



Western Water Resources, Climate, and Science

Kevin Werner

Western Region Climate Service Director

March 2, 2015

NOAA's Climate Stewards Presentation



Outline



- Western Water Resources
 - Colorado River Basin
 - California
- Impacts of a changing climate
 - Current Status
 - Future Projections
- Action



Western Water Resources



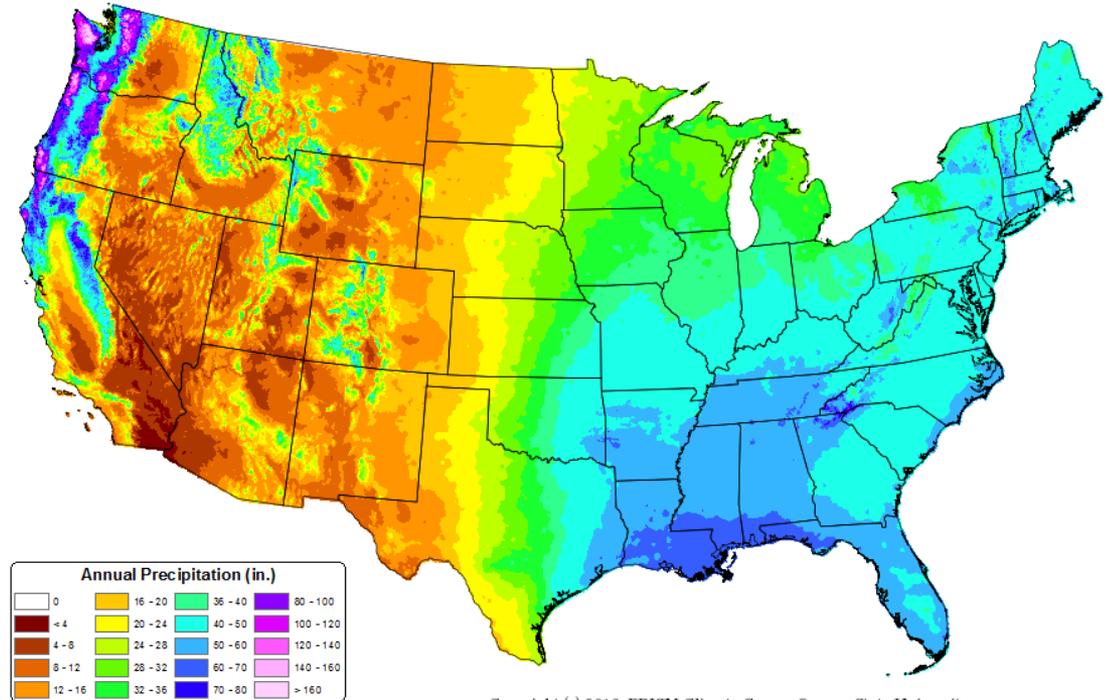
Context:

- Vast majority of water supply originates as snow in high elevation mountains
- Extensive water conveyance systems move water to farms and cities creates reliance on distant rather than local supplies

Challenges:

- Supply and demand curves crossing for major river systems in the semi-arid Southwest
- Multiple uses often in conflict particularly in Northwest
- Climate variability is large

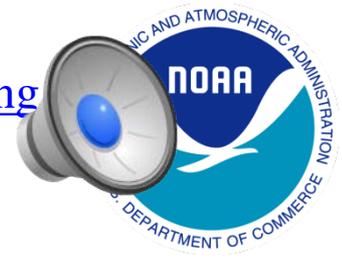
30-yr Normal Precipitation: Annual
Period: 1981-2010



Copyright (c) 2013, PRISM Climate Group, Oregon State University

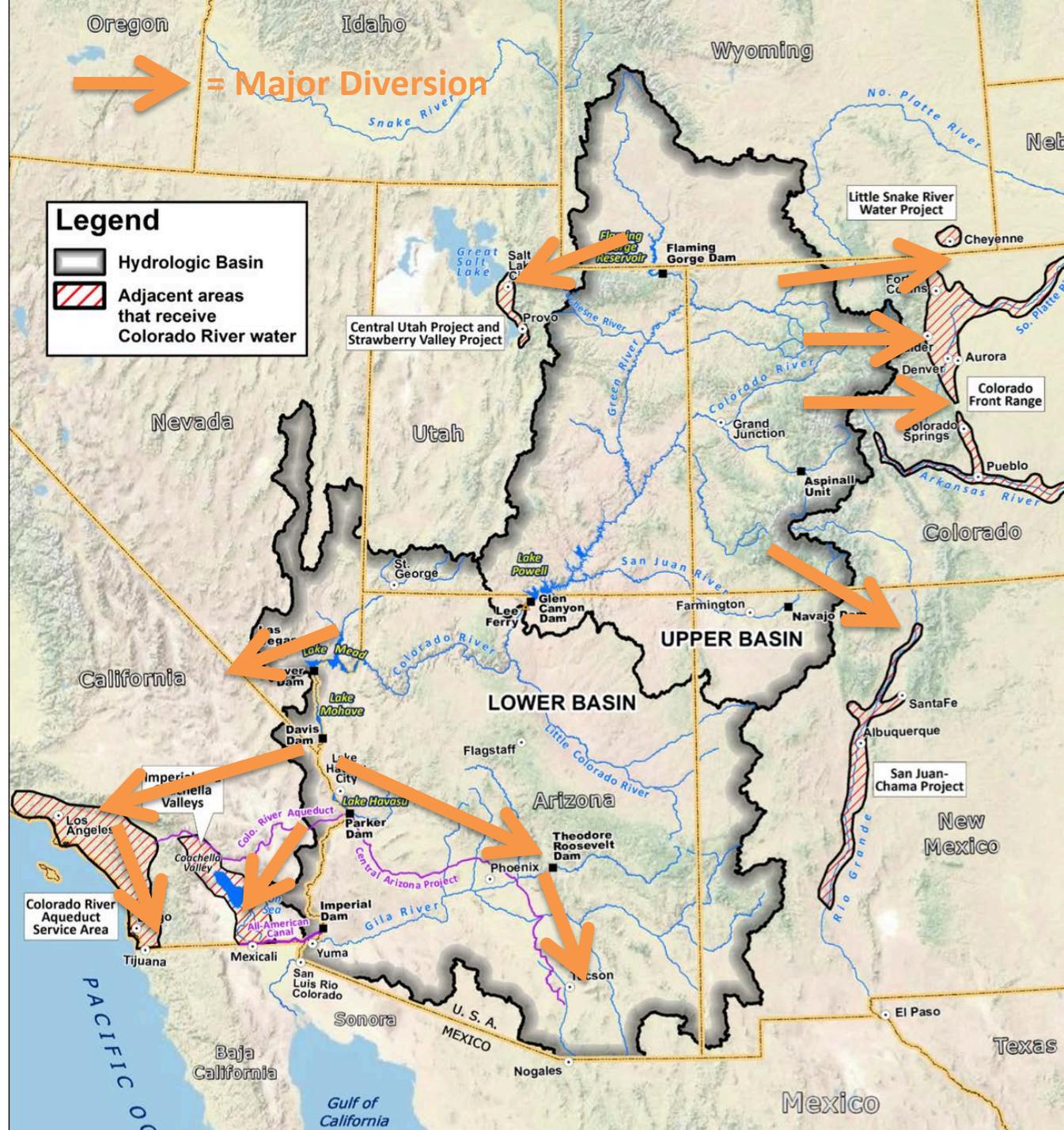


Why the Colorado River Stopped Flowing -All Things Considered, July 14, 2011



Colorado River Basics

- 7 States, 2 Nations
- Annual Flow 16.4 MAF (20,000 GL = 20 km³)
- Storage Capacity = 60 MAF
- 25 M People
- All of the Major Cities in Southwest
- 3.5m Irrigated Acres
- 250,000 mi² Basin Area (650,000 km²)
- Huge Topographic and climatic Variability
- 90 Years of Agreements known as 'Law of the River'
- Basic Allocation: 50/50 Split Upper Basin – Lower Basin (Colorado Compact) + 1.5 MAF for Mexico



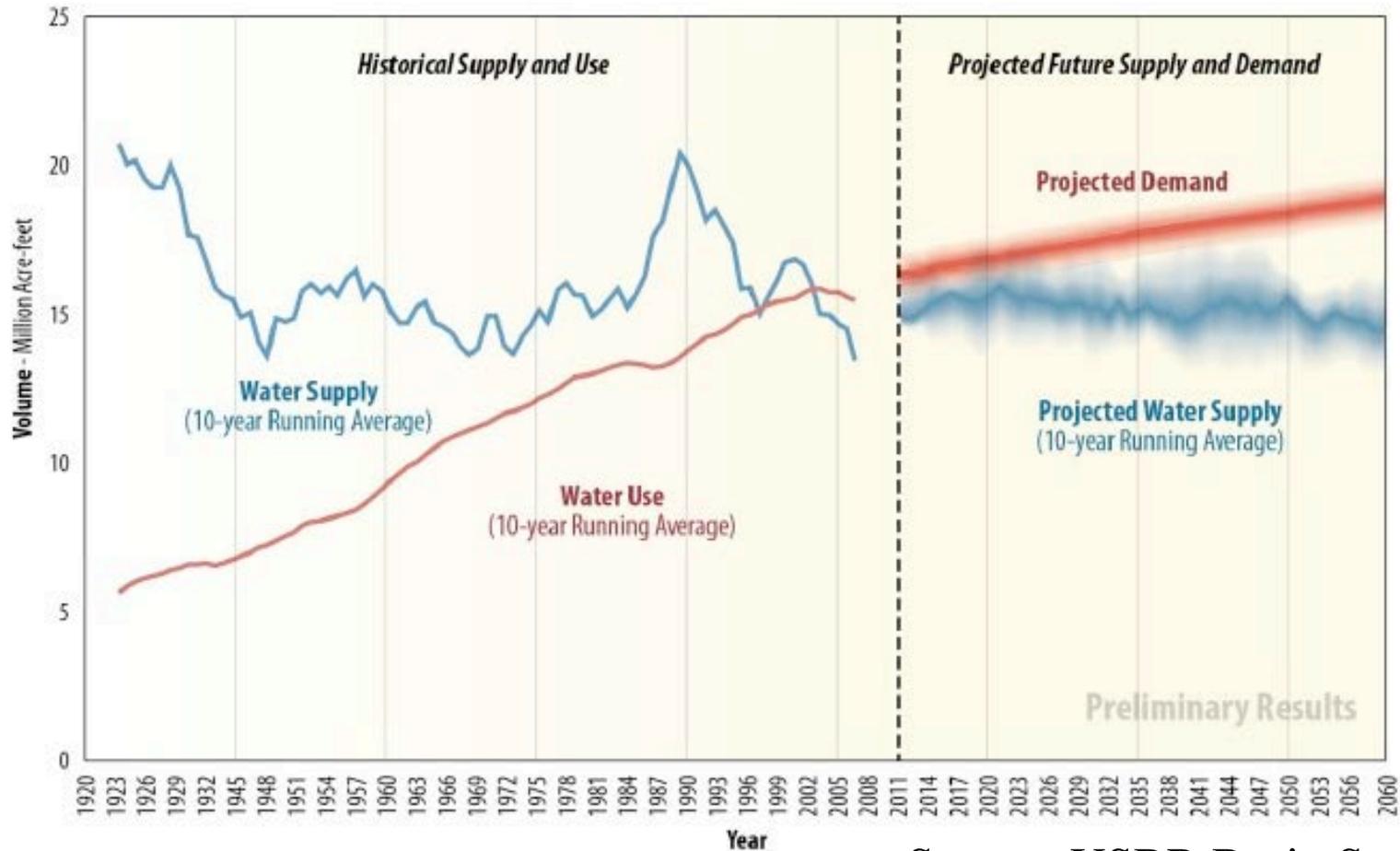


Long Term Supply / Demand



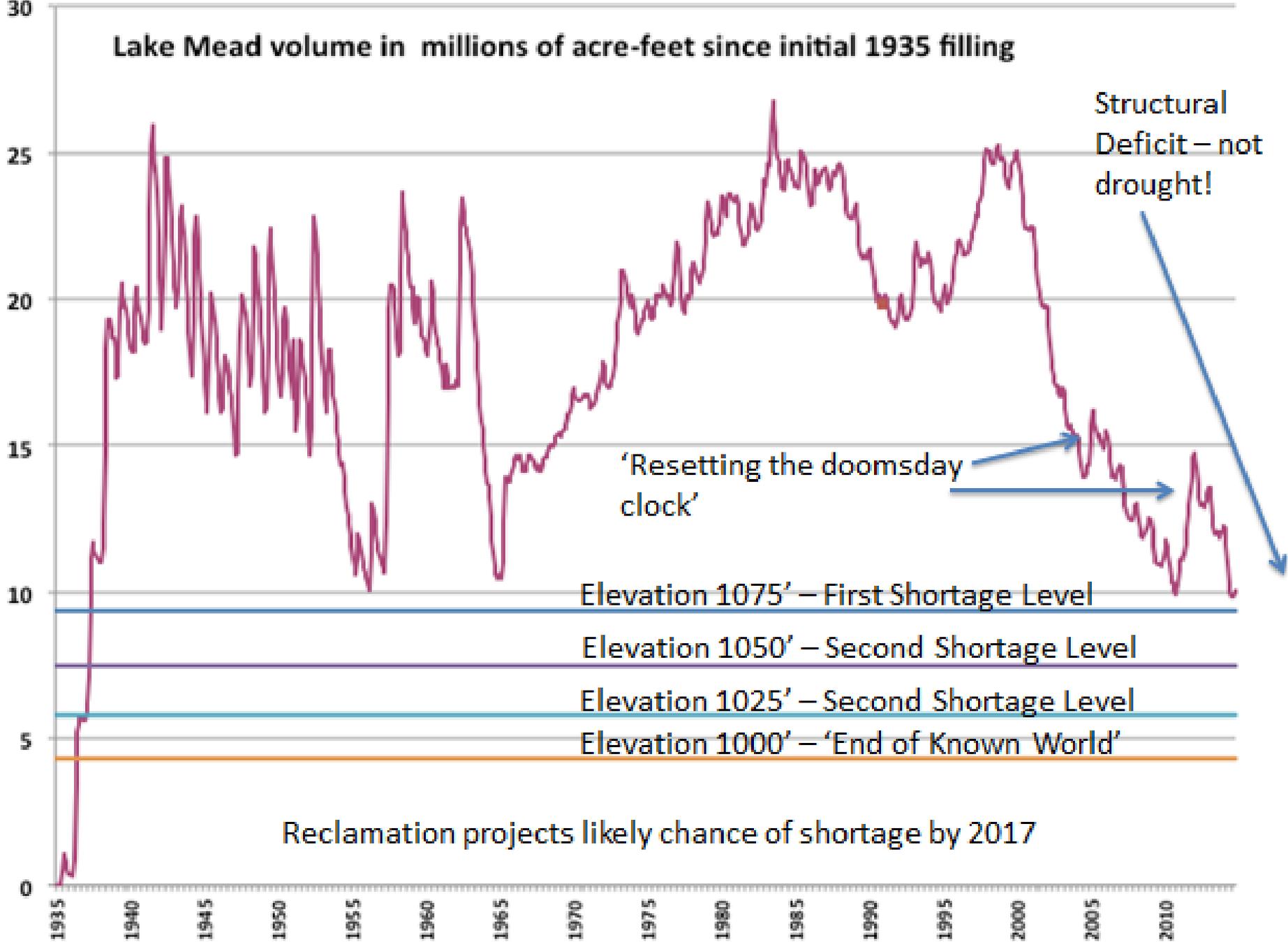
FIGURE 2

Historical Supply and Use and Projected Future Colorado River Basin Water Supply and Demand



Source: USBR Basin Study

Lake Mead volume in millions of acre-feet since initial 1935 filling





\$\$ Value of Water Resources relative to Flooding



- Damage from 1/10 AZ storm: \$11m^a
- Damage from 6/10 UT flooding: \$6.5m^a
- Damage from 12/10 UT/NV storm: \$11m^a
- Damage from 2011 runoff CO/UT: ~\$100m (unverified)

- Colorado River average annual runoff: 15 MAF
- Replacement value of \$200-800/AF -> \$3-12b^b

- **Economic value of water resources (every year) far greater than flooding damages

- Sources:
- a: WFO, FEMA (via stormdata); b: Communication with water managers in basin

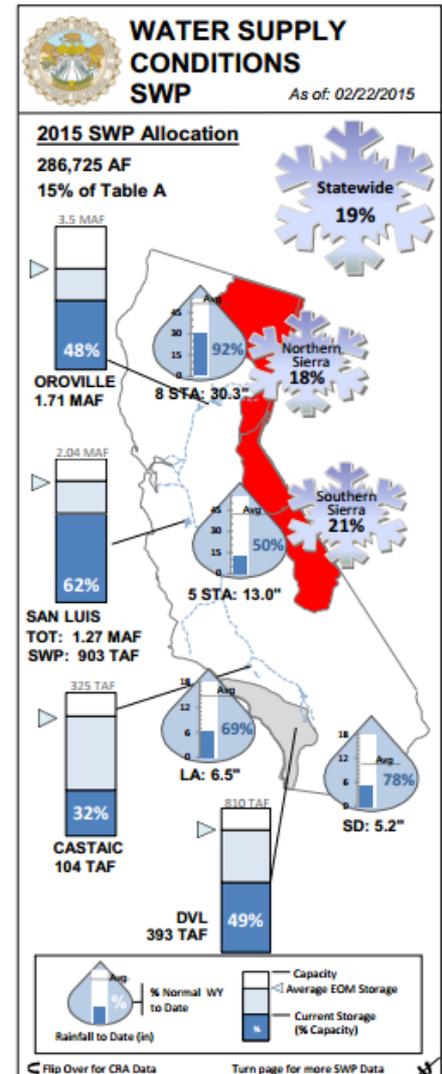
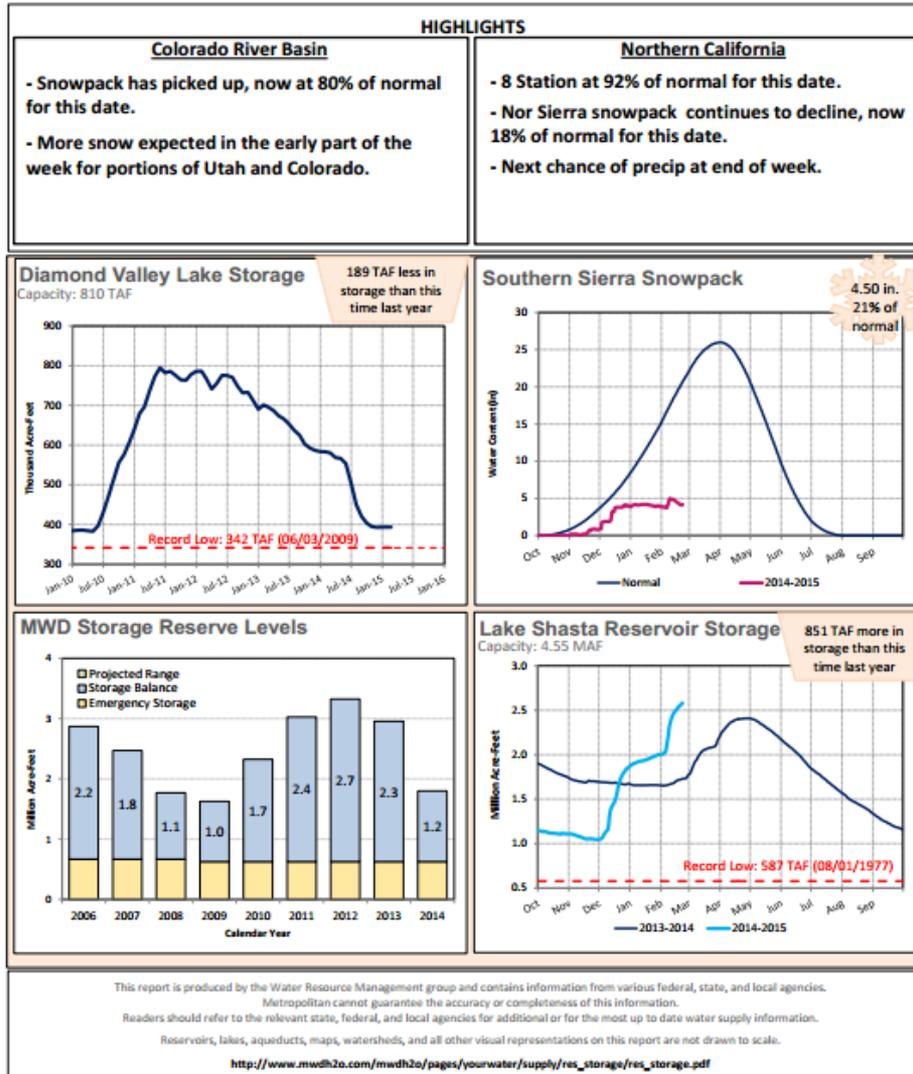
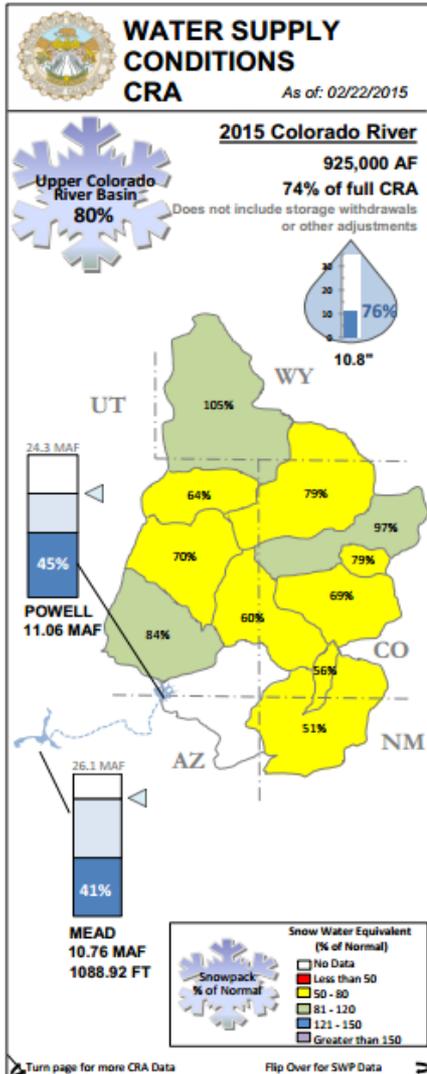


California Drought





Current Conditions





Impact of Climate Change





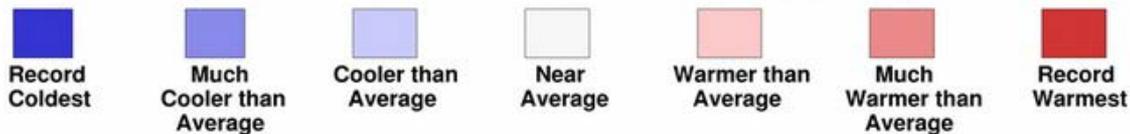
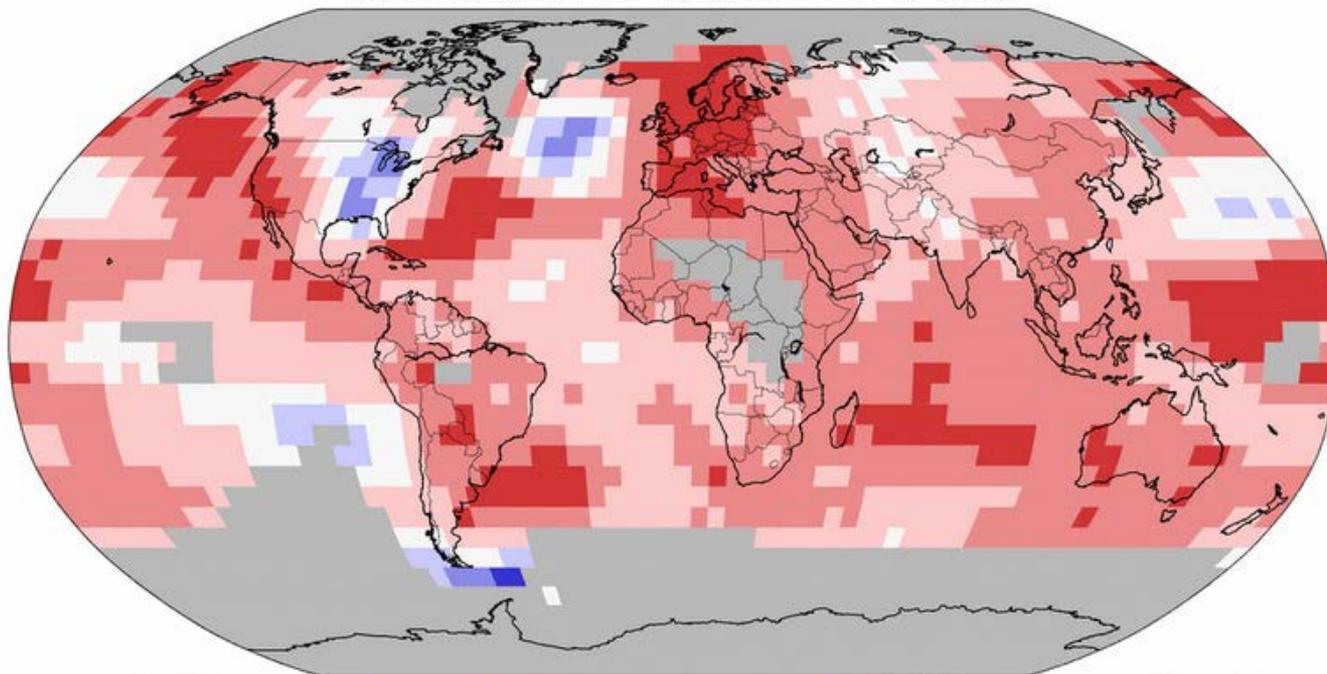
2014 Global Temperature



Land & Ocean Temperature Percentiles Jan–Dec 2014

NOAA's National Climatic Data Center

Data Source: GHCN–M version 3.2.2 & ERSST version 3b





Global Temperatures



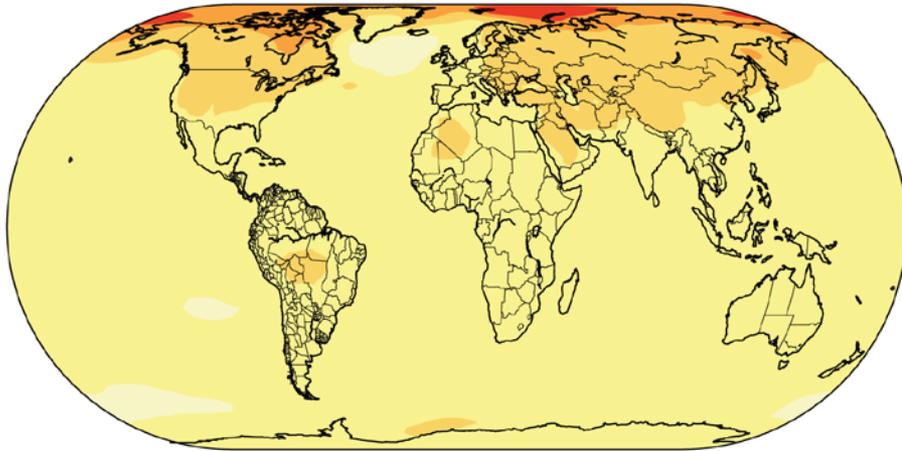
RANK 1 = WARMEST PERIOD OF RECORD: 1880–2014	YEAR	ANOMALY °C	ANOMALY °F
1	2014	0.69	1.24
2 (tie)	2010	0.65	1.17
2 (tie)	2005	0.65	1.17
4	1998	0.63	1.13
5 (tie)	2013	0.62	1.12
5 (tie)	2003	0.62	1.12
7	2002	0.61	1.10
8	2006	0.60	1.08
9 (tie)	2009	0.59	1.06
9 (tie)	2007	0.59	1.06



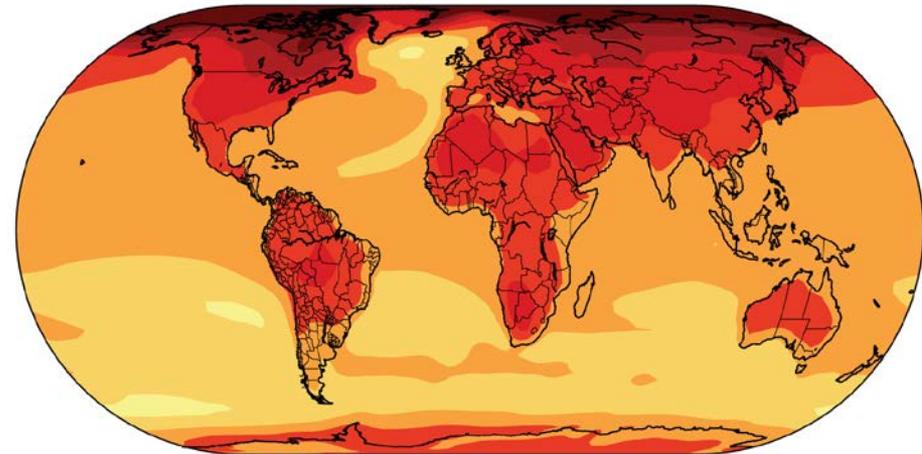
Projected Temperature INCREASE by our Grandchildren's Time



Rapid Emission Reductions



Emission Increases Continue



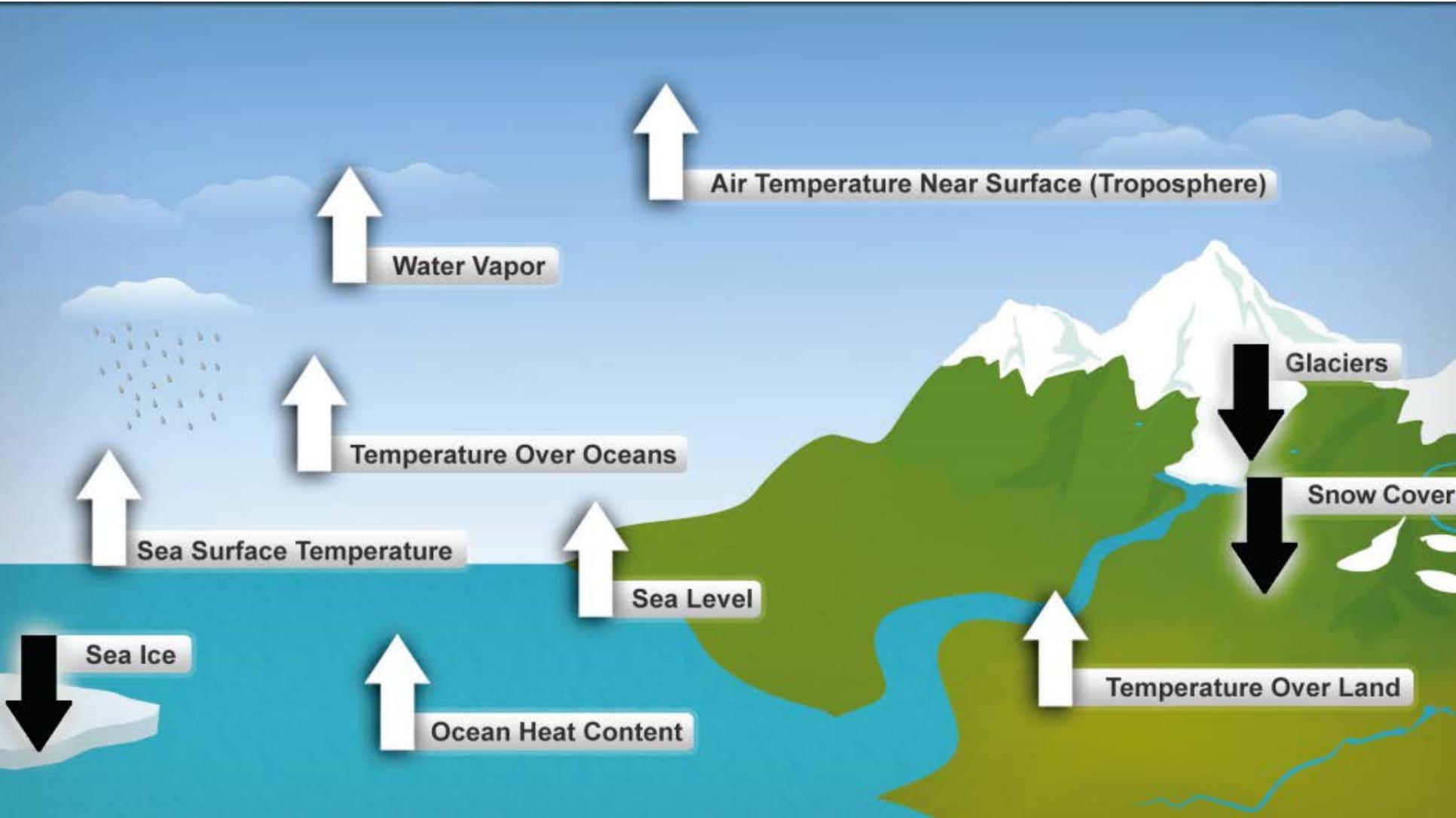
2071-2099 relative to 1970-1999

Temperature Change (°F)



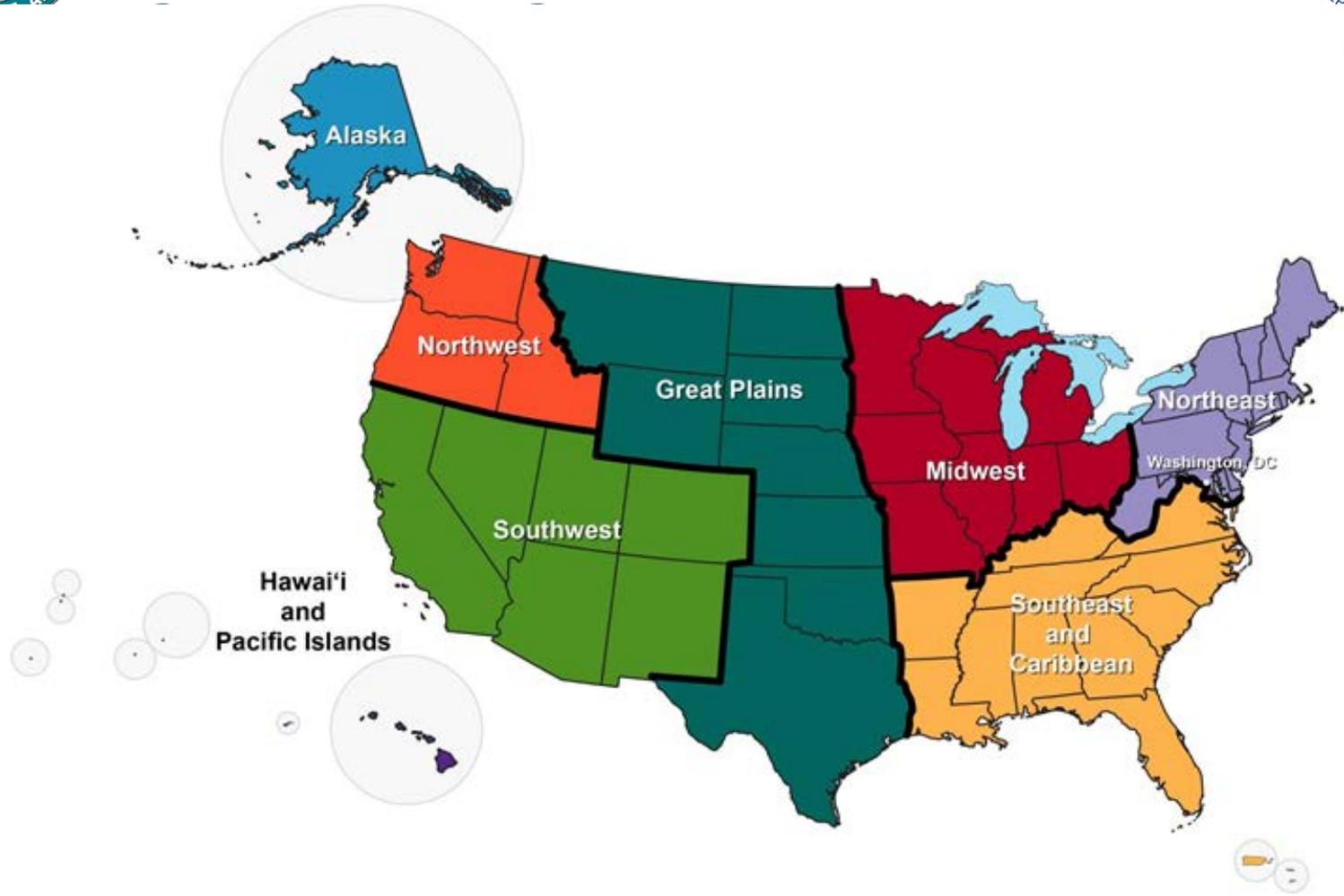


All indicators expected to **increase** in a warming world are **increasing** and those expected to **decrease** are **decreasing**



Third National Climate Assessment

DEPARTMENT OF COMMERCE





Main Messages



- Largest & most comprehensive **for the U.S.**
- Climate change is happening **now**
- America is **feeling the effects**
- Important **opportunities** to manage & prepare



U.S. Global Change Research Program
**National Climate
Assessment**



Key Messages for the West



Northwest:

1. Water Related Challenges
2. Coastal Vulnerabilities
3. Impacts on Forests
4. Adapting Agriculture

Southwest:

1. Reduced Snowpack and Streamflows
2. Threats to Agriculture
3. Increased Wildfire
4. Sea Level Rise and Coastal Damage
5. Heat Threats to Health

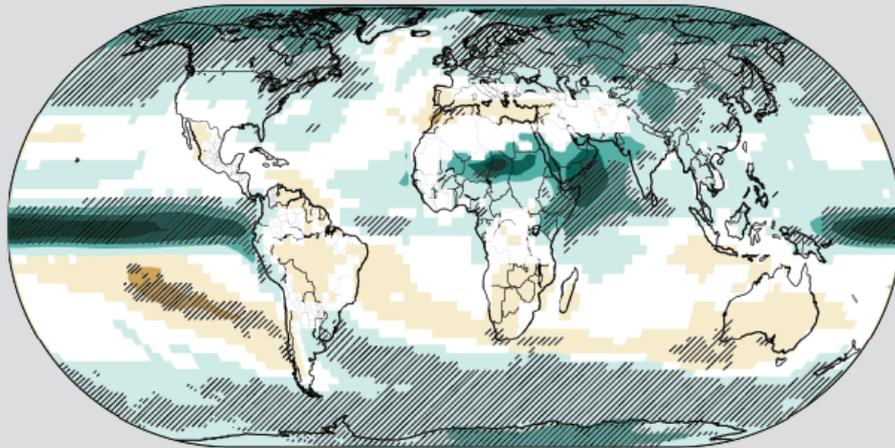


Projected Precipitation Change

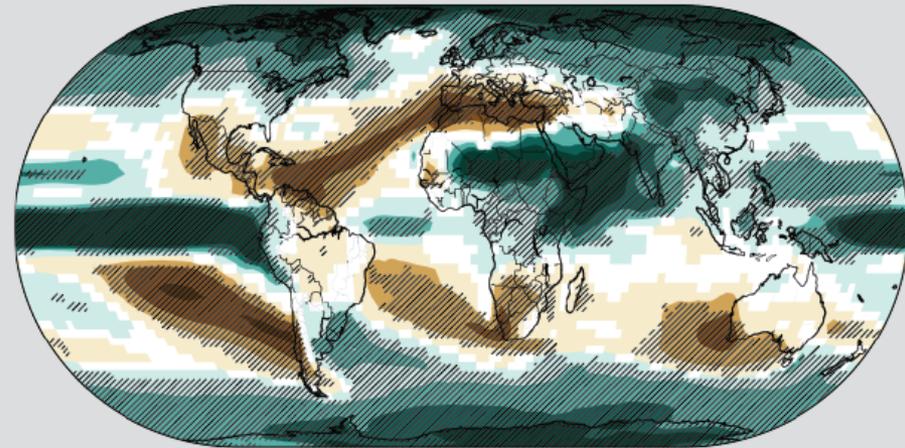


Projected Change in Average Annual Precipitation

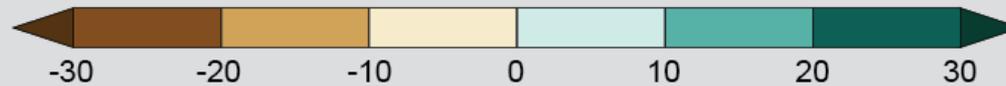
Rapid Emissions Reductions (RCP 2.6)



Continued Emissions Increases (RCP 8.5)



Precipitation Change (%)

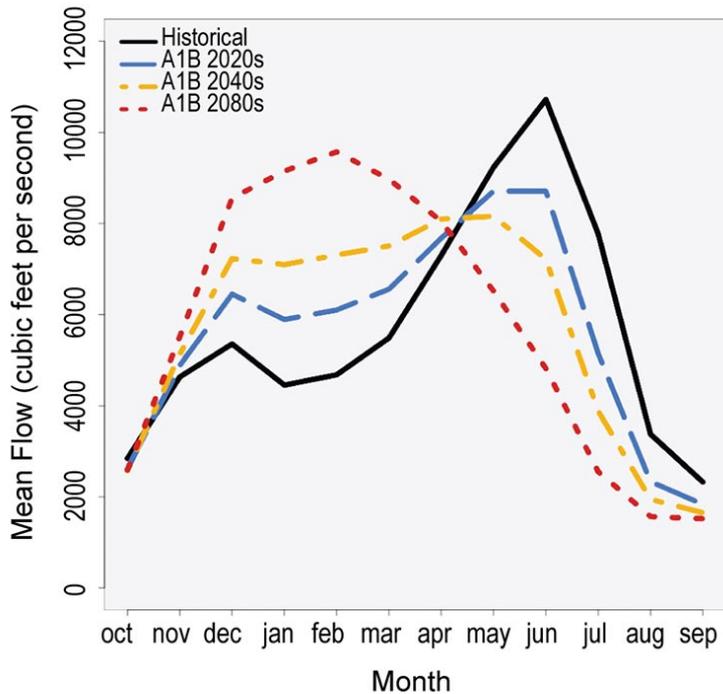




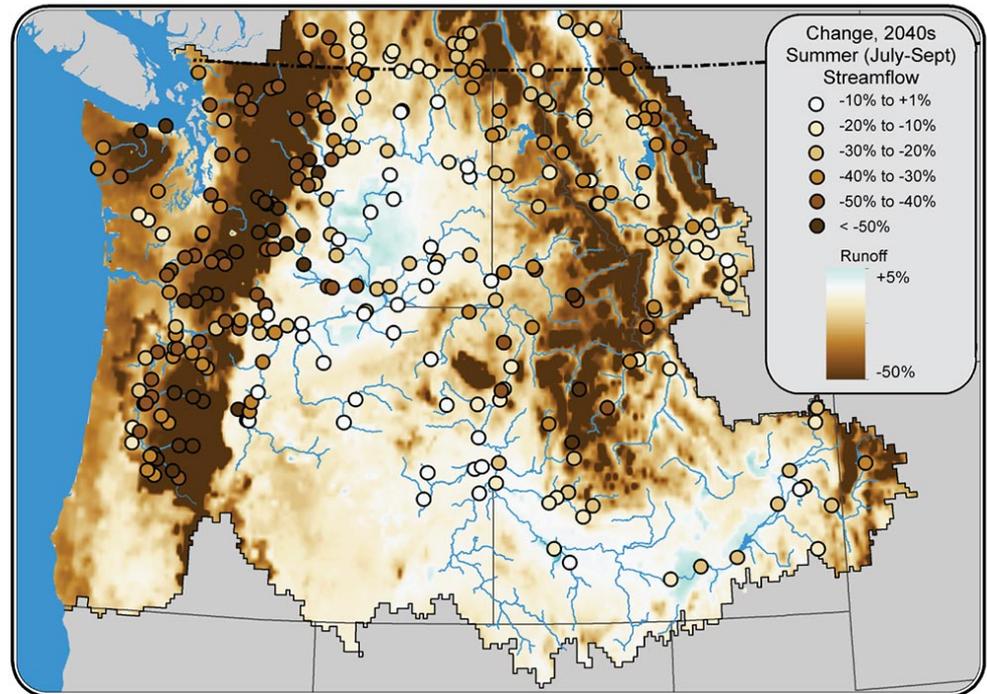
Water-related Challenges



Future Shift in Timing of Stream Flows



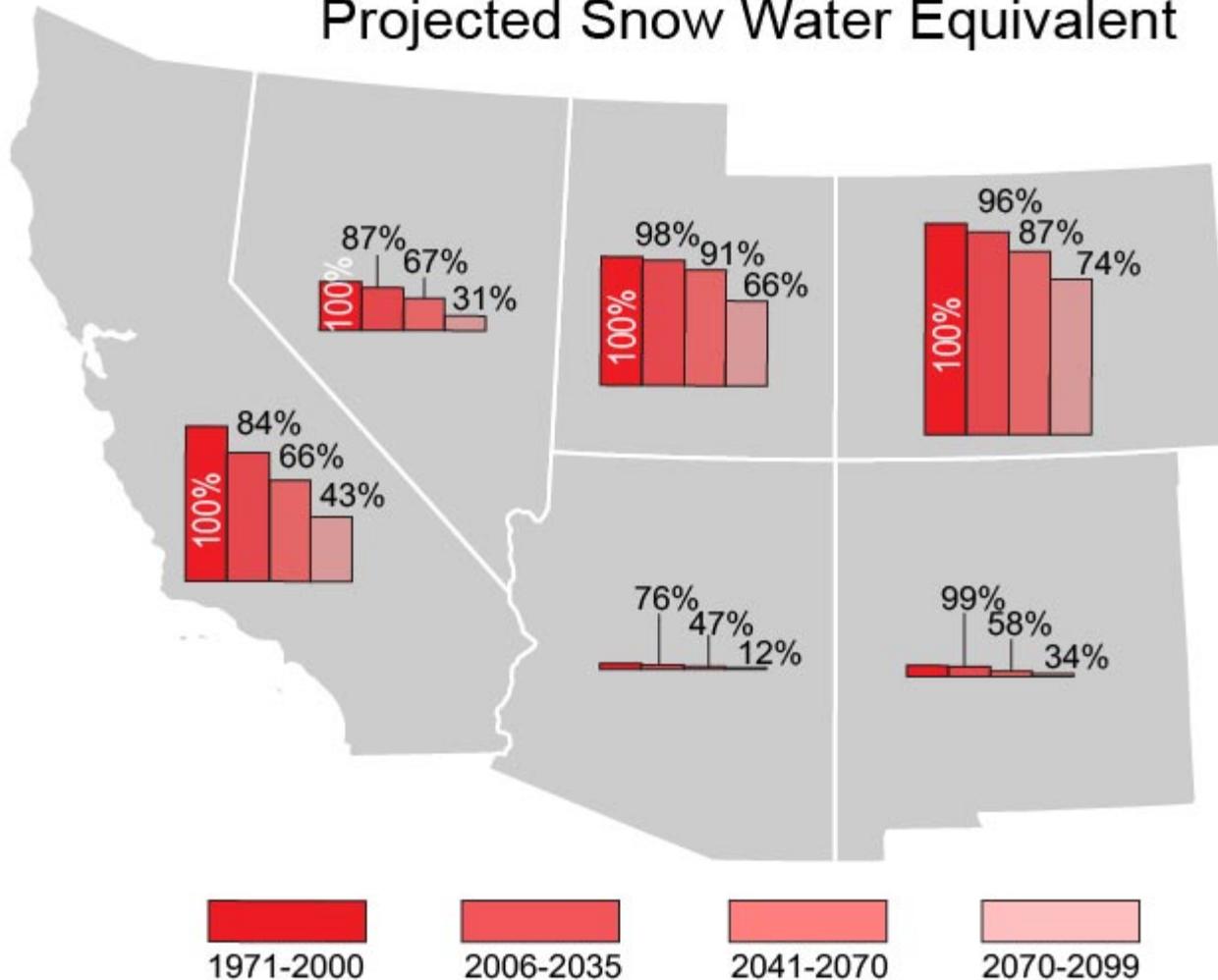
Reduced Summer Flows





Water-related Challenges

Projected Snow Water Equivalent





Big Cottonwood Creek climate sensitivity

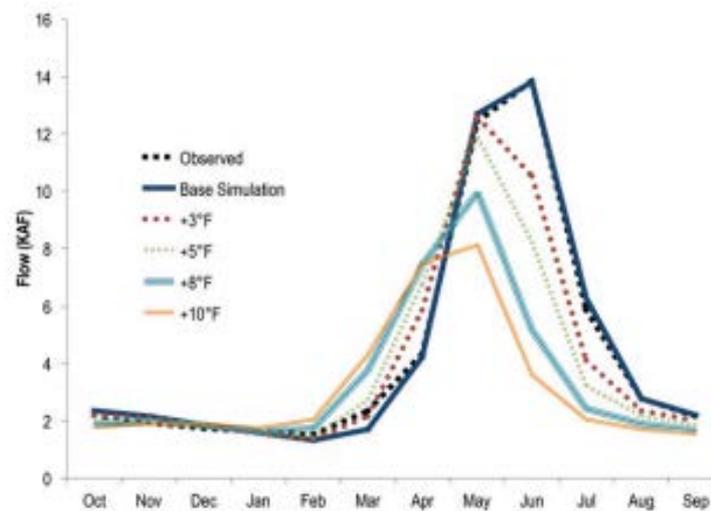


Figure 6. Big Cottonwood Creek runoff sensitivity to temperature as indicated by 30-yr mean (water years 1981–2010) monthly runoff volumes forced by various temperature changes. Temperature changes (°F) are indicated in the legend, where “base” signifies base climate historical simulation with no temperature adjustment. Also shown is the observed mean monthly streamflow.

Credit: Bardsley et al, 2013

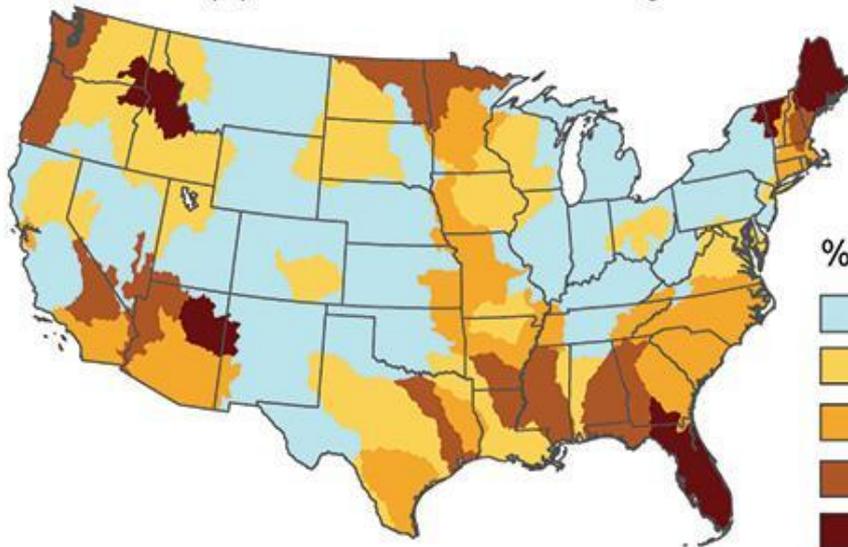


Water quality and water supply are jeopardized by climate change in a variety of ways that affect ecosystems and livelihoods.

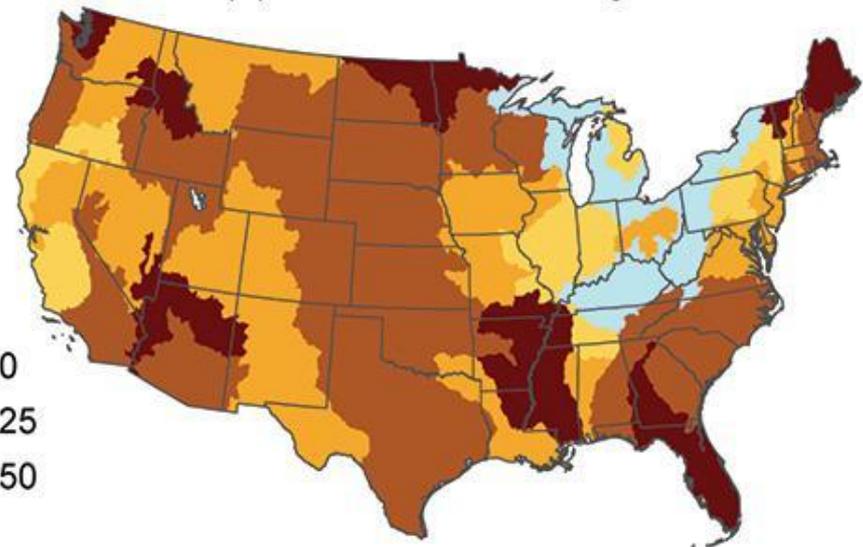


Projected Changes in Water Withdrawal

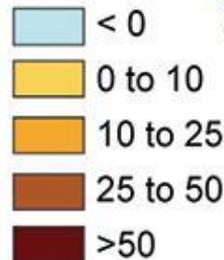
(a) Without Climate Change



(b) With Climate Change



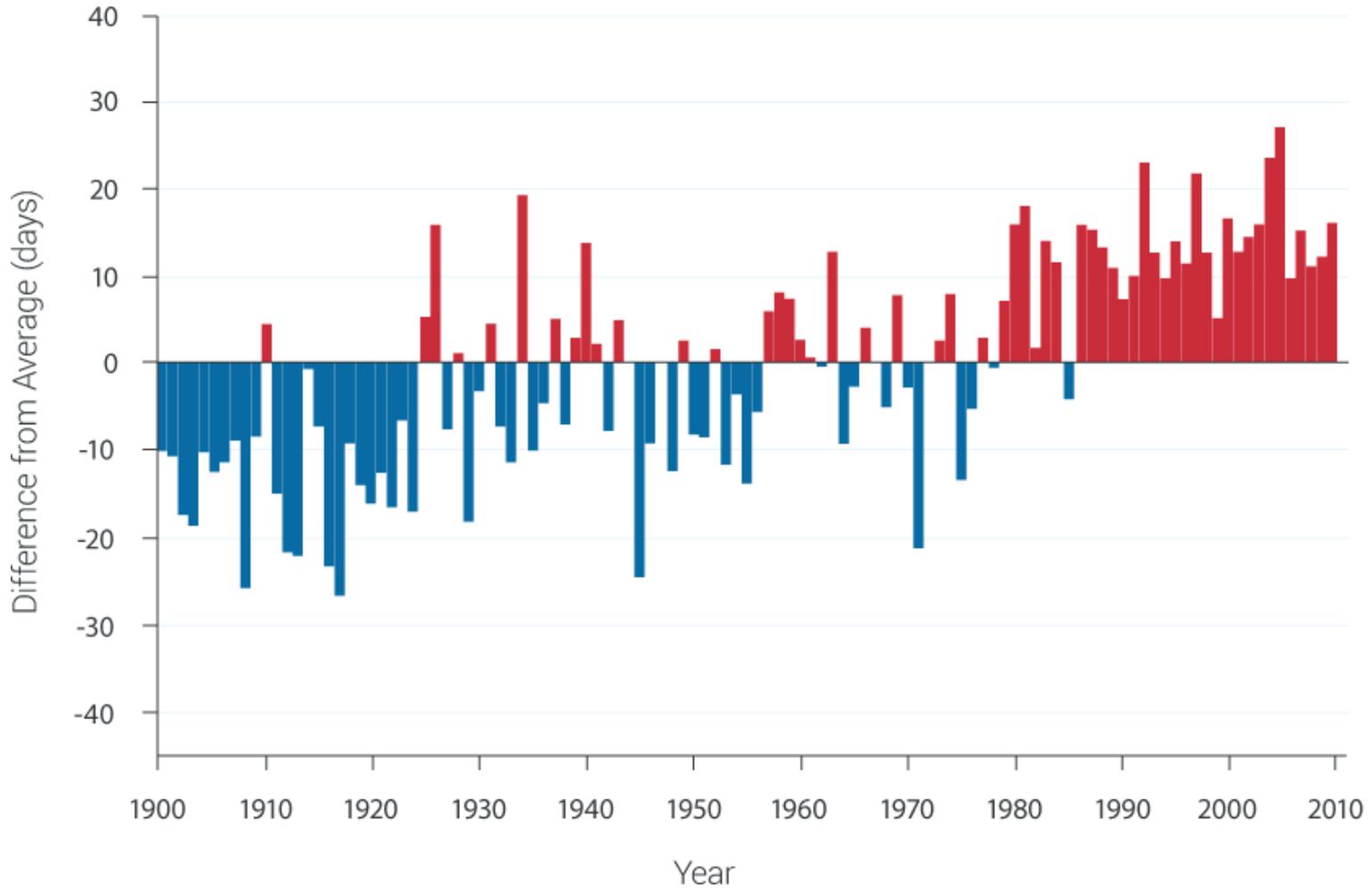
% change





Threats to Agriculture

Longer Frost-free Season Increases Stress on Crops





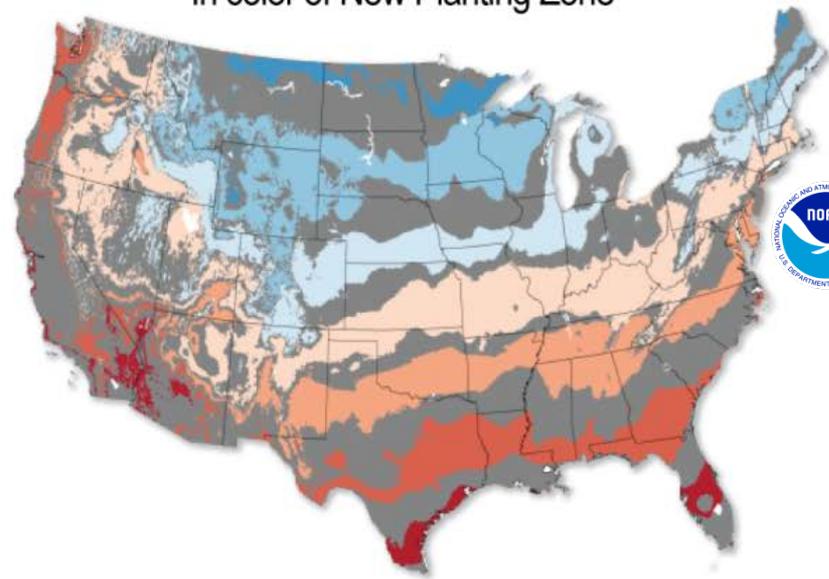
Shift in Plant Hardiness Zones



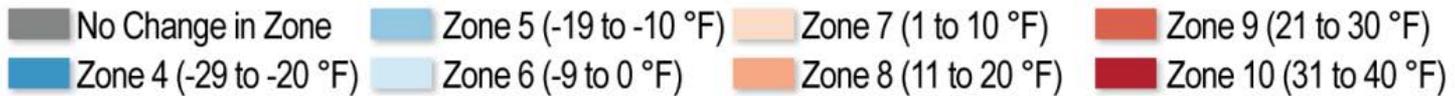
Zone Changes in Past 10 Years
In color of New Planting Zone



Zone Changes in Next 30 Years
In color of New Planting Zone

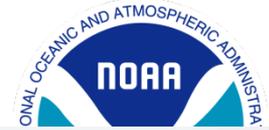


Average Annual Extreme Minimum Temperature by Climate-Related Planting Zone





nca2014.globalchange.gov



National Climate Assessment

GlobalChange.gov



SEARCH



DOWNLOAD

Highlights

Explore highlights of the National Climate Assessment including an Overview, the report's 12 overarching findings, and a summary of impacts by region.

[→ EXPLORE HIGHLIGHTS](#)



Full Report

Explore the entire report covering our changing climate, regions, cross sector topics, and response strategies in full detail.

[→ EXPLORE THE REPORT](#)





Meet the Challenges of a Changing Climate

The Climate Resilience Toolkit provides resources and a framework for understanding and addressing the climate issues that impact people and their communities.

- 1 Identify the Problem
- 2 Determine Vulnerabilities
- 3 Investigate Options
- 4 Evaluate Risks & Costs
- 5 Take Action



Find Out How People Are Building Resilience



Forests to Faucets

[Watch video >](#)



Building a Bridge to Reduce Risk

[Watch video >](#)



Dune Migration and Shoreline Protection

[Watch video >](#)



Louisiana's Front Line Defense from Storm and Surge

[Watch video >](#)

<http://toolkit.climate.gov/>



Action

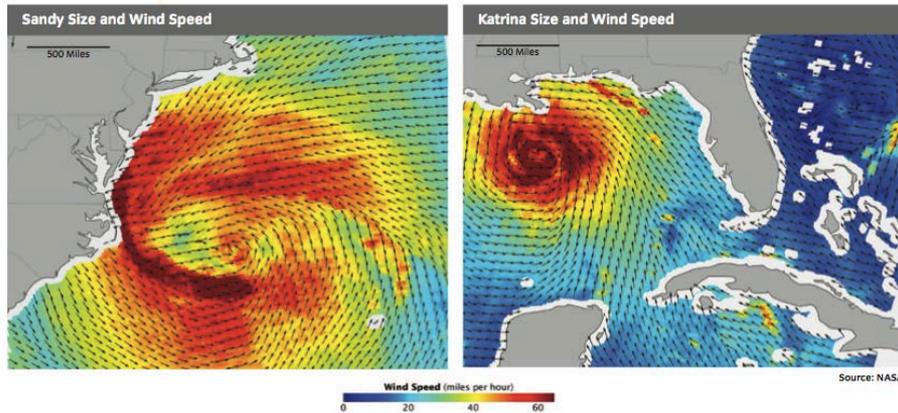


- Two recent examples



Sandy

43 deaths... 6,500 patients evacuated from hospitals and nursing homes... Nearly 90,000 buildings in the inundation zone... 1.1 million New York City children unable to attend school for a week... close to 2 million people without power... 11 million travelers affected daily... \$19 billion in damage...



Credit: PlanNYC, NYC SIRR

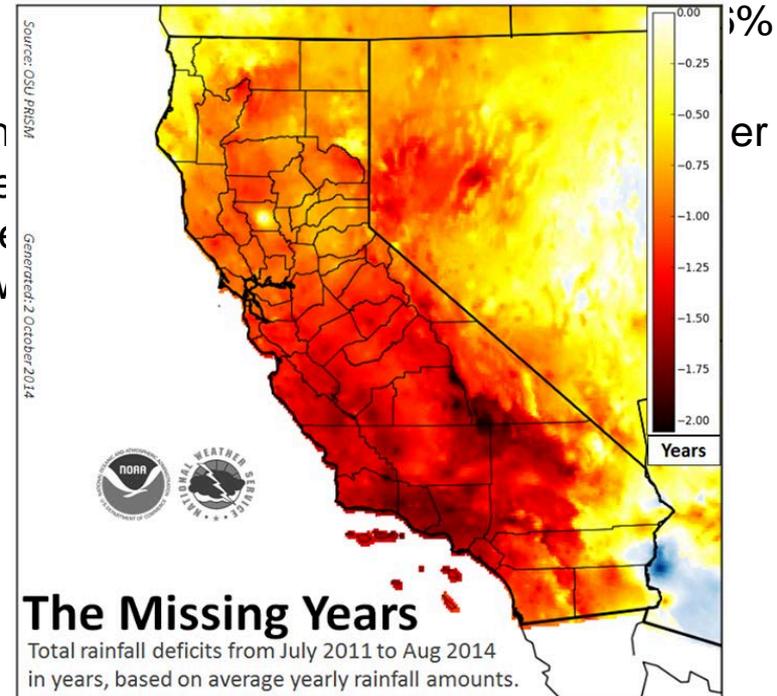


CA Drought

2012-2014 driest 3 year period on record for much of state

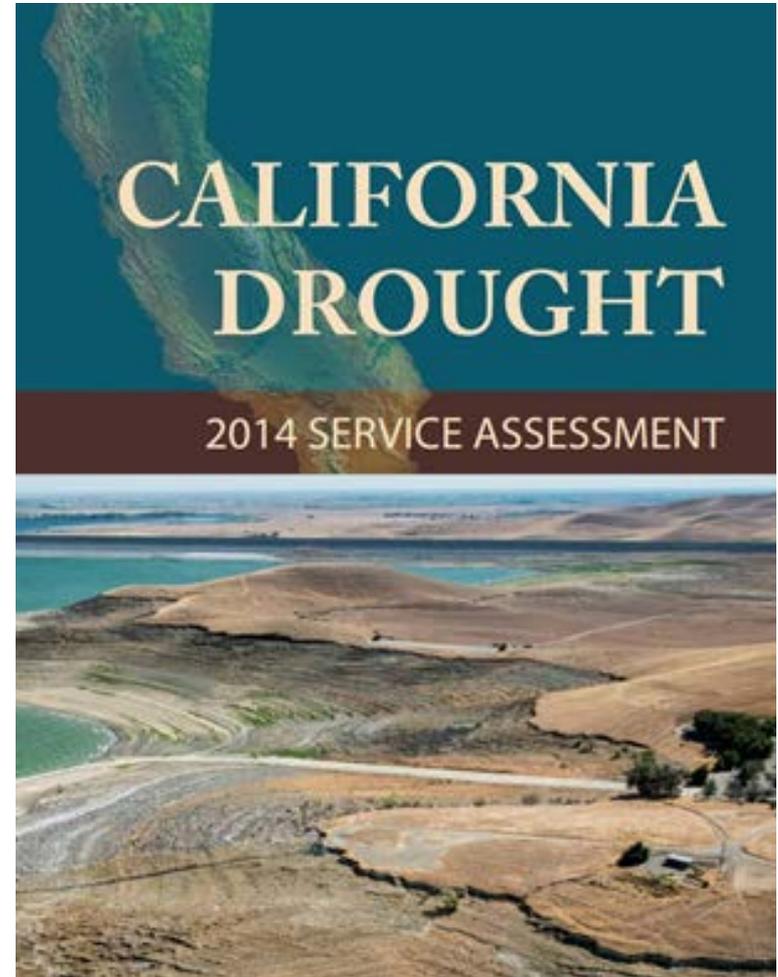
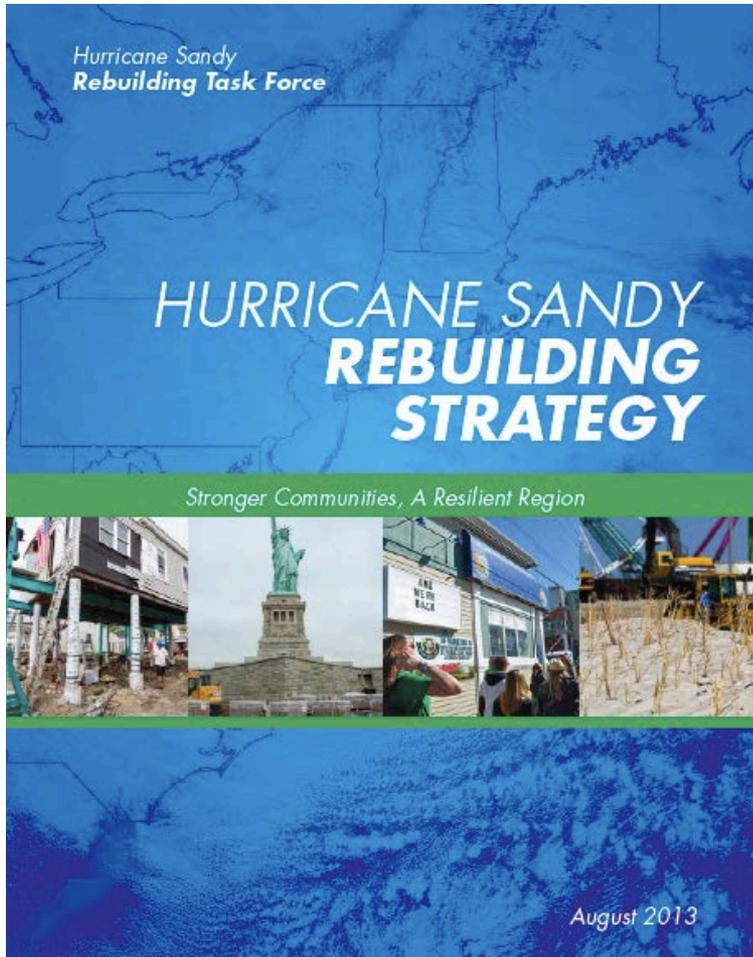
- Key 2014 statistics:
 - Precipitation: Less than 2 years worth of average precipitation over last 3 years
 - Reservoirs: Aug 2014 statewide

- California shortage snow/precipitation groundwater





My Roles





Lessons Learned



Sandy

1. Decision making is highly complex but human centric
2. Politics and money matter
3. Relationships matter
4. People are tribal - especially in DC
5. Government is silo-ed; Many veto points exist; Many fewer willing to approve
6. You can lead a horse to water...

CA Drought

1. Strong and widespread interest in drought and water resources analytical and prediction capabilities
2. Relationships matter
3. Decision making is highly complex but human centric
4. You can lead a horse to water...



Common Themes



- Science agencies generally:
 - Disconnected from management/decision making agencies
 - More reactive than proactive
 - Not inherently coordinated/focused around problem
- Ideas for success:
 - Work to understand how others operate and build relationships
 - Be persistent and adaptive; decision makers ignore much more often than they say no.
 - Substance matters; Application does too



Discussion



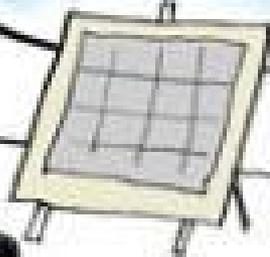
- Climate is changing
- Science is one tool among many for addressing it
- Answers lie with broader society



CLIMATE SUMMIT

WHAT IF IT'S A BIG HOAX AND WE CREATE A BETTER WORLD FOR NOTHING?

- ENERGY INDEPENDENCE
- PRESERVE RAINFORESTS
- SUSTAINABILITY
- GREEN JOBS
- LIVABLE CITIES
- RENEWABLES
- CLEAN WATER, AIR
- HEALTHY CHILDREN
- ETC. ETC.



YEL
PITT
LIFE US/DAW



Questions?



Kevin Werner

Western Region Climate Service Director

Phone: 206.860.3490

Email: kevin.werner@noaa.gov

