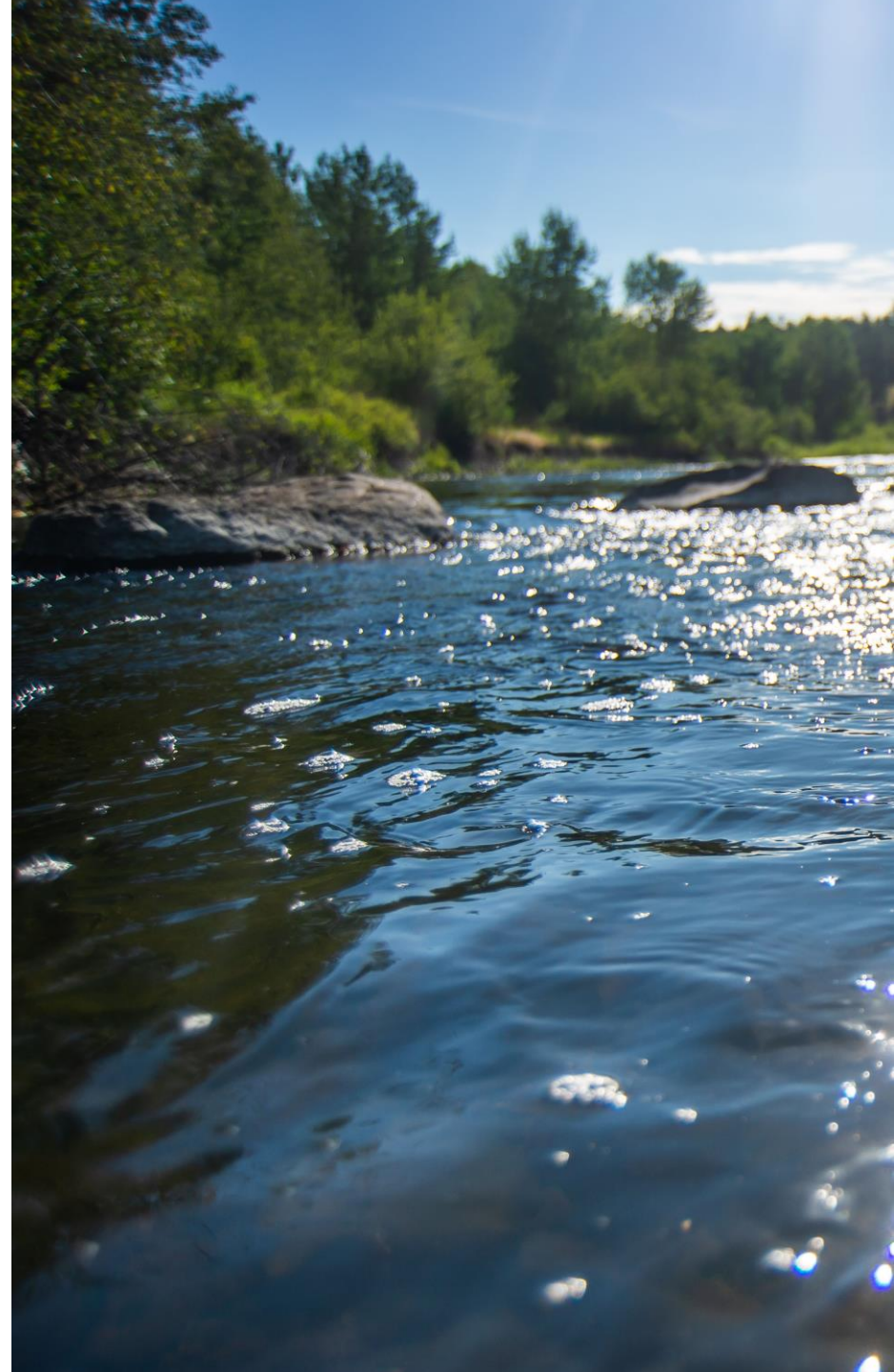




— BUREAU OF —  
RECLAMATION

# 2021 SECURE Report West-Wide Climate and Hydrology Assessment

June 23, 2021



# Agenda Overview

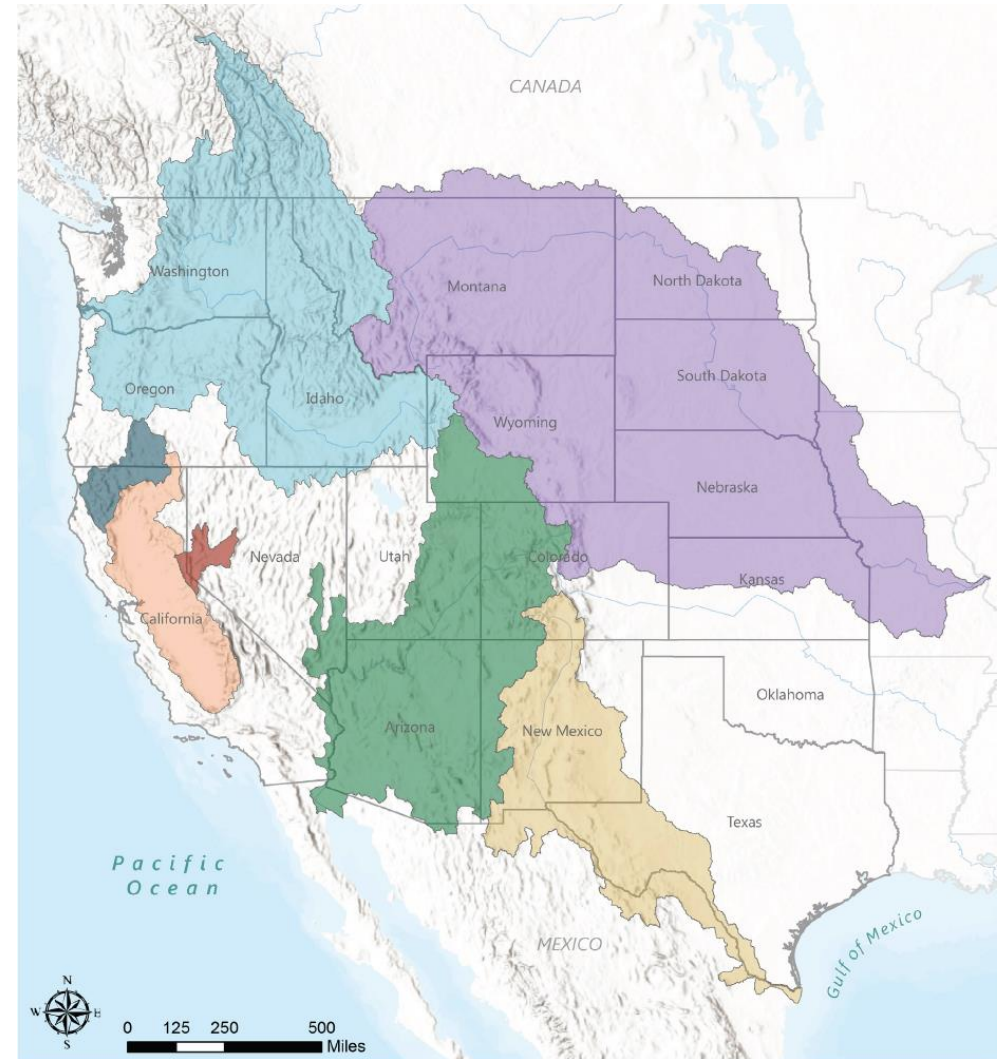
- Introduction of 2021 SECURE Water Act Report
- Reclamation's Mission
- West-Wide Climate and Hydrology Assessment
- SECURE Web Portal and Resource Links



# P.L. 111-11, Subtitle F, SECURE Water Act, Section 9503(c) Requirement

REPORTING. Not later than 2 years after the date of enactment of this Act, and every 5 years thereafter, the Secretary shall submit to the appropriate committees of Congress a report that describes for each major Reclamation river basin—

1. Effects and risks resulting from global climate change with respect to the quantity of water resources
2. Impacts of global climate change with respect to operations
3. Mitigation and adaptation strategies considered and implemented
4. Coordination activities conducted
5. Implementation of a monitoring plan in coordination with NOAA, USGS and NRCS



## Legend

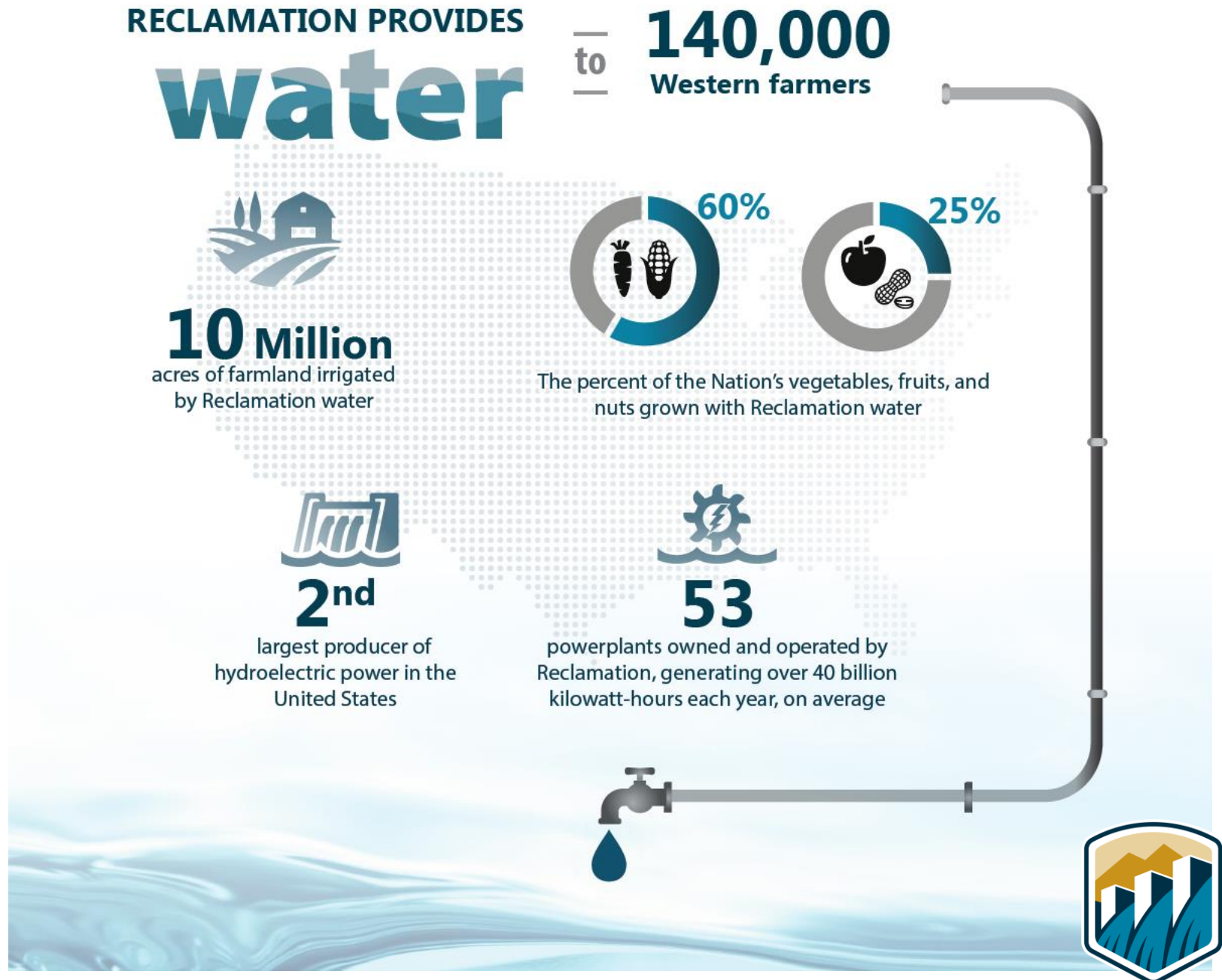
Colorado River Basin	Missouri River Basin	Truckee and Carson River Basins
Columbia River Basin	Rio Grande Basin	State Boundary
Klamath River Basin	Sacramento and San Joaquin River Basins	





# Reclamation's Mission

- Reclamation was established in 1902 and is best known for the dams, powerplants, and canals it constructed within the 17 Western States.
- Reclamation is the Nation's largest wholesale water supplier
- We operate 338 reservoirs with a total storage capacity of 140 million acre-feet.
- Reclamation owns 53 power plants, generating over 40 billion kilowatt-hours each year, on average.



# How Climate Change Impacts Reclamation's Mission

- Climate change impacts many aspects of water management
- Poses risks to reliable water and power deliveries, resilient infrastructure, and maintenance of ecosystems impacted by Reclamation projects
- Understanding how changing conditions impact water uses helps us develop approaches to address those risks.

Increasing temperatures, decreasing snowpack, changes to the volume of precipitation, and changes to runoff timing and volume across the west will affect numerous aspects of water management:

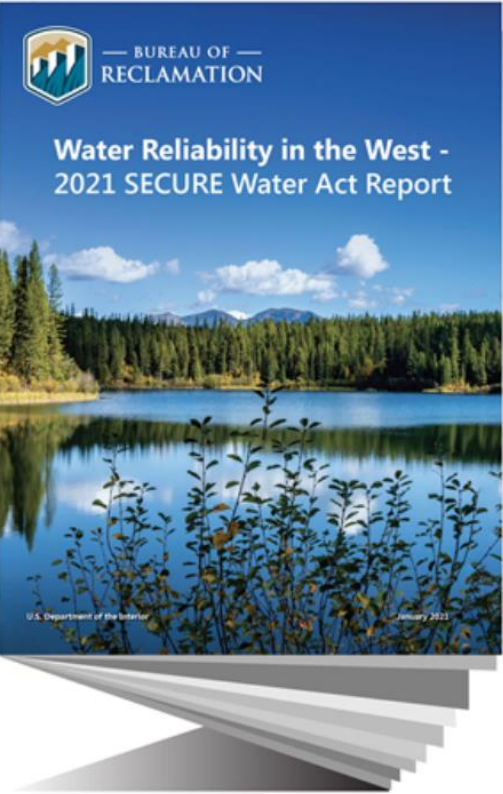
- Water Deliveries
- Water Quality
- Recreation
- Fish and Wildlife Habitat
- Hydropower
- Endangered, Threatened, or Candidate Species
- Flood Control
- Ecological Resilience

**Impacts**  
Select each icon below to learn more.



# 2021 SECURE Report Components

## Summary Report to Congress



## Supporting Technical Materials and Other Resources



West-Wide Assessment



Fact Sheets



Basin Reports  
Results from Basin Studies, Pilots and Innovations




SECURE Web Portal






# West-Wide Assessment



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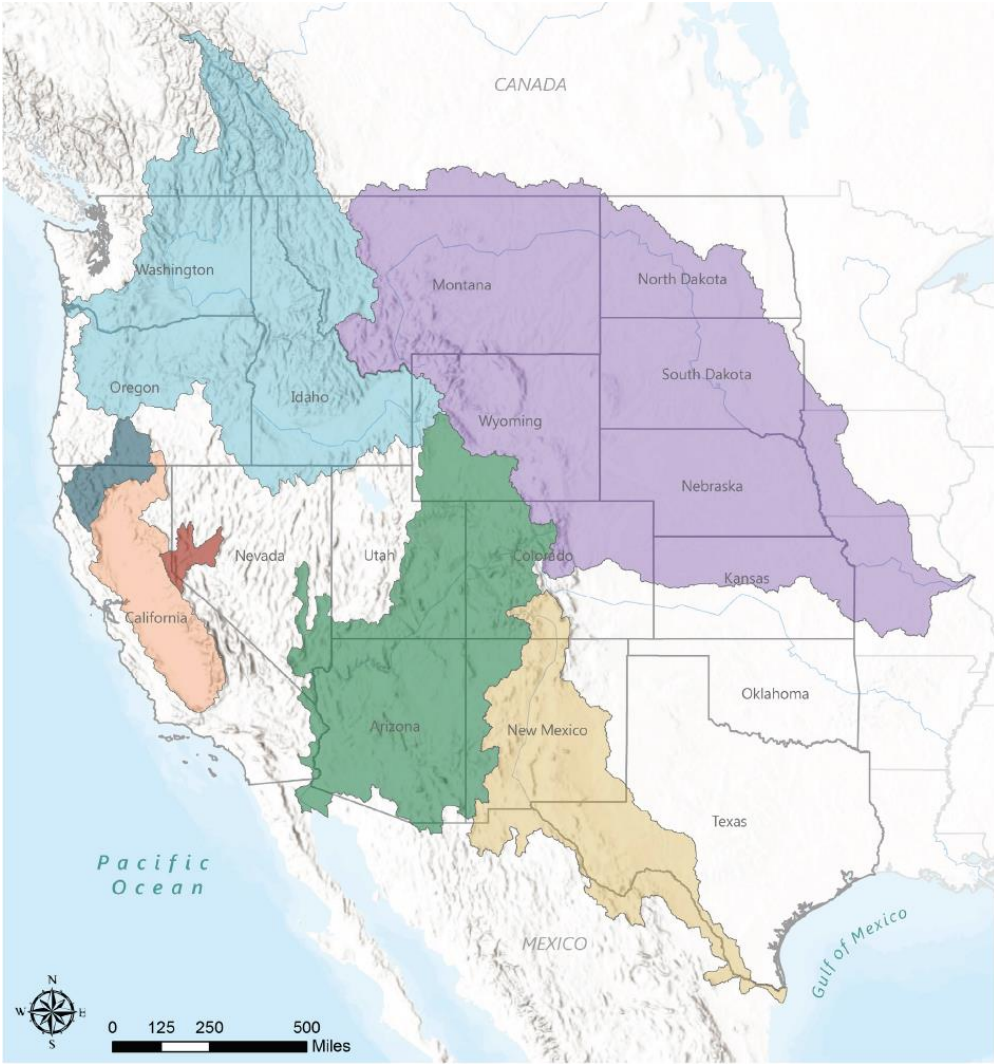
Technical Memorandum No. ENV-2021-001









**West-Wide Climate and Hydrology Assessment**



U.S. Department of the Interior

March 2021



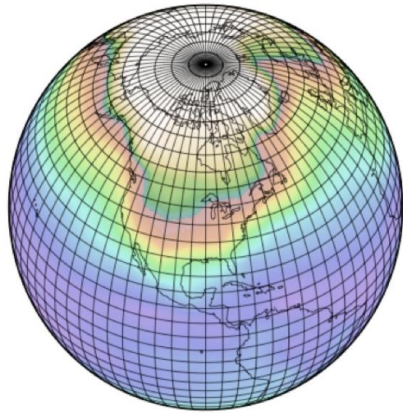
- Legend**
-  Colorado River Basin
  -  Missouri River Basin
  -  Truckee and Carson River Basins
  -  Columbia River Basin
  -  Rio Grande Basin
  -  State Boundary
  -  Klamath River Basin
  -  Sacramento and San Joaquin River Basins



# West-Wide Assessment

## Overview

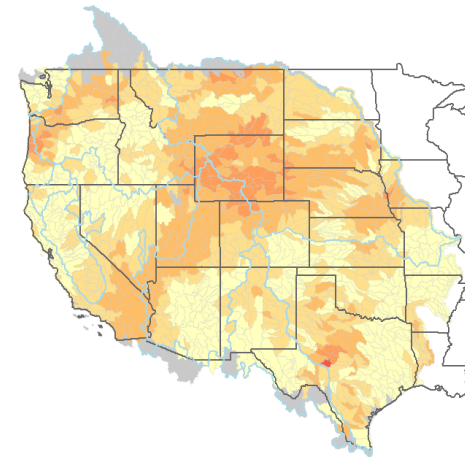
West-wide evaluations of climate information to help inform system reliability during warmer, wetter, and drier periods using:



Downscaled hydroclimate projections



Paleohydrology



Probability of Regime Shift (%)  
0 to 50 50 to 60 60 to 70 70 to 80 80 to 90 90 to 100

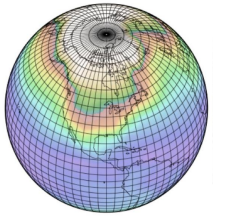
Drought analysis





# West-Wide Assessment

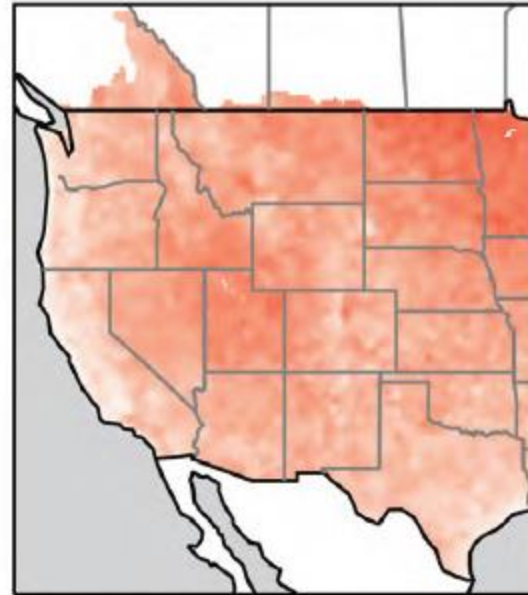
## Downscaled Hydroclimate Projections



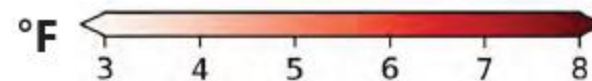
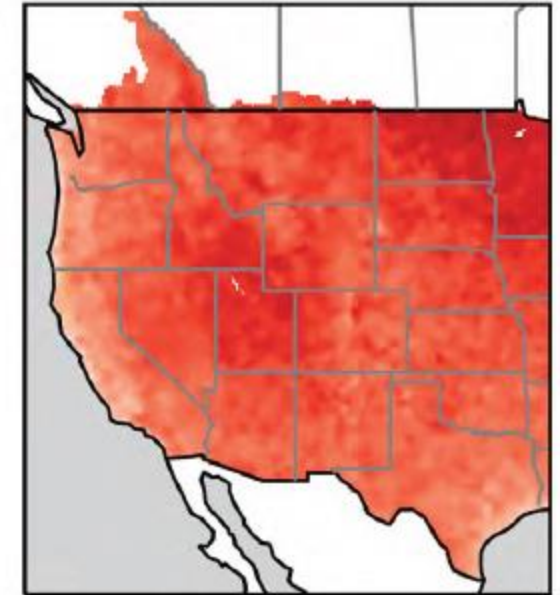
- Uses global climate models (GCMs) from a contemporary Coupled Model Intercomparison Project Phase 5 (CMIP5)
- Under scenarios with higher greenhouse gas concentrations, increases in temperature are more severe (warmer, more red) than in scenarios with lower greenhouse gas concentrations
- Projections of future temperature, precipitation, snowpack, and streamflow across the West

### Temperature Increases

Lower scenario (RCP4.5)

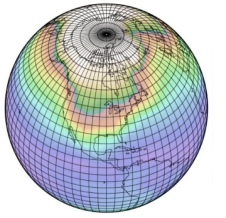


Higher scenario (RCP8.5)



# West-Wide Assessment

## Downscaled Hydroclimate Projections

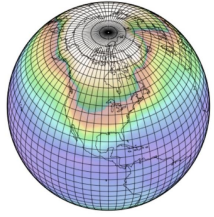


Results from 2021 are largely consistent with the 2016 SECURE Report

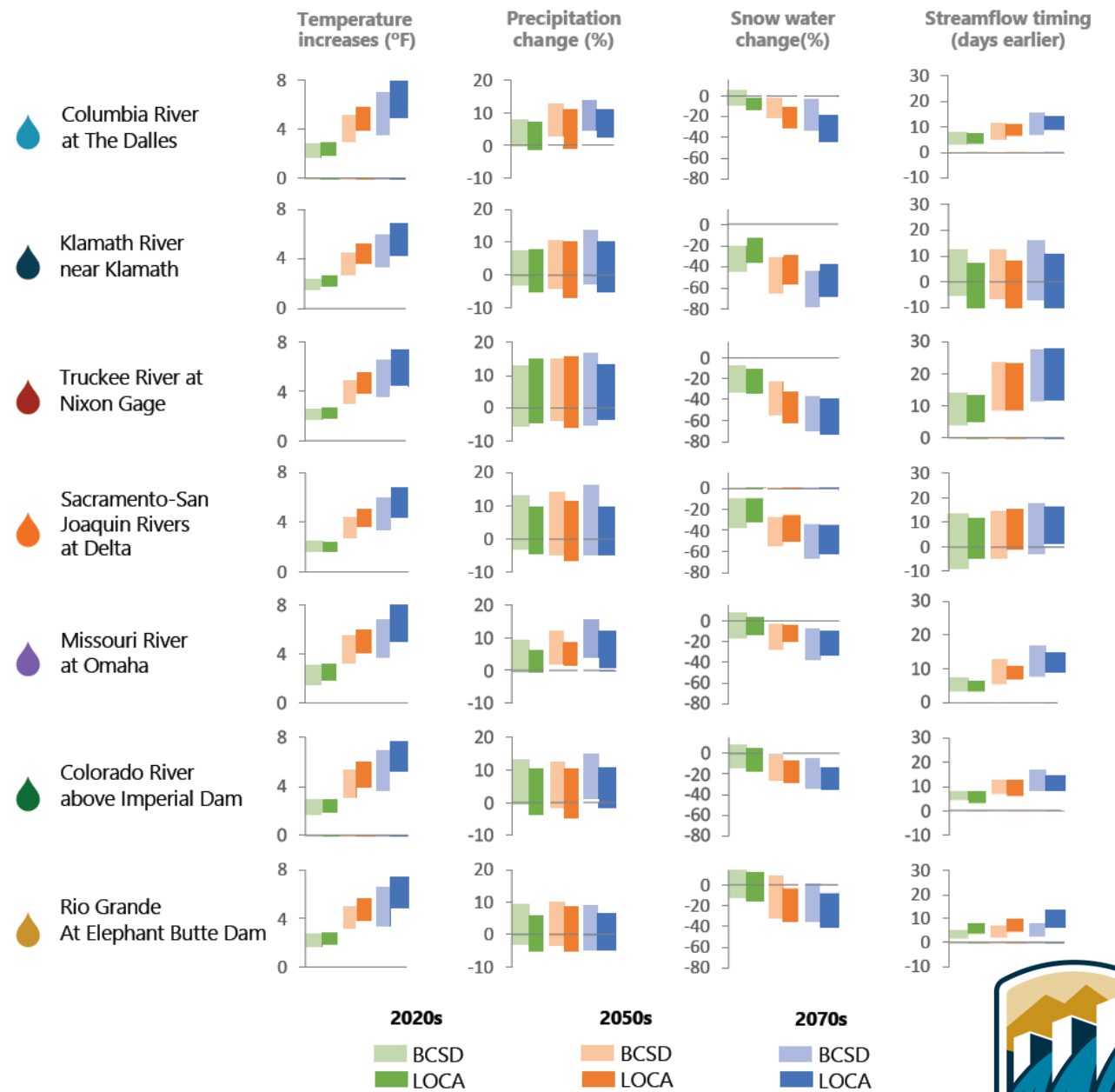
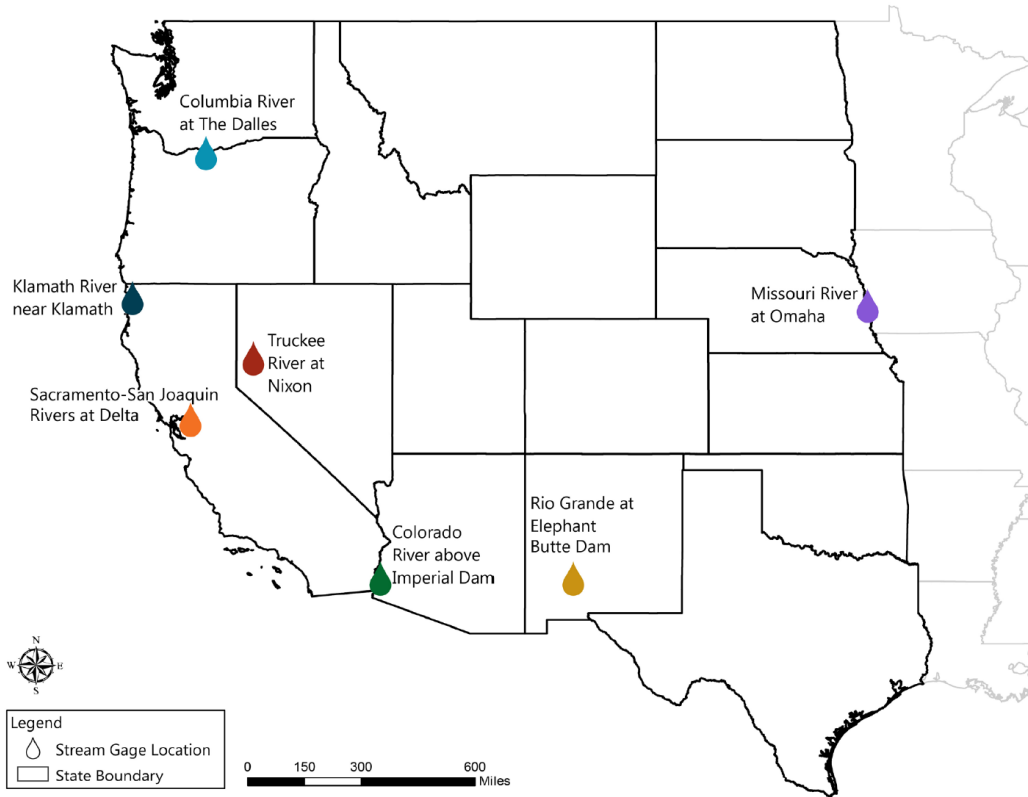
## Takeaways

- Temperatures will increase progressively through the future decades over the major Reclamation river basins (Basins) during the 21st century
- Precipitation changes vary considerably across the Basins with basins in the north (e.g., Columbia and Missouri) generally showing an increase in precipitation
- April 1st snowpack will largely decrease for nearly all the Basins
- Timing and quantity of stream flows will continue to change as temperature and precipitation levels change, and nearly half of the annual runoff is estimated to generally happen earlier in the major Reclamation river basins





# Climate and Hydrology Summary

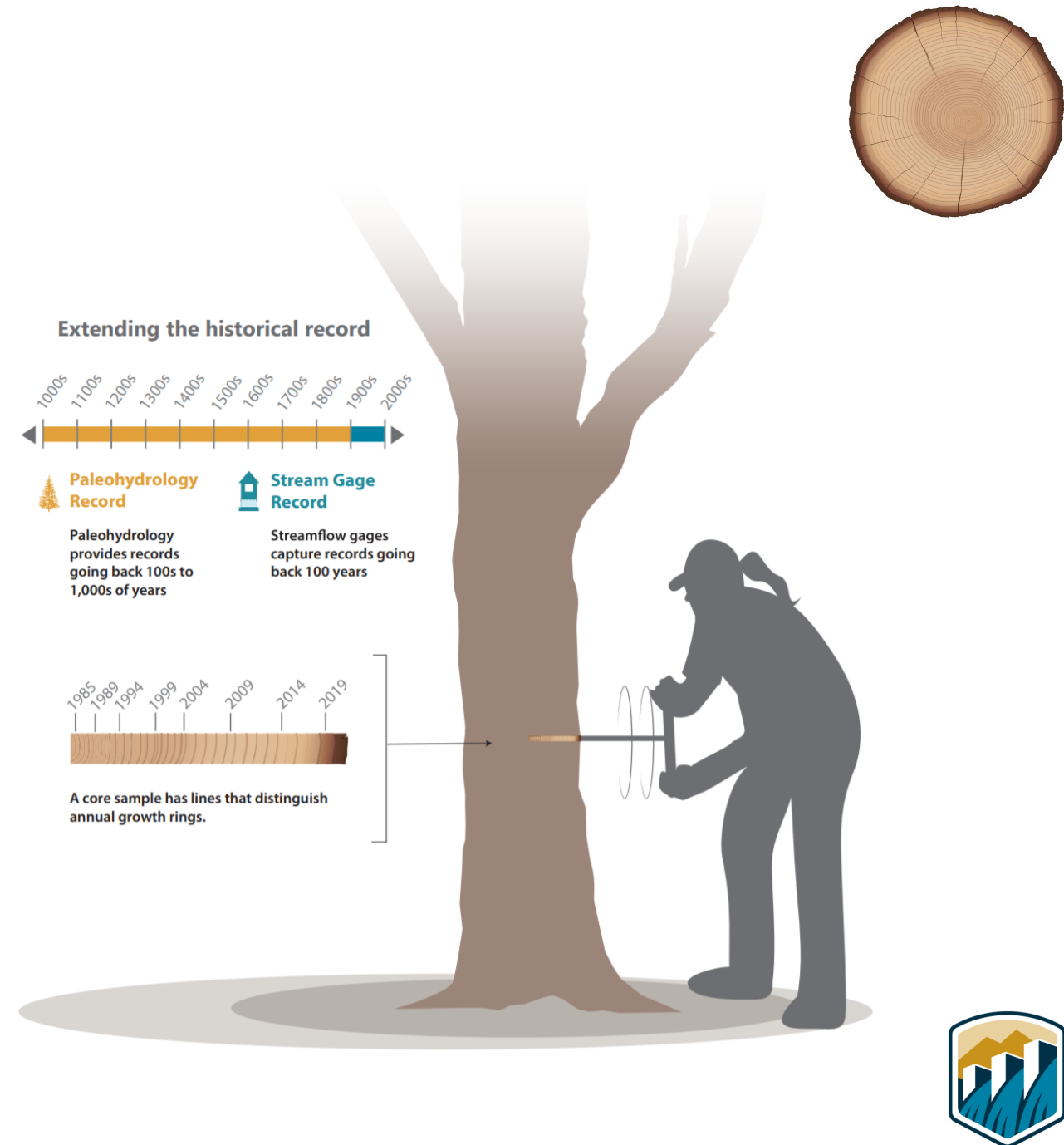




# Paleohydrology

## Overview

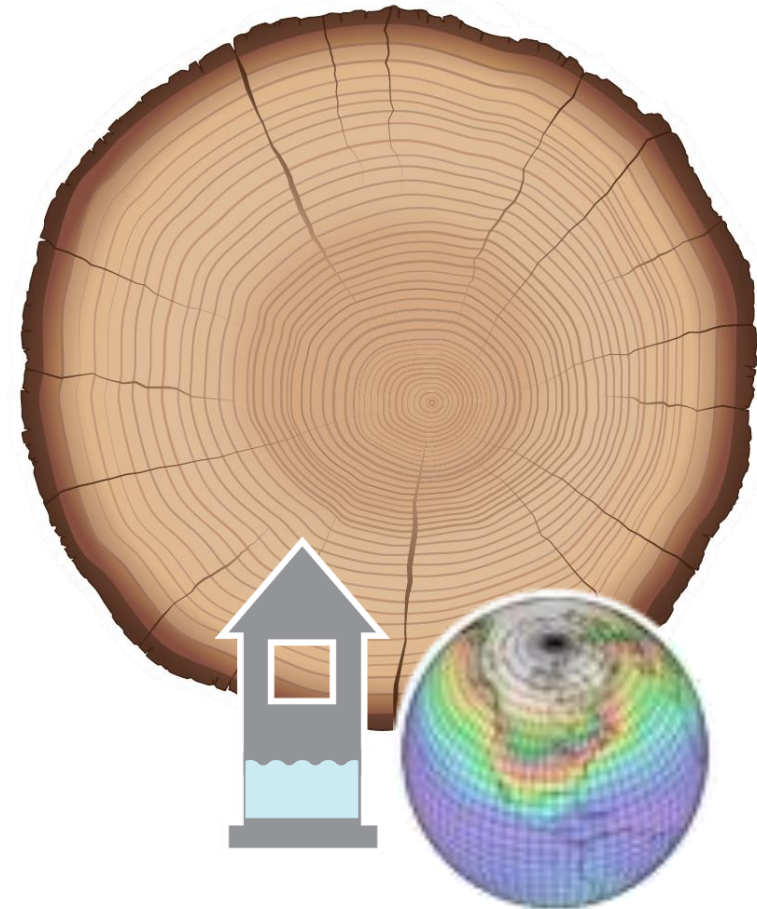
- Paleohydrology involves the use of tree-rings to develop reconstructions of hydroclimate variables such as streamflow going back centuries before stream gages were installed
- These longer records of wet and dry periods can be used to inform water managers about the duration, severity, and frequency of past droughts
- The 2021 Assessment uses paleohydrology to inform long term planning in addition to projections of future climate



# Paleohydrology

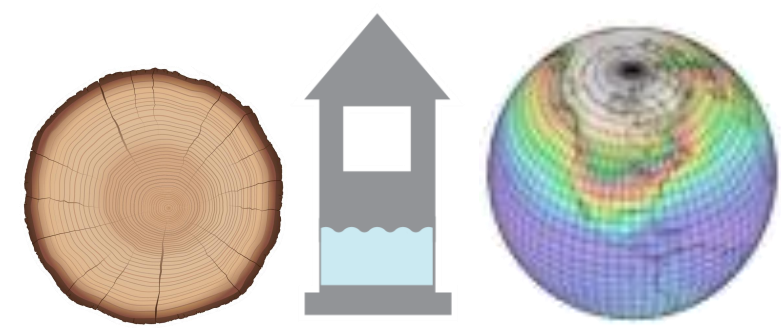
## Applications

- Using paleohydrology, the stream gage record and future projections, we can compare past droughts to potential future droughts
- We can also use paleohydrology to learn about the likelihood of shifting in or out of a drought
- Knowing more about the occurrence of given drought events will help stakeholders to prepare and subsequently adapt to changing hydroclimate conditions

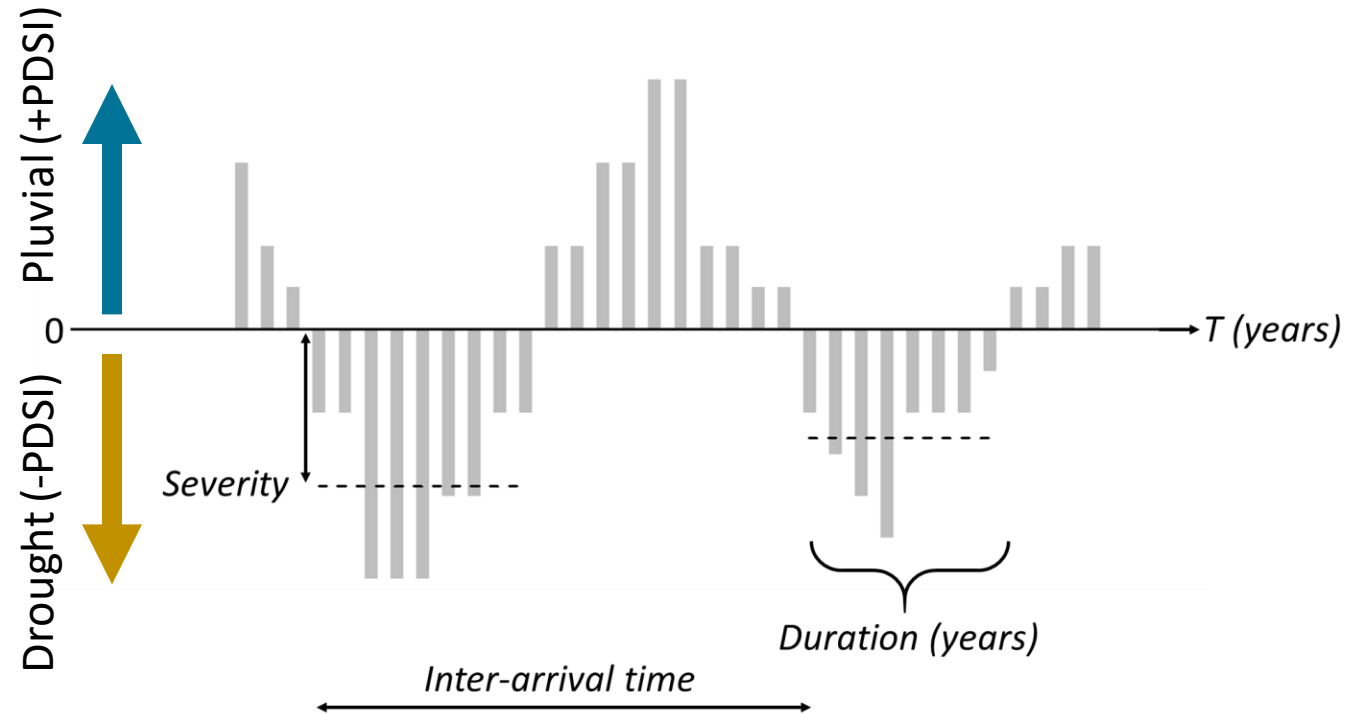


# West-Wide Drought Analysis

## Distant past and future projected drought index



- Another use of paleohydrology is reconstructed Palmer Drought Severity Index\* (PDSI, 1473-2005)
- We have also computed future projections of PDSI using CMIP5-LOCA (2006-2099)
- We have quantified characteristics of droughts that occurred in the distant past and in the future
  - Drought duration
  - Drought severity
  - Drought inter-arrival time



\* Cook, E.R., R. Seager, R.R. Heim, R.S. Vose, C. Herweijer, and C. Woodhouse, (2010). Megadroughts in North America: Placing IPCC projections of hydroclimatic change in a long-term paleoclimate context. *Journal of Quaternary Science*, 25(1), 48–61, doi:10.1002/jqs.1303.

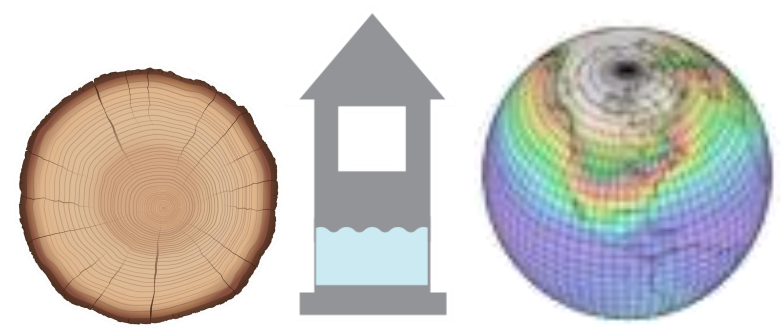




# West-wide Drought Analysis

## Projected Changes in Drought Duration

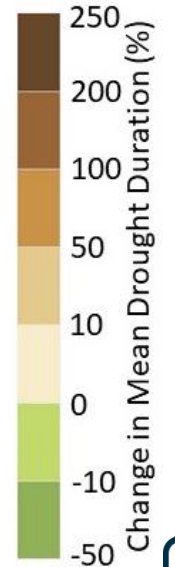
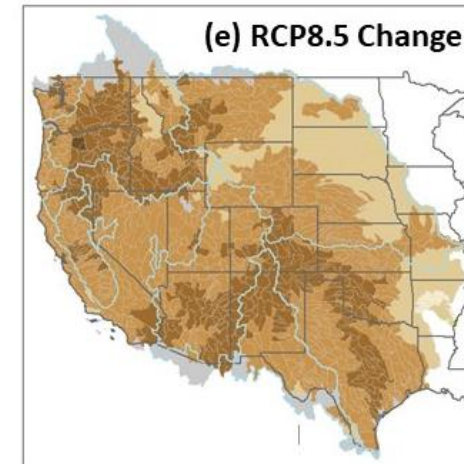
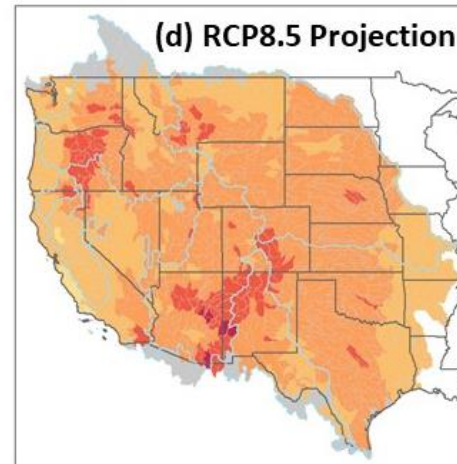
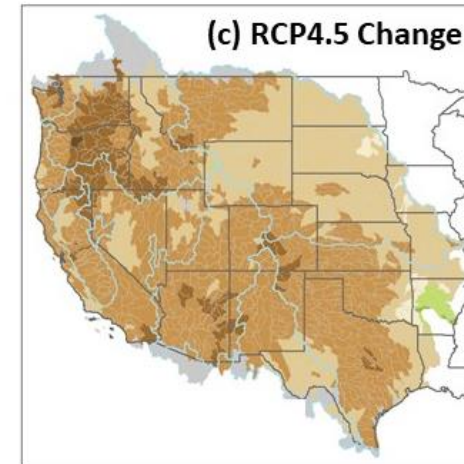
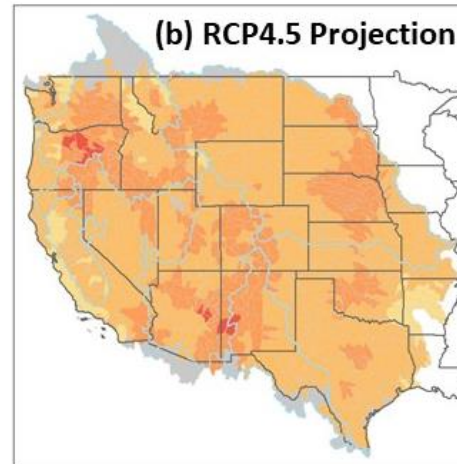
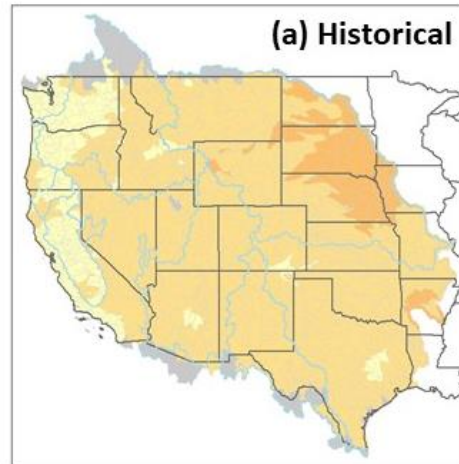
*Drought duration will increase and be greater with higher emissions*



Historical (1473 – 2005)

Future (2006 – 2099)

Change

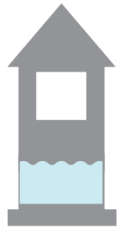


See Figure 83 in the 2021 Assessment Report

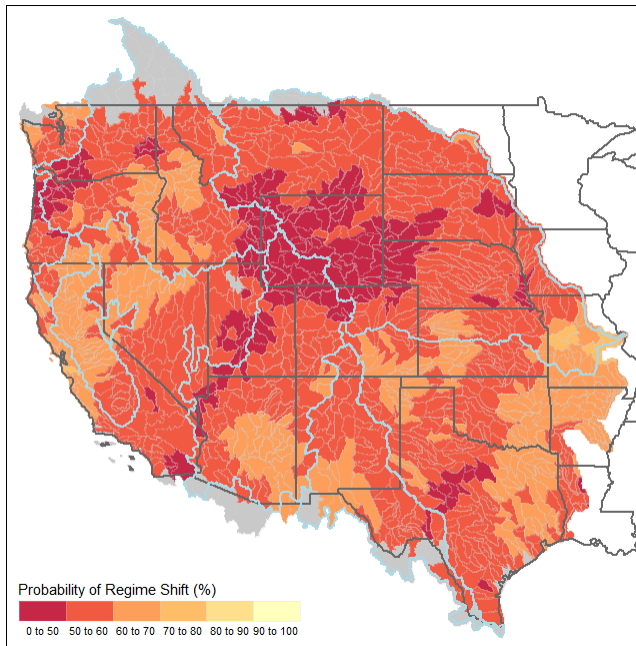
# West-wide Drought Analysis

## Drought Regime Shift Analysis

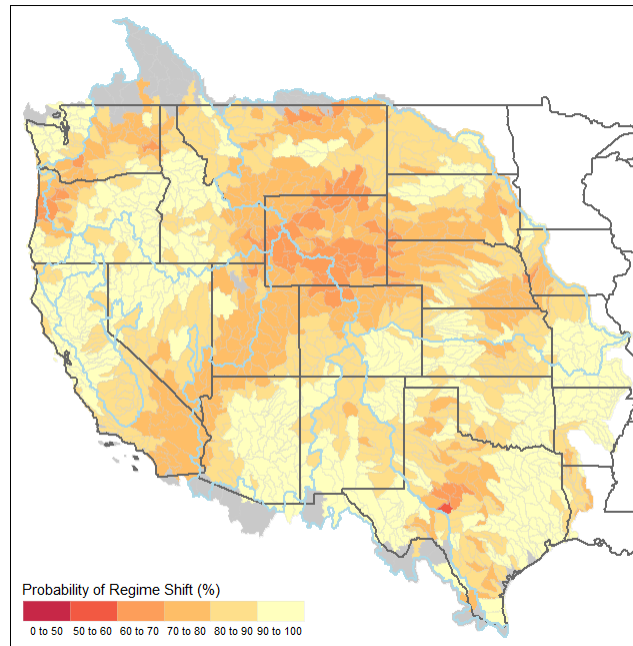
*Likelihoods of going into or coming out of a drought vary across the West*



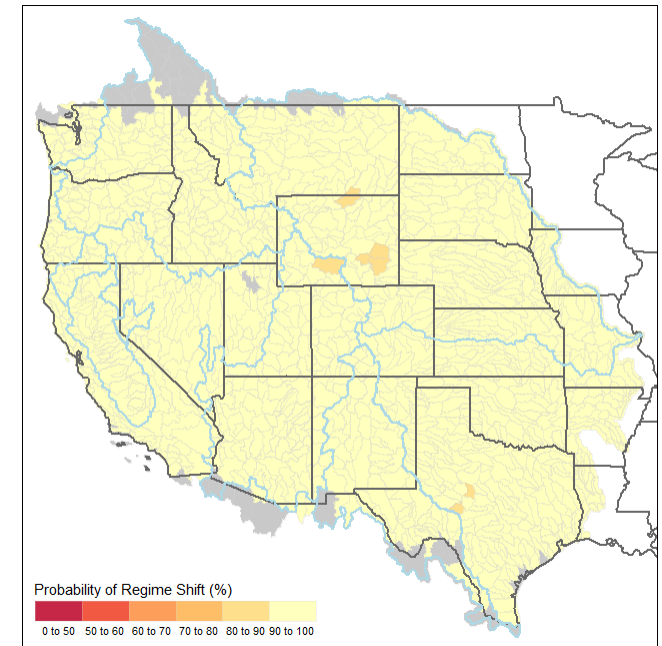
(A) 5-year outlook; time in drought 5 years



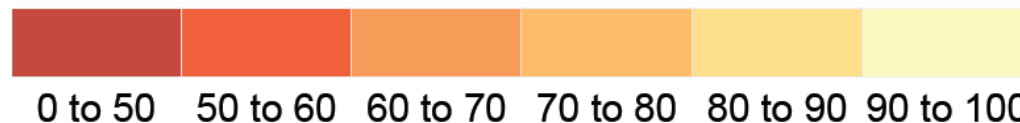
(B) 5-year outlook; time in drought 20 years



(C) 10-year outlook; time in drought 20 years

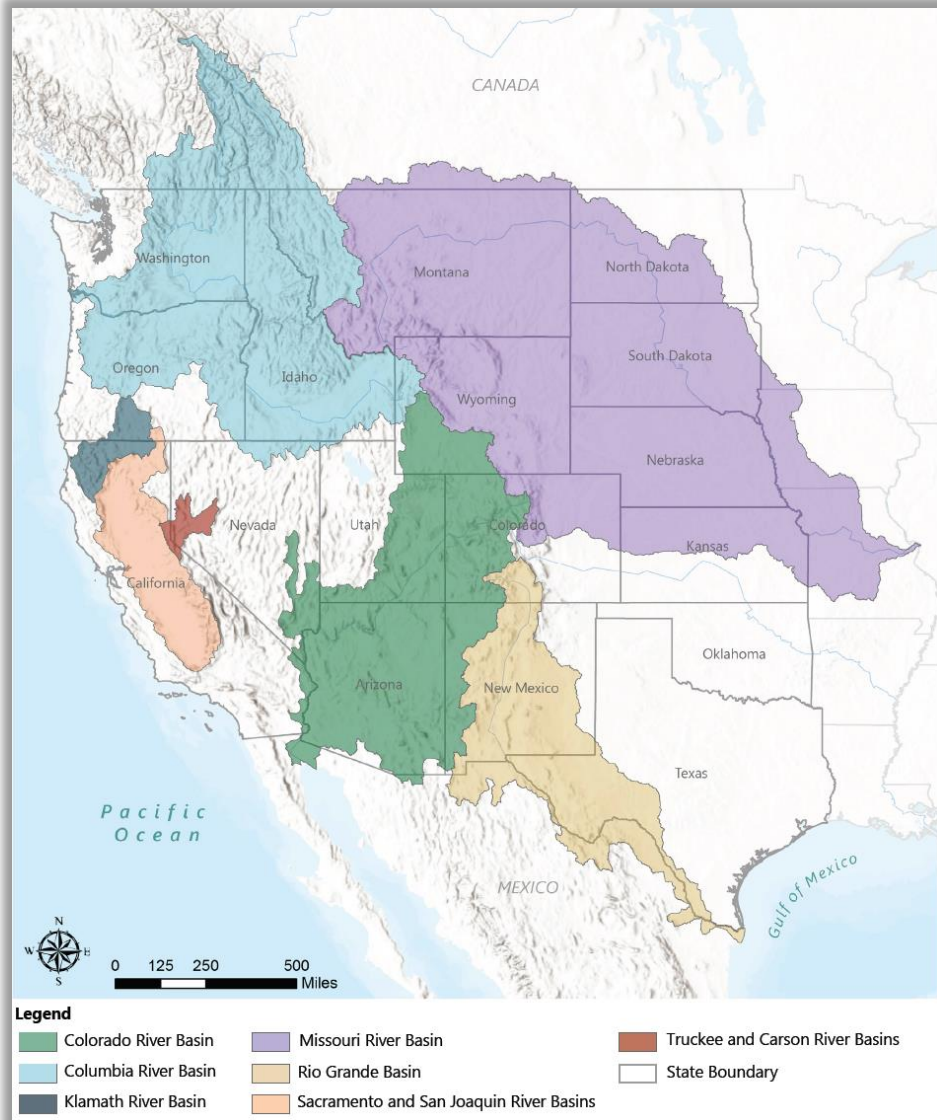


Probability of drought (or pluvial) transitions (%)



# Water Supply Reliability Assessment

## Overview



- Analysis performed in each major Reclamation river basin
- This work has allowed exploration of the question: *How might a river basin respond if distant past droughts were to occur today under current operating policies and water demands?*
- Impacts of paleo droughts compared with more recent historical droughts vary based on river basin





# Water Supply Reliability Assessment

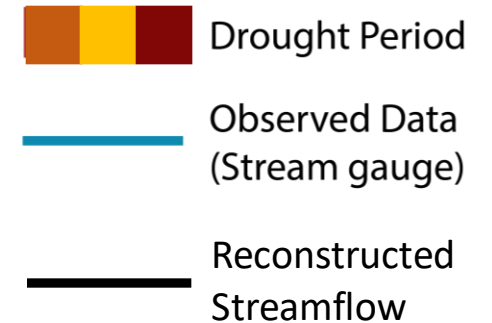
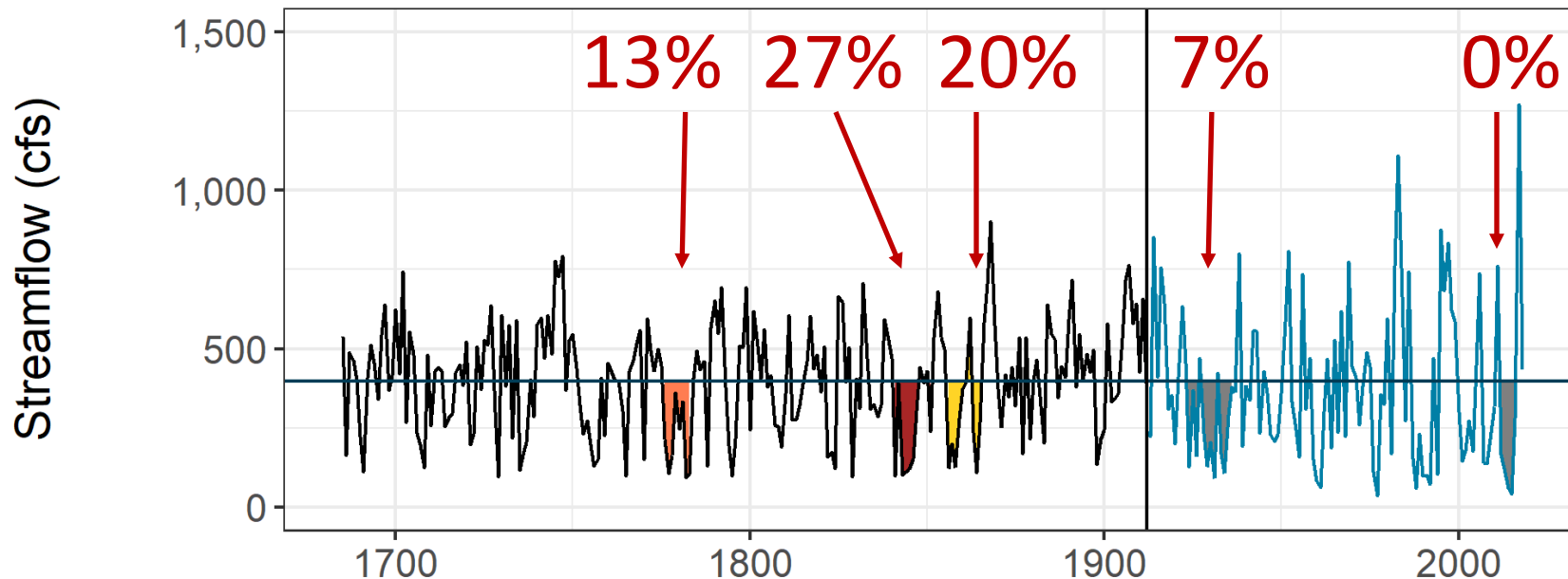
## Example Results



*If droughts of the more distant past happened today...*

**Lahontan Reservoir storage target on June 30 would be impacted by distant past droughts, but not as much as by recent historical droughts**

Carson River nr Fort Churchill, NV

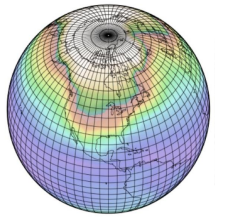


**Baseline  
Average is 40%  
(1901-2017)**



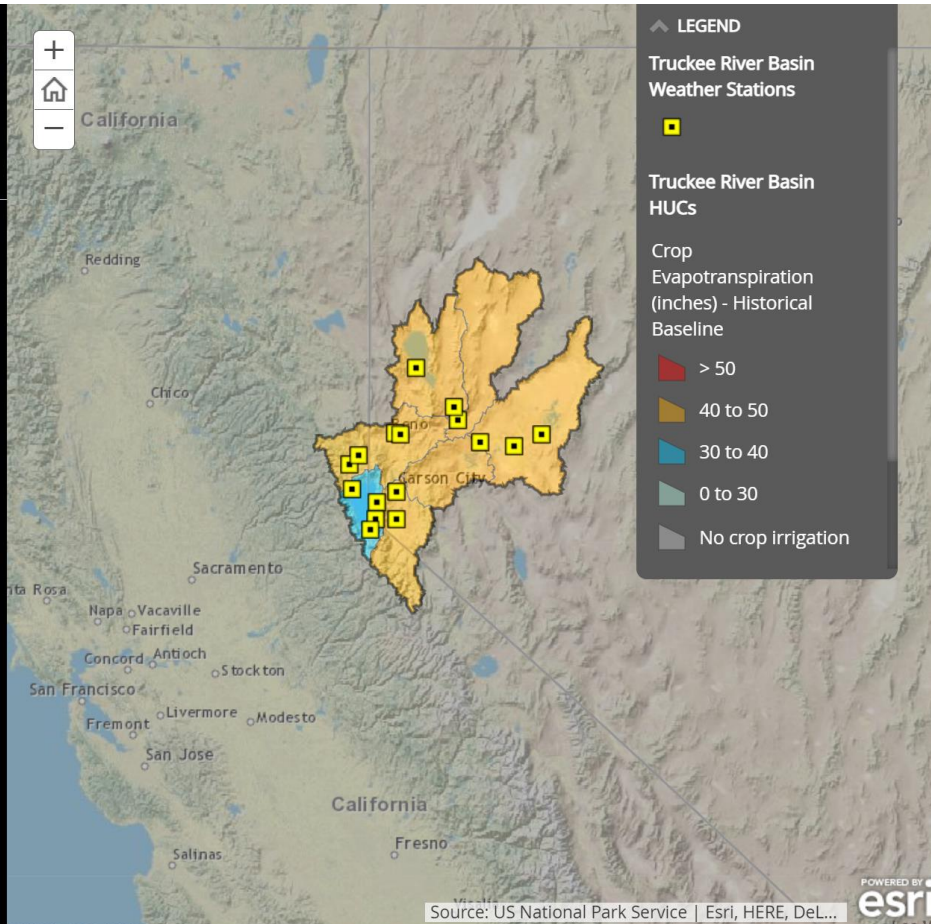
# Demands Analysis

## Overview



### Irrigation Demand Projections

The Truckee and Carson Rivers are major sources of water for western Nevada including approximately 234,025 acres of irrigated crop lands. Primary crops include alfalfa, other hay and grains. The map at right shows the HUC8 watersheds within the basin and the locations of weather stations (Met Nodes) used in the estimation of historical and future irrigation demands. Data from one or more Met Nodes were used for each watershed. In most cases the Met Node(s) associated with a watershed are within the watershed, but Met Nodes located in adjacent watersheds are used in some cases.



- Built on 2015 irrigation demand and reservoir evaporation projections
- Urban landscapes throughout the Western U.S. are a substantial consumer of water resources
- Projected increases in temperature will lead to large increases in plant water consumption
- Future projections of water demand for warm season turfgrass in Las Vegas, NV show increases of 13.7 in/year by the 2080s

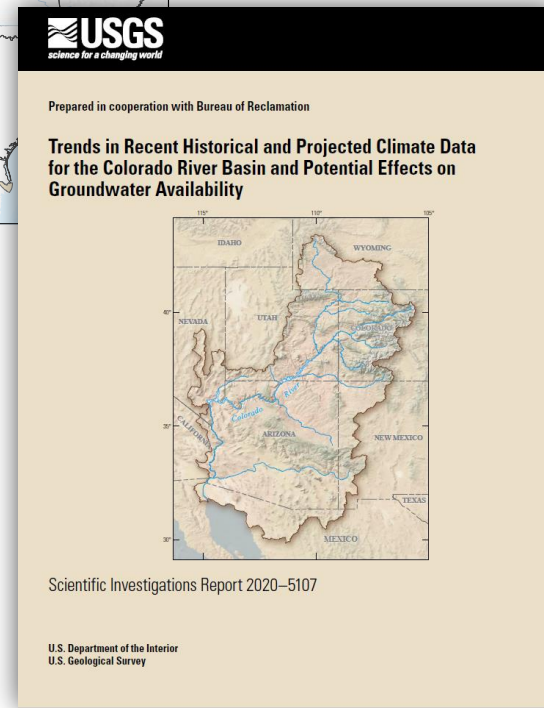
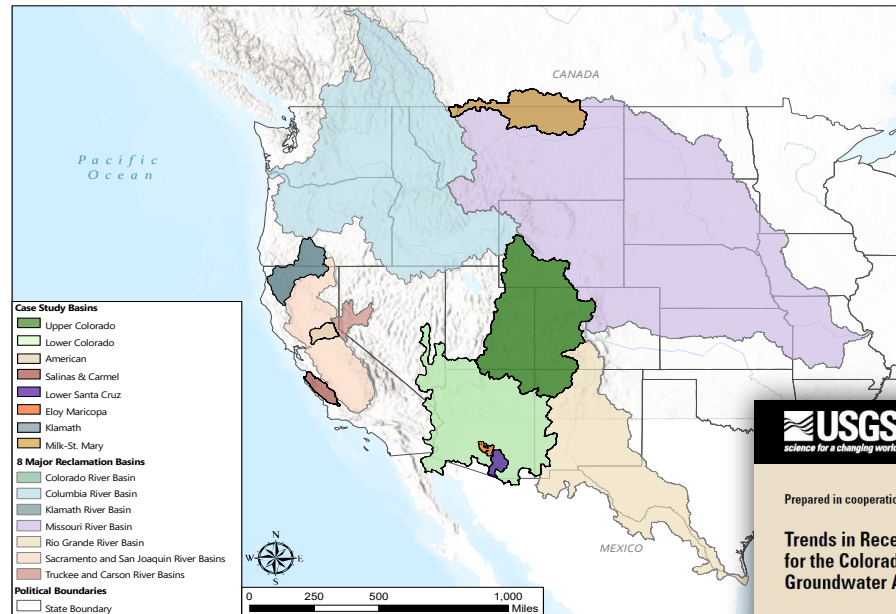
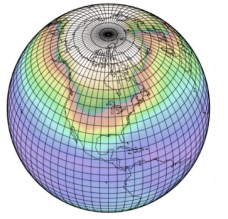
2015 Irrigation Demand and Reservoir Evaporation Projections Data Portal

<https://www.usbr.gov/main/dashboard.html>



# Groundwater Impacts Synthesis

## Overview



- Climate-driven changes in recharge and discharge continue to be an active area of research
- Synthesis of existing work through basin studies
- Collaboration effort with the USGS show that compared to the historical period 1951-2015, projected groundwater infiltration will be:
  - less in the Lower Colorado River Basin
  - more in the Upper Colorado River Basin



# Hydrology Assessment

## Managing Risks and Uncertainty

- Using a range of techniques collectively provides a more robust analysis, especially when different techniques reveal similar conclusions
- Future conditions are ultimately uncertain
  - Reducible uncertainties stem from an evolving understanding of complex system processes and imperfect representation of those processes in models
  - Irreducible uncertainties stem from the chaotic nature of the climate system
- Information presented in the 2021 Assessment offers an illustration of new and updated tools that water managers may use to support risk analyses based on uncertain conditions.

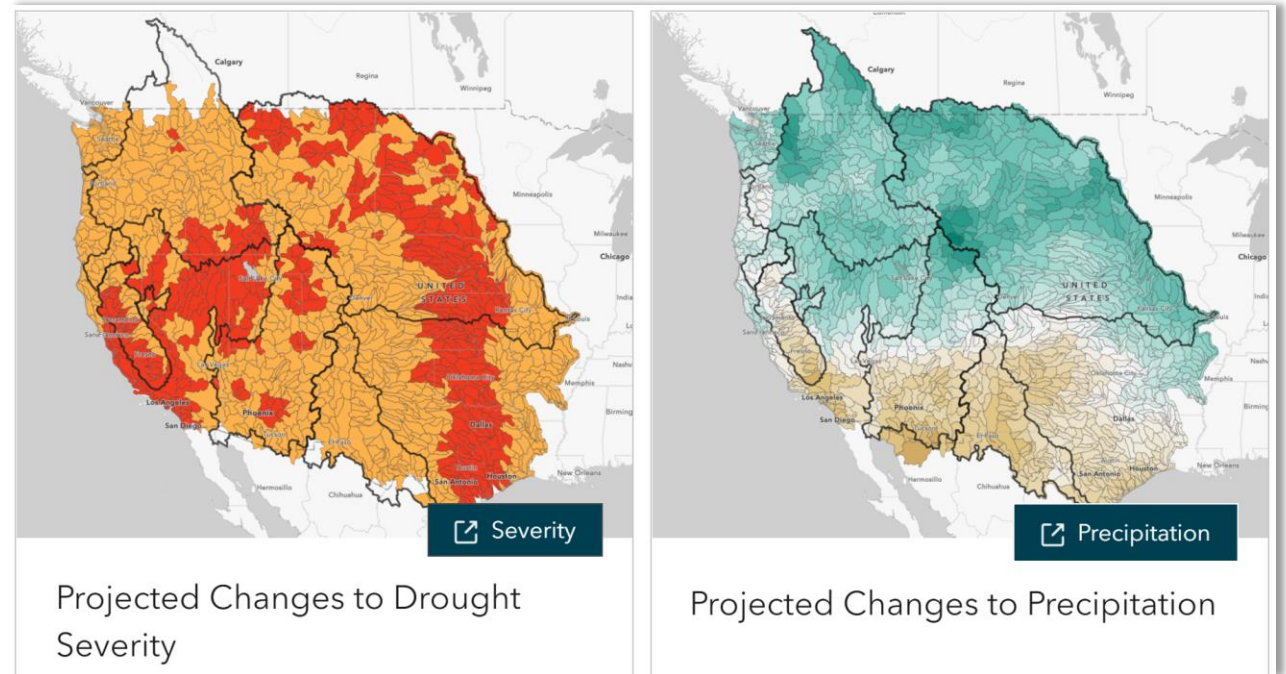




# 2021 West-Wide Assessment

## New Information and Tools

- Downscaled hydroclimate projections
- Streamflow reconstructions using tree rings
- Drought information for over 1,200 watersheds
- West-wide drought analysis
- Water supply reliability assessment
- Urban water demands assessment
- Groundwater synthesis



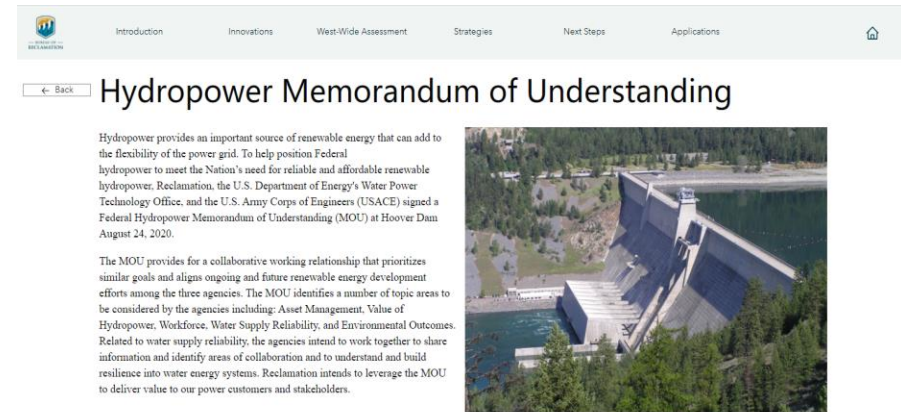
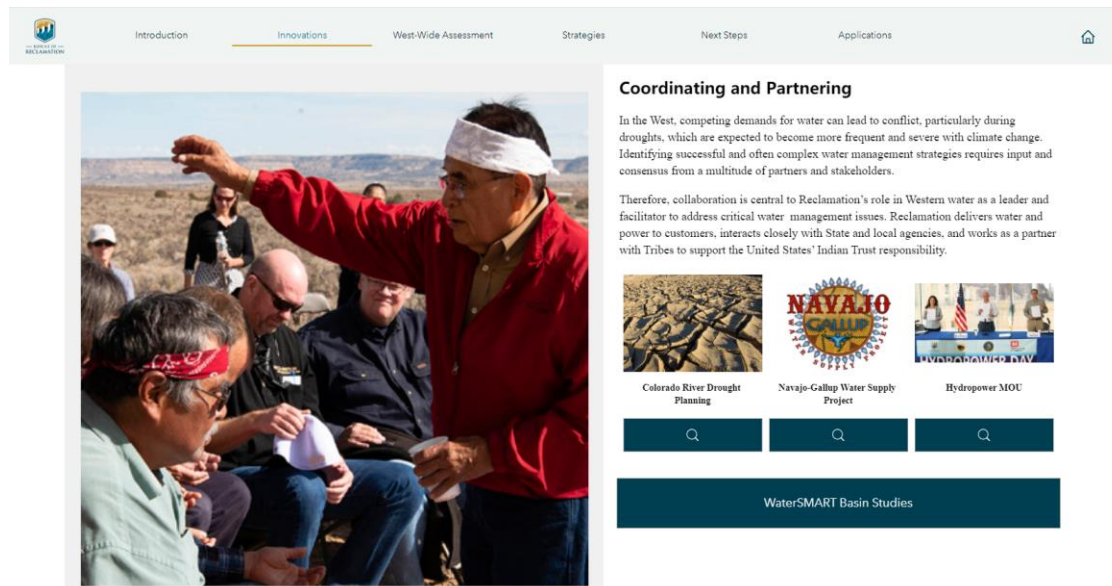
# SECURE Web Portal

- The web portal illustrates the content of the SECURE Report
- Users will encounter an easy to navigate, media-rich presentation of select material and examples from the Report, the West-Wide Assessment, and Basin Studies



Every five years, Reclamation submits a report to Congress under the SECURE Water Act analyzing projected risks to water supplies in the West using the best available science and highlighting collaborative efforts to mitigate those risks. This Water Reliability in the West – 2021 SECURE Water Act Report (2021 Report) provides a west-wide assessment of changes to water supplies, uses, and demands and highlights progress and describes actions taken to increase water supply reliability since the 2016 Report.

Safe and secure water supplies are a continuing fundamental pursuit for life in the West. The 2021 Report provides an assessment of climate change impacts to water uses in the West and adds a new set of West-wide information based in paleohydrology derived from tree-rings. This report describes our collaborative actions taken to increase the reliability of water and power deliveries since 2016, including: science and research, planning, infrastructure sustainability, efficient hydropower production, and on-the-ground actions to meet needs for irrigation, municipalities, power, Tribes, and the environment.



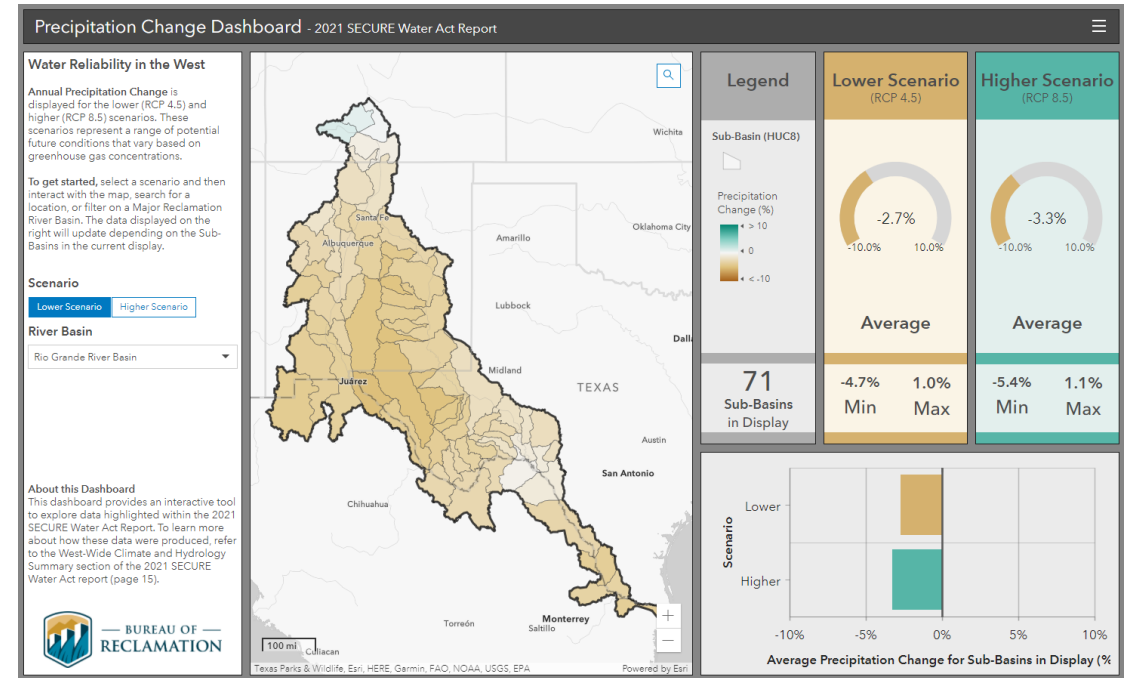
<https://www.usbr.gov/climate/>





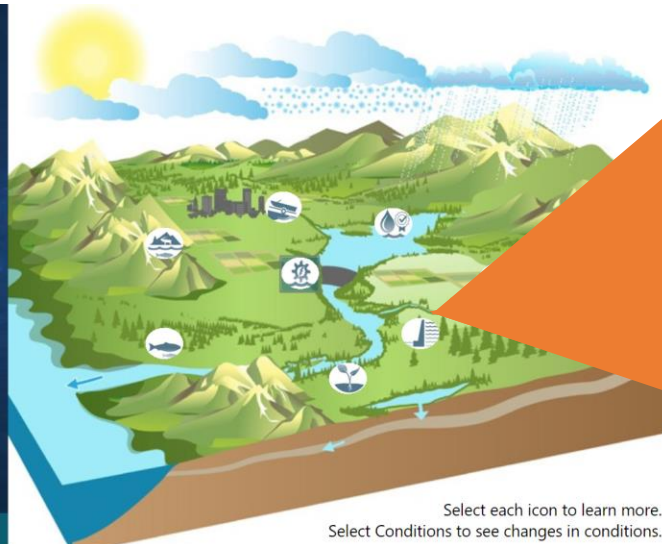
# SECURE Web Portal

The website provides select opportunities to interact with information and datasets the report contains



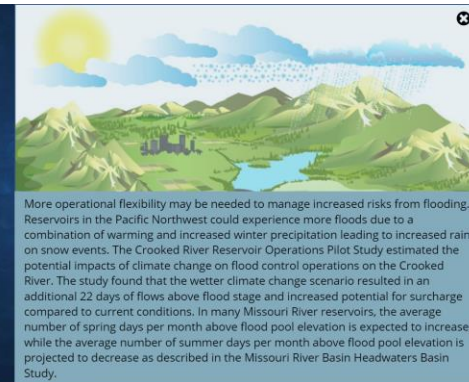
- Increasing temperatures, decreasing snowpack, changes to the volume of precipitation, and changes to runoff timing and volume across the west will affect numerous aspects of water management:
- Water Deliveries
  - Water Quality
  - Recreation
  - Fish and Wildlife Habitat
  - Hydropower
  - Endangered, Threatened, or Candidate Species
  - Flood Control
  - Ecological Resilience

Conditions



## Flood Control

Precipitation changes are expected to occur, interacting with warming to cause larger and more frequent floods, even in areas where total precipitation is projected to decline. Impacts vary by basin.



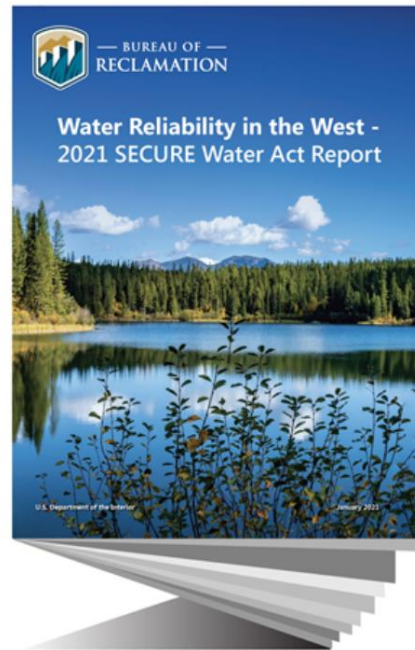
<https://www.usbr.gov/climate/>



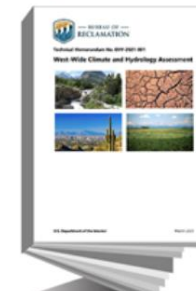
# Link for 2021 SECURE Report Documents and Web Portal

- All 2021 SECURE Report documents and Web Portal available at: <https://www.usbr.gov/climate/secure/2021secure.html>

## Summary Report to Congress



## Supporting Technical Materials and Other Resources



West-Wide Assessment



Fact Sheets



Basin Reports

Results from Basin Studies, Pilots and Innovations



SECURE Web Portal





# Collaborations and Acknowledgements

*This work is performed by Reclamation's Technical Service Center in partnership with the United States Geological Survey (USGS), University of Arizona, Columbia University, Desert Research Institute, National Center for Atmospheric Research, Aspen Global Change Institute, and in collaboration with Reclamation regions and area offices.*

# SECURE Webinars

- Missouri River Basin Webinar: April 15, 2021
- Columbia River Basin: April 20, 2021
- Colorado River Basin (plus West-Wide Assessment): April 23, 2021
- Rio Grande Basin: May 4, 2021
- Truckee River Basin: May 7, 2021
- Klamath River Basin: May 11, 2021
- Sacramento and San Joaquin Rivers Basin: May 13, 2021

Link to recorded webinars available at:  
<https://www.usbr.gov/climate/>



# Questions?

## Contacts

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Peter Soeth, Public Affairs, [psoeth@usbr.gov](mailto:psoeth@usbr.gov)

Katie Schultz, Water Resources and Planning Office, [kschultz@usbr.gov](mailto:kschultz@usbr.gov)



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