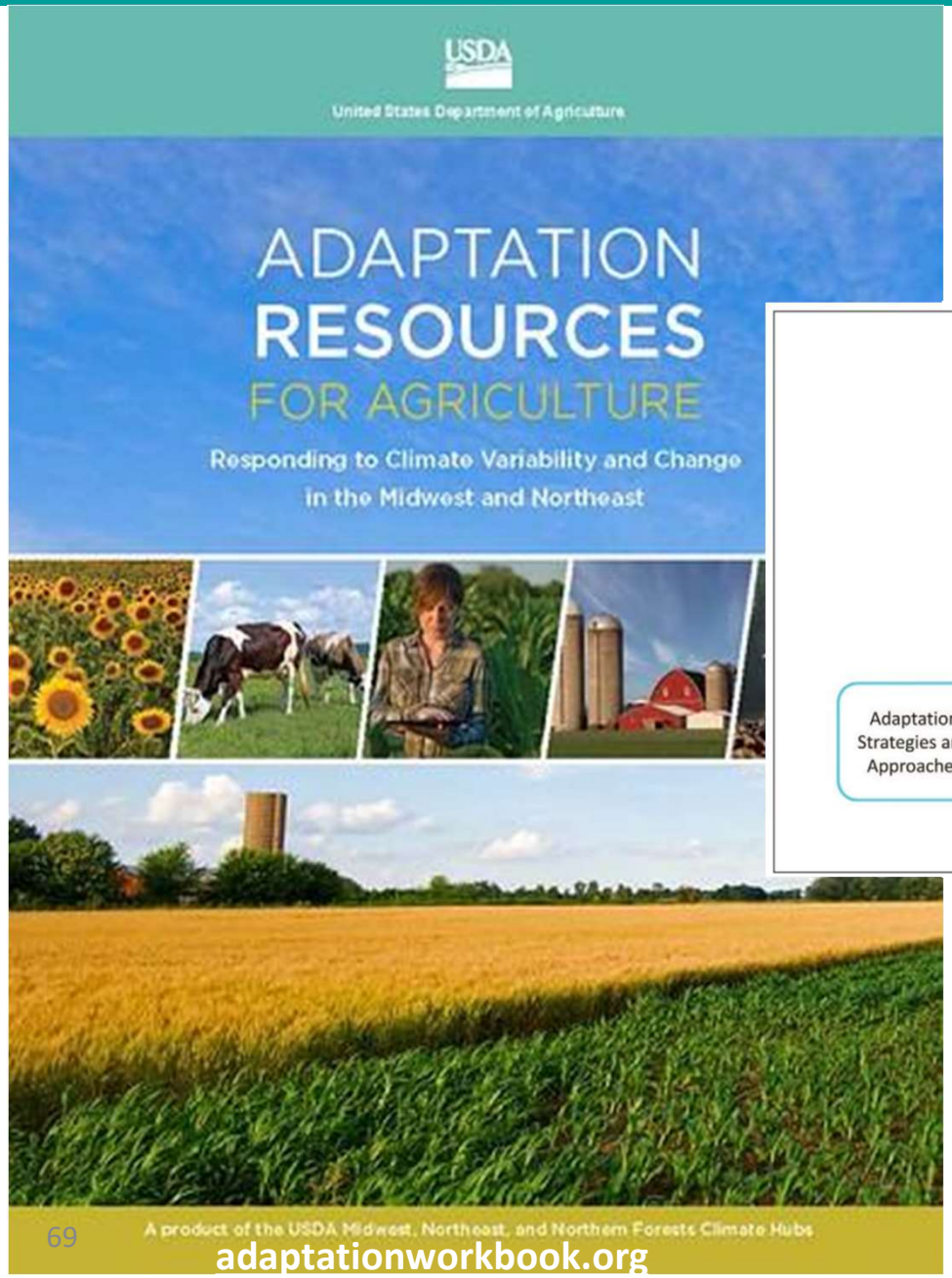
- Grass-Cast
- AgRisk Viewer
- CocoRahs
- Beef Decision Toolshed

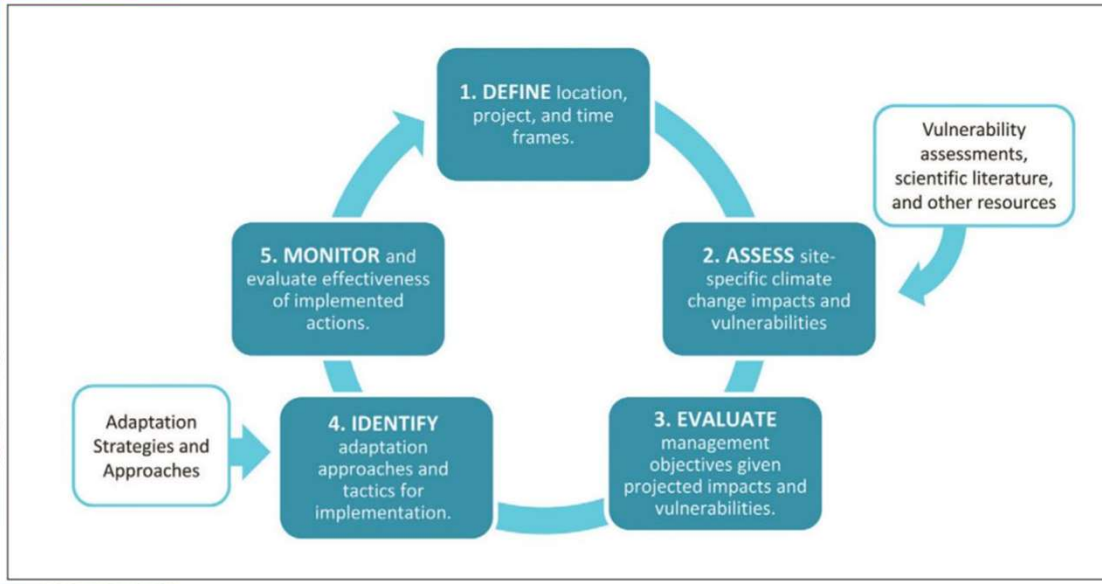
USDA Resources



Natural Resources Conservation Service

nrcs.usda.gov





Natural Resources Conservation Service

nrcs.usda.gov

adaptationworkbook.org

What other partners/resources are available in Arizona?

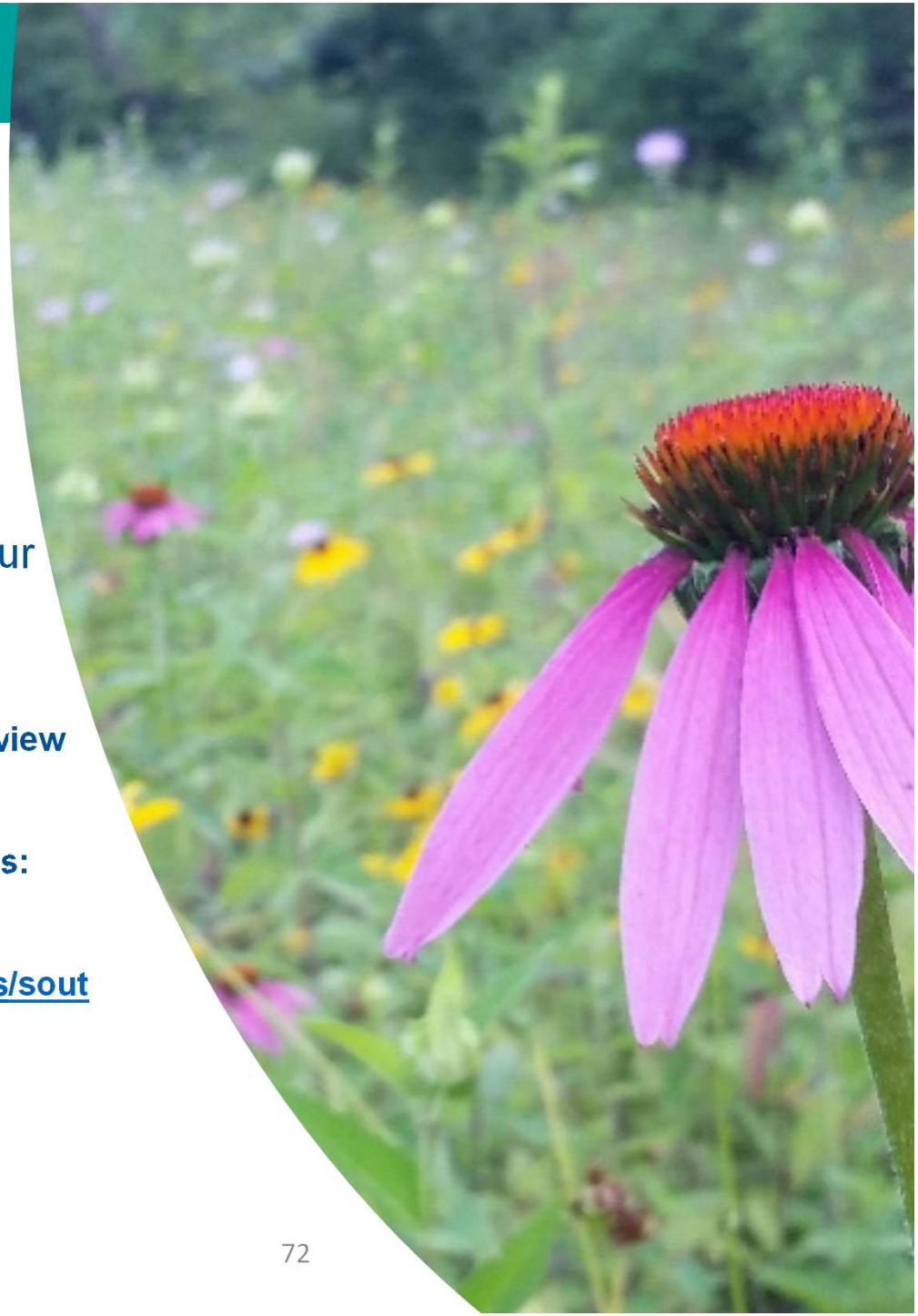
USDA United States Department of Agriculture
Southwest Climate Hub

Climate Smart Agriculture and NRCS

Natural Resources Conservation Service

nrcs.usda.gov/

Where to Start the Conversation About Climate Informed Agriculture



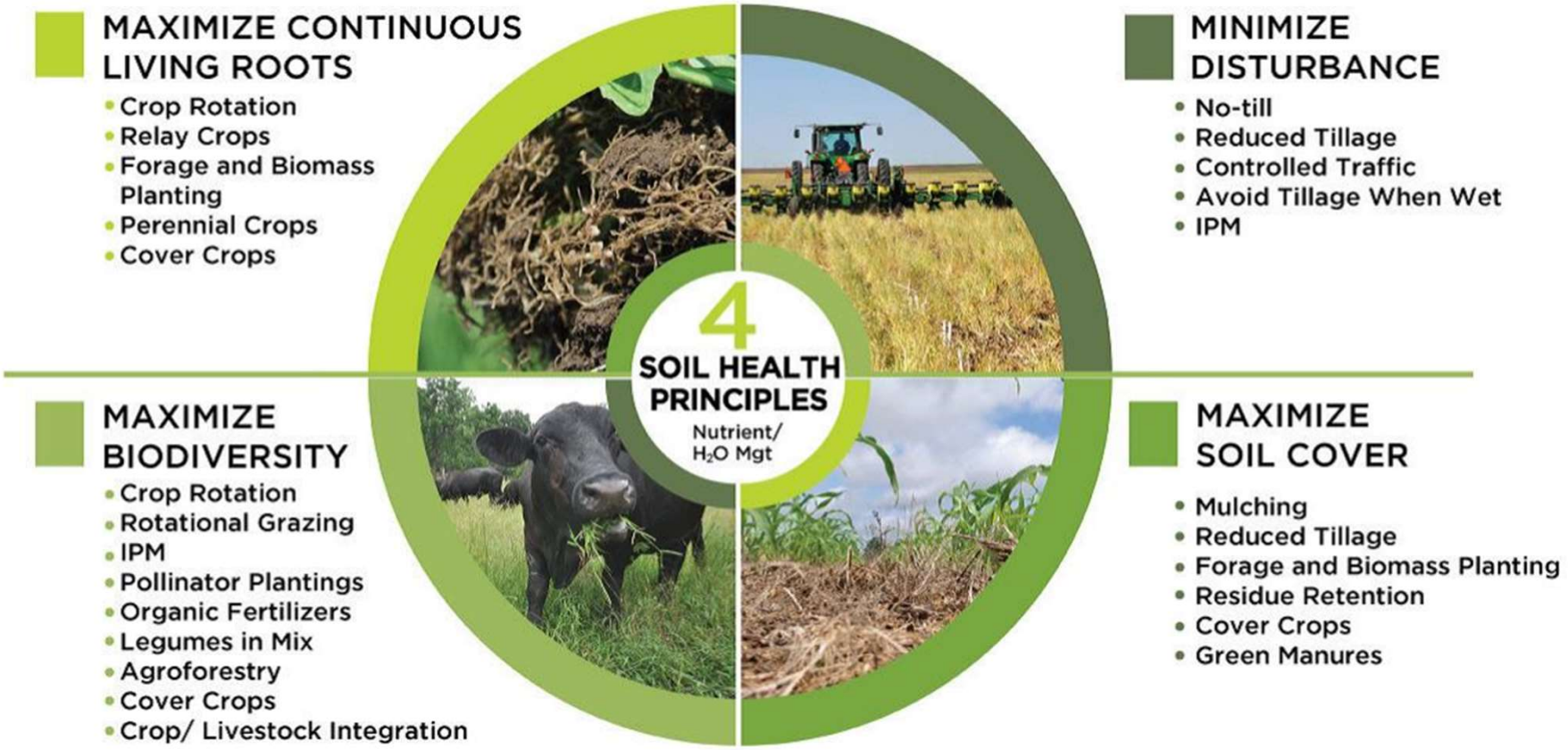
Understand the Climate Information for your area:

- **NOAA State Summaries https://statesummaries.ncics.org/**
- **Weather Explorer to see a county level view of historic and projections: https://crt-climate-explorer.nemac.org/**
- **US Drought Monitor and other resources: www.drought.gov**
- **USDA Climate Hubs: https://www.climatehubs.usda.gov/hubs/southwest**

Where to Start the Conversation About Climate Informed Agriculture

- NRCS professionals know the Landscape and Operation Vulnerabilities
  - Lowlands
  - Steep slopes
  - Poor soils
  - Overgrazing
- Will current practices be sufficient to address the extremes and changes in a changing climate?
- Think through specific crops/operations you are familiar with and use site specific information (ecological site descriptions) to inform planning.

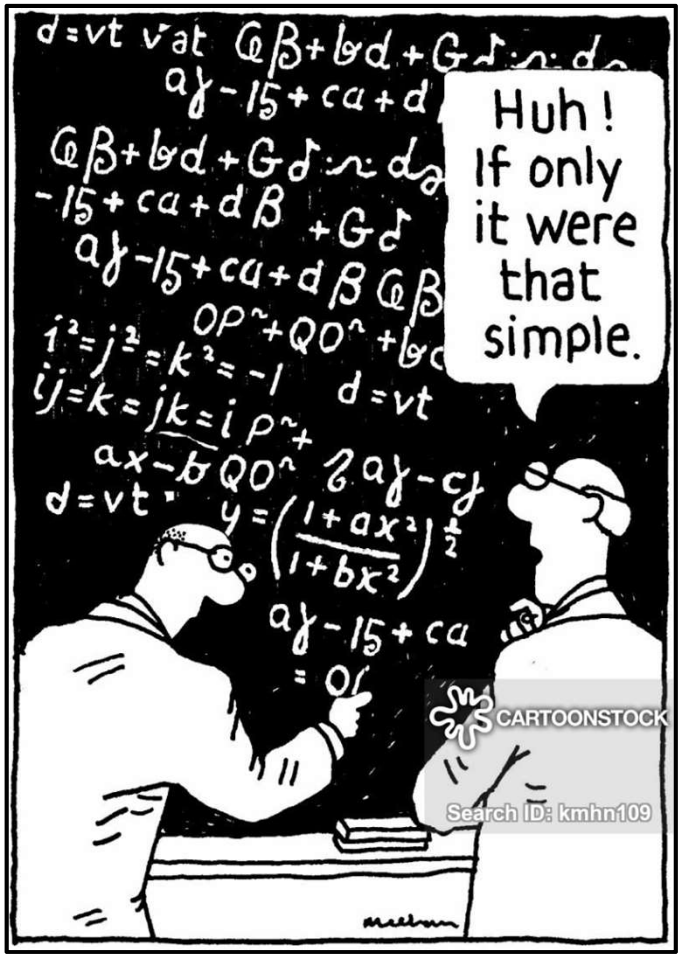
Photo: Scott Woodall



Where to Start the Conversation About Climate Informed Agriculture

- Continue Promoting Keystone NRCS Campaigns
  - Soil Health
  - Contingency plans
    - **Drought**
    - **Flooding**
    - **Extreme heat**
    - **Cold Snaps**
    - **Blizzards**

Relaying the information



NRCS has been translating science into information and actions that agricultural producers can use since it's inception in 1935

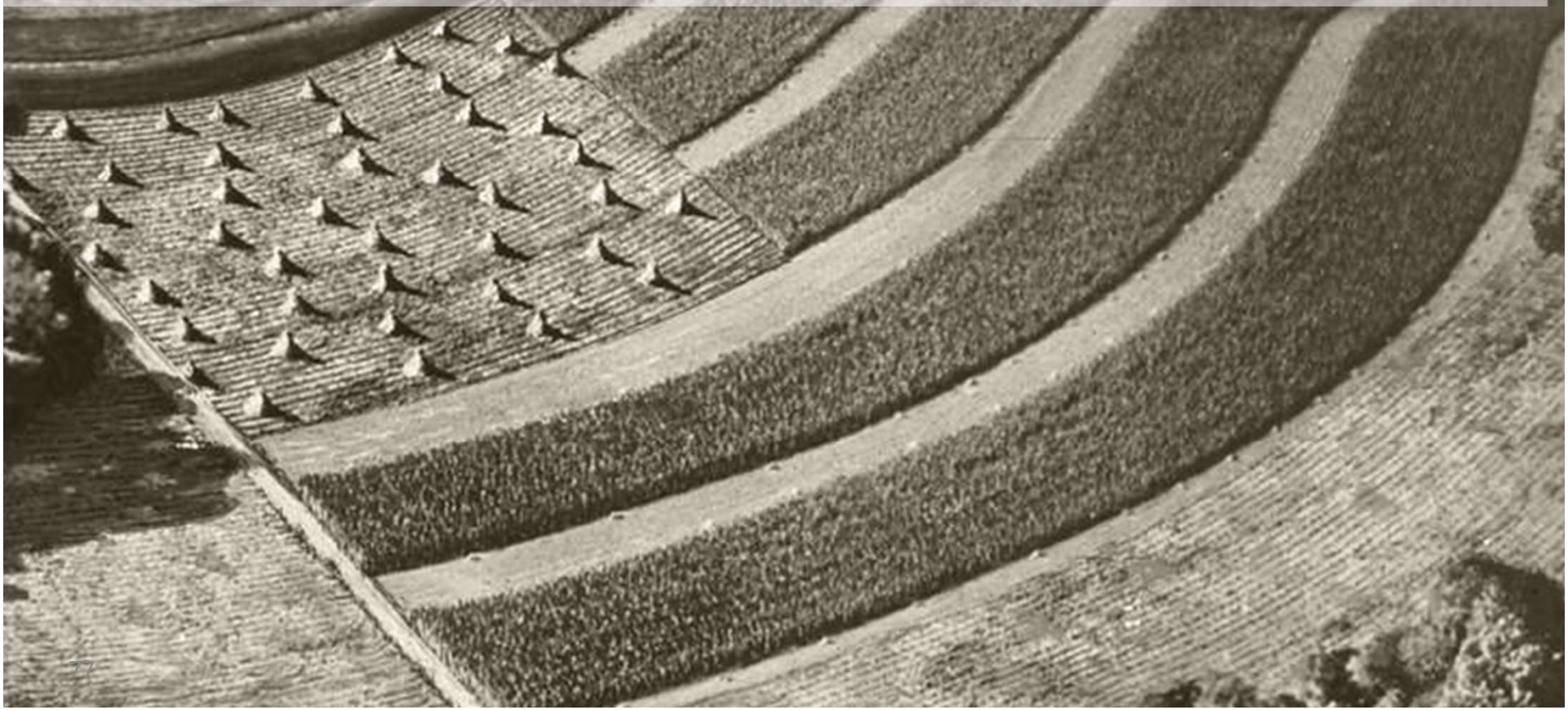
Natural Resources Conservation Service

nrcs.usda.gov

Local, trusted messengers are the most effective communicators.

Source: Ron Raynor A Tumbling T, (2021).

NRCS Vision: *A world of clean and abundant water, healthy soils, resilient landscapes, and thriving agricultural communities through voluntary conservation.*



We need your feedback!

Please complete 2-minute survey by following the link in the chat box.

https://www.surveymonkey.com/r/BWGVRJL

Available Resources:

Southwest Climate Hub: https://www.climatehubs.usda.gov/hubs/southwest

Drought.gov - https://www.drought.gov/

Drought Monitor - https://droughtmonitor.unl.edu/

AgRisk Viewer - https://www.climatehubs.usda.gov/hubs/southwest/tools/agrisk-viewer

Climate Smart Restoration Tool - https://climaterestorationtool.org/csrt/

LOCA Historic and projections:- https://scenarios.globalchange.gov/loca-viewer/

Fourth National Climate Assessment - https://nca2018.globalchange.gov/chapter/1/

Climate toolbox - https://climatetoolbox.org/tool/future-climate-dashboard

EPA Climate Scenarios Map: https://epa.maps.arcgis.com/apps/MapSeries/index.html?appid=3805293158d54846a29f750d63c6890e

Fire Science: https://greatbasinfirescience.org/tools-trainings/climate-adaptation-integration-tool-cait/

Weathered | The Worst Drought in 1200 Years: What Does it Mean for Your Food? | PBS Digital Studios (facebook.com)

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