Climate Resilience Planning For Water Systems

In Washington State

This workshop was developed through a collaboration between the University of Washington Climate Impacts Group (CIG) and Washington State Department of Health's Office of Drinking Water (DOH). Support for this workshop is provided by the NOAA National Integrated Drought Information System (NIDIS).

As you enter, please type your name and affiliation in the chat.

Please make sure you have access to the workshop materials.
A printed or online copy will work.
Links to the materials will also be provided in the chat.

CEU Credits

- DOH will send your name and certified operator number to the organization awarding credits.
- To receive the credits, you must complete the full duration of the training.
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Climate Impacts and Resilience Planning

Crystal Raymond
UW Climate Impacts Group

clrfire@uw.edu

Climate Impacts and Resilience for Water Systems in Washington

Crystal Raymond, PhD
Climate Adaptation Specialist

CLIMATE IMPACTS GROUP

W EARTHLAB
UNIVERSITY of WASHINGTON

Image ©CIG; with aerial support from

The University of Washington Climate Impacts Group builds climate resilience by advancing awareness of climate risks & enabling science-based action to manage those risks.

CIG.uw.edu

"The past seven years are on track to be the seven warmest on record"

U.S.News & WORLD REPORT

2021 a Record-Breaking Drought Year in Parts of Washington

This has been a record-breaking year of drought in much of Eastern Washington.

U.S.News & WORLD REPORT

State: 2021 Shaping up as Bad Wildfire Season in Washington

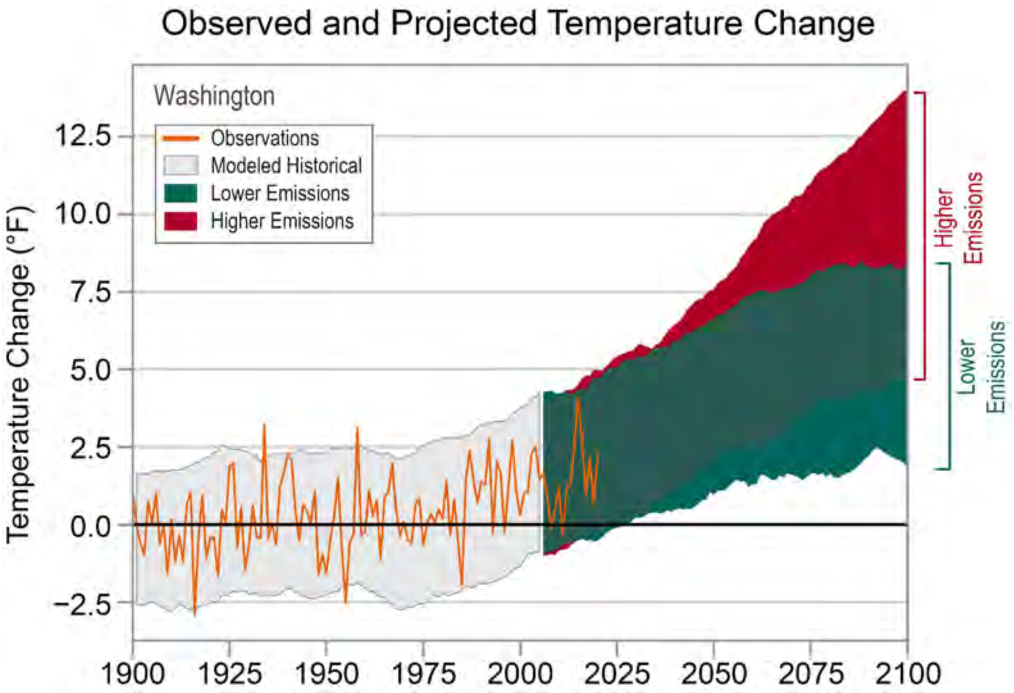
More than 30 wildfires are currently burning in Washington state in what is shaping up as a very busy fire season.

Climate Matters: Washington's economy, infrastructure and natural systems were built to succeed in the context of the climate of the past.

Planning for climate resilience is a process like many other planning processes…

The primary difference is recognizing that planning to only the p*ast* climate will leave us *insufficiently prepared for future* climate changes and impacts to water systems.

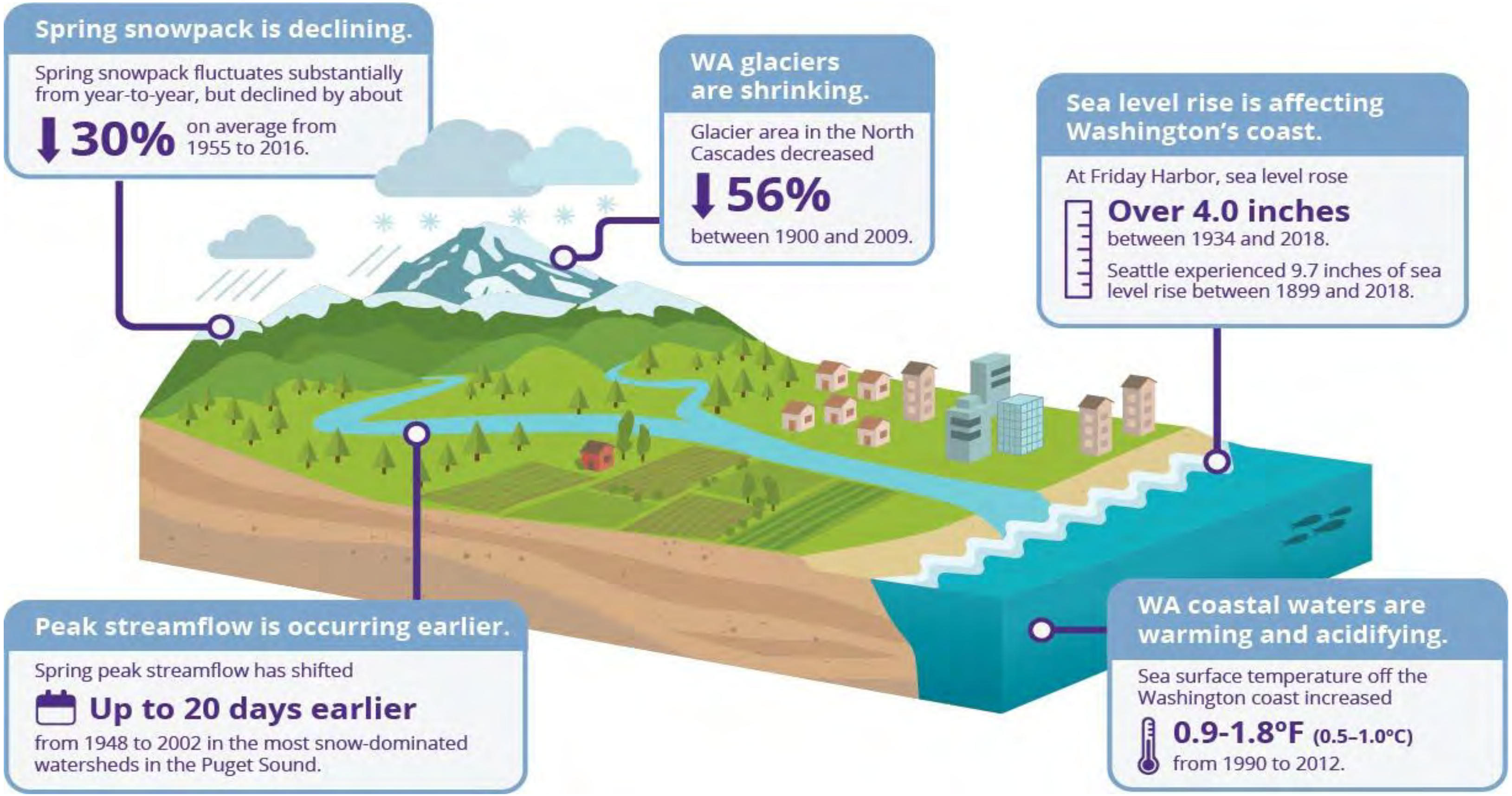
Since the beginning of the 20th century, temperatures in Washington have risen about 2°F.



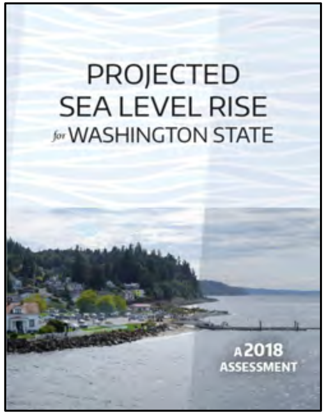
Since 1986, all but 5 years have been above the long-term (1895–2020) average.

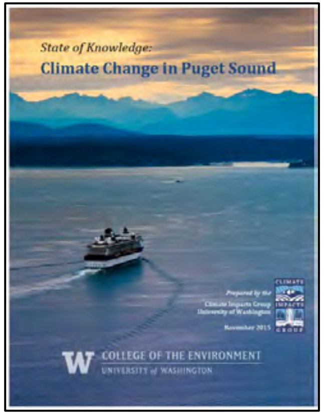
Frankson et al. 2022 NOAA NCEI State Climate

Many local consequences of warming are being observed in Washington from the mountains to the coast.



How is the climate expected to change in Washington?

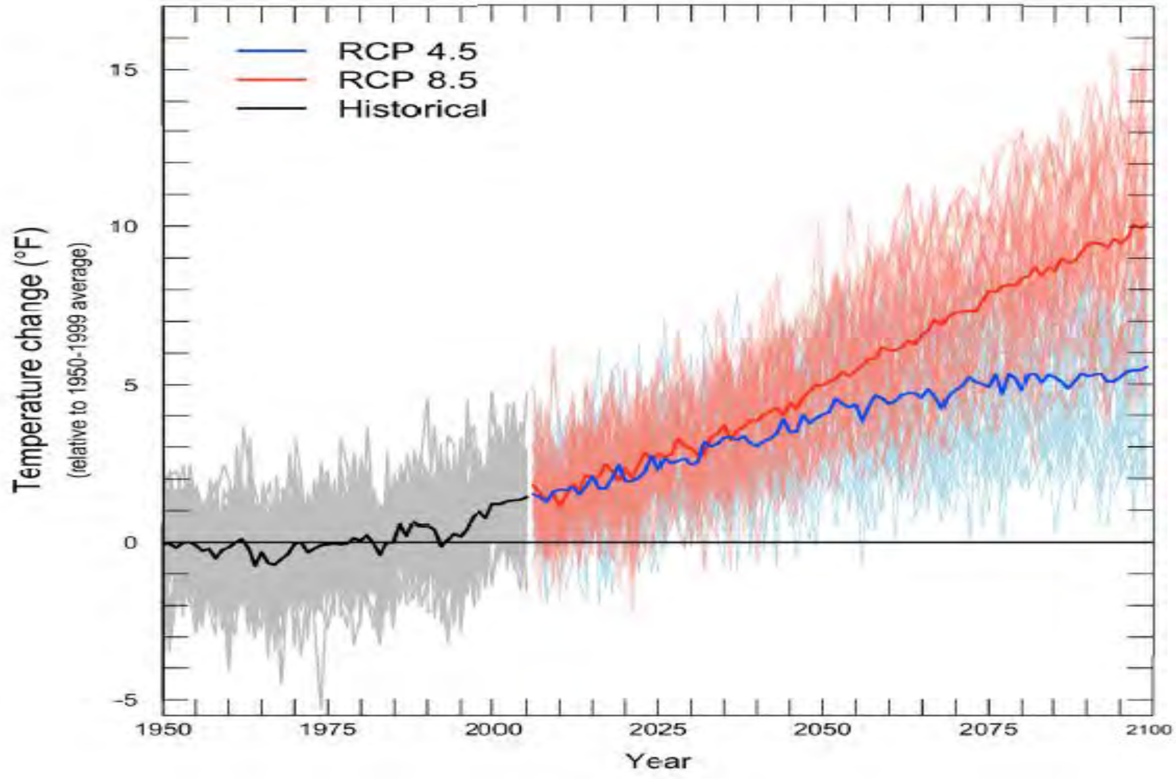




Multiple changes are expected for the climate, waterways, and lands of Washington state.

- Warming, more frequent heat waves
- Rising seas & increased coastal flooding
- Less snowpack, earlier spring runoff
- Drier summers & more frequent droughts
- Less summer streamflow
- Higher winter streamflow & increased riverine flooding
- More wildland fire
- Wetter winters & heavier rainfall

Rapid warming is expected across Washington state and in all seasons.



By the 2050s, Washington state is projected to see warming of

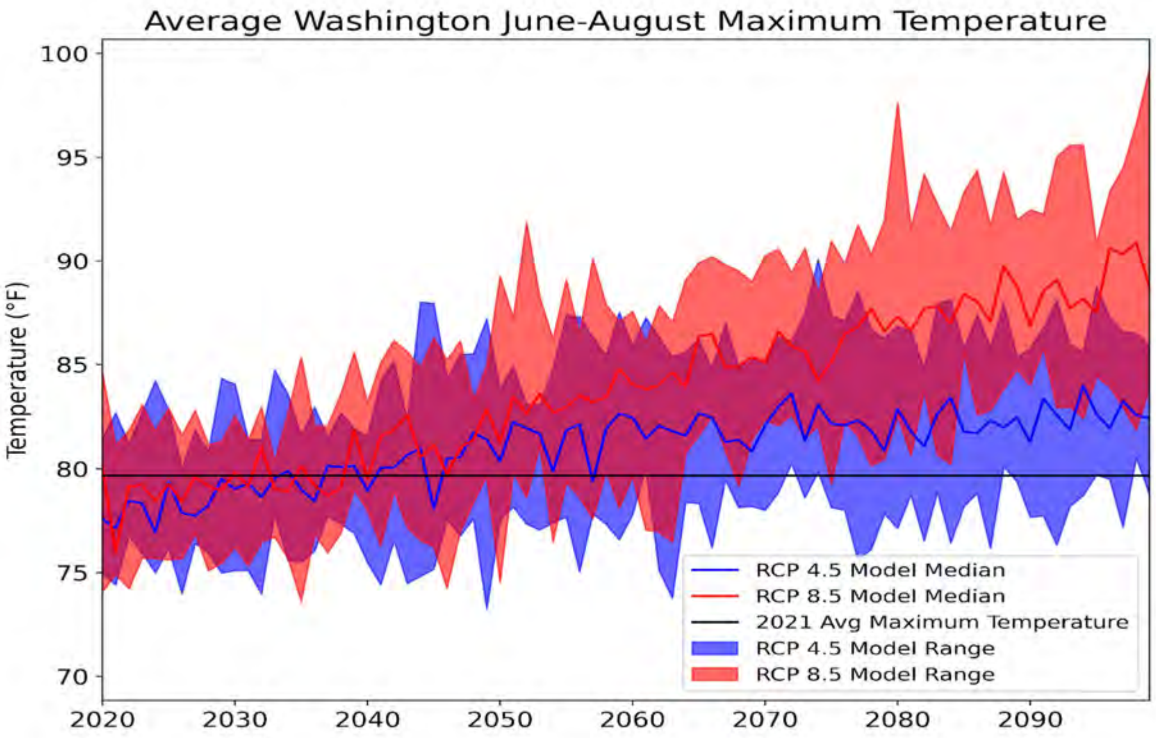
+5.8°F (3.1-8.5°F) High scenario (RCP 8.5)

+4.3°F (2.0-6.7°F) Low scenario (RCP 4.5)

Relative to 1950-1999

Snover et al. 2013

Extreme high temperatures and heat waves are expected to increase in frequency and severity.



By the 2030s, the 2021 maximum summer temperature of 79.8F will become common, with a 40% chance of occurring each year for a low scenario and 45% chance for a high scenario.

In the Northwest, the area burned by wildfire is expected to double in grass & shrublands and quadruple in forests.

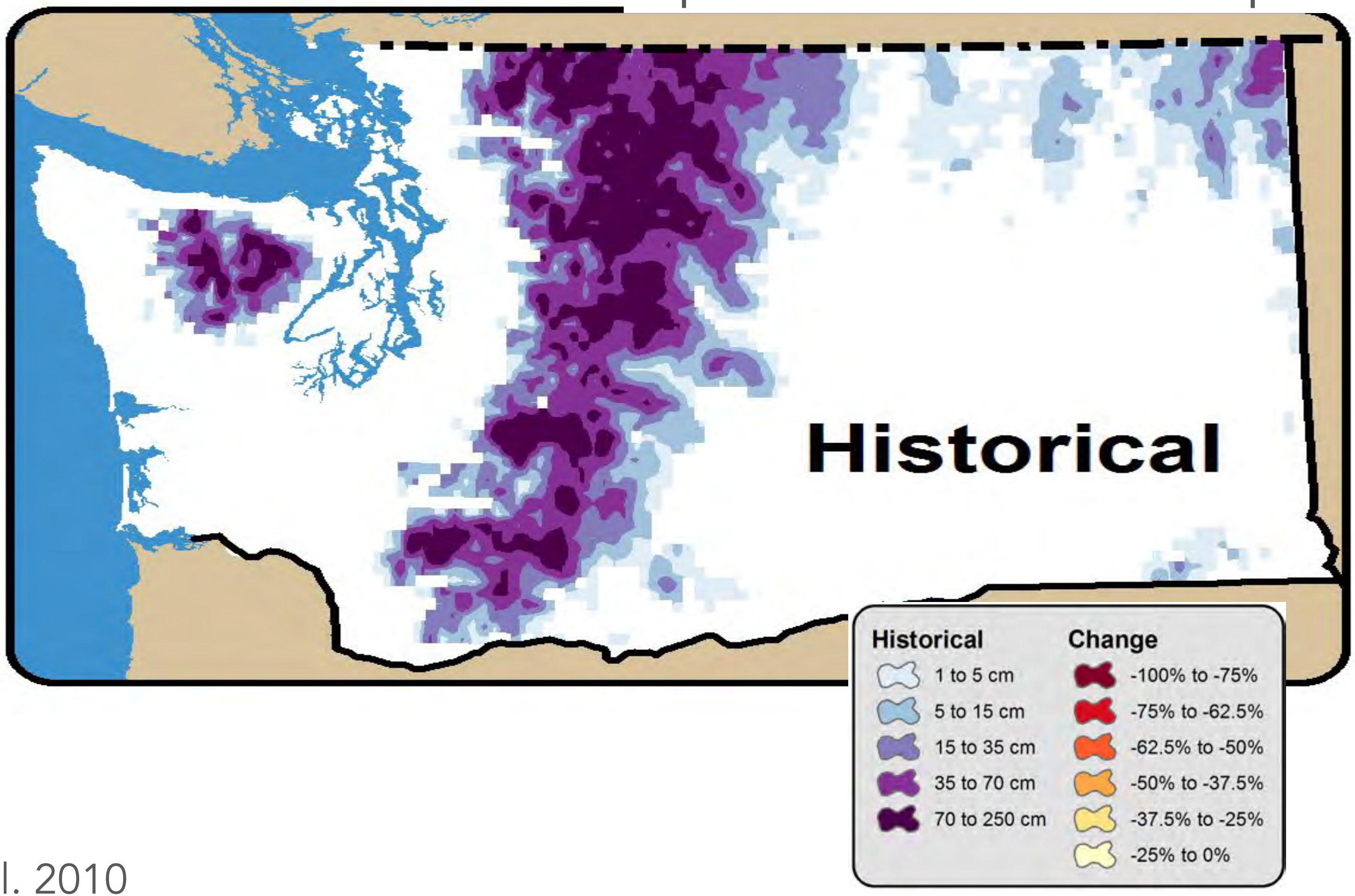
By 2040s

x 4 in forests

x 2 in grass & shrublands

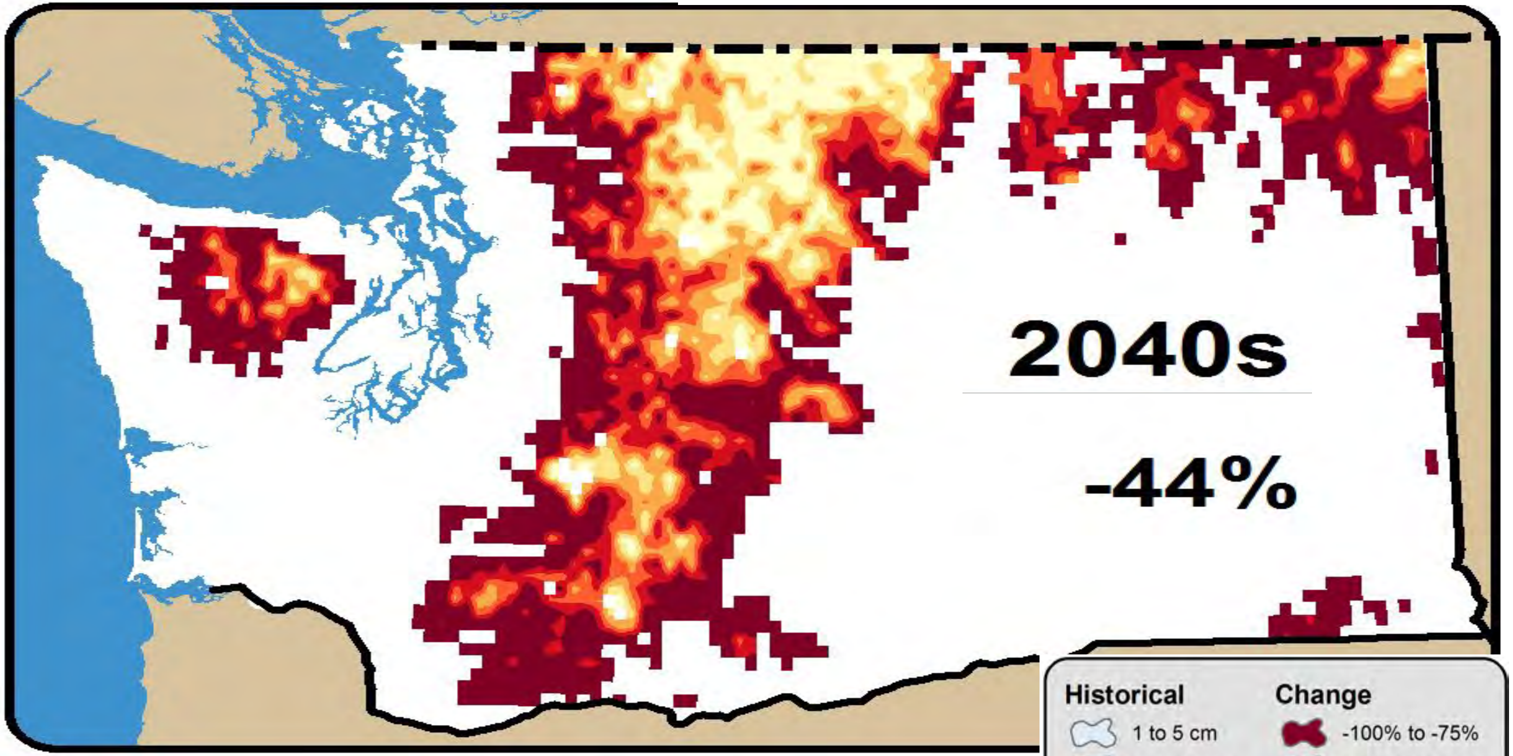
Relative to 1980-2006 average; moderate greenhouse gas scenario, Littell et al. 2010, 2012, Photo, DNR 2019

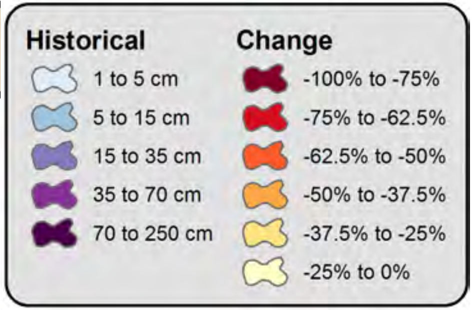
April 1 Snow Water Equivalent



Elsner et al. 2010

April 1 Snow Water Equivalent

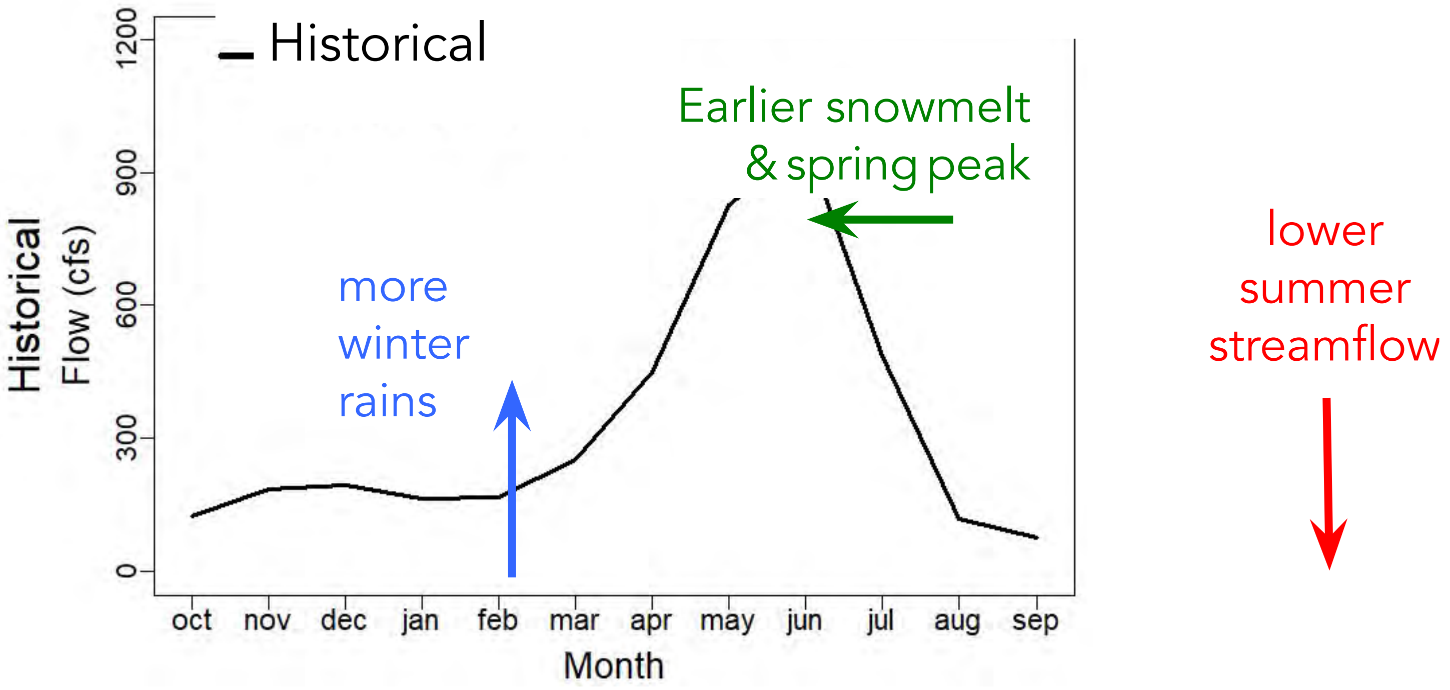




Warmer temperatures will decrease winter snowfall and spring snowpack.

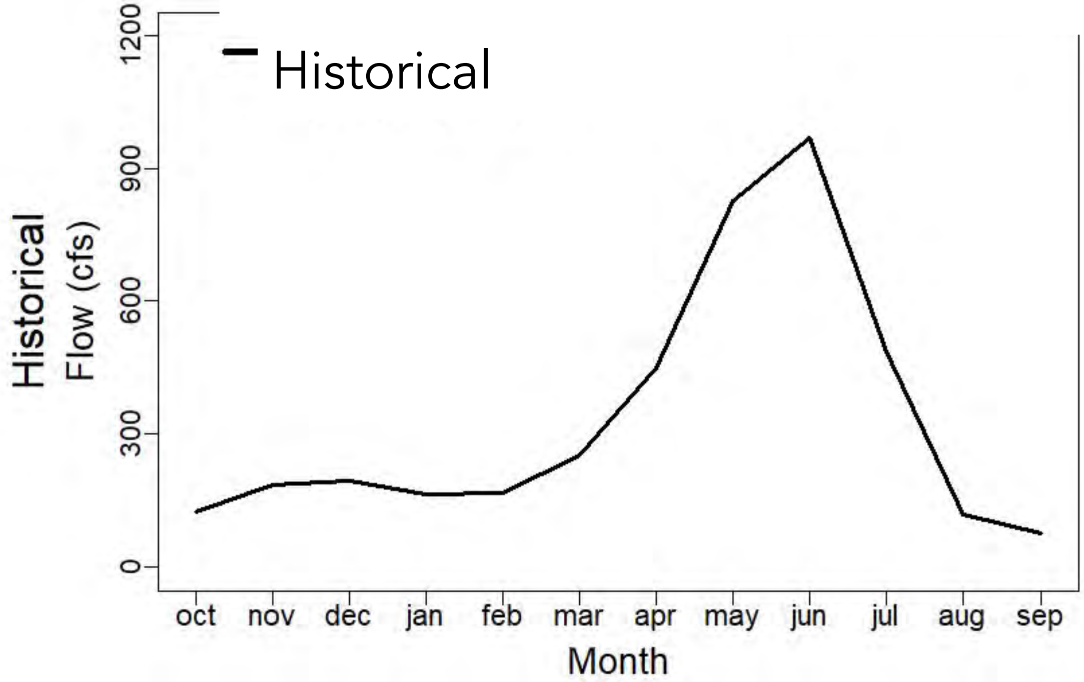
Elsner et al. 2010

Many watersheds are expected to have higher winter flows, early spring runoff, and summer streamflows.



Shifting streamflow: Entiat River

Many watersheds are expected to have higher winter flows, early runoff, and lower spring & summer flows.



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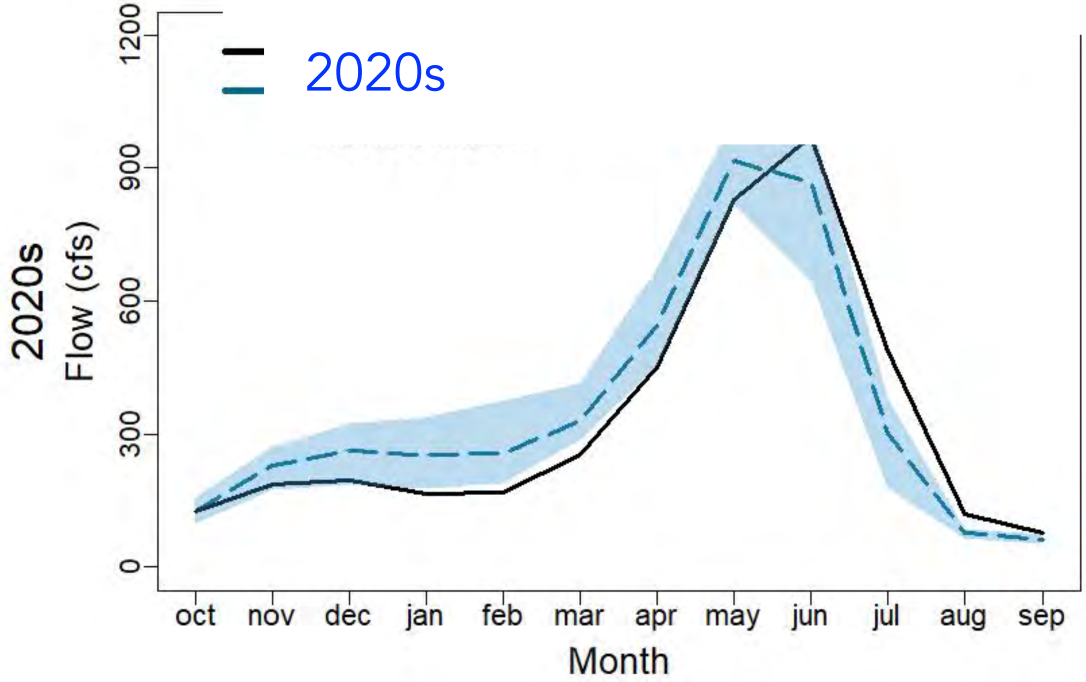

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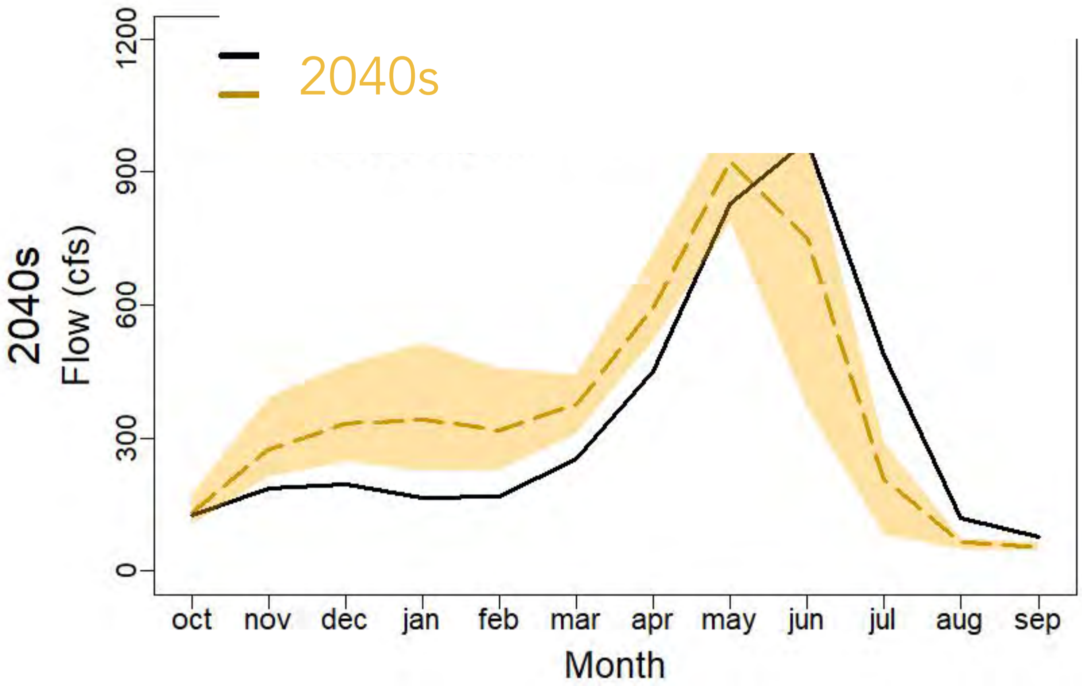

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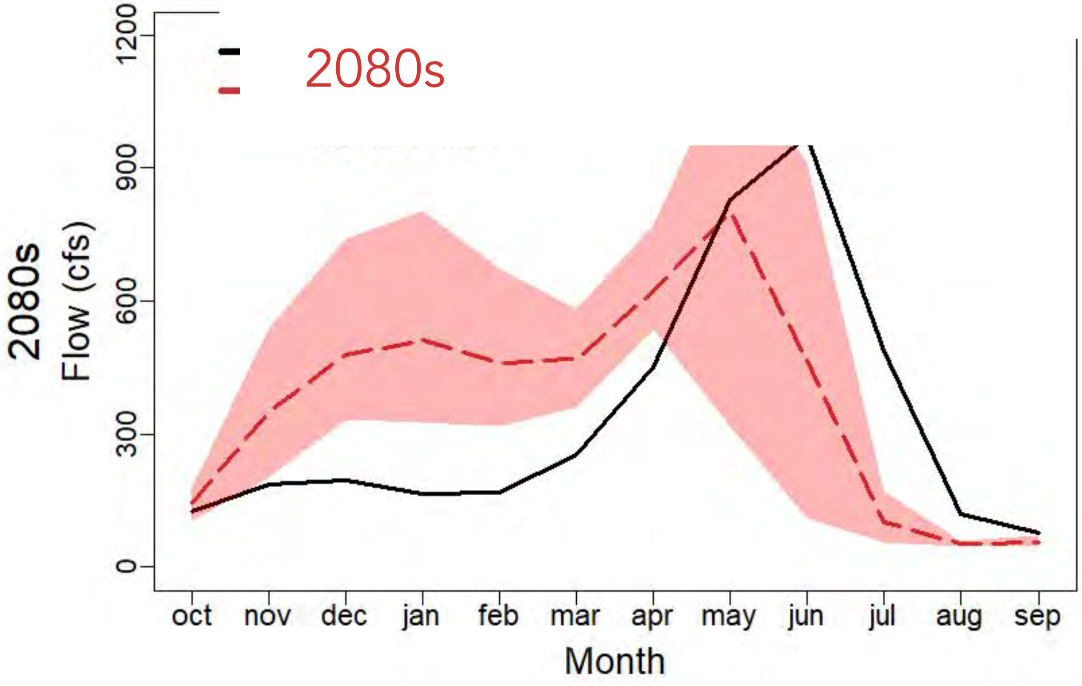


Shifting streamflow: Entiat River

The highest river flows in Puget Sound's 12 largest rivers are projected to increase 18% to 55% by the 2080s.

under a moderate (A1B) greenhouse gas scenario, relative to 1970-99; Mauger et al. 2015

Sea levels are rising, increasing coastal flooding, saltwater intrusion, and bluff erosion.

Alki Beach, West Seattle, January 21, 2010 , Photo: Hugh Shipman, Source: Washington Dept of Ecology

Key drivers of climate change impacts on water systems in Washington.

Warmer temperatures and more heat waves increasing water demand and reducing water quality.

Changes in the hydrologic cycle affecting water supply reliability and water quality, with financial implications.

Increasing climate-related natural hazards, such as wildfires and floods, affecting infrastructure, water supply reliabilty, and



Risks to water systems

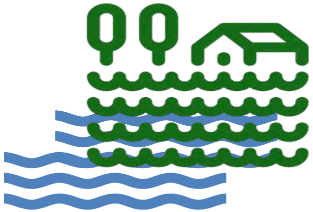
Increasing demand, reduced supply, changes in supply & demand timing, damaged infrastructure, reduced water quality, reduced reliability & higher operating costs.



The extent of harm from global warming depends on…

How much warming occurs

Local resilience to warming's impacts



Today's actions shape tomorrow's risks through…

Deciding whether to plan & manage our communities, economy & systems for the climate of the future or the climate of the past

Image: Kitsap Sun

Image ©CIG; with aerial support from LightHawk

Image: King County

Every single day, people are making decisions & investments that will either exacerbate or ameliorate the impacts of climate change, for decades to come.

Image: WA DNR

Image: Seattle Times

Drinking Water Resilience

Brian Sayrs
Department of Health Office of Drinking Water

brian.sayrs@doh.wa.gov

We work with others to protect the health of the people of Washington State by ensuring safe and reliable drinking water.

DRINKING WATER CLIMATE RESILIENCE PLANNING

March 1, 2022, Small Water System Climate Resilience Workshop
Washington Department of Health, Office of Drinking Water

Presenter

Brian A. Sayrs

Planning Policy Lead

Office of Drinking Water

Multiple Barriers Approach

- **Transportation**

  Driver's education
  Driver's licenses
  Rules of the Road
  Traffic lights
  Speed limits
  Traffic barriers
  Traffic calming
  Crumple zones
  Seat belts
  Air bags
  Emergency rescue

- **Water Systems**

  Certified operators
  Professional development
  Engineering standards
  O&M manuals
  Financial control systems
  Sanitary surveys
  Consumer Confidence Reports
  Monitoring & reporting
  Public notification
  Special Purpose Investigations
  Find & Fix

Managing Risk and Severity of Events

- Multiple barriers manage risk and severity
- Climate change is altering risk and severity
- So, climate change must be accounted for
  - Each asset has new or greater vulnerabilities
  - Emergencies may cause more/different losses
  - Stronger water shortage responses
  - More effective water use efficiency measures
  - New capital requirements and financial need

Existing Processes

Detecting

- Asset inventory
- Vulnerability assessment

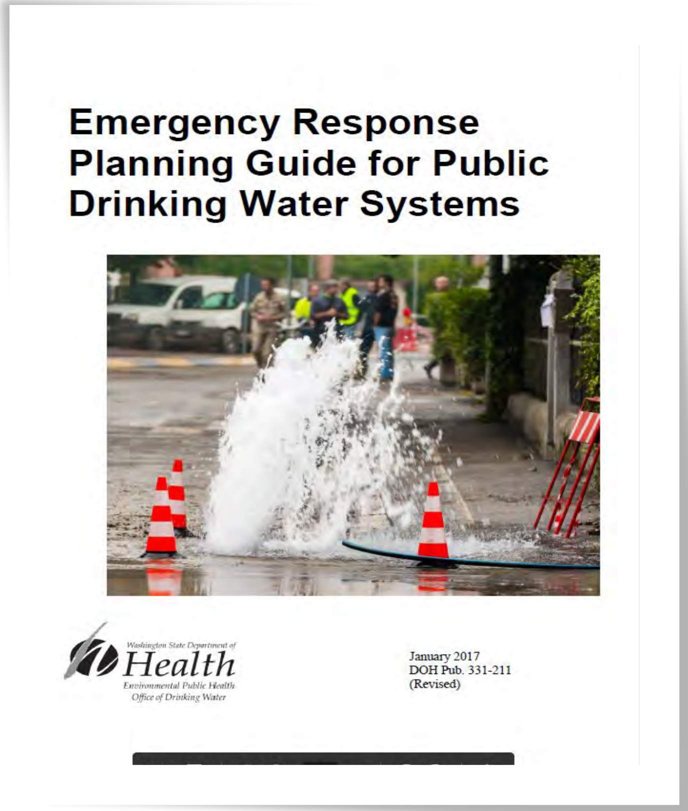
Preparing

- Emergency response plans
- Water shortage response plans
- Water use efficiency plans*

Implementing

- Capital facilities plan
- Financial plan

*Or conservation



Emergency Response Planning Guide for Public Drinking Water Systems

Web page

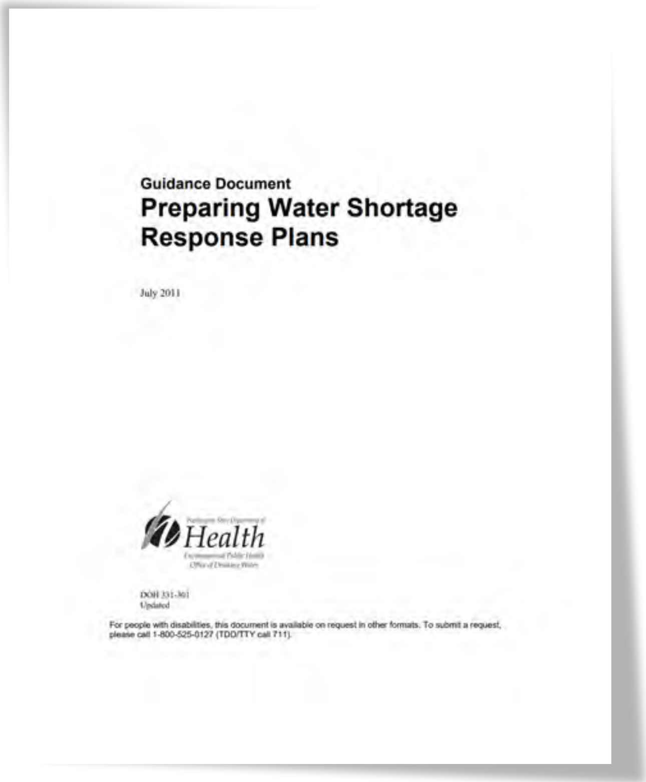
DOH Publication 331-211 (pdf)

Preparing Water Shortage Response Plans

Web page

DOH Publication 331-301 (pdf)

Template (doc)

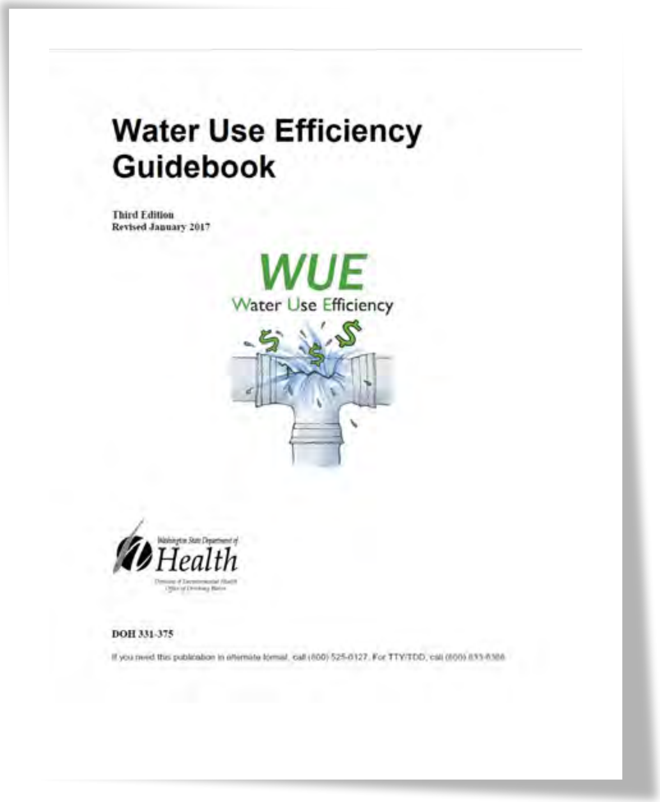

Guidance Document

Preparing Water Shortage Response Plans

July 2011

DOH 331-301
Updated

For people with disabilities, this document is available on request in other formats. To submit a request, please call 1-800-525-0127 (TDD/TTY call 711).


Water Use Efficiency Guidebook

Third Edition
Revised January 2017

WUE
Water Use Efficiency

Washington State Department of Health

DOH 331-375

Water Use Efficiency Guidebook

Third Edition

Web page

DOH Publication 331-375 (pdf)

Operational Public Health Emergency Prevention

Plan Type	Emergency Response	Water Shortage Response	Water Use Efficiency
Prevents	Negative public health outcomes	Emergencies	Fragility, including water shortages
Timing	During emergencies	Prior to and during emergencies	Prior to and during water shortages
Focus	Managing water system activities	Influencing short-term consumer activities	Influencing long-term consumer habits and reducing water loss
Character	Reactive	Responsive	Proactive

Today's To Do List

- During each session, think about your assets' vulnerabilities and needed operational changes
- Remember that you already have the tools
- You're not alone!
  - Other systems are making progress on this
  - We're here to help guide you
- Remind others that emergencies are expensive—prevention saves money!
- Focus on how customers rely on us

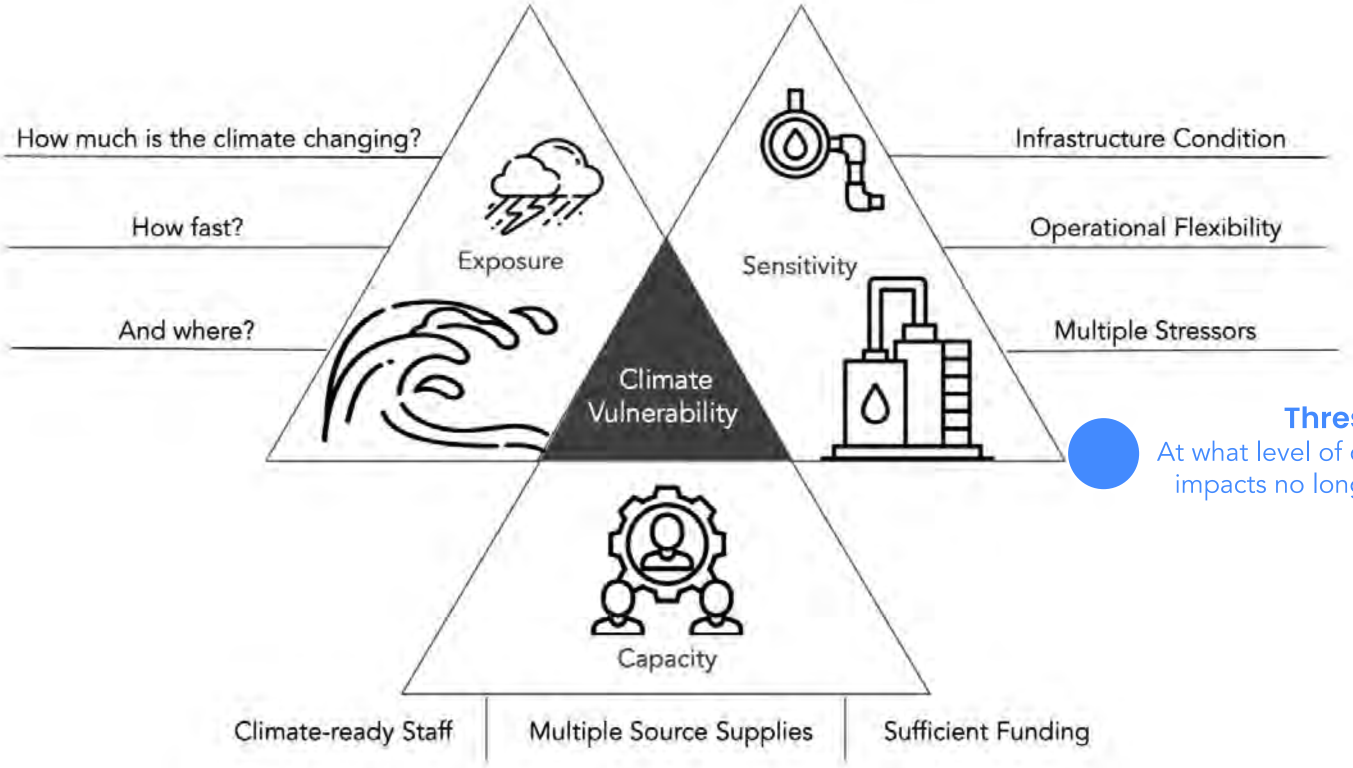
Resilience Planning 101:

Assessing Climate Vulnerability

25 Minutes

Elements of Climate Vulnerability

Workshop Materials: Page 8-9



Thresholds

At what level of change are climate impacts no longer manageable?

Workshop Materials: Page 10-12

Worksheet: Assessing Climate Vulnerability		
Climate Impacts What types of climate impacts is your water system exposed to?	**Water System Impacts** How did these climate events impact your water system? Think about the technical, managerial, and operational functions of your system.	**Threshold** How much change would need to occur to cause a problem? At what level of change are climate impacts no longer manageable?

You will have time to think through the worksheets independently, and share your experiences through guided discussions.

Climate Impact

Which climate impacts have affected your system's ability to deliver safe and reliable drinking water?

Water System Impact

How did these events impact your water system?

Think water supply and quality, service delivery and reliability, infrastructure and operations, finances, and health and safety.

Threshold

Is there a level of change or threshold at which impacts would no longer be acceptable?

Breakout Groups

Enter your assigned breakout room.

- Northwest
- Southwest
- Eastern

Overview

Drought in Washington State

Karin Bumbaco
Office of the Washington State Climatologist

kbumbaco@uw.edu

Office of the Washington State Climatologist

Cooperative Institute for CLIMATE, OCEAN & ECOSYSTEM STUDIES

Overview of Drought in WA State

Karin Bumbaco
Office of the Washington State Climatologist
Cooperative Institute for Climate, Ocean, and Ecosystem Studies
University of Washington
1 March 2022

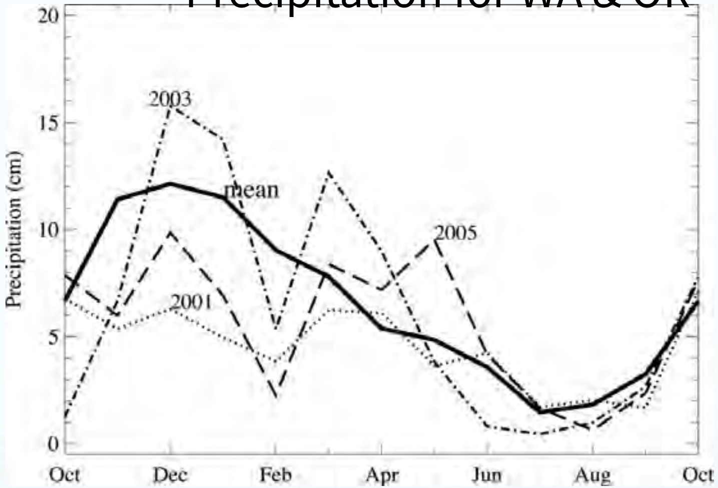
"Flavors" of Drought

1) Dry winter (e.g., 1976-77, 2000-01) impacting snowpack

2) Warm winter (e.g., 2004-05 in WA; 2014-15) impacting snowpack

3) Dry summer (e.g., 2003, *2021?*)

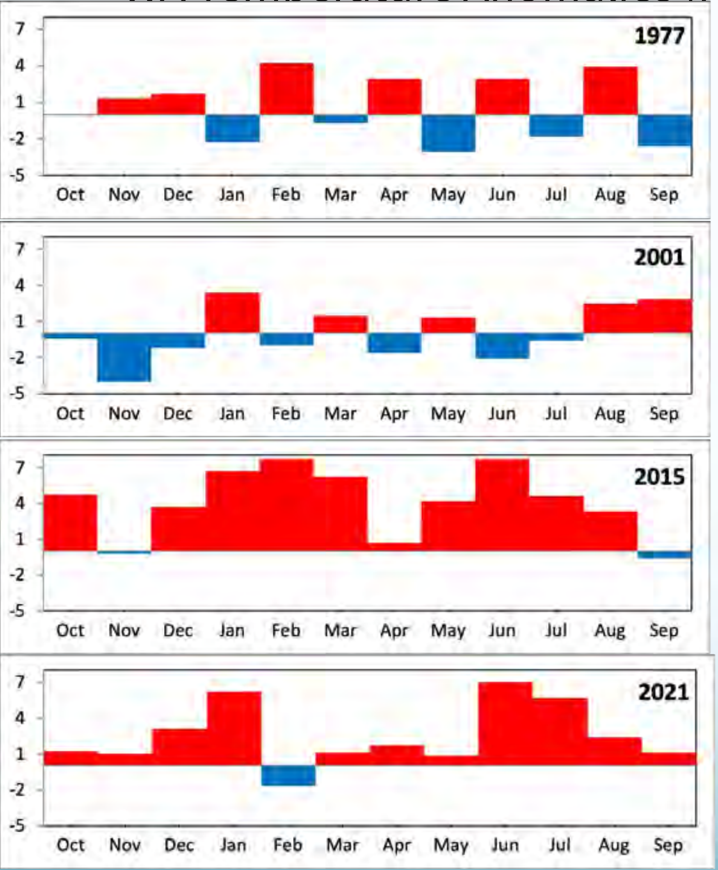
Precipitation for WA & OR



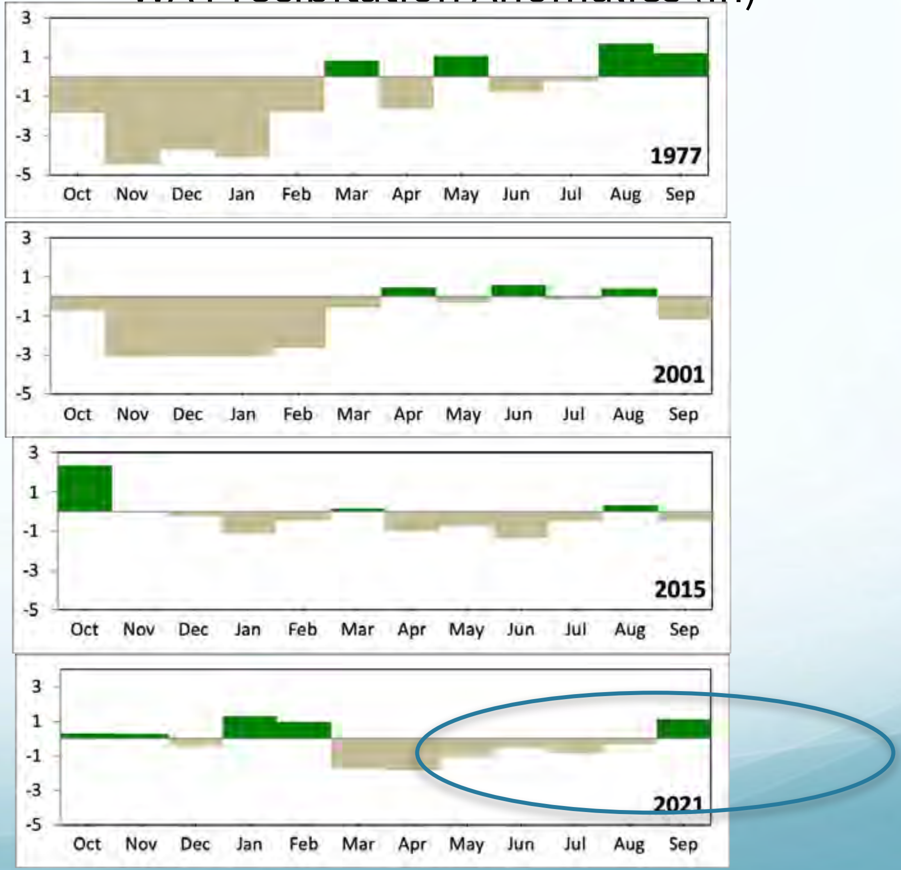
Bumbaco & Mote, 2010

Historical Droughts

WA Temperature Anomalies (F)



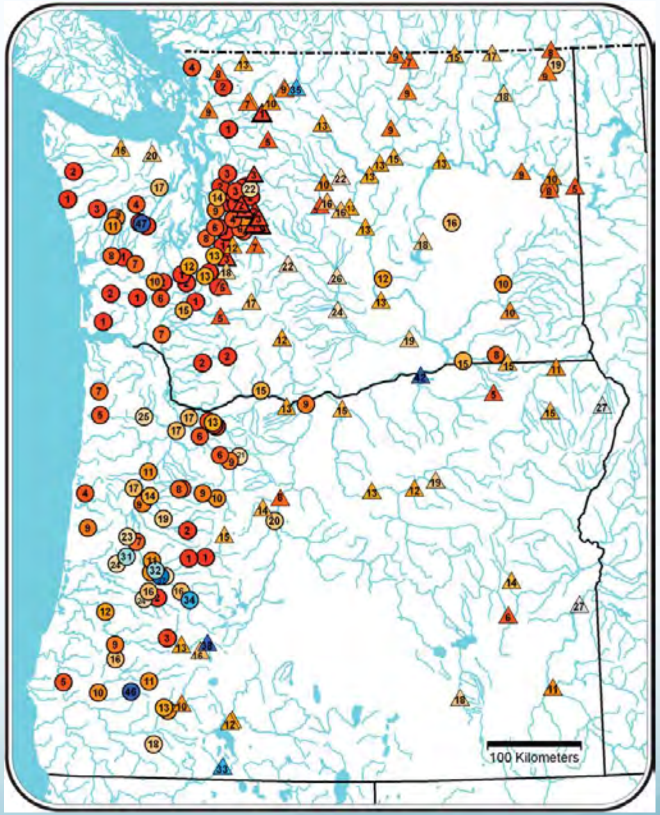
WA Precipitation Anomalies (in)



Anomalies compared to 1901-2000 mean

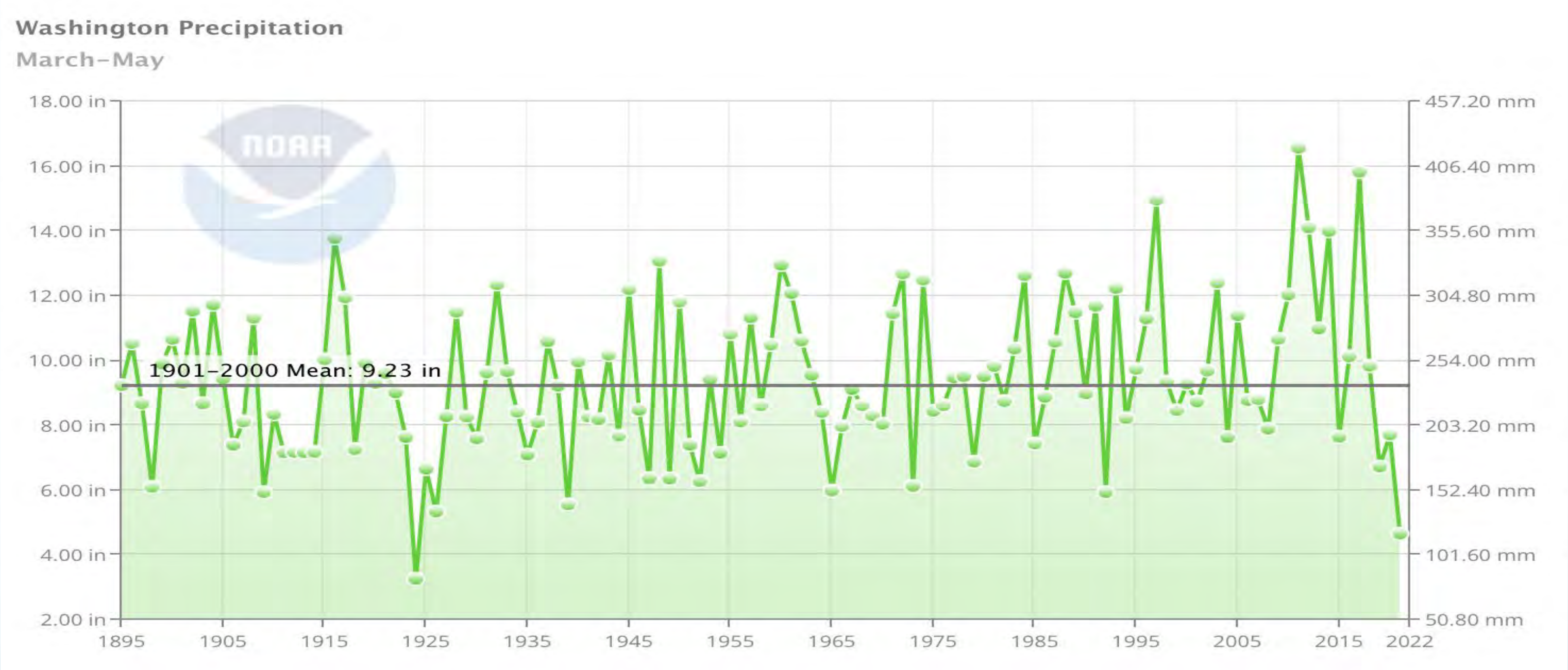
Was 2020-21 the dry summer flavor?

- 2003: dry conditions began in May and persisted through Sept
  - But followed a wet Mar and Apr
- Primary impact: hydrologic drought in western WA and NW OR



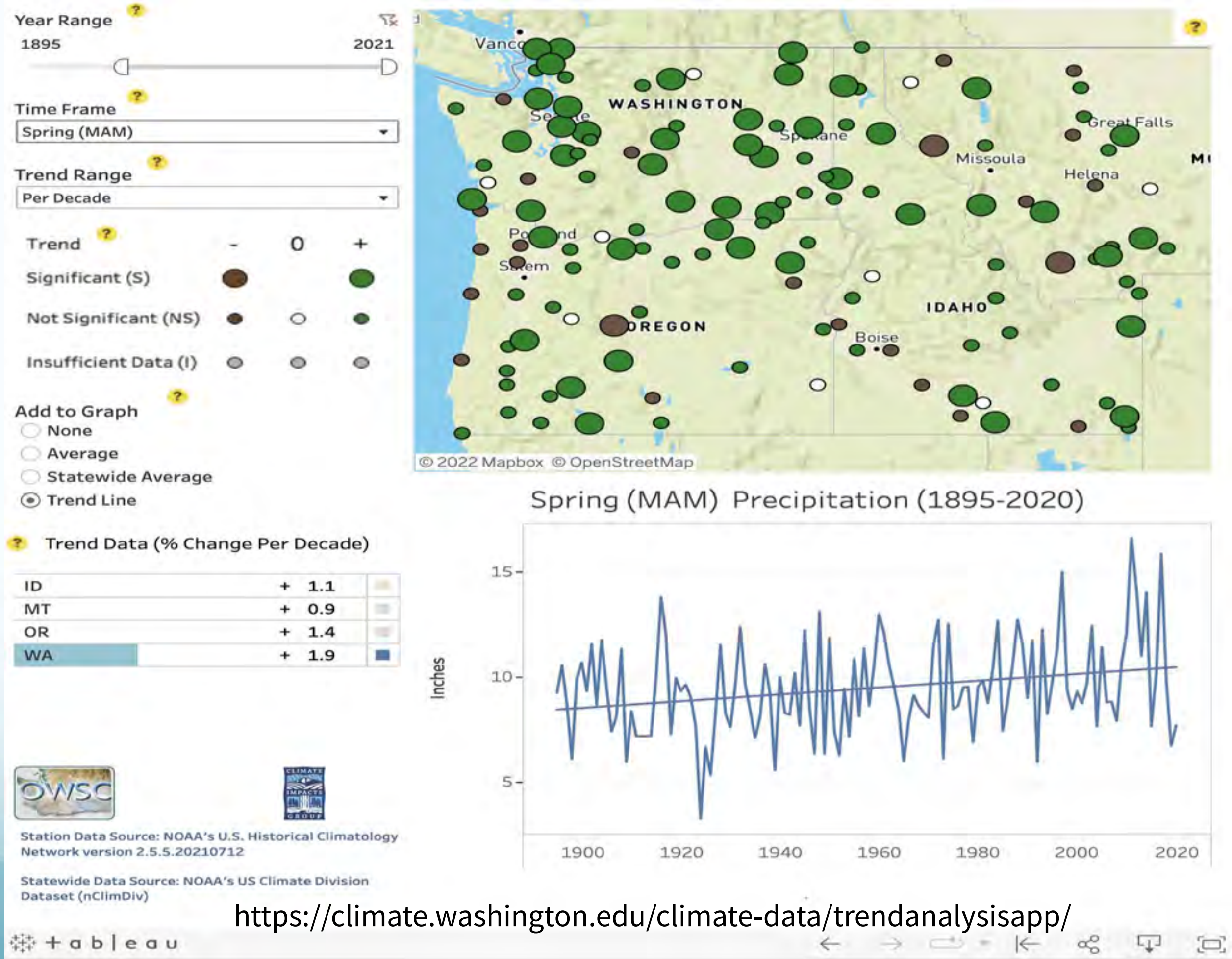
Streamflow rankings for Jun-Sept 2003 (Bumbaco and Mote 2010)

Dry 2021 Spring was Key



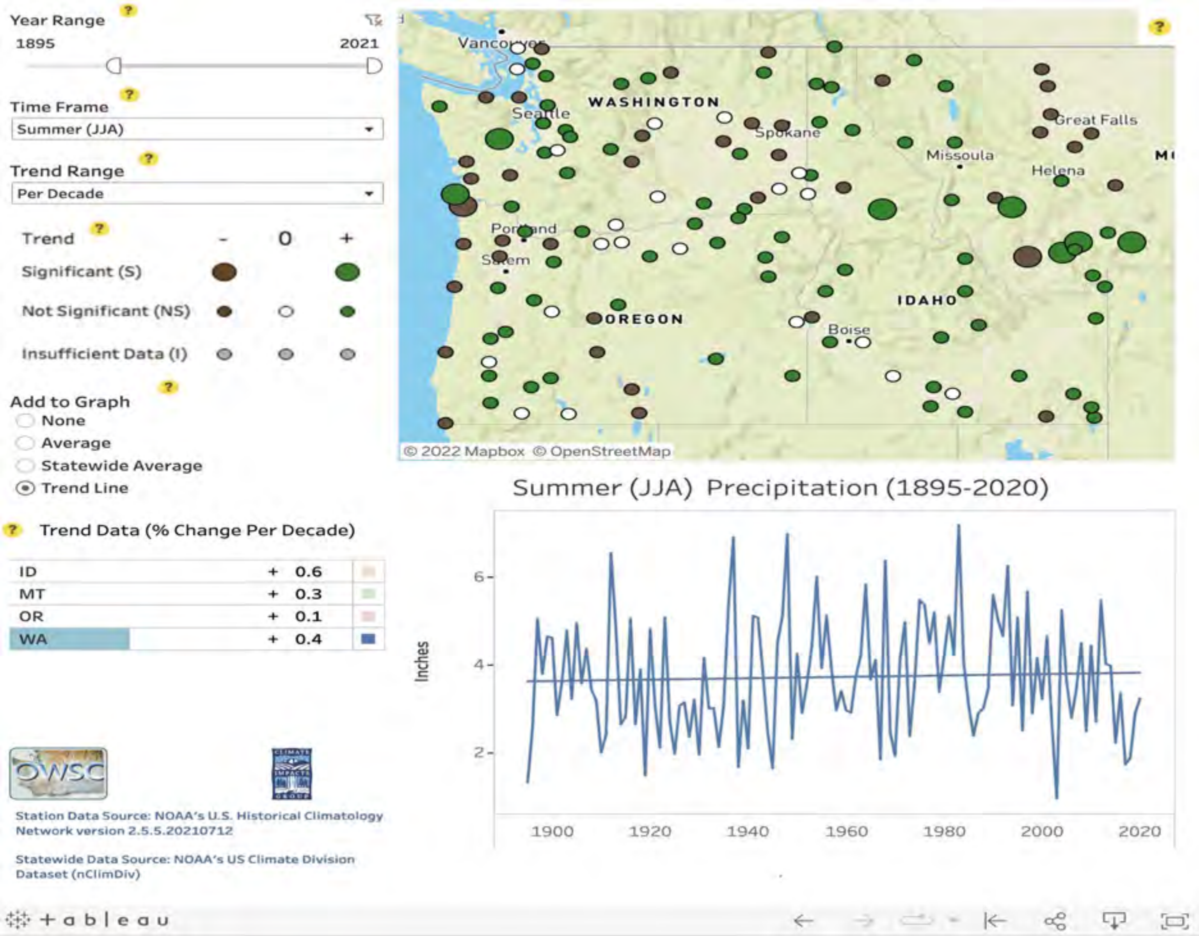
NOAA Climate at a Glance

Dry Spring: New Normal?

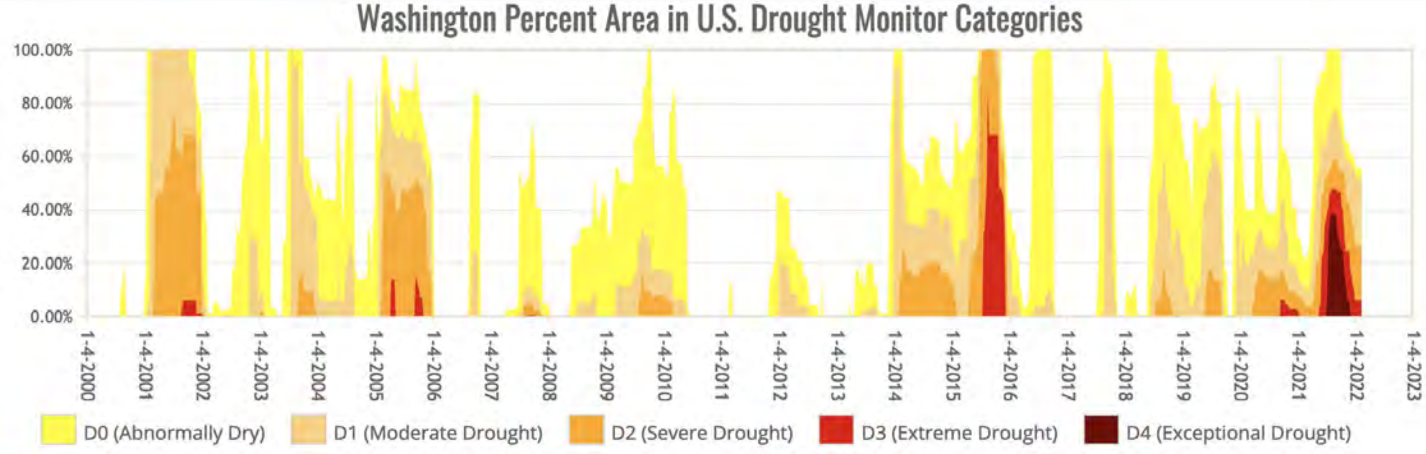


https://climate.washington.edu/climate-data/trendanalysisapp/

Summer Precipitation

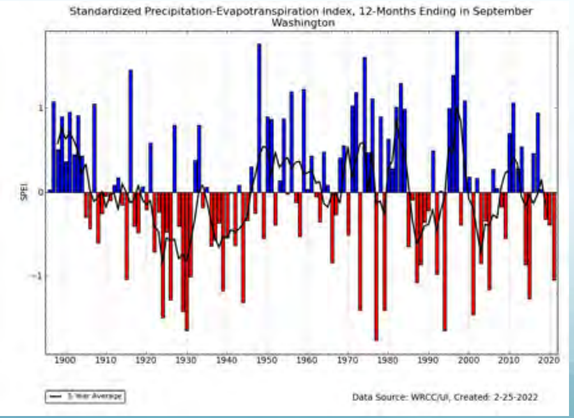


Drought Time Series



D3: 3-5th percentile
Once every 20-50 yrs

D4: 0-2nd percentile
Once or twice every 100 yrs

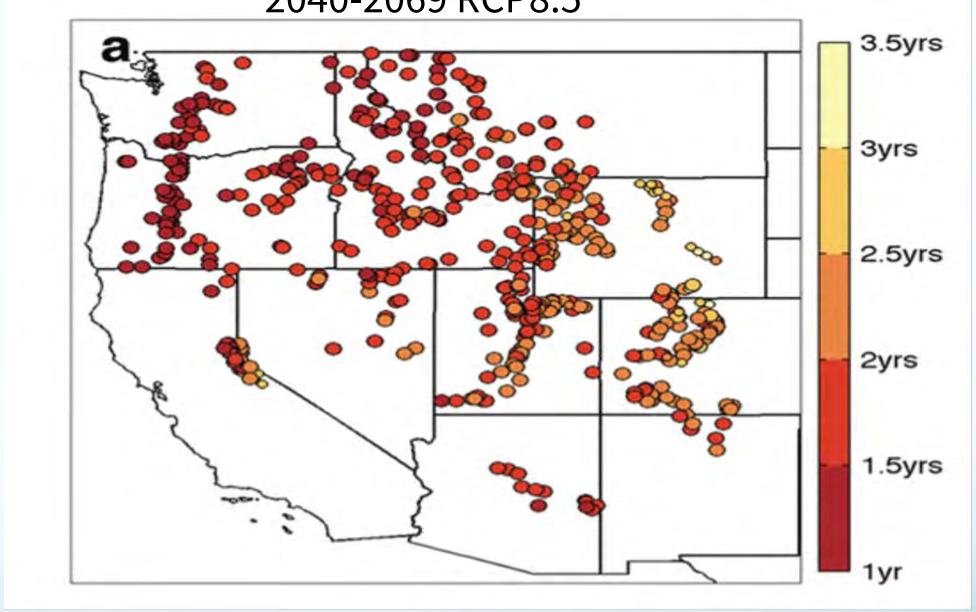


- No clear trend in WA droughts

How do we expect drought to change?

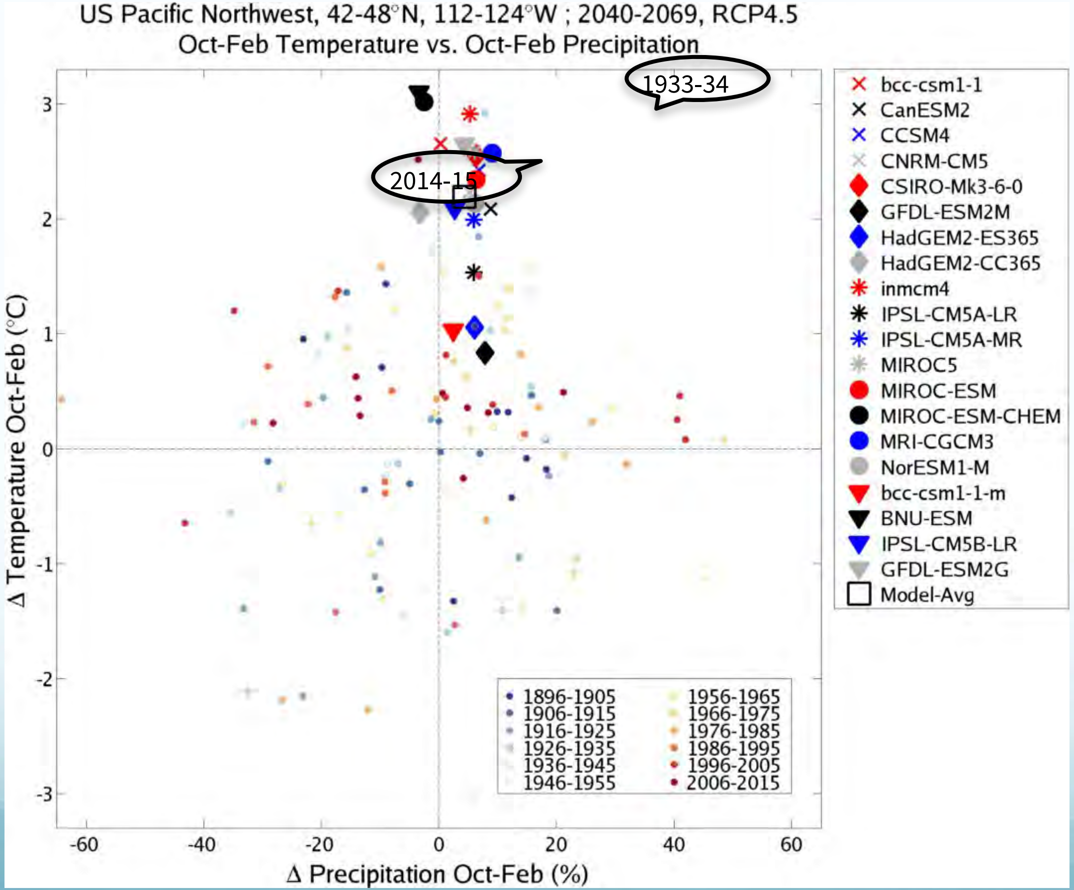
- Warmer temperatures appear to be the main driver
- Multi-year drought: higher likelihood of back-to-back warm years in the future than back-to-back dry years.

2040-2069 RCP8.5



Mean return intervals of low-snowfall years (defined as the 25th percentile for the historical period of 1950-2005) from Lute et al. 2015

2015 as a dress rehearsal

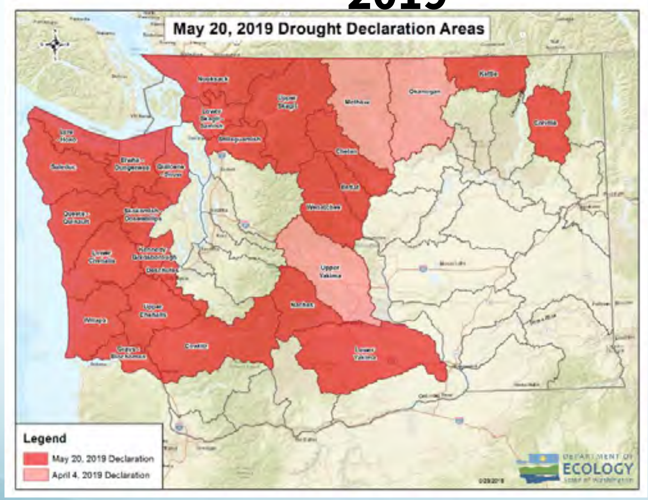


Abatzoglou 2015

WA Drought Declaration

- Water supply condition are below or expected to fall below 75% of normal and there is potential for undue hardships due to low water supply

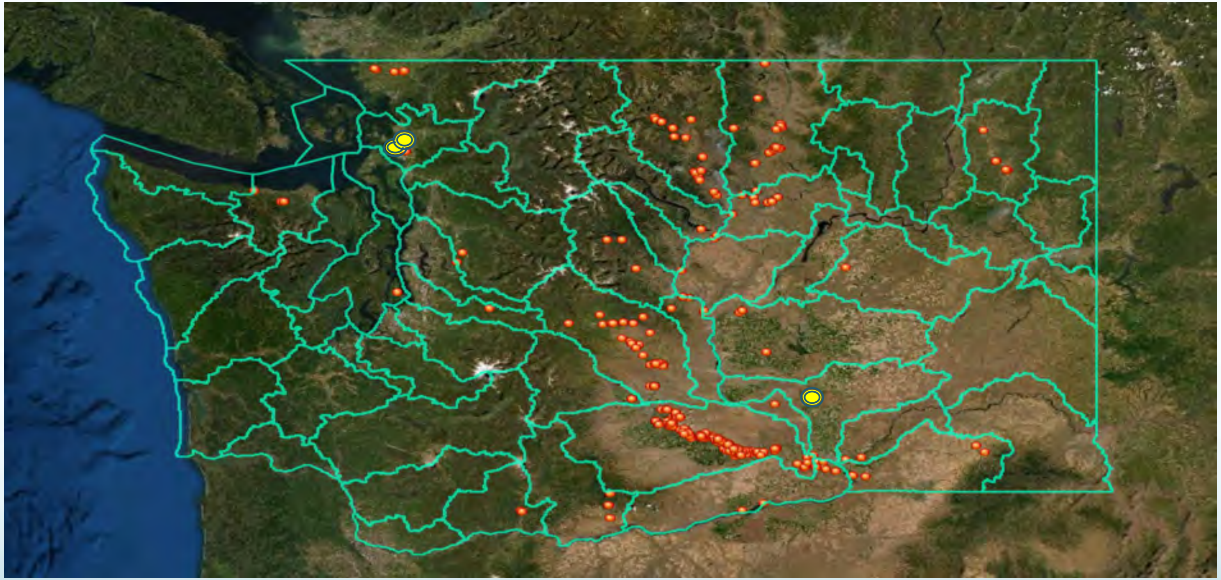
2019



July 14, 2021

Location of Drought Permits (1994-2021)

- 2021 drought: Total number of emergency permits were the lowest during any declared drought
    - Drinking water: reimbursement for water trucking expenses for Clallam County PUD at the Island View water systems



- 1994-2019
- 2021

(slide from Jeff Marti, ECY)

Grant Funding during Drought

Table 1. 2015 Drought Funding.

Type	Applicant - Activity	Amount $	Purpose	Location
Grant	Okanogan Forage Project - Drought related feed program	500,000	Agriculture	Central Region (Okanogan County)
Grant	Lower Stemilt Irrigation District - Water Diversion transfer from Stemilt Creek to Columbia River	297,348	Agriculture	Central Region (Chelan County)
Grant	Jones LID #2 Well - Develop emergency well as alternative/ supplemental source	291,700	Agriculture	Central Region (Yakima County)
Grant	Clallam County PUD #1 - Domestic water supply change of source & booster pump installation	258,190	Public Water Supply	Southwest Region (Clallam County)
Grant	City of Moxee - Well Improvements - replace pump, piping, valves, fittings & electrical, etc.	133,000	Public Water Supply	Central Region (Yakima County)
Grant	Stemilt Irrigation District - Pipe replacement & gravity feed improvements	102,500	Agriculture	Central Region (Chelan County)
Grant	Skagit PUD - Watering stations	75,000	Public Water Supply	Northwest Region (Skagit County)
Grant	Jamestown S'Klallam Tribe - Fish Passage - acquire & install temporary diversion dams	74,430	Fisheries	Southwest Region (Clallam County)
Grant	Whitworth Water District #2 - Water station upgrades to offset dry wells	56,550	Public Water Supply	Eastern Region (Spokane County)
Grant	Stevens County - Drinking water project, new well for domestic supply	47,000	Public Water Supply	Eastern Region (Stevens County)
Grant	Kennewick Irrigation District - Pump rental and capture of return flows	45,304	Agriculture	Central Region (Benton County)
Grant	Kennewick Irrigation District - Residential conservation	28,872	Agriculture	Central Region (Benton County)
Grant	City of Sequim - Reclaimed water delivery for irrigation and aquifer recharge	21,783	Fisheries	Southwest Region (Clallam County)
Grant	Startup Water District - Well Rehab. - pull pump, scrub screen, remove debris, install new pump, etc.	19,451	Public Water Supply	Northwest Region (Snohomish County)
Grant	Icicle Irrigation District - Channel modification to access 8Mile Lake and Colchuck Lake	12,500	Agriculture	Central Region (Chelan County)

- 2015: Just under $2 million
- 2019: ~$685k

Final Remarks

- The WA drought during water year 2021 was unique in that a ***dry spring*** followed by a ***warm summer*** was the cause of drought conditions after a normal April 1 snowpack
- Previous types of droughts identified were dry winter, warm winter, and dry summer type droughts
- While there are significant, warming temperature trends throughout WA, little can be said for the trend in drought occurrence
- We expect to see more droughts in the future, driven by a continuation of warmer temperatures
- The 2015 drought, the warm snowpack drought, is the type of drought we expect to see more of

Overview

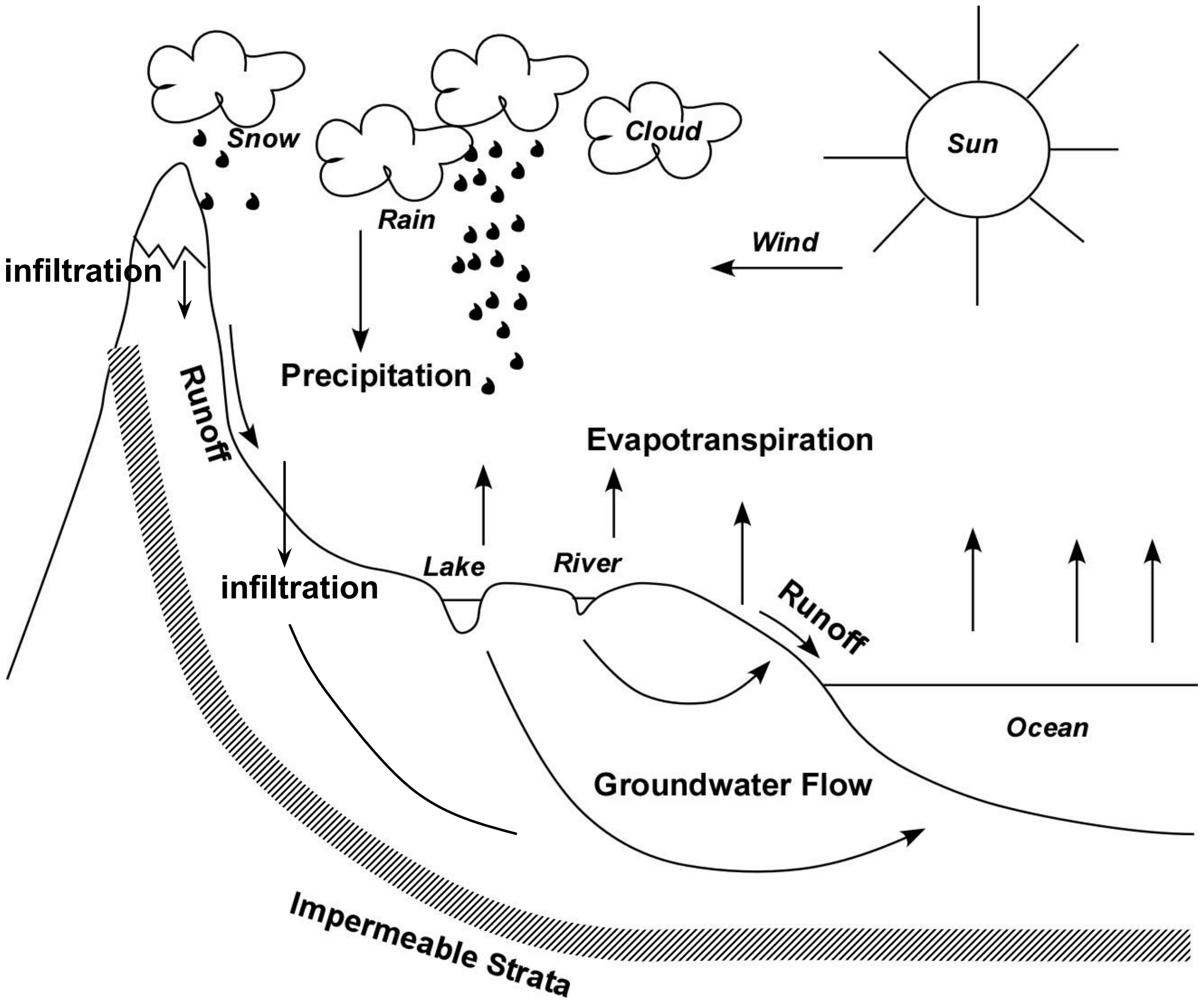
Climate Impacts on Groundwater: Quantity and Quality

Rebecca Neumann
UW Civil and Environmental Engineering

rbneum@uw.edu

Climate Impacts on Groundwater: Quantity & Quality

Rebecca Neumann, Civil & Environmental Engineering, University of Washington



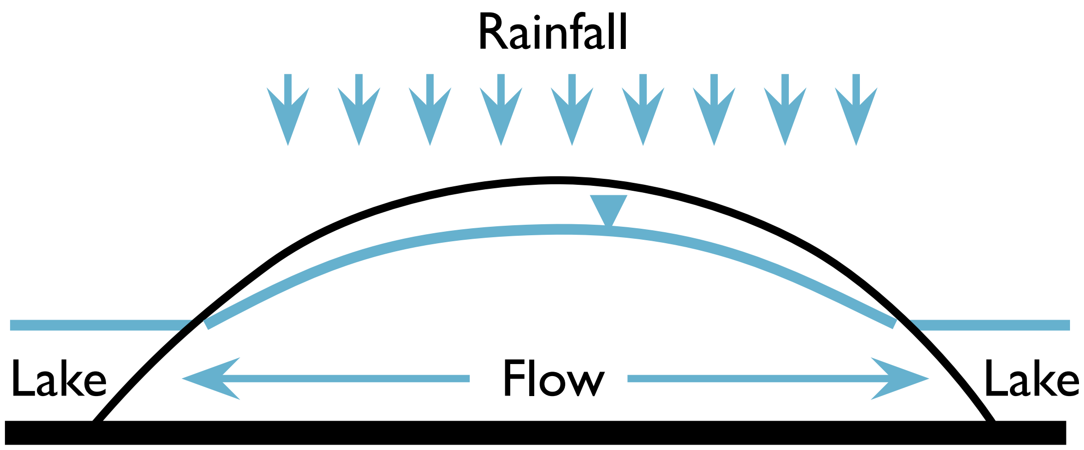
Groundwater in the Hydrologic Cycle

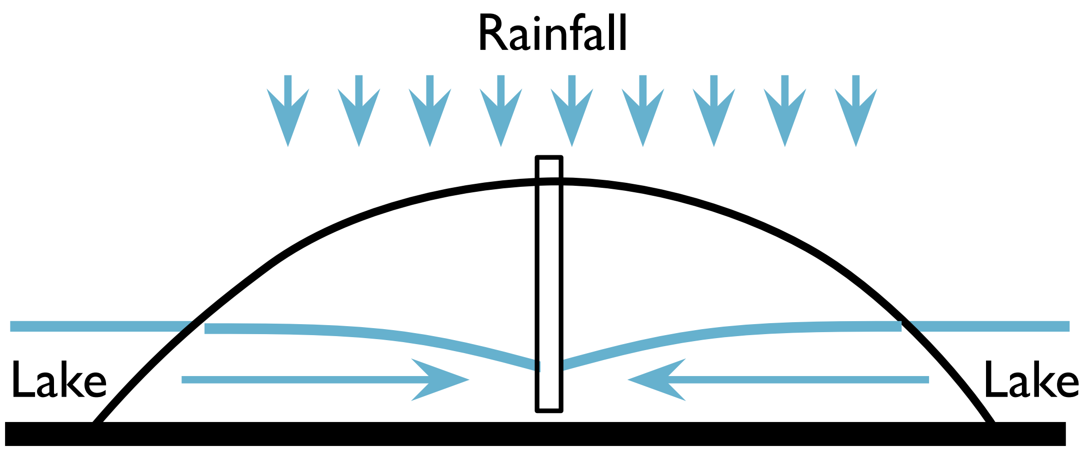
Surface water is connected to groundwater

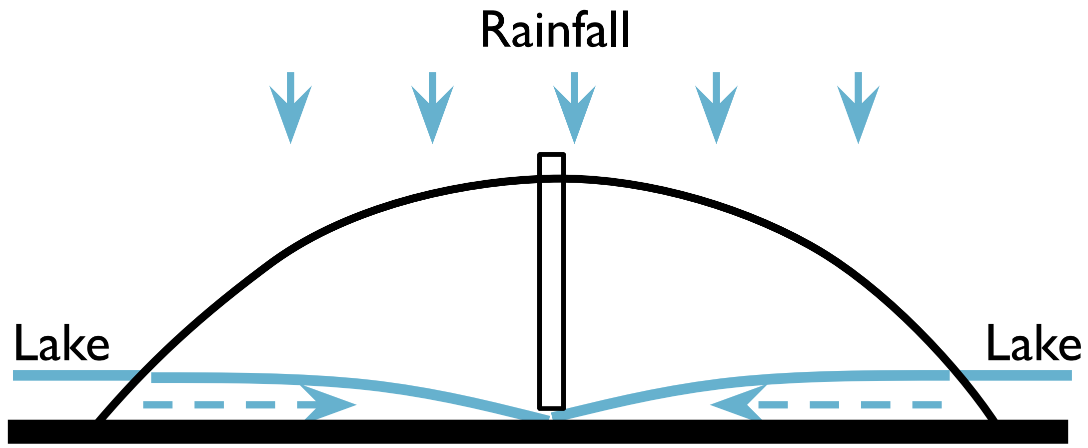
Where does pumped water come from?

"All water discharged by wells is balanced by a loss of water from somewhere" (Theis, 1940)

- Water removed from aquifer storage
- Capture of natural recharge
- Reduction/capture of natural discharge
- Water pulled in from nearby surface water bodies







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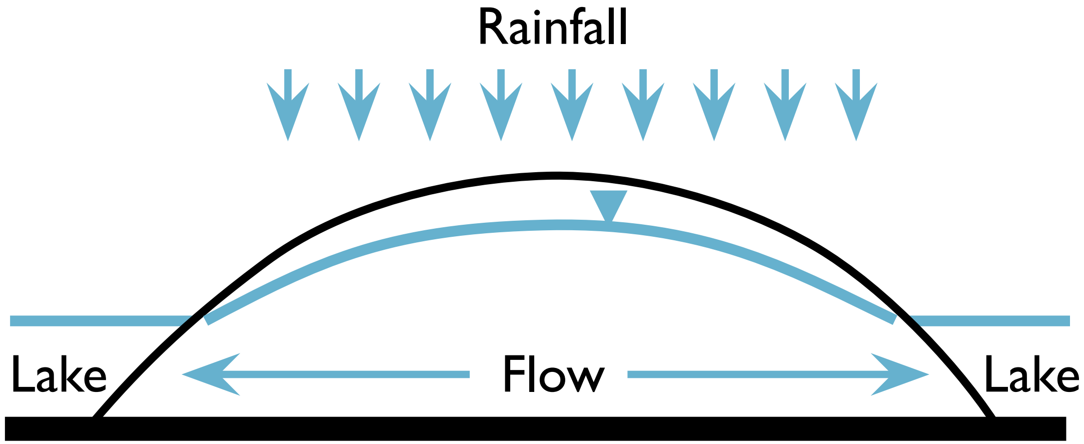
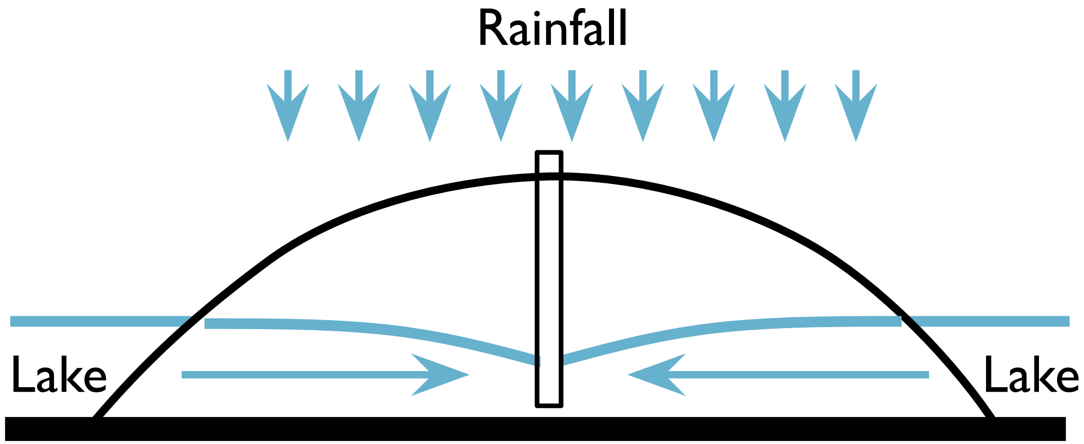
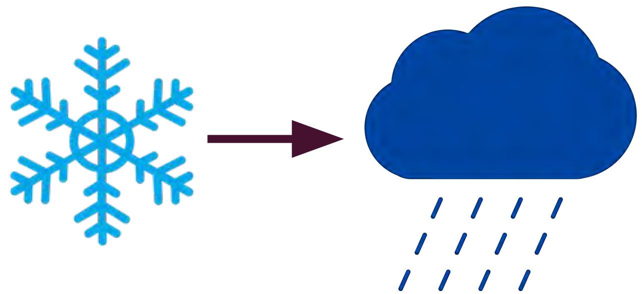
- Water pulled in from nearby surface water bodies





Climate Change and Groundwater Supply: Direct Impacts

Expect climate change will have a minor *direct* impact on groundwater recharge and storage

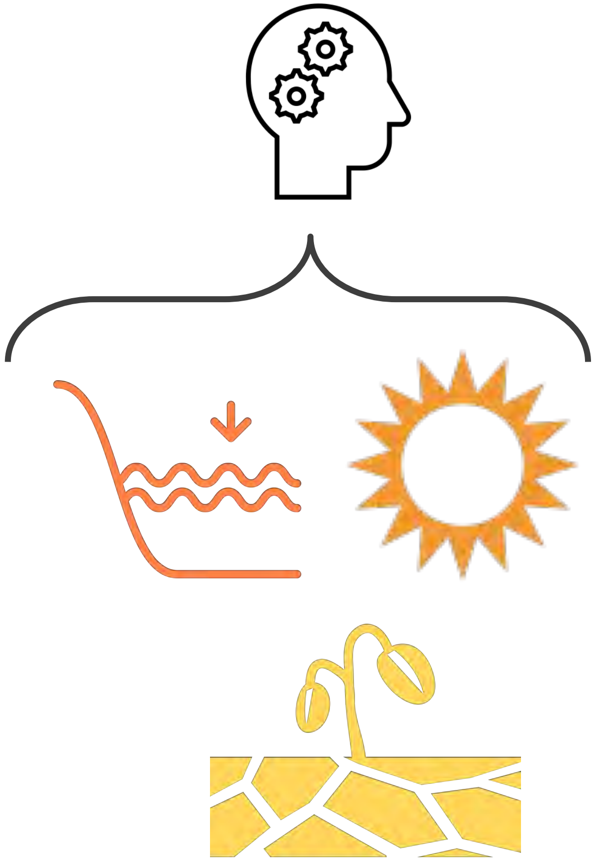


- Changes to snowpack (more rain, less snow, and earlier melt)
  - □ change in timing of recharge
  - More recharge in winter and less recharge in spring and early summer
- Annual recharge volumes not expected to change dramatically
  - Annual recharge (not seasonal) matters for groundwater

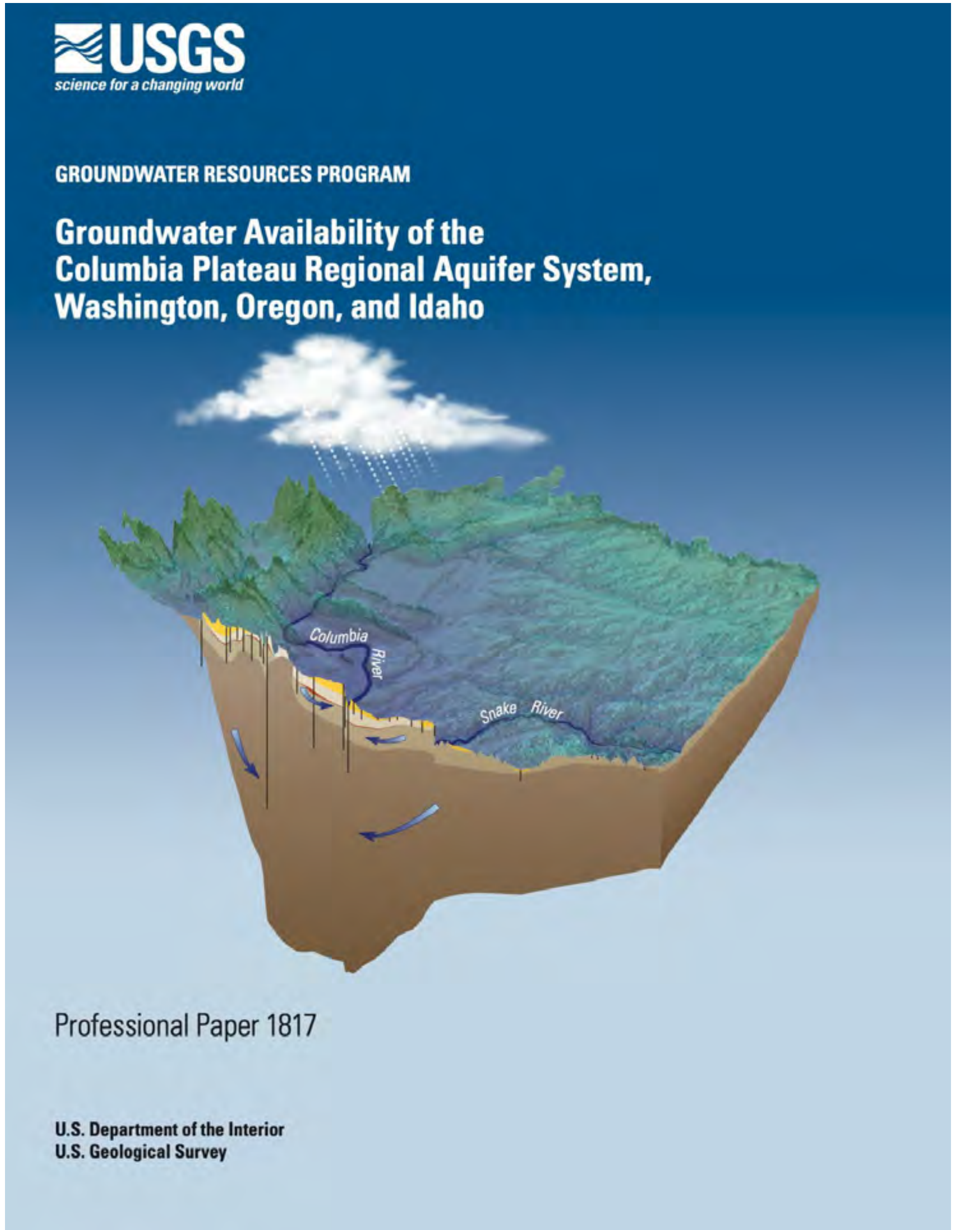
Climate Change and Groundwater Supply: Direct Impacts

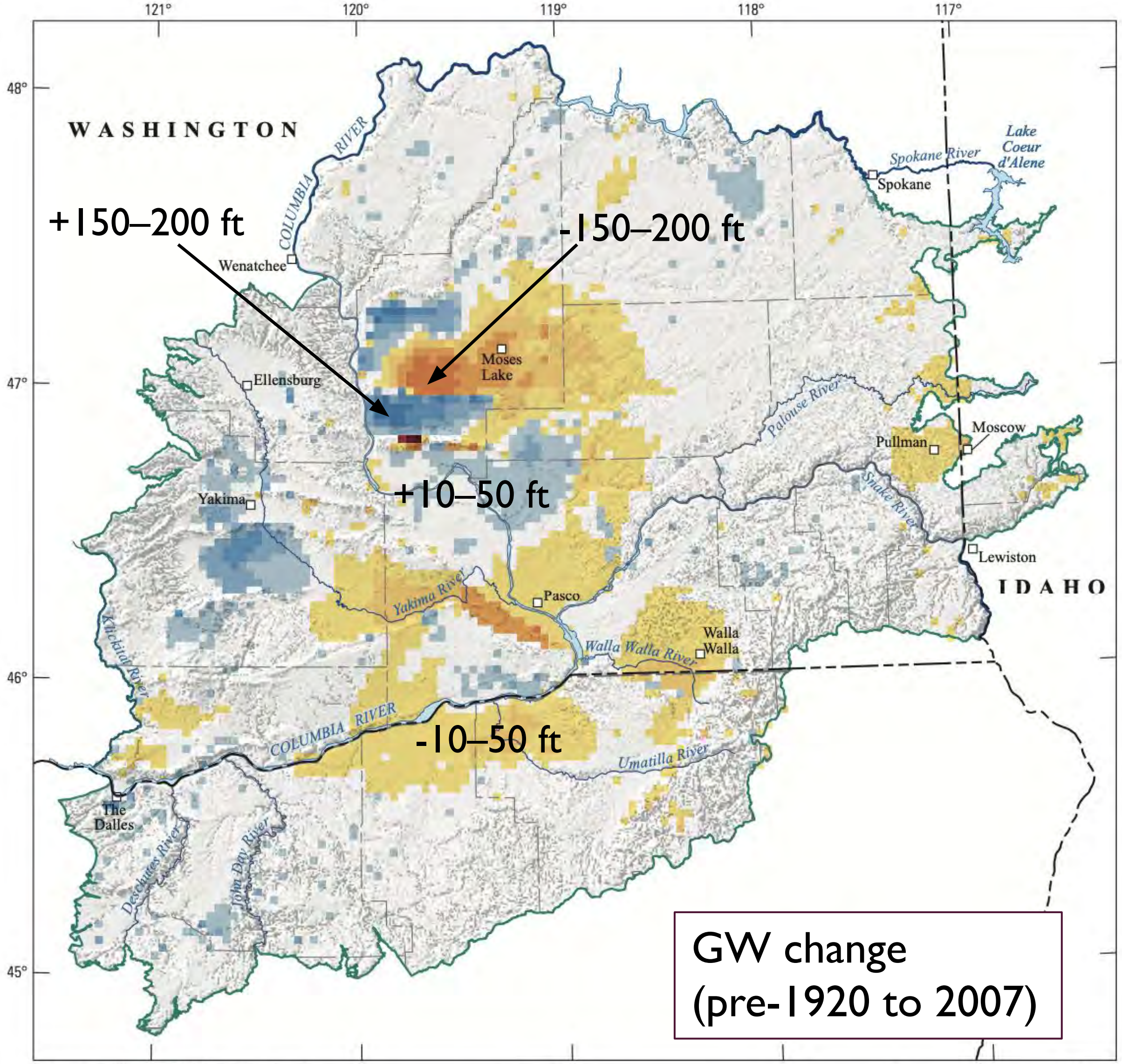
Human response to climate change is expected to have a large impact on groundwater recharge and storage*

- Projected increase in demand for groundwater will lead to reduced water tables
  - Growth in state human population
  - Reduction in summertime surface water supply
  - Increase in irrigation demand (longer growing season, greater ET rates)
  - Increased potential for sustained summer droughts

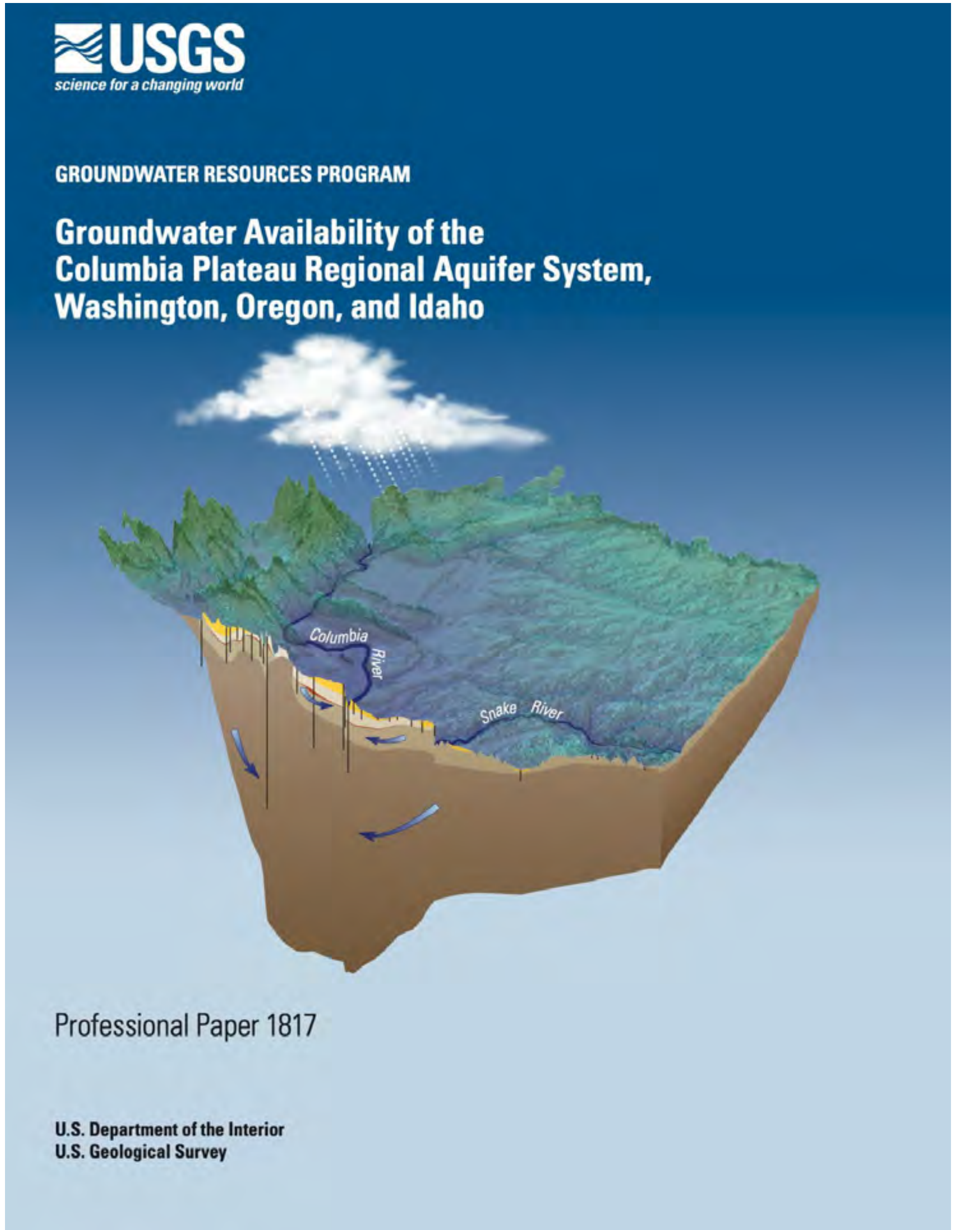


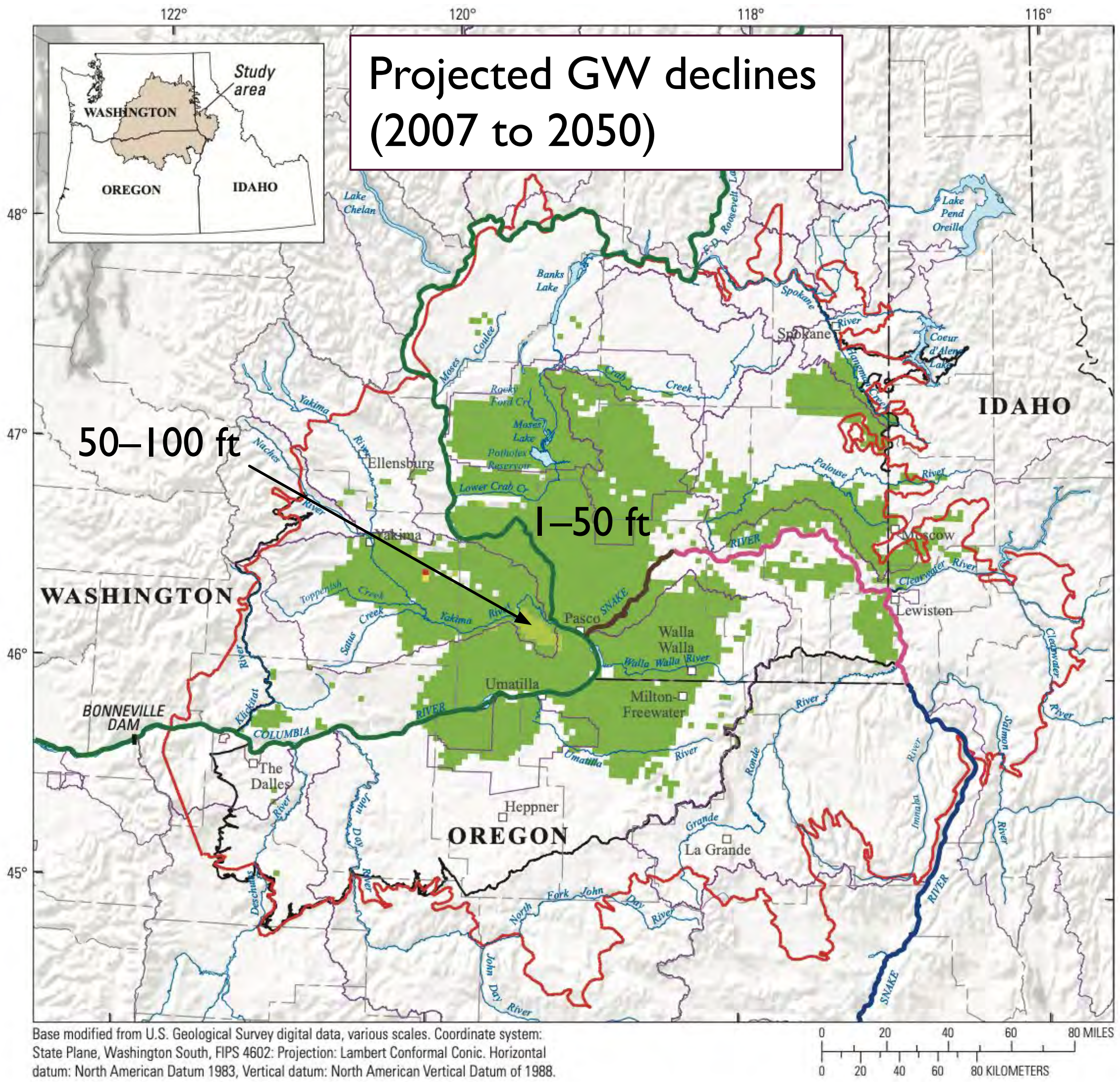
* Particularly in Eastern WA where precipitation < ET





Due to 2007 water availability and use constraints (no projected increase in demand)





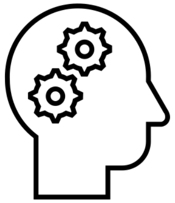
Due to <u>2007</u> water availability and use constraints (no projected increase in demand)

Climate Change and Groundwater Supply: SUMMARY

- Annual groundwater recharge not expected to change

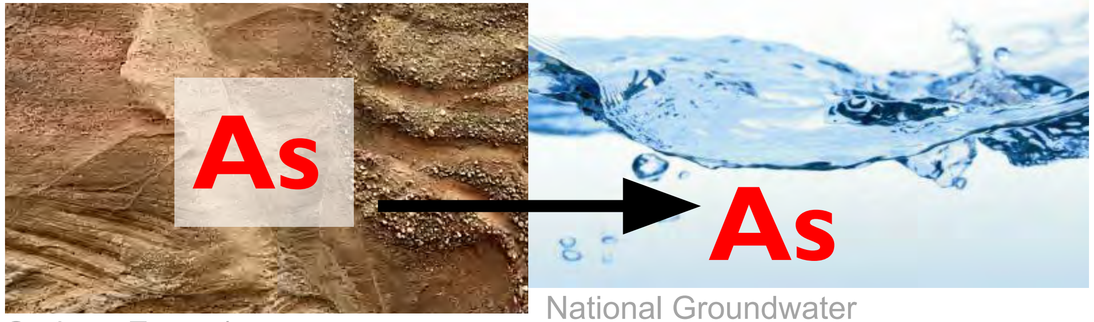
…. but…

- Human response to climate change will affect groundwater supplies
  - expect increased demand for groundwater
     reduced water tables



Groundwater Contamination

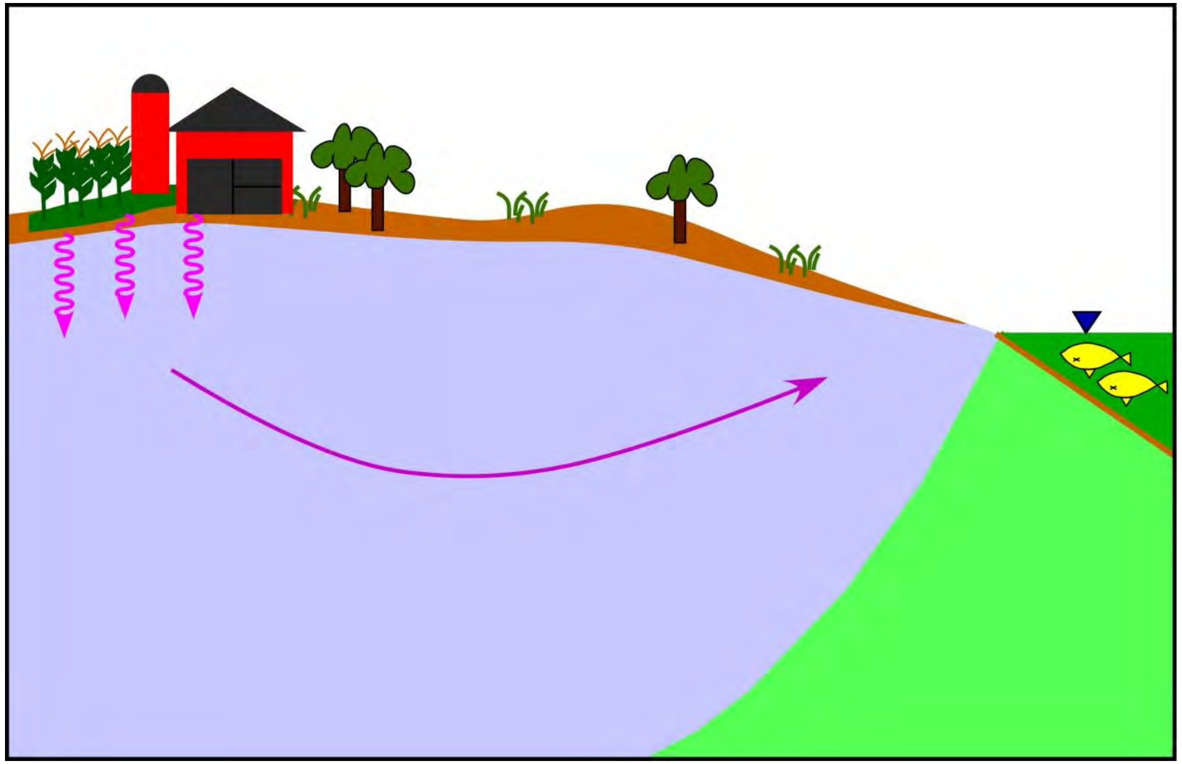
Geologic Sources



Graham Eaton / naturepl.com

National Groundwater Association

Human Sources



![USGS logo]

science for a changing world

The Quality of Our Nation's Waters

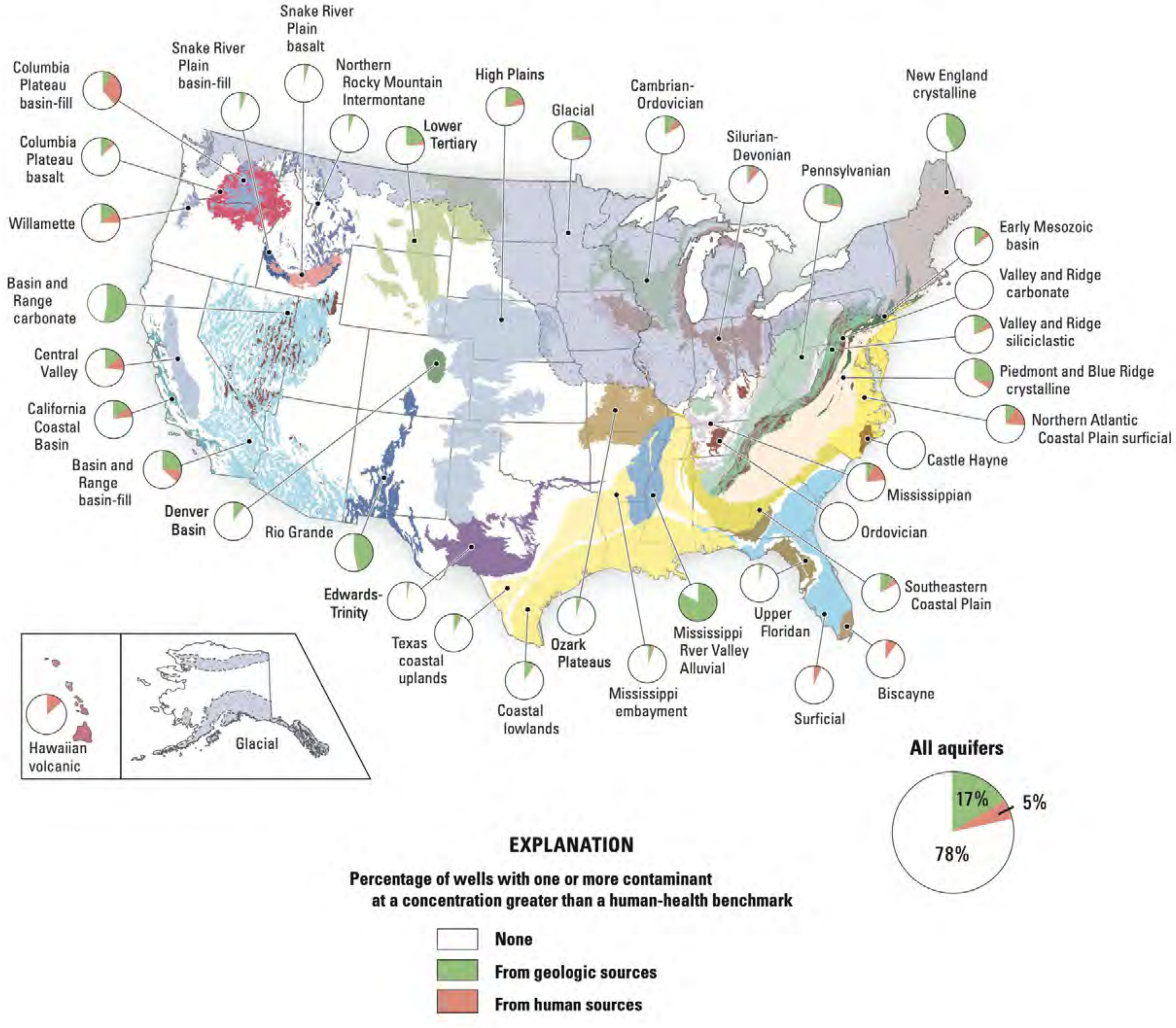
Water Quality in Principal Aquifers of the United States, 1991–2010

National Water-Quality Assessment Program

Circular 1360

U.S. Department of the Interior
U.S. Geological Survey

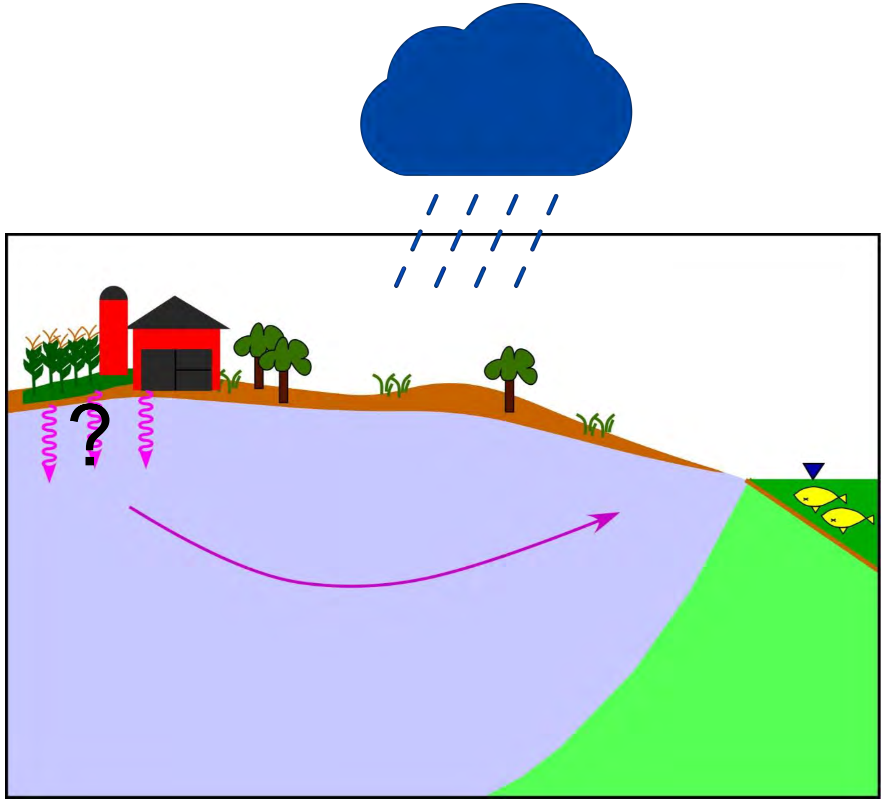
Exceedances of human-health benchmarks by one or more contaminants



Climate Change and Groundwater Quality: Surface Contamination

Impacts of climate change on groundwater quality are uncertain

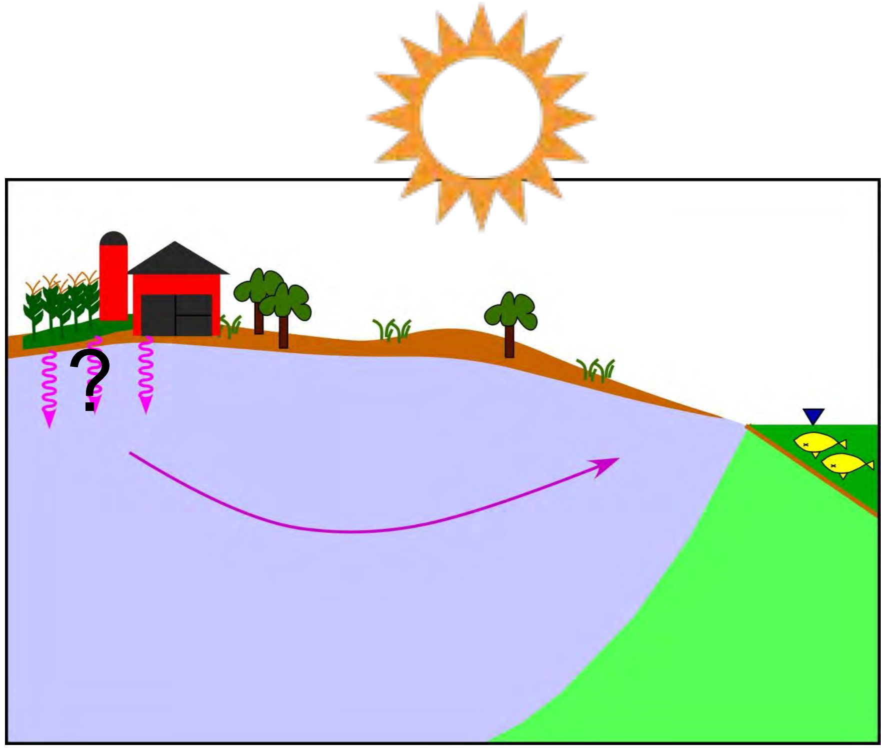
- Changes in recharge can alter transport of <u>surface contamination</u> into aquifers
  - Increased storm intensity
    - □ flush soil nitrate into water table
    - □ quickly exceed soil infiltration capacity
      - □ reduce transport of soil nitrate to water table



Climate Change and Groundwater Quality: Surface Contamination

Impacts of climate change on groundwater quality are uncertain

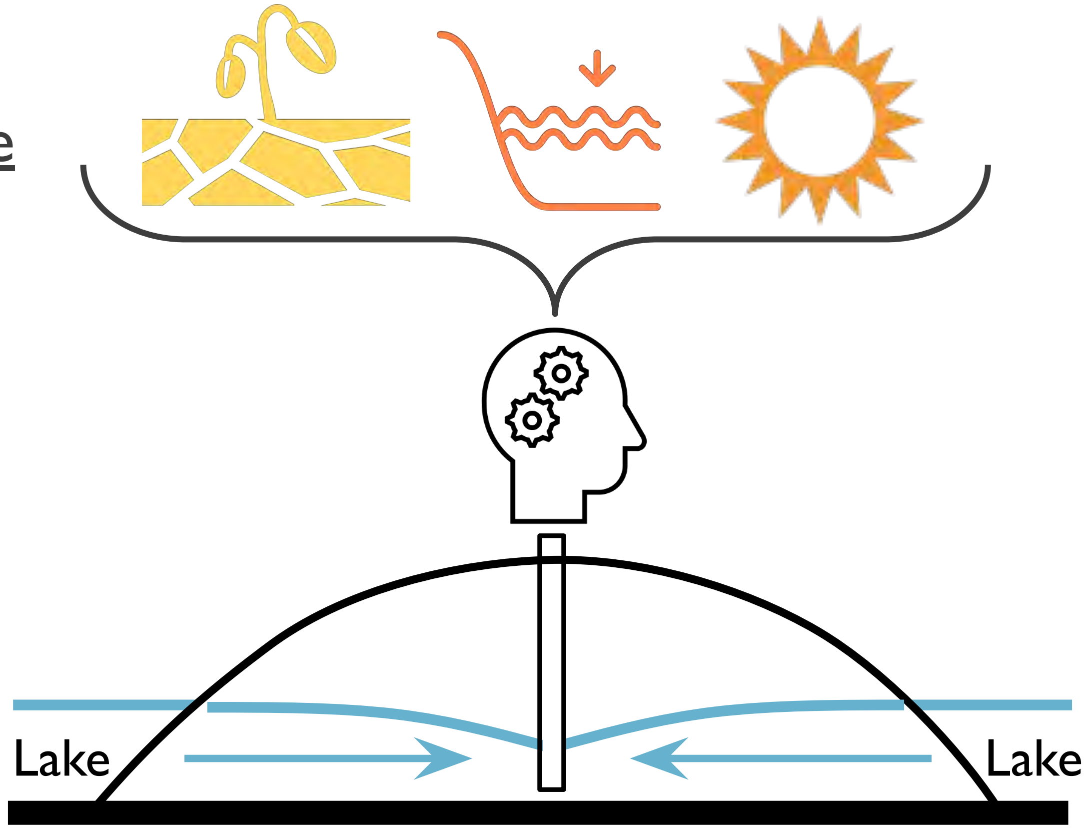
- Changes in recharge can alter transport of <u>surface contamination</u> into aquifers
  - Increased plant growth and ET demand
    - □ more water transpired, less return flow □ decrease in chemical leaching to groundwater
    - □ increase in planting/harvest cycle per year □ increase in irrigation, fertilizer, pesticides application □ increase in chemical leaching to groundwater



Climate Change and Groundwater Quality: Surface Contamination

Impacts of climate change on groundwater quality are uncertain

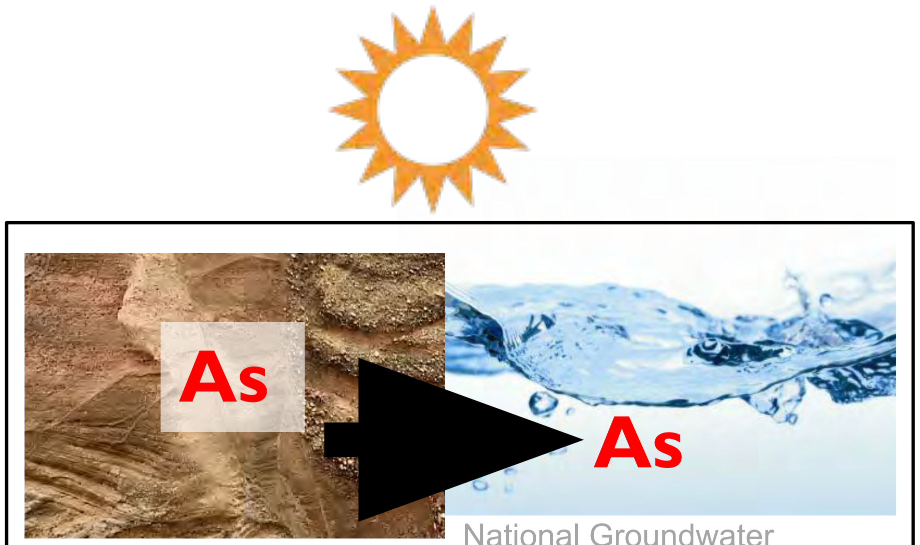
- Changes in recharge can alter transport of surface contamination into aquifers
  - Increased pumping of groundwater can pull contaminated surface water into aquifers



Climate Change and Groundwater Quality: Geologic Contamination

Impacts of climate change on groundwater quality are uncertain

- Changes in recharge can alter transport of <u>geologic contamination</u> into aquifers
  - Warmer temperatures increase rates of microbial redox reactions that mobilize geologic contaminants



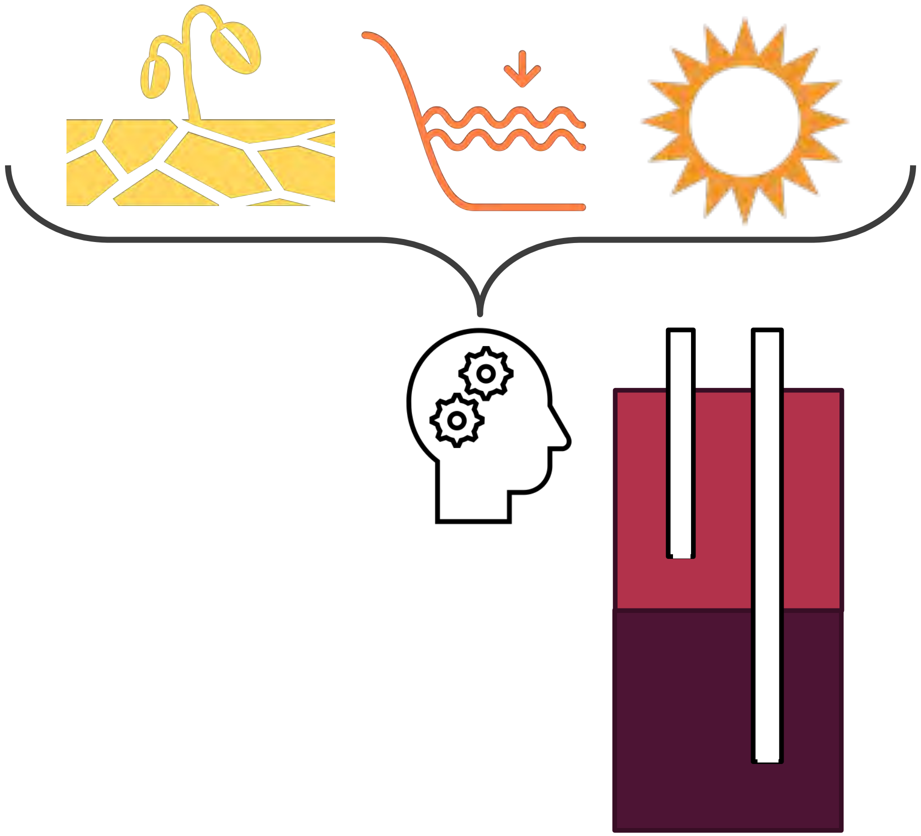
Graham Eaton / naturepl.com

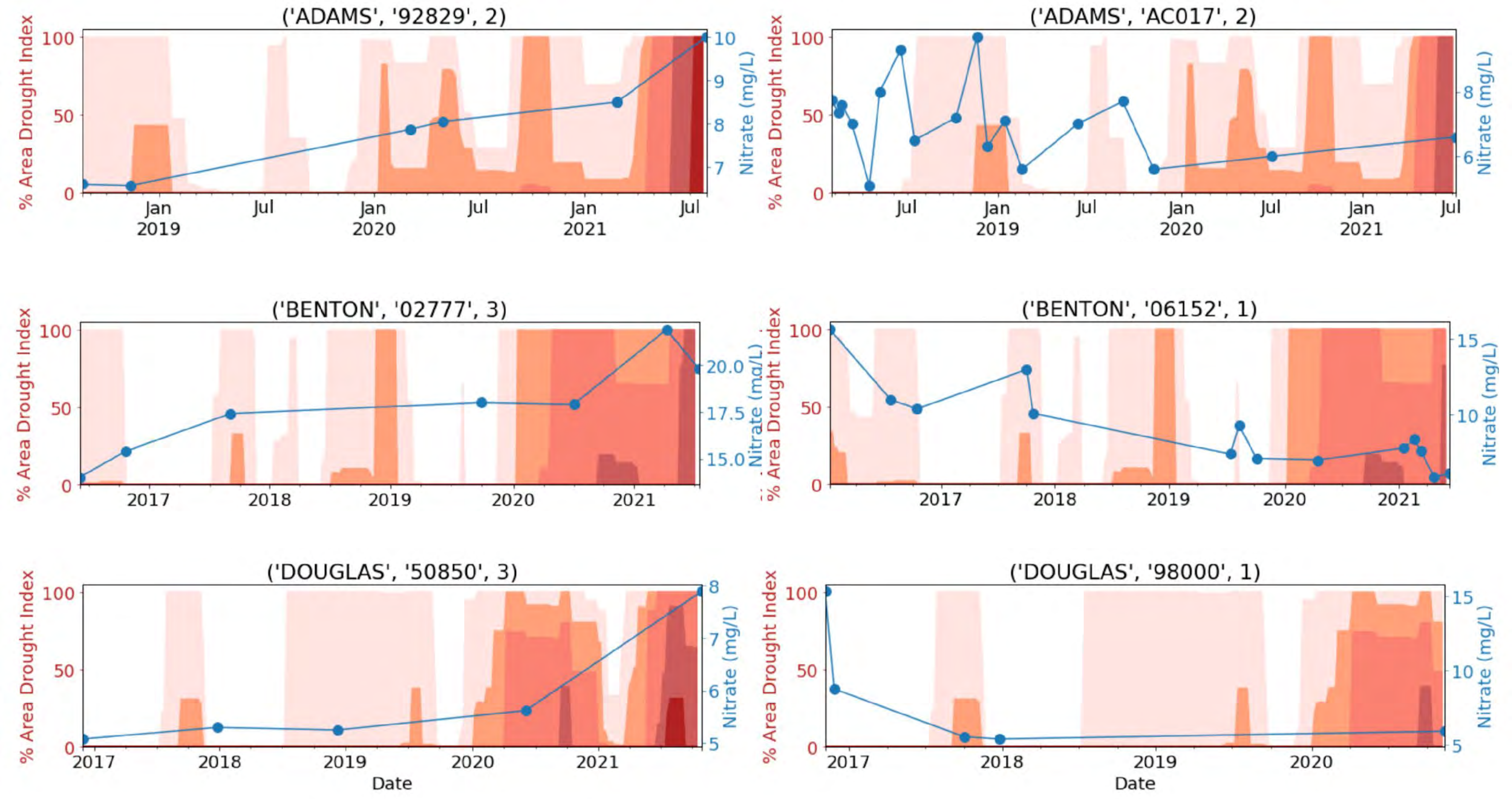
National Groundwater Association

Climate Change and Groundwater Quality: Geologic Contamination

Impacts of climate change on groundwater quality are uncertain

- Changes in recharge can alter transport of <u>geologic contamination</u> into aquifers
  - Increased water demand and declining groundwater levels deepening existing wells or drilling new wells
    - Deeper groundwater usually older = more contact with geologic matrix = more mineral content and/or geologic contamination

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('BENTON', '06152', 1)
('DOUGLAS', '50850', 3)
('DOUGLAS', '98000', 1)
% Area Drought Index
Nitrate (mg/L)
Date

Climate Change and Groundwater Quality: SUMMARY

- Impacts of climate change on groundwater quality are uncertain
- Local conditions will dictate how water quality changes

Key Take Away

Groundwater quantity and quality are more sensitive to ***how*** humans respond to climate change than to the direct effects of climate change

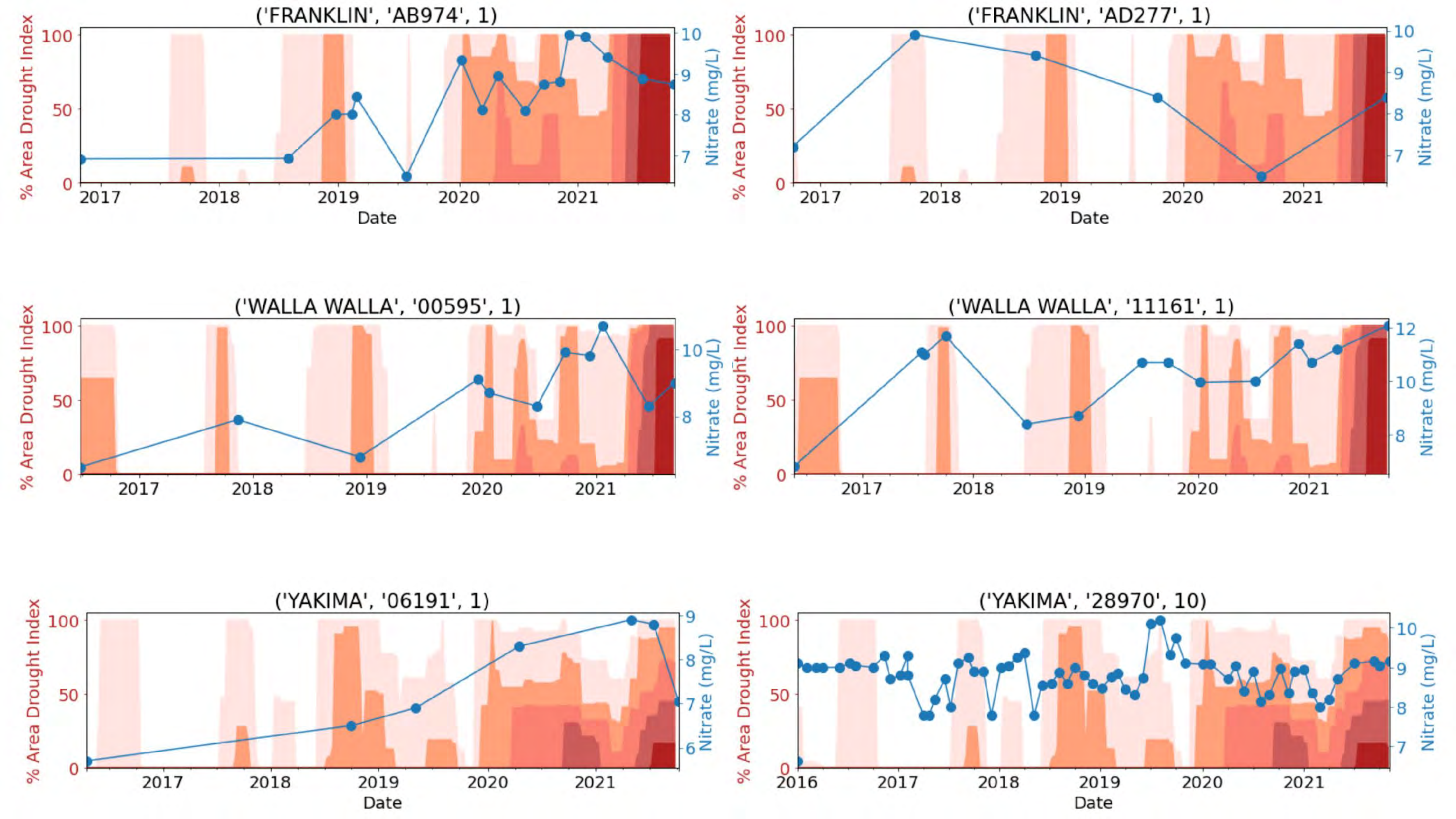
- Smart and integrated management of water resources can protect groundwater in the face of climate change

CLIMATE CHANGE AND GROUNDWATER SUPPLY: INDIRECT IMPACTS

Mountain recharge could be affected* by changes to forest plant communities and soil hydraulic characteristics caused by climate-driven changes in:

- Temperature
- Pests
- Wildfire

* Net effect is unknown



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% Area Drought Index
Nitrate (mg/L)
Date
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% Area Drought Index
Nitrate (mg/L)
Date
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% Area Drought Index
Nitrate (mg/L)
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Nitrate (mg/L)
Date
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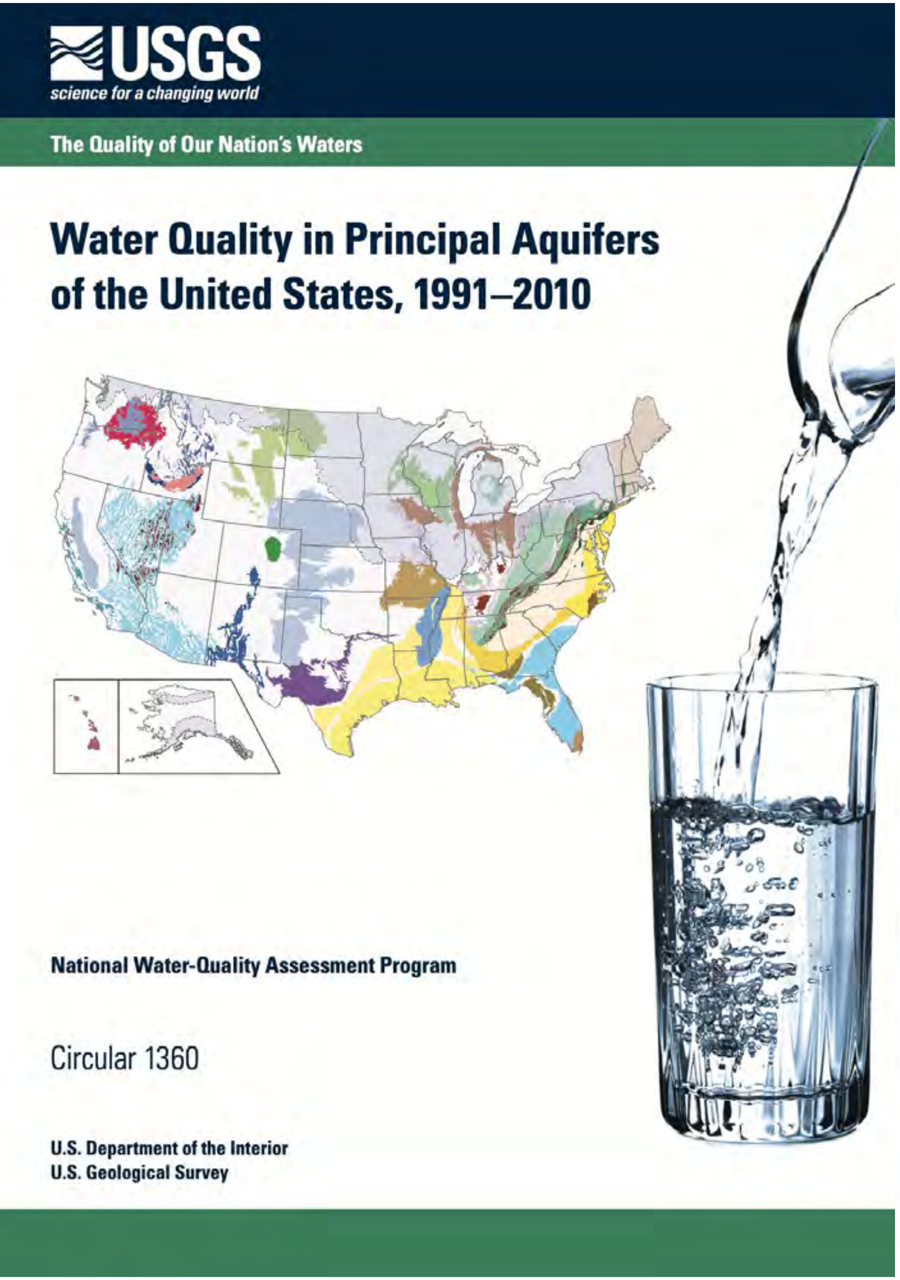
% Area Drought Index
Nitrate (mg/L)
Date



Contaminant	Human-health benchmark		Number of wells sampled	Percentage of samples with concentrations greater than the benchmark	Number of Principal Aquifers with one or more exceedances of the benchmark
	Value	Type			
Contaminants from geologic sources					
Manganese	300 µg/L	HBSL	3,662	6.9	25 of 41
Arsenic	10 µg/L	MCL	3,074	6.7	20 of 37
Radon	*4,000 pCi/L (300 pCi/L)	Proposed AMCL (Proposed MCL)	3,120	3.6 (62)	15 of 41
Strontium	4,000 µg/L	HBSL	1,956	1.7	10 of 29
Uranium	30 µg/L	MCL	3,258	1.6	12 of 37
Fluoride	4 mg/L	MCL	3,655	<1	8 of 41
Molybdenum	40 µg/L	HBSL	3,036	<1	8 of 37
Lead	15 µg/L	Action level	3,035	<1	3 of 37
Antimony	6 µg/L	MCL	3,026	<1	4 of 37
Selenium	50 µg/L	MCL	3,036	<1	4 of 37
Zinc	2,000 µg/L	HBSL	2,979	<1	3 of 37
Any	**Various**	**Various**	**3,669**	**16**	**35 of 41**
Contaminants from human sources					
Nitrate	10 mg/L as N	MCL	3,621	4.1	21 of 41
Dieldrin	†0.002 µg/L	HBSL	3,553	<1	14 of 41
Perchloroethene	5 µg/L	MCL	3,272	<1	5 of 41
Trichloroethene	5 µg/L	MCL	3,322	<1	5 of 41
1,2-Dibromo-3-chloropropane (DBCP)	0.2 µg/L	MCL	3,321	<1	2 of 41
Any	**Various**	**Various**	**3,669**	**4.5**	**29 of 41**

*The proposed Alternative Maximum Contaminant Level is the primary human-health benchmark used in this circular for radon.

† Low end of HBSL range corresponding to a 10^{-6} (one in a million) cancer risk. The HBSL range corresponds to a 10^{-6} to 10^{-4} cancer risk range.

Lessons Learned

A Review of Climate Change Considerations in Washington Water System Plans

Erica Asinas
UW Climate Impacts Group

easinas@uw.edu

Erica Asinas
Research Scientist, UW Climate Impacts Group

A Systematic Review of Water System Plans

Which water systems are considering climate change in their water system plans?

Case Study and Lessons Learned

How are water systems incorporating climate change into their plans?
What are the lessons for small to medium sized water systems?

Best Practices

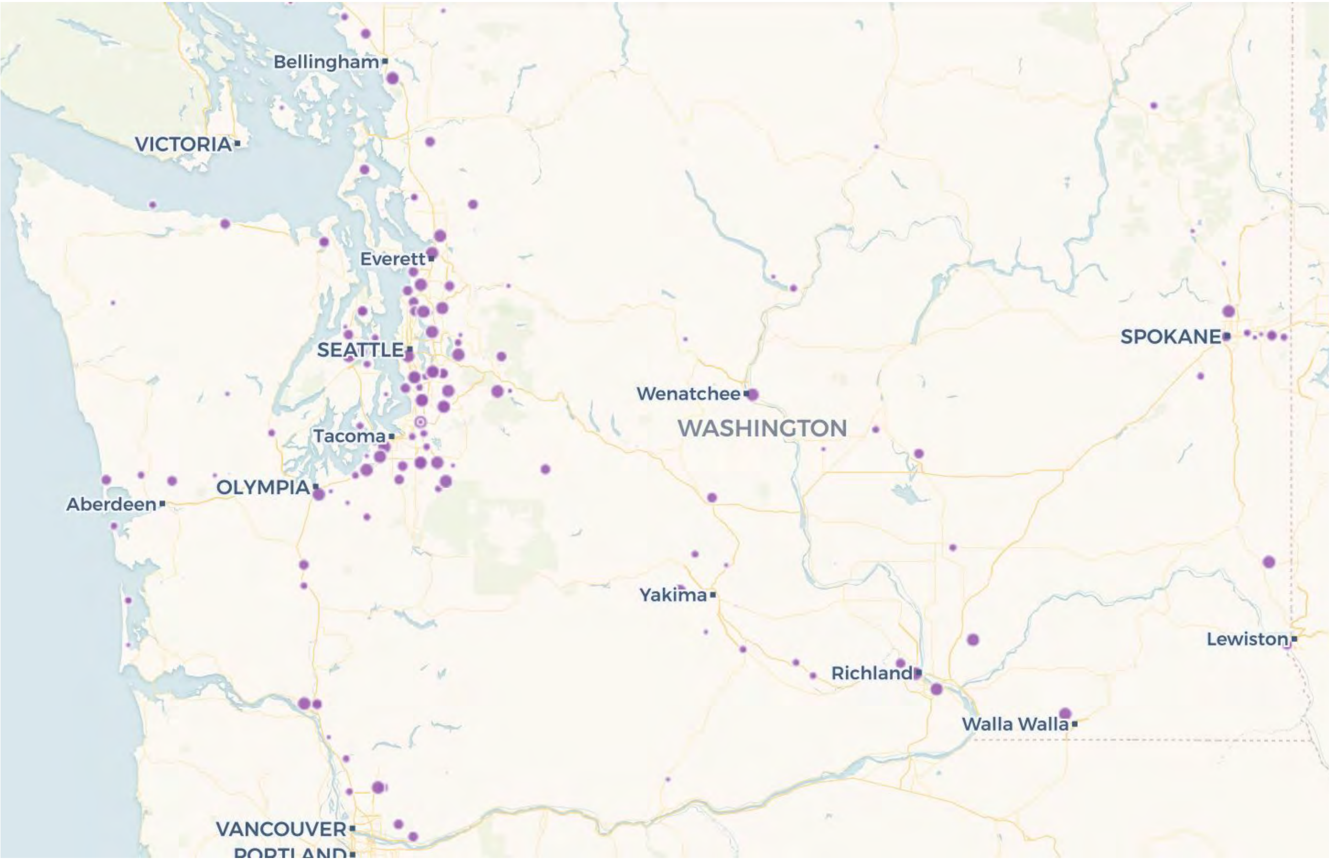
How can systems manage uncertainty in resilience planning?

WHO

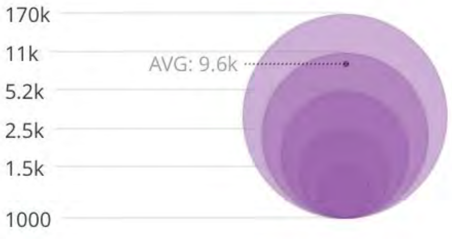
is considering climate change
in their water system plans?

A Systematic Review of Water System Plans

Active Group A Community Systems with over 1,000 Service Connections



Total Service Connections

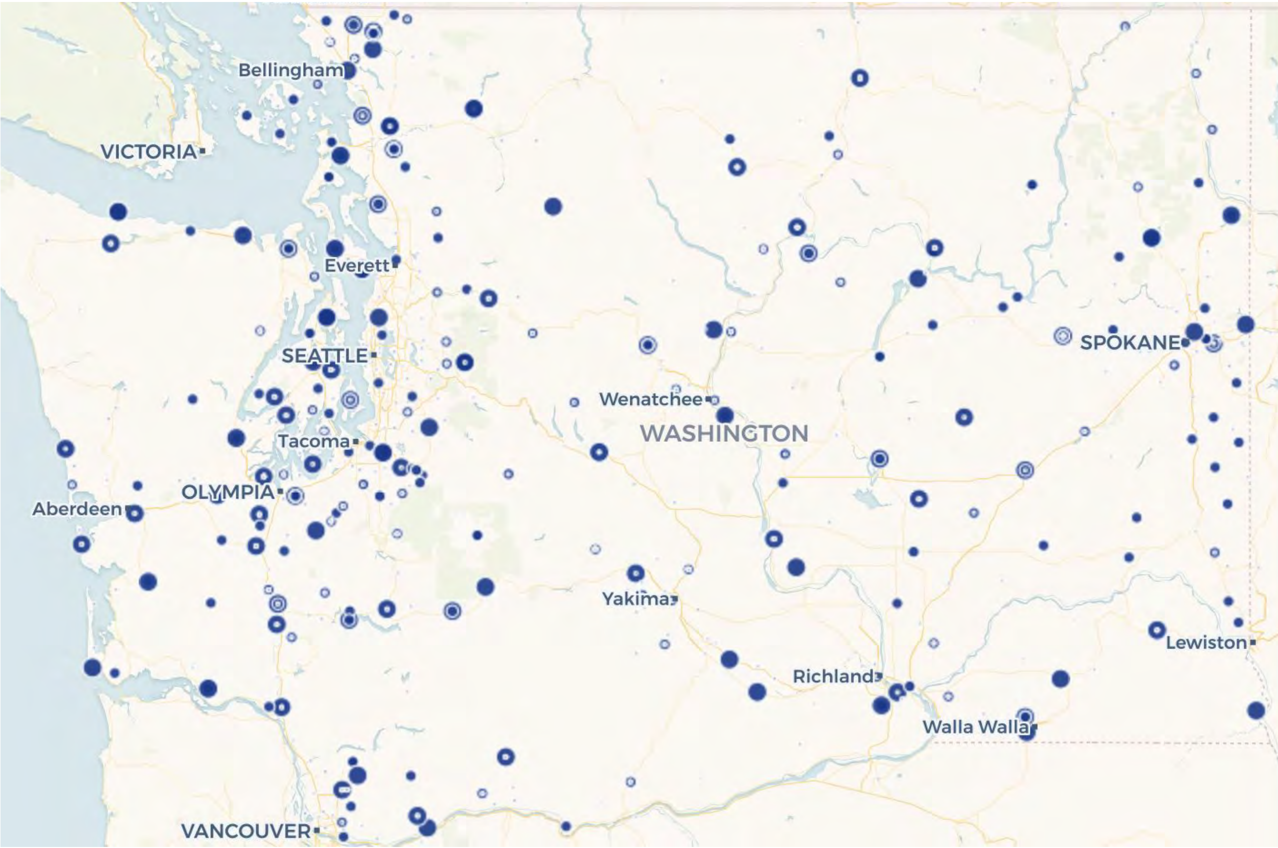


Ownership Type

Ownership Type	Count
CITY/TOWN	132
SPECIAL DISTRICT	71
ASSOCIATION	12
INVESTOR	10
PRIVATE	8
OTHER	10

Not within the scope of research

Group A Community Systems with less than 1,000 Service Connections



Total Service Connections

Ownership Type

INVESTOR	2.2k
PRIVATE	1.9k
ASSOCIATION	782
SPECIAL DISTRICT	461
CITY/TOWN	406
OTHER	659

Representative Sampling

Category	Total	%	Sample
Group A Community Systems over 1000 service connections	243	100%	15%
Without Federal, County, or State	233	96%	36
Size Range by Max. Total Population			
25th Percentile: <5,000 Max Total Population	65	27.9%	10
Eastern	26	11.2%	4
Northwest	22	9.4%	3
Southwest	17	7.3%	3
25th to 75th Percentile 5,001 - 25,000 Max Total Population	108	46.4%	17
Eastern	33	14.2%	5
Northwest	46	19.7%	7
Southwest	29	12.4%	4
75th Percentile 25,000 Max Total Population	60	25.8%	10
Eastern	11	4.72%	2
Northwest	37	15.88%	6
Southwest	12	5.15%	2

15%

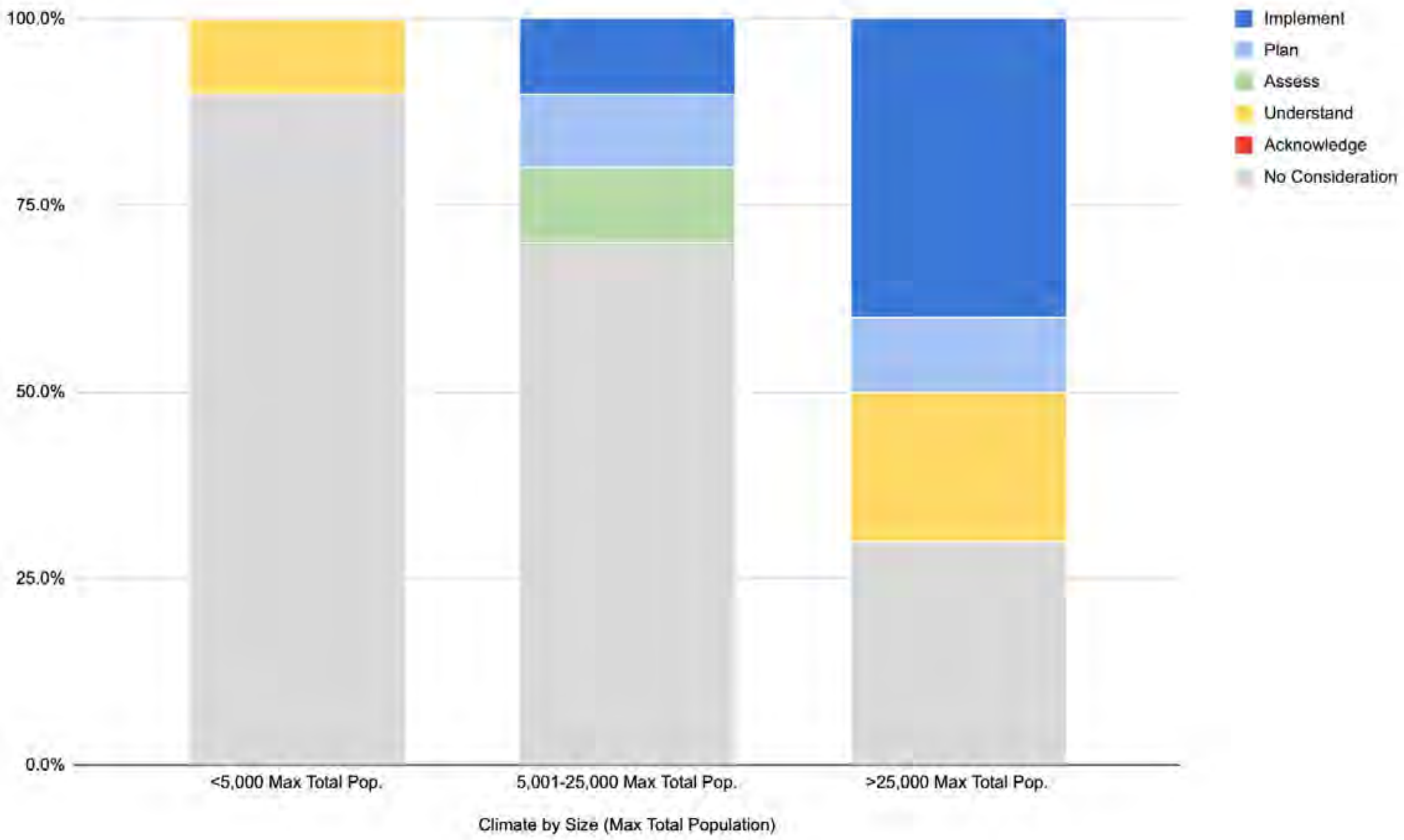
of the total

36 Water System Plans

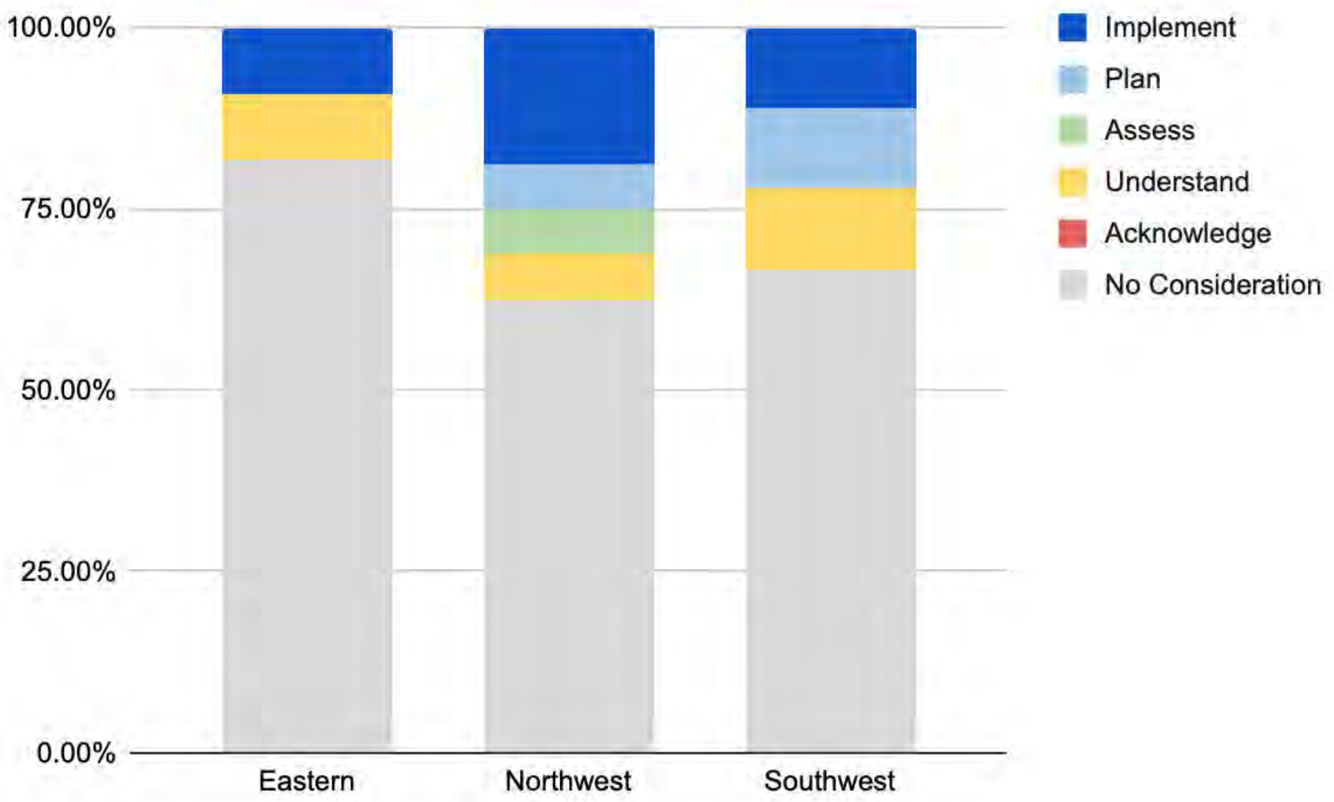
Methods: Climate Change in Water System Plans

No Consideration	No mention of climate change.
Acknowledge	Acknowledges climate change is occurring
Understand	Indicates an understanding of climate change impacts to water system, but has not done further assessment of potential vulnerabilities.
Assess	Assessed water system vulnerabilities to potential climate changes.
Plan	Incorporated climate projections and related vulnerabilities into water system planning.
Implement	Implemented climate adaptation and resilience actions.

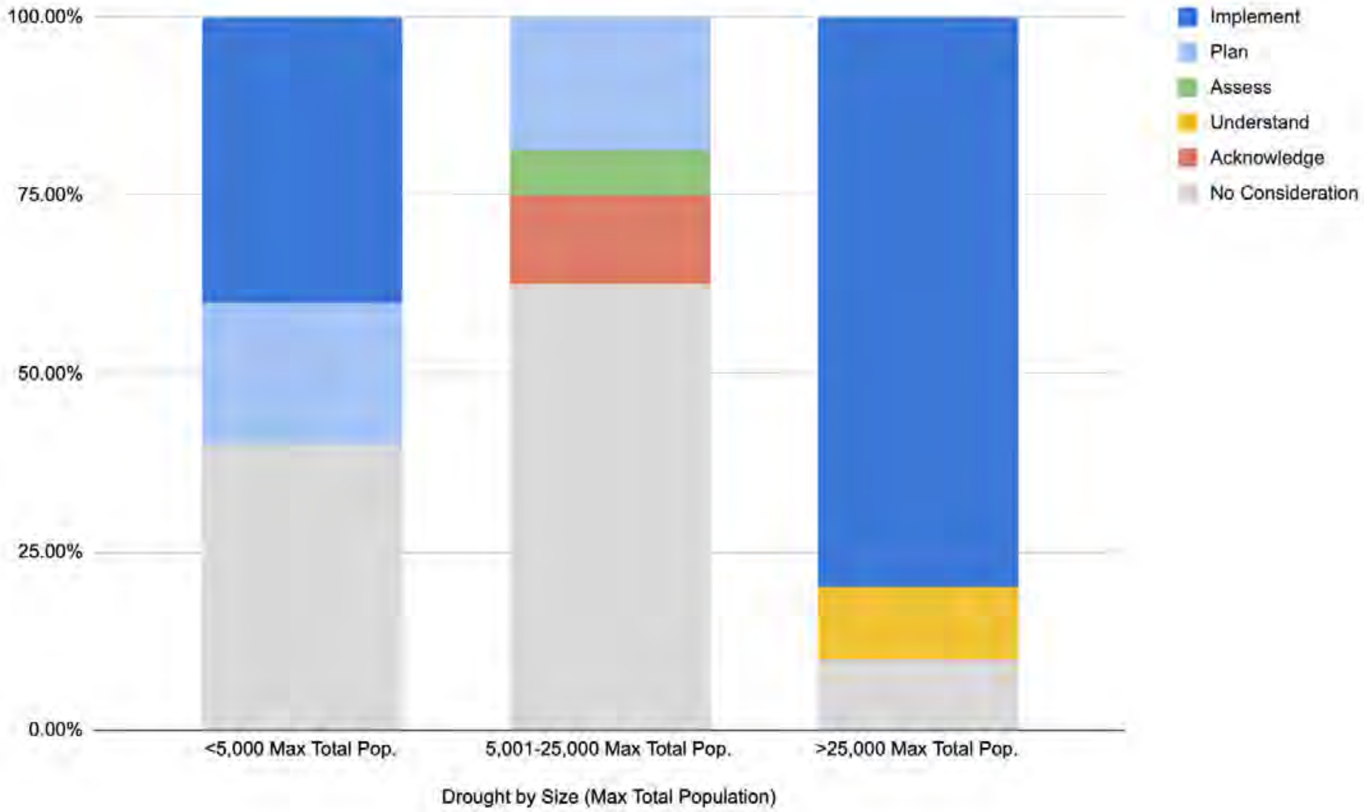
Climate Change by Size (Max Total Population)



Climate Change by Region

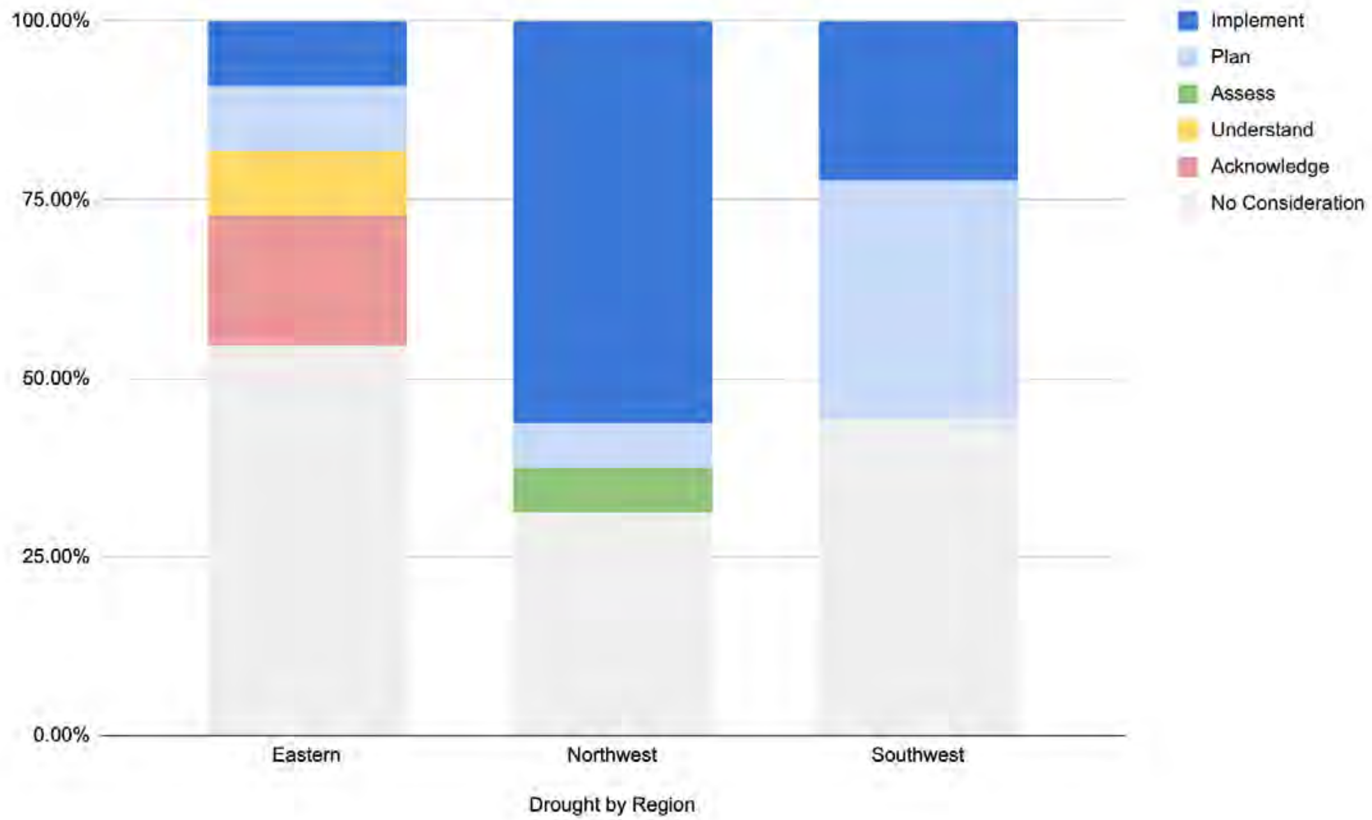


Drought



100.00%
75.00%
50.00%
25.00%
0.00%
<5,000 Max Total Pop.
5,001-25,000 Max Total Pop.
>25,000 Max Total Pop.
Drought by Size (Max Total Population)
Implement
Plan
Assess
Understand
Acknowledge
No Consideration

Drought



100.00%
75.00%
50.00%
25.00%
0.00%
Eastern
Northwest
Southwest
Drought by Region
Implement
Plan
Assess
Understand
Acknowledge
No Consideration

Drought

61%

of water system plans that were
assessing, planning, and implementing
responses to drought linked it to climate change.

Some caveats…

- We were only able to look at publicly available plans, which could impact the findings.

- Analysis is still ongoing. We are also looking at other impacts, such as flooding, wildfire, and resilience actions for water quality.

- This is only an assessment of how climate is being used in existing water system plans, which may not reflect resilience actions utilities are taking.
    - Climate resilience can happen outside of water system plans.
    - Water System Plans are required to be updated every 10 years.
        - Our knowledge of climate change is always evolving and we can be responsive to emerging risks and needs.

HOW

is climate change being incorporated into water system planning?

Case Study Analysis: The City of Everett

Using Climate Information in Supply and Demand Analysis

The City of Everett – Climate Change and Drought Impacts to Supply

Would the water system have enough supply to meet 2015 and 2035 forecast demand levels under severe drought?

Surface Water: Sultan River Basin

Surface Water – Spada Reservoir

Using Climate Information in Supply and Demand Analysis

The City of Everett – Climate Change and Drought Impacts to Supply

Historical Drought

1987 Drought
- Worst drought on record
- Summer and Fall Drought
- Low precipitation and extremely low stream flows through December

2015 Drought
- Low snowpack with hot, dry conditions from March through July
- Heavy rains returned by October ending the drought

Extended Historical Drought

Climate Impacts on Drought

Increased Frequency
- What would the worst drought on record look like two years in a row?
- Modeled a multi-year drought from 1986 to 1988

*They ended up not using this scenario. Supply conditions would be similar if it occurred another year.

Extreme Drought

Climate Impacts on Drought

Increased Severity
- Increased the severity of the 1987 drought to a point where the supply systems failed to meet projected demands, even with certain demand and supply management measures take.
- Reduced reservoir inflow to point where they couldn't meet demand

The City of Everett – Climate Change and Drought

Table 7 Everett Summary of Analysis and Conclusions

Mitigation Measures Included in Analysis[3]	Scenario 1 Historical Drought[1]		Scenario 2 Extreme Drought[2]
	2015	2035	2035
Reservoir Operations (e.g., early refill, lower draw down)	No	No	No
Emergency Sources (e.g., wells)	No	No	No
Curtailment (voluntary)[4]	Yes	Yes	Yes
Instream Flow Reductions to Critical-year Levels[4]	Yes	Yes	Yes
Conclusion	Can meet demand for people and fish (with 20.7 billion gallons [63,600 acre-feet] of water remaining in storage at the end of the dry season).		Can meet demand for people and fish if inflow is reduced by additional 25% (with 17.7 billion gallons [54,200 acre-feet] of water remaining in storage at the end of the dry season).

Yes = the technique was applied in the drought modeling analysis

No = the technique was not applied in the analysis

1. Supply conditions are those of the worst drought on record, which was 1987. Supply conditions are assumed to be similar if the 1987 drought were repeated for a second year.
2. Everett chose to match the supply under which SPU would not meet its demand, to compare operations with its closest neighbor under identical weather conditions.
3. The mitigation measures shown in this table represent the tools identified specifically for this modeling effort. Different combinations of these tools could be implemented depending on drought conditions, available resources, and other factors.
4. Implementation of Everett's Drought Response Plan and the associated allowed instream flow reductions are assumed to be standard operating procedure when the water level in Spada Reservoir drops below elevation 1,420 feet, which occurred in all indicated scenarios.

A note on groundwater

Groundwater Assessment did not evaluate Scenario 1 or 2

Groundwater would not be impacted by a single-year drought / short-term events.

However, multi-year drought with low precipitation and low snowpack would lead to aquifer decline or depletion.

The City of Everett – Climate Change and Drought Impacts to Supply

Collaboration: Vulnerability Assessment and Opportunities for Resilience

WATER SUPPLY FORUM
Serving Snohomish, King & Pierce Counties

TACOMA PUBLIC UTILITIES

EVERETT WASHINGTON

Seattle

- Risk Assessment was conducted for Everett, Seattle Public Utilities (SPU) and Tacoma Water.
- Under the extreme drought scenario, SPU and Tacoma would not be able to meet their demands.
- Potential for Everett to provide drought relief through an emergency intertie.
  ***However, coincidence of drought conditions is high across these basins, indicating that all systems face concurrent and relatively consistent reductions in available supply.

Lessons Learned

Potential Applications for Small to Medium Water Systems

1. **You don't always need to have new models or data.**
   Existing regional climate data can be a good starting point for understanding and assess climate impacts to your system.
   Past events can also help us better envision and prepare for the future.

2. **Put climate change into context.**
   Impacts, sensitivities, and resilience needs are dependent on unique characteristics of your system. You are the expert!

Lessons Learned

Potential Applications for Small to Medium Water Systems

3

You don't have to go it at alone.

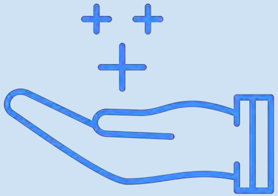
Collaborations and partnerships are a key to resilience.

- Resource-sharing results in shared benefits.
- Platform to share experiences, lessons, and insights.
- Network of support.
- Collaboratively design solutions and create a stronger base for advocacy

Managing Uncertainty in Resilience Planning

Best Practices

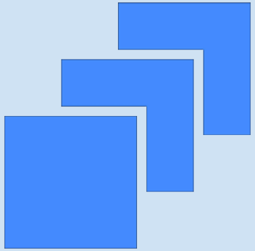
Workshop Materials Page 8



Focus on more certain projections

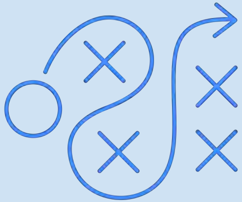
Low-regret Options

Win-win Solutions



Bound uncertainties

robust strategies
That respond to
a range of futures



Be flexible and responsive.

Adjust as new insights, risks, and opportunities emerge.

Learn from other uncertainties.

Other uncertainties like population, development, or pandemics.

Resilience Planning 101:

Building Resilience

25 Minutes

Workshop Materials: Page 12-14

Worksheet 2: Building Resilience			
Climate Impact and Threshold Briefly describe the climate impacts and threshold for which you want to plan and build resilience.			
Category	**Water System Function**	**System Sensitivity** What qualities of these functions make them more or less sensitive to future climate impacts?	**Resilience Needs** How can infrastructure, operations, finances, and organizational attributes be modified to respond to climate impacts? What changes need to happen to achieve climate resilience?
Source	Water Source Type(s)		
	Source Quality		
	Source Capacity		
	Water Rights		
Alternative Sources	Emergency Intertie		
	Alternative Supplies (E.g. Trucking water)		
Demand	Demand Projections		

You will have time to think through the worksheets independently, and share your experiences through guided discussions.

Climate Impact + Threshold

Describe the climate impact and related thresholds you identified in the previous Activity. Use this as a reference point for identifying climate resilience actions.

Water System Functions

A list of water system functions are provided to help you think through more specific resilience actions. Consider how the current state of these functions are sensitive to climate impacts.

System Sensitivities

Describe qualities of these water system functions that make them more sensitive to future climate impacts.

Resilience Needs

How might some of these functions be adjusted so your system can adequately respond to future impacts and avoid reaching critical thresholds?

Breakout Groups

Enter your assigned breakout room.

- Northwest
- Southwest
- Eastern

Resources and Tools

Creating Resilient Water Utilities

Wesley Wiggins
Environmental Protection Agency (EPA)

wiggins.wesley@epa.gov

U.S. EPA's Creating Resilient Water Utilities

Wesley Wiggins – ORISE Fellow

Creating Resilient Water Utilities: Our Mission

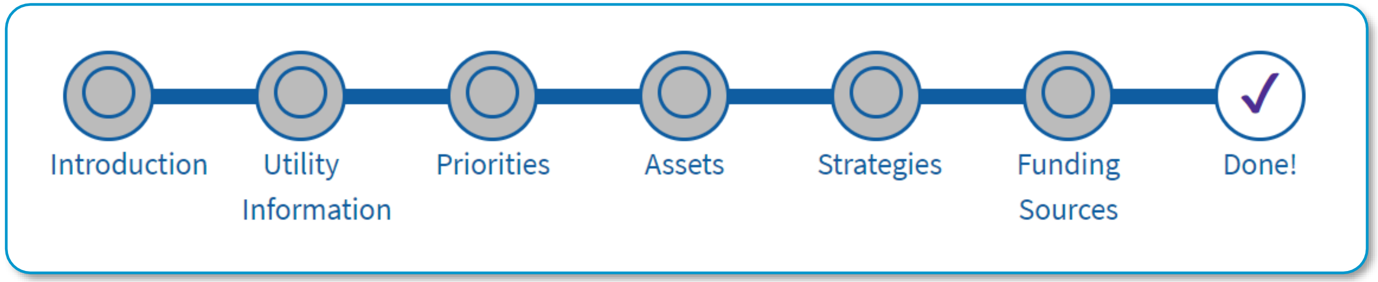
- Provide utilities with the practical tools, training, and technical assistance needed to increase resilience to climate change
- Promote a clear understanding of climate science data and potential long-term adaptation options
- Collaborate with utilities and partners to increase our reach and improve our tools

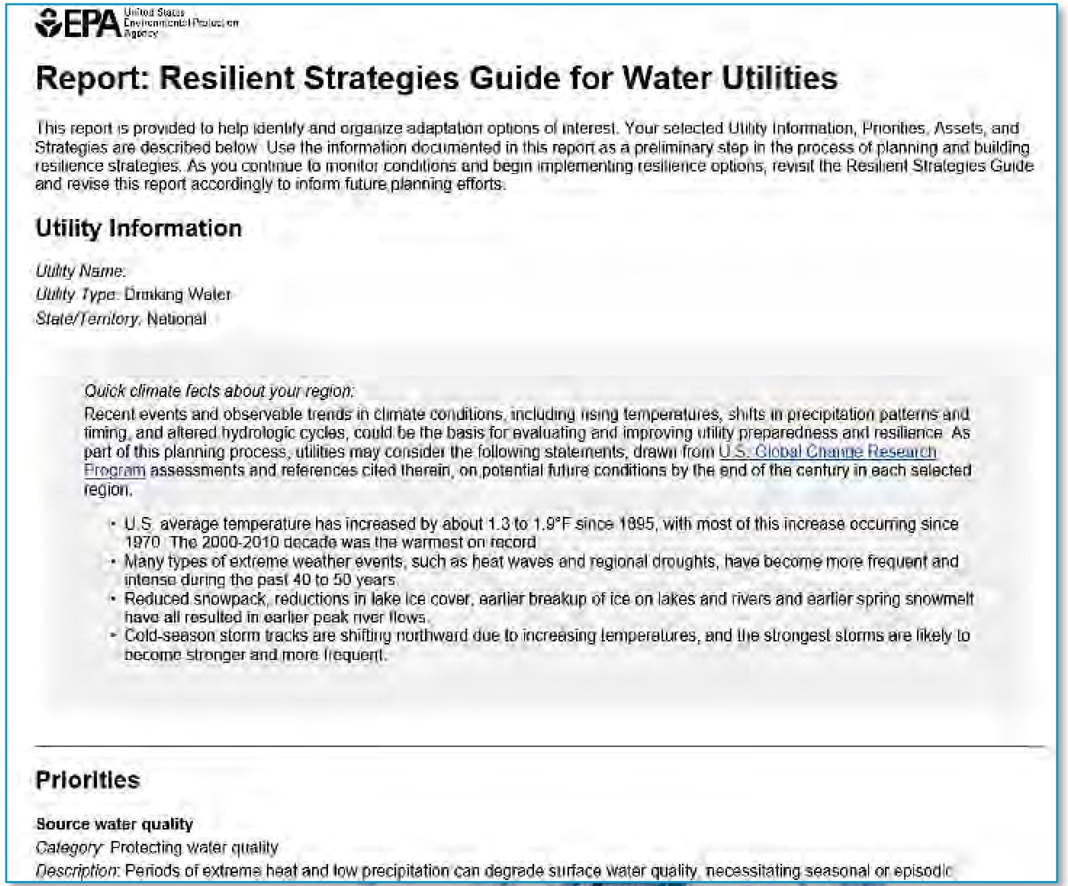
From Left to Right: Griggs Reservoir on Scioto River in OH; Water Replenishment District in Southern CA; Water Sanitation Area in Cincinnati, OH; Water Treatment Plant in San Diego, CA

EPA

Resilient Strategies Guide

- **Free**, online application for reviewing resilience strategies used by water utilities
- Introduction to adaptation planning for those with limited experience
- Provides **strategies and potential funding options** based on location, priorities, and assets
- Final report documents selected strategies to explore during adaptation planning
- Takes **5 – 10 minutes** to complete





EPA United States Environmental Protection Agency

Report: Resilient Strategies Guide for Water Utilities

This report is provided to help identify and organize adaptation options of interest. Your selected Utility Information, Priorities, Assets, and Strategies are described below. Use the information documented in this report as a preliminary step in the process of planning and building resilience strategies. As you continue to monitor conditions and begin implementing resilience options, revisit the Resilient Strategies Guide and revise this report accordingly to inform future planning efforts.

Utility Information

Utility Name:
Utility Type: Drinking Water
State/Territory: National

Quick climate facts about your region:

Recent events and observable trends in climate conditions, including rising temperatures, shifts in precipitation patterns and timing, and altered hydrologic cycles, could be the basis for evaluating and improving utility preparedness and resilience. As part of this planning process, utilities may consider the following statements, drawn from U.S. Global Change Research Program assessments and references cited therein, on potential future conditions by the end of the century in each selected region.

- U.S. average temperature has increased by about 1.3 to 1.9°F since 1895, with most of this increase occurring since 1970. The 2000-2010 decade was the warmest on record.
- Many types of extreme weather events, such as heat waves and regional droughts, have become more frequent and intense during the past 40 to 50 years.
- Reduced snowpack, reductions in lake ice cover, earlier breakup of ice on lakes and rivers and earlier spring snowmelt have all resulted in earlier peak river flows.
- Cold-season storm tracks are shifting northward due to increasing temperatures, and the strongest storms are likely to become stronger and more frequent.

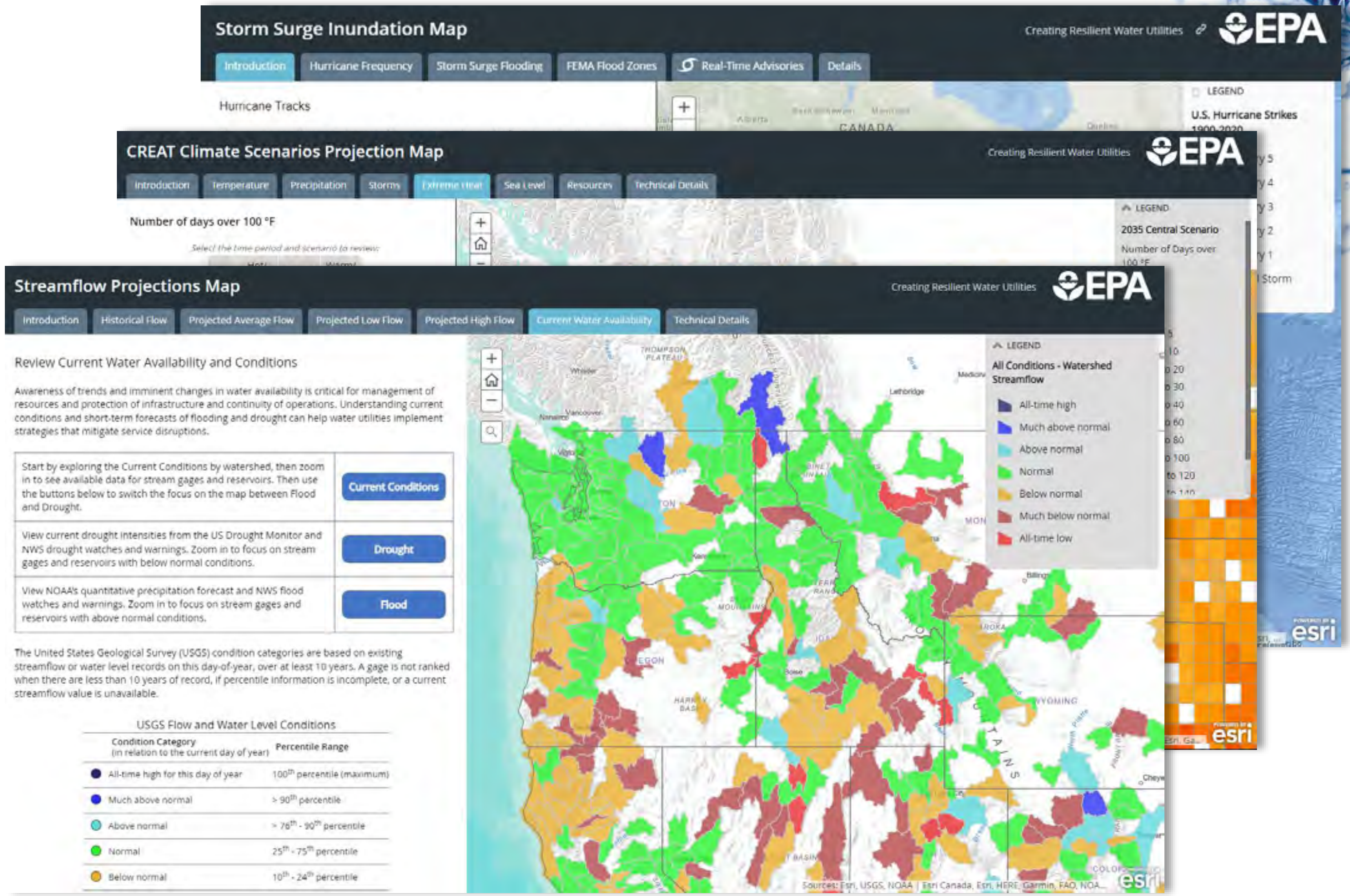
Priorities

Source water quality
Category: Protecting water quality
Description: Periods of extreme heat and low precipitation can degrade surface water quality, necessitating seasonal or episodic

EPA

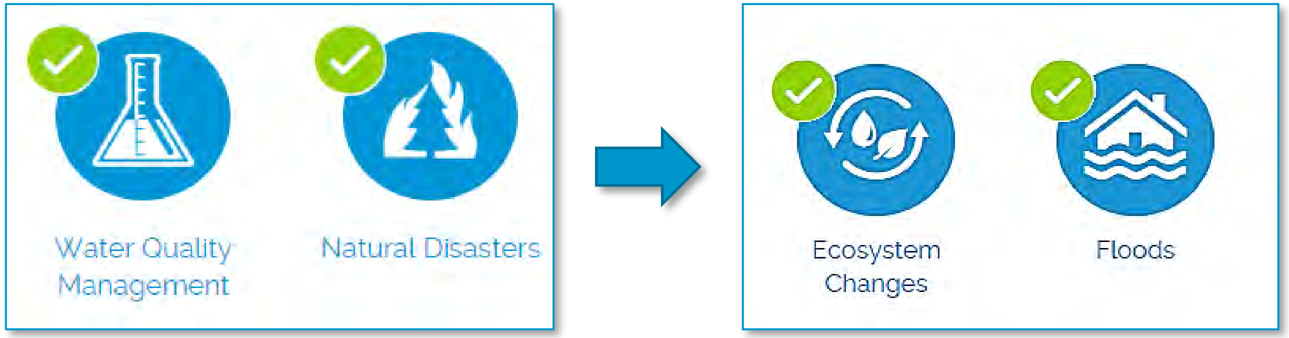
Interactive Climate Change and Weather Maps

- Storm Surge Inundation Map
  - Displays coastal flooding, hurricane surge models, FEMA flood zones, and more
- Climate Scenarios Projection Map
  - Displays local scenarios, potential changes in temperature and precipitation, and more
- Streamflow Projections Map
  - Displays possible changes in flow conditions and current conditions for U.S. streams and rivers



Climate Resilience Evaluation and Awareness Tool

- **First of its kind** – web-based climate change risk assessment tool for the water sector
- **Flexible** and **customizable** framework
- **Guides users** through identifying impacts, vulnerable assets, and adaptation options to help **reduce risks**
- Built with **significant stakeholder input**
- CRWU conducts trainings and workshops to assist utilities



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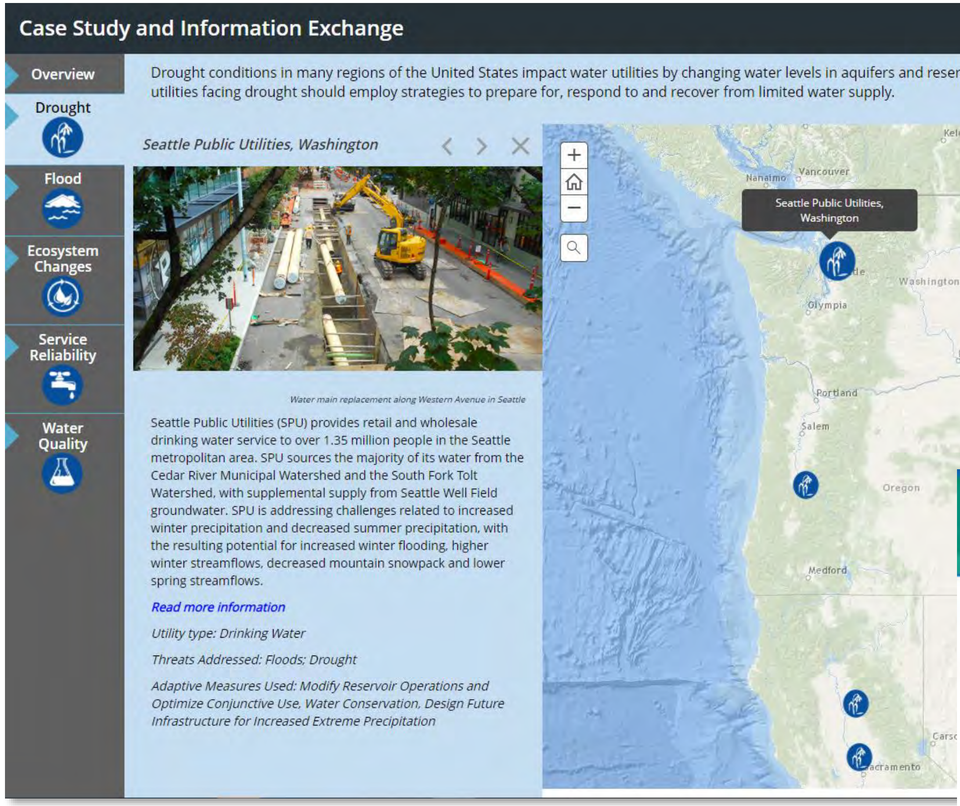
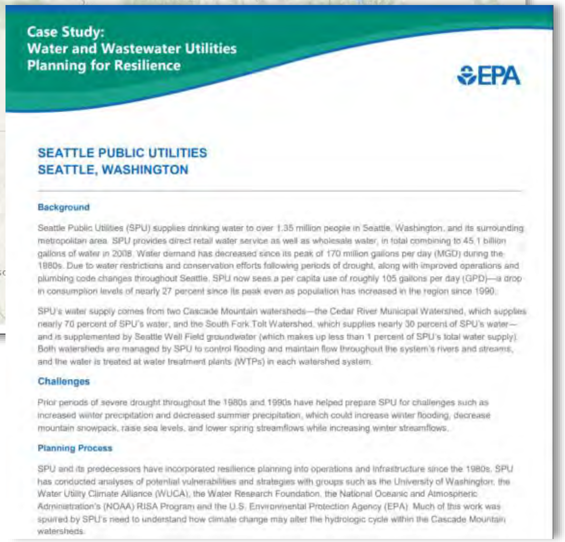
Case Study and Information Exchange Map





Case Study:
Water and Wastewater Utilities
Planning for Resilience

EPA

SEATTLE PUBLIC UTILITIES
SEATTLE, WASHINGTON

Background

Seattle Public Utilities (SPU) supplies drinking water to over 1.35 million people in Seattle, Washington, and its surrounding metropolitan area. SPU provides direct retail water service as well as wholesale water, in total combining to 45.1 billion gallons of water in 2008. Water demand has decreased since its peak of 170 million gallons per day (MGD) during the 1980s. Due to water restrictions and conservation efforts following periods of drought, along with improved operations and plumbing code changes throughout Seattle, SPU now sees a per capita use of roughly 105 gallons per day (GPD)—a drop in consumption levels of nearly 27 percent since its peak even as population has increased in the region since 1990.

SPU's water supply comes from two Cascade Mountain watersheds—the Cedar River Municipal Watershed, which supplies nearly 70 percent of SPU's water, and the South Fork Tolt Watershed, which supplies nearly 30 percent of SPU's water—and is supplemented by Seattle Well Field groundwater (which makes up less than 1 percent of SPU's total water supply). Both watersheds are managed by SPU to control flooding and maintain flow throughout the system's rivers and streams, and the water is treated at water treatment plants (WTPs) in each watershed system.

Challenges

Prior periods of severe drought throughout the 1980s and 1990s have helped prepare SPU for challenges such as increased winter precipitation and decreased summer precipitation, which could increase winter flooding, decrease mountain snowpack, raise sea levels, and lower spring streamflows while increasing winter streamflows.

Planning Process

SPU and its predecessors have incorporated resilience planning into operations and infrastructure since the 1980s. SPU has conducted analyses of potential vulnerabilities and strategies with groups such as the University of Washington, the Water Utility Climate Alliance (WUCA), the Water Research Foundation, the National Oceanic and Atmospheric Administration's (NOAA) RISA Program and the U.S. Environmental Protection Agency (EPA). Much of this work was spurred by SPU's need to understand how climate change may alter the hydrologic cycle within the Cascade Mountain watersheds.

- Helps utilities connect with their peer utilities, share experiences, and learn best practices
- **57+** CREAT success stories available
- Case Studies Map grows as CRWU works with more utilities

Trainings and Workshops

- Partnerships to provide training and direct technical assistance to utilities
- CRWU conducts regional workshops based on climate regions in the U.S.
  - Upcoming training in Alaska
- All CRWU Regional Workshops are recorded and uploaded to the Training Center
- CREAT Training for Northwest (WA, OR, ID) starts in April 2022
  - *Introduction: Wednesday, April 20th*
  - *Session 1: Tuesday, May 3rd*
  - *Session 2: Thursday, May 5th*
  - *Session 3: Tuesday, May 10th*
  - *Session 4: Tuesday, May 24th*

Contact Us

Curt Baranowski: Baranowski.curt@epa.gov

Wesley Wiggins: Wiggins.wesley@epa.gov

Steve Fries: fries.steve@epa.gov

Klara Zimmerman: zimmerman.klara@epa.gov

Sign Up for CRWU Newsletter

Email: crwuhelp@epa.gov

CRWU website: www.epa.gov/crwu

Questions and Feedback

Contact: easinas@uw.edu

Thank you for joining us!