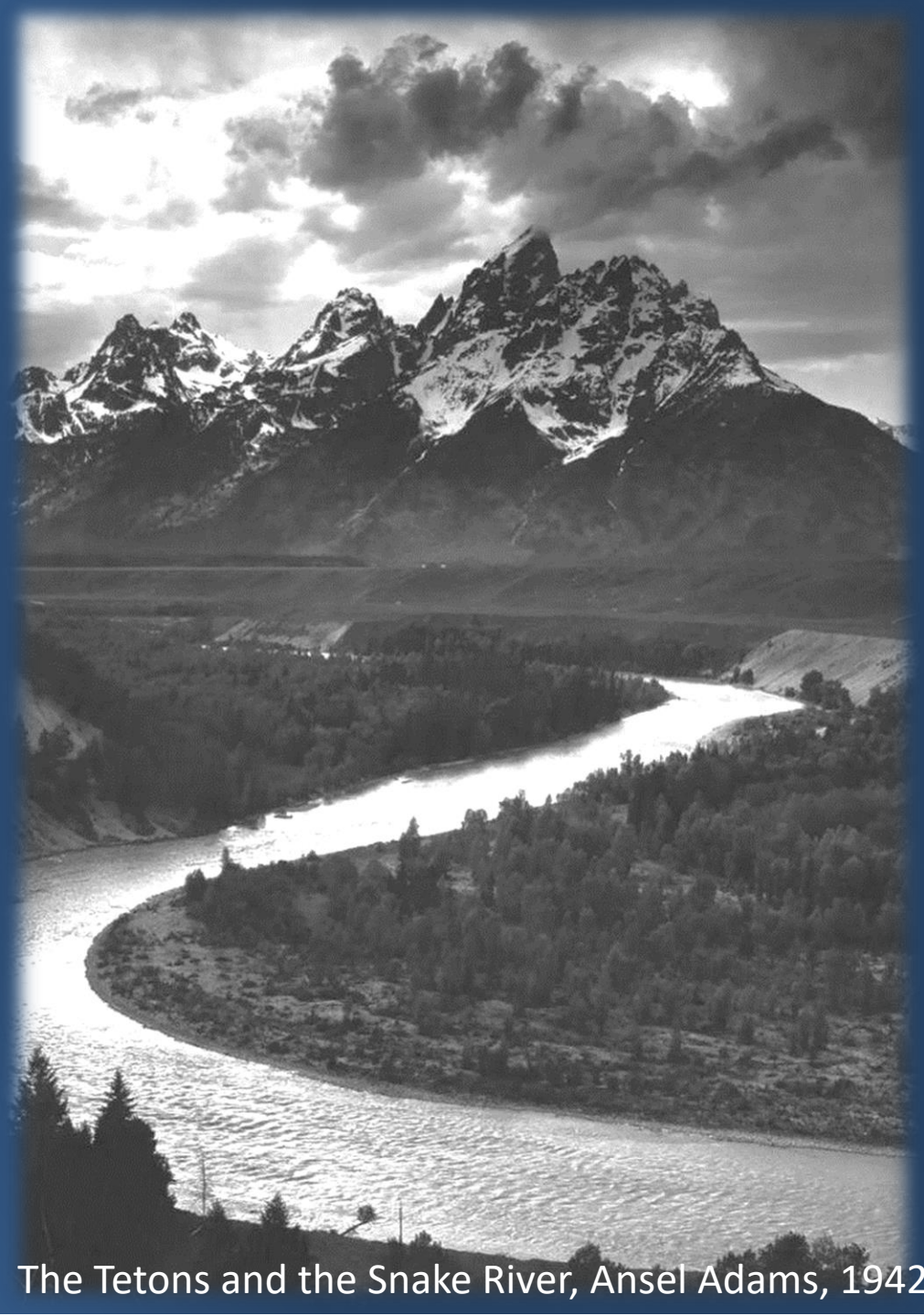

The Tetons and the Snake River, Ansel Adams, 1942.

Wyoming Anticipating Climate Transitions: integrating geospatial data and tools to understand risk, consider future scenarios and build adaptive capacity

Jeff Hamerlinck, PhD, AICP, GISP
Director, Wyoming Geographic Information Science Ctr
Associate Director, School of Computing
University of Wyoming -- Laramie, WY
President-Elect, UCGIS

UNIVERSITY OF WYOMING

National States Geographic Information Council
Western States Caucus

April 24, 2024

Presentation Outline

- **Context - The WyACT Project**
- **Geospatial in Action**
  - **SEaSON cyberinfrastructure**
  - **WyADAPT Middleware**
- **Concluding thoughts**

Acknowledgements

- **WyACT - Anticipating the Climate-Water Transition and Cascading Challenges to Socio-Environmental Systems in America's Headwaters**
  - NSF Award #OIA-2149105 (2022-2027)
  - Principal Investigators: B. Ewers, B. Geerts, C. Knapp, B. Shuman, D. Williams

Thanks to **Dr. Shannon Albeke** and the **WyGISC "Dev Team"** at UWYO, as well as all the members of the WyACT project.

Thanks also to **NSGIC** for fostering such a great geospatial community over the last 25+ years, and to **Karen Rogers**, Geospatial Program Manager, Bureau of Land Management (Wyoming State Office) and past NSGIC President for this invitation.

EPSCoR Wyoming

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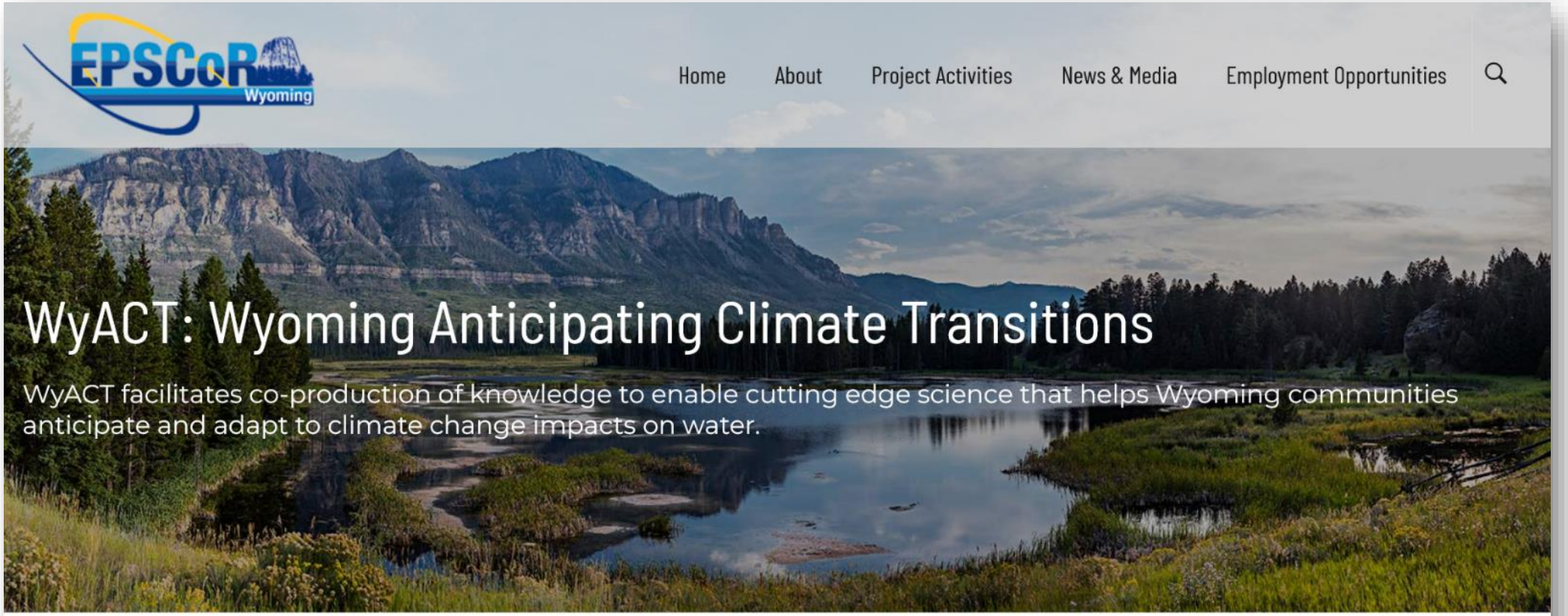


WyACT: Wyoming Anticipating Climate Transitions

WyACT facilitates co-production of knowledge to enable cutting edge science that helps Wyoming communities anticipate and adapt to climate change impacts on water.

Vision

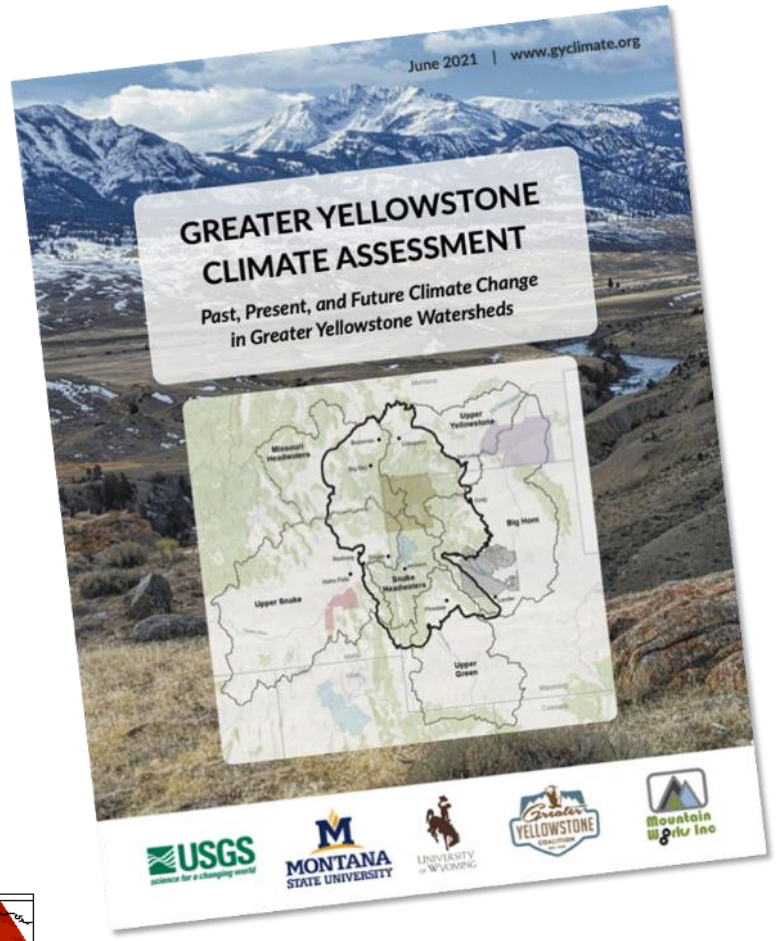
WyACT will establish lasting and nationally competitive capabilities and infrastructure that improves predictive understanding of the coupled human-environment impacts of climate change on water availability. WyACT will enable Wyoming's communities to anticipate and prepare for significant and lasting changes in water availability.

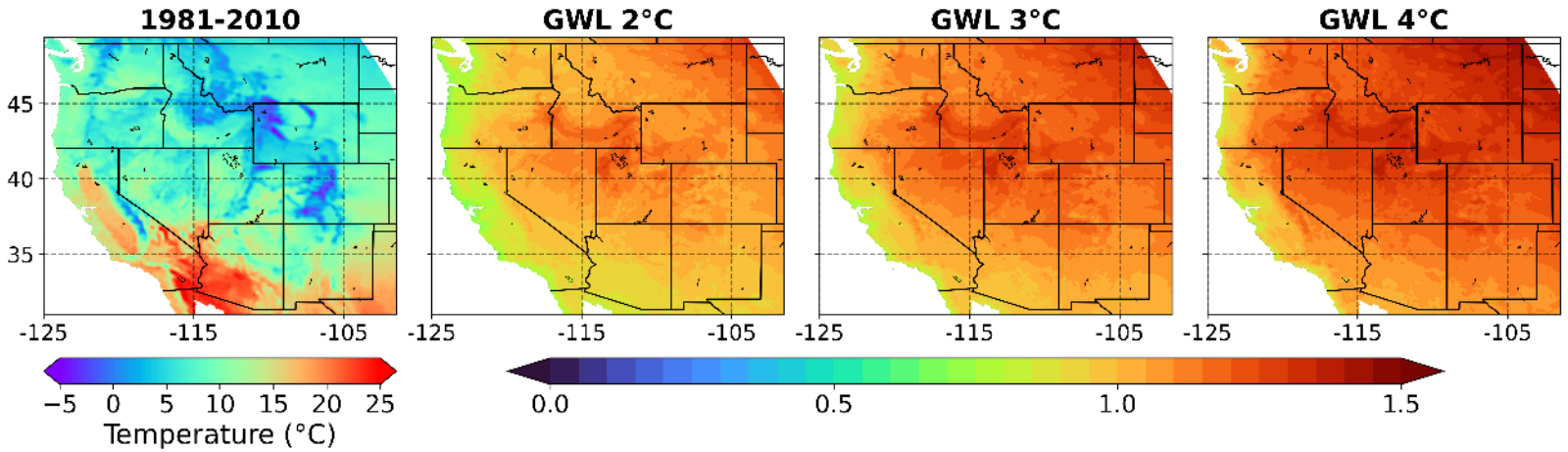
News & Updates

Read all News

WyACT Motivation

- Climate change will have a profound effect on Wyoming's water resources
- Communities have diverse climate change views and adaptive capacity
- Science and model skepticism limits planning and adaptive capacity





WyACT Motivation

- Co-production of knowledge
  - interdisciplinary and transdisciplinary approaches
  - remove barriers between intellectual merit and broader impacts
  - move the needle on trust in science and models

- University of Wyoming elevating research competitiveness and outcomes in Greater Yellowstone Ecosystem
  - UW NPS Research Station in Grand Teton NP
  - High impact scholarship and relationships
  - New research capacity
    - Modeling
    - Engagement
    - Cyberinfrastructure

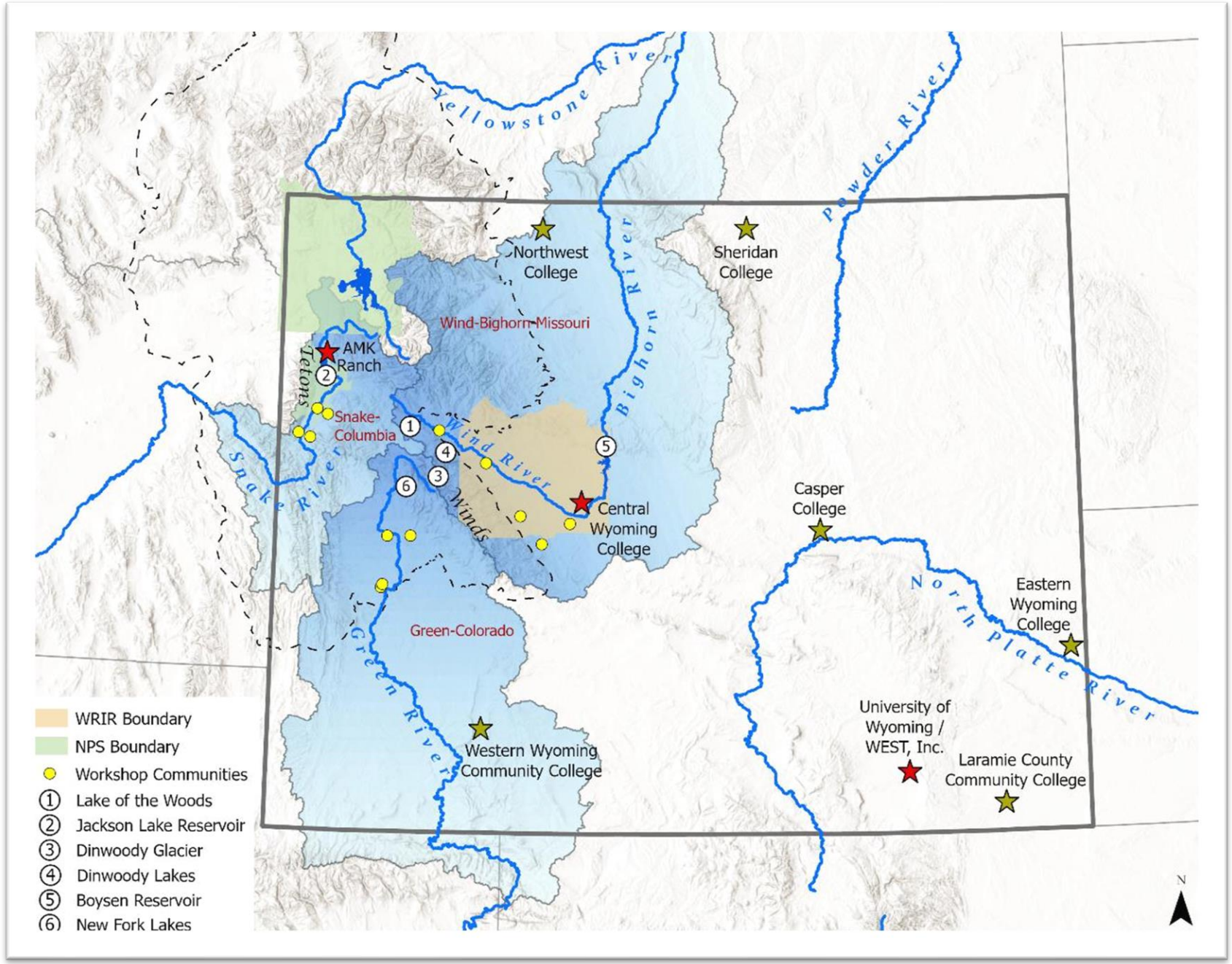
WyACT Research Questions

RQ1: What are the climate related risks and vulnerabilities impacting water availability?

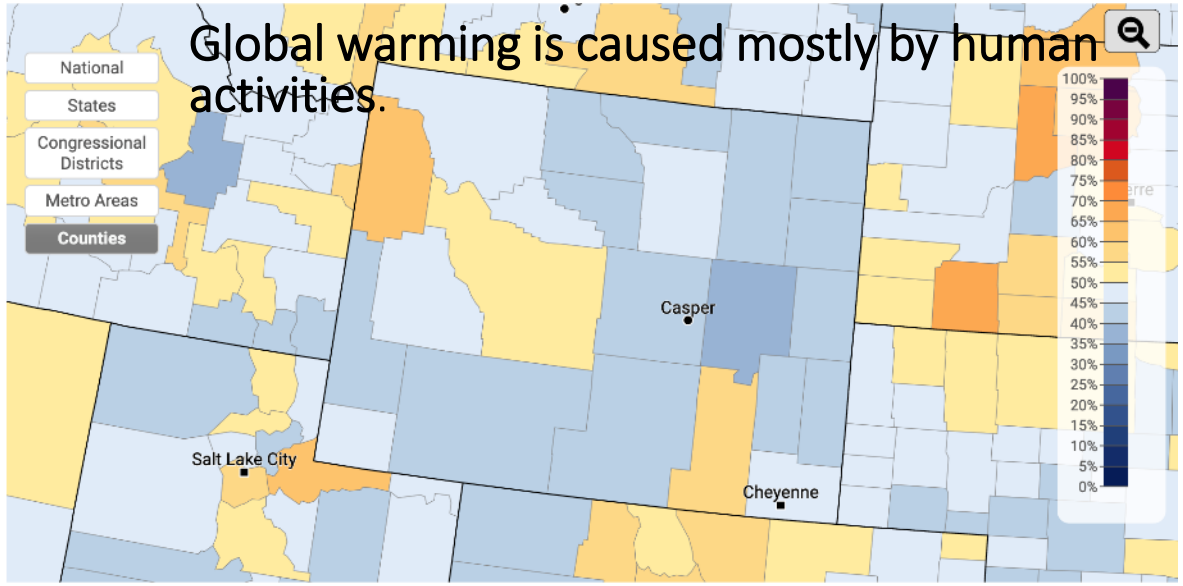
RQ2: How do communities and stakeholders perceive, and how will they respond to, climate-driven changes in water availability?

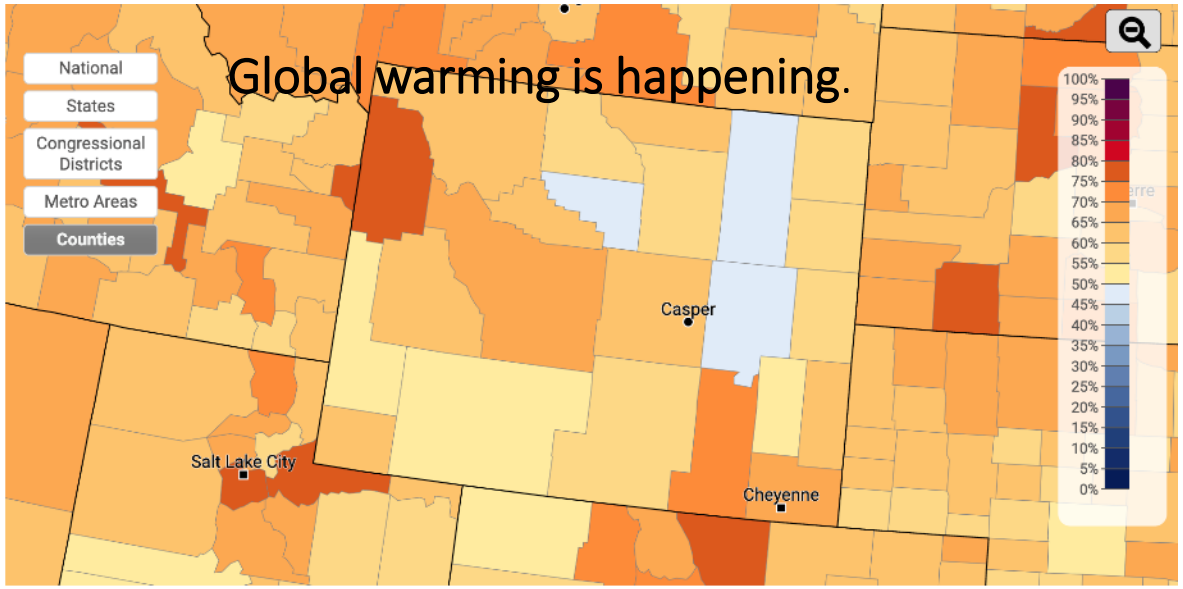
RQ3: How can the co-production process build adaptive capacity?

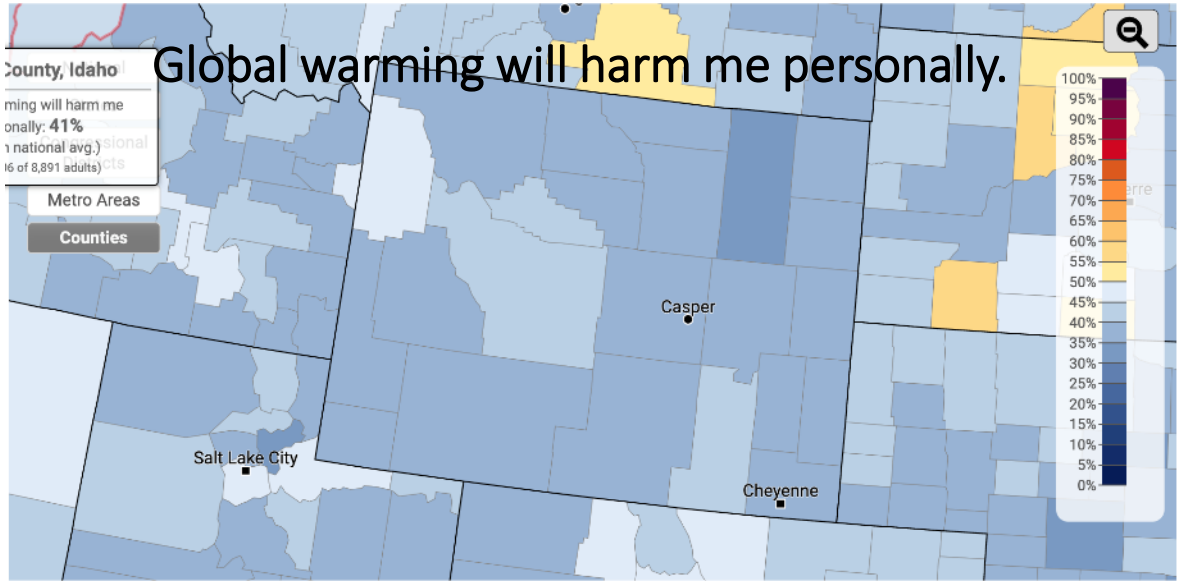
RQ4: How might societal responses interact with biophysical processes and feedbacks to alter future risks and vulnerabilities?


Yellowstone River
Powder River
Bighorn River
Wind River
Snake River
Green River
Tetons
Winds
Northwest College
Sheridan College
Casper College
Central Wyoming College
Eastern Wyoming College
Western Wyoming Community College
University of Wyoming / WEST, Inc.
Laramie County Community College
AMK Ranch
Wind-Bighorn-Missouri
Snake-Columbia
Green-Colorado
North Platte River
WRIR Boundary
NPS Boundary
Workshop Communities
1 Lake of the Woods
2 Jackson Lake Reservoir
3 Dinwoody Glacier
4 Dinwoody Lakes
5 Boysen Reservoir
6 New Fork Lakes
N

Climate Change Perceptions in Wyoming

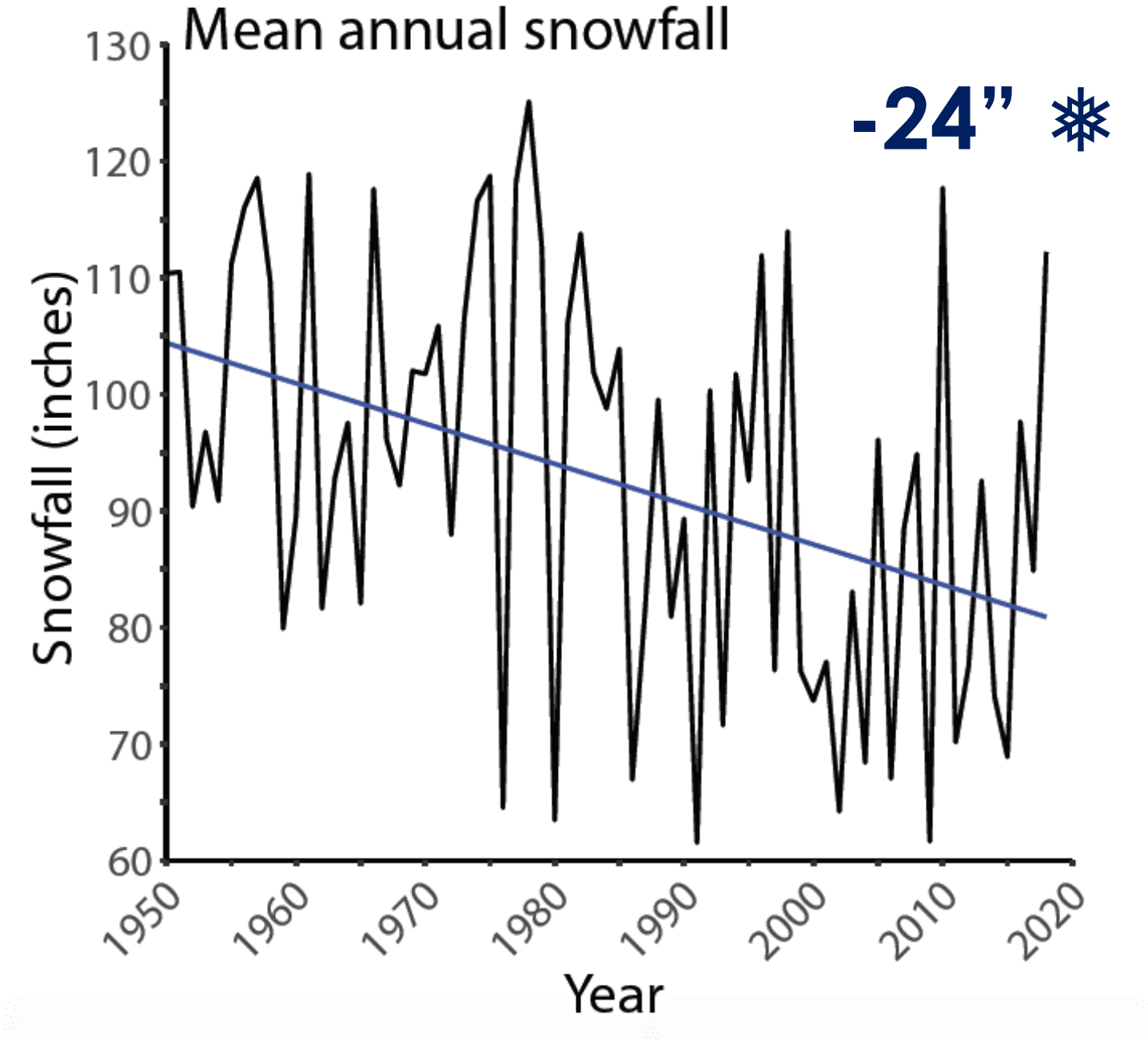






Yale Climate Change Opinion Maps 2021

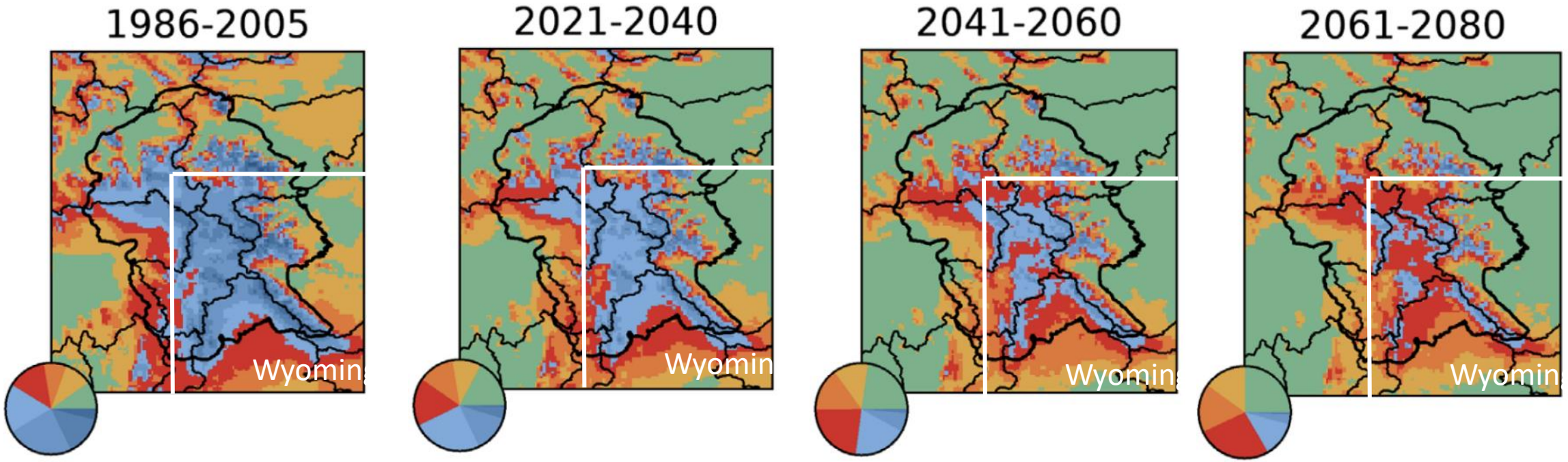
Water availability is a primary concern in Wyoming



source: Hostetler et al. (2021) Greater Yellowstone Climate Assessment

Transitioning from a **SNOW** to a RAIN dominated climate

(RCP 4.5)



circles show percent area in the GY dominated by **snow**, **mix**, **rain**

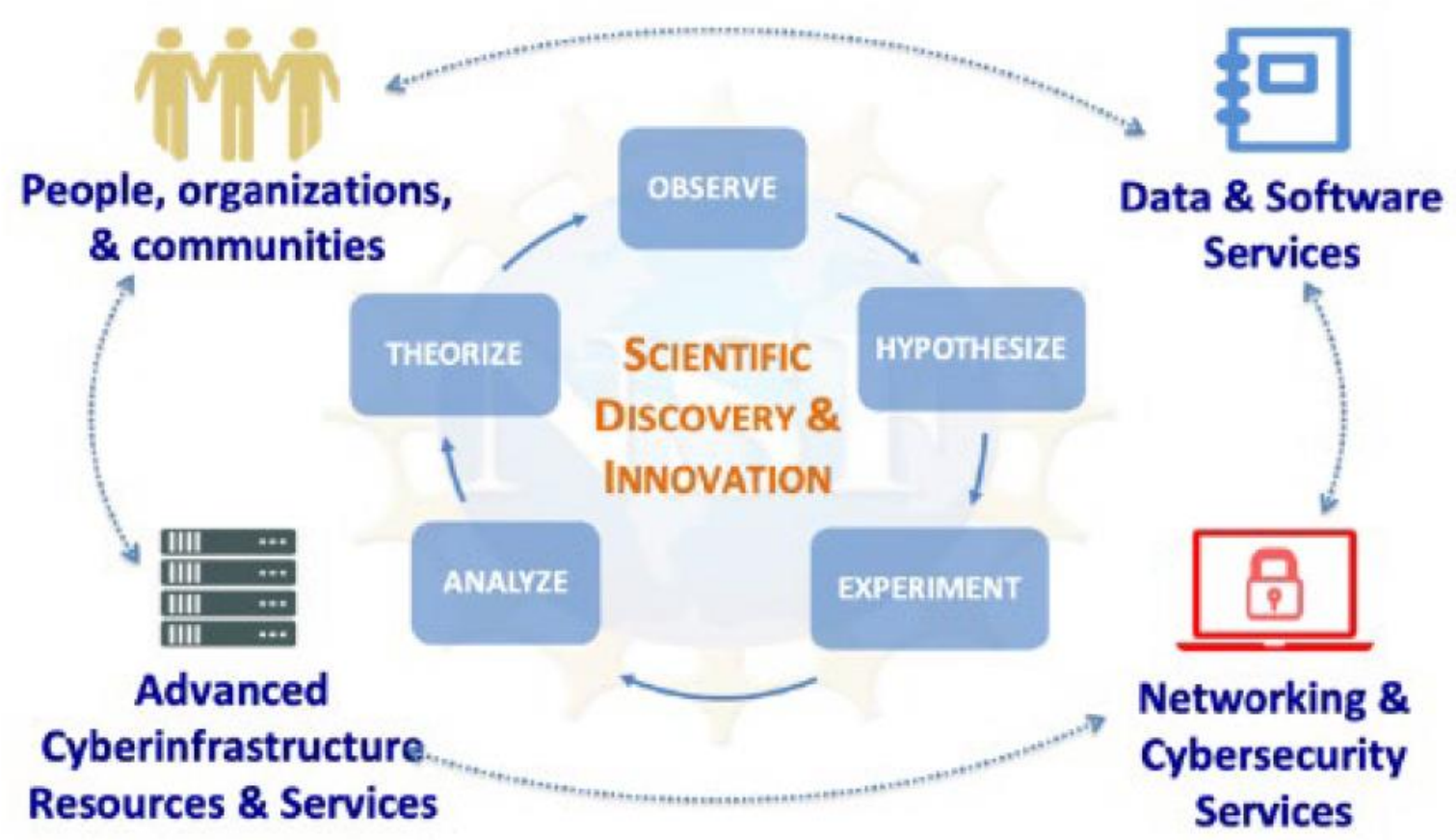
Hostetler et al. (2021) Greater Yellowstone Climate Assessment.

Gyclimate.org

WyACT and Geospatial

- Role of geospatial information in societal challenges.
- Emphasis on credible spatial decision-making.
- Addressing the impact of regional climate change on water resources.

Cyberinfrastructure Components



"Transforming Science Through Cyberinfrastructure: NSF's Blueprint for a National Cyberinfrastructure Ecosystem for Science and Engineering in the 21st Century," https://www.nsf.gov/cise/oac/vision/blueprint-2019/

CI Contributors
develop
new capabilities

Faculty, students, postdocs, and scientists who help create new CI capabilities (hardware, software, data, networking and security).

CI Professionals
deploy & support
new capabilities

Uniquely skilled professional staff who deploy and support research CI and who serve as bridges between CI Contributors and CI Users.

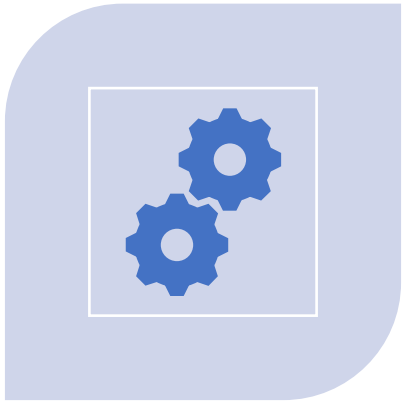
CI Users
exploit
new capabilities

Domain scientists and engineers and their students who utilize these CI capabilities for scientific discovery.

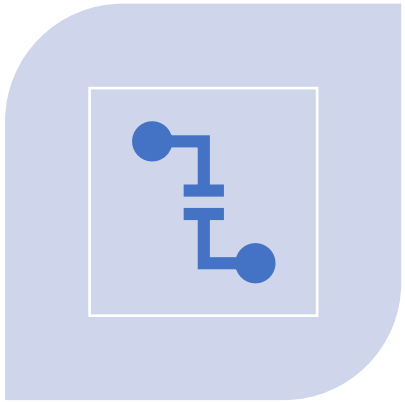
"Transforming Science Through Cyberinfrastructure: NSF's Blueprint for a National Cyberinfrastructure Ecosystem for Science and Engineering in the 21st Century," https://www.nsf.gov/cise/oac/vision/blueprint-2019/

The Role of CyberGIS Frameworks

VALUE AND CHALLENGES OF CYBERGIS FOR DOMAIN-SPECIFIC USERS.



NEED FOR DYNAMIC INFORMATION DISPLAYS FOR EXPLORATORY ANALYSIS.



OVERCOMING DISCONNECTS BETWEEN CYBERINFRASTRUCTURE SCIENCE AND ON-GROUND APPLICATION.

The Socio-Environmental Systems Observatory Network (SEaSON)

Goal: Coordinate social, economic, and biophysical observations for sustained monitoring of system changes and process interactions

- How are climate change impacts expressed at the boundaries of natural and human-centered environments?
- How do processes at these boundaries interact at multiple scales?
- How will stakeholder access to and participation in integrated observations influence system behavior and community decisions?

SEaSON observations

Qualitative and quantitative data

Streaming Sensors

- Lake buoys
- Eddy covariance flux towers
- Micrometeorological stations
- Stream flow gauges

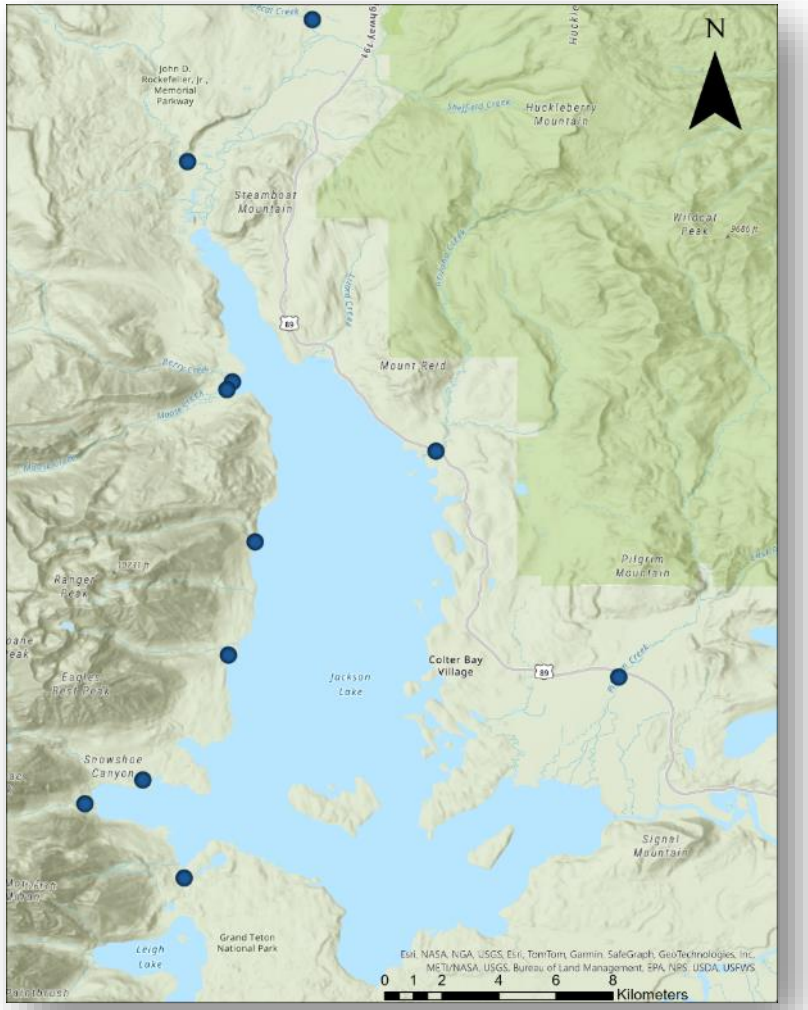
Non-streaming Sensors

- Stream temperature and dissolved oxygen sensors
- FLAMe – lake and river water quality
- Snowtography cameras

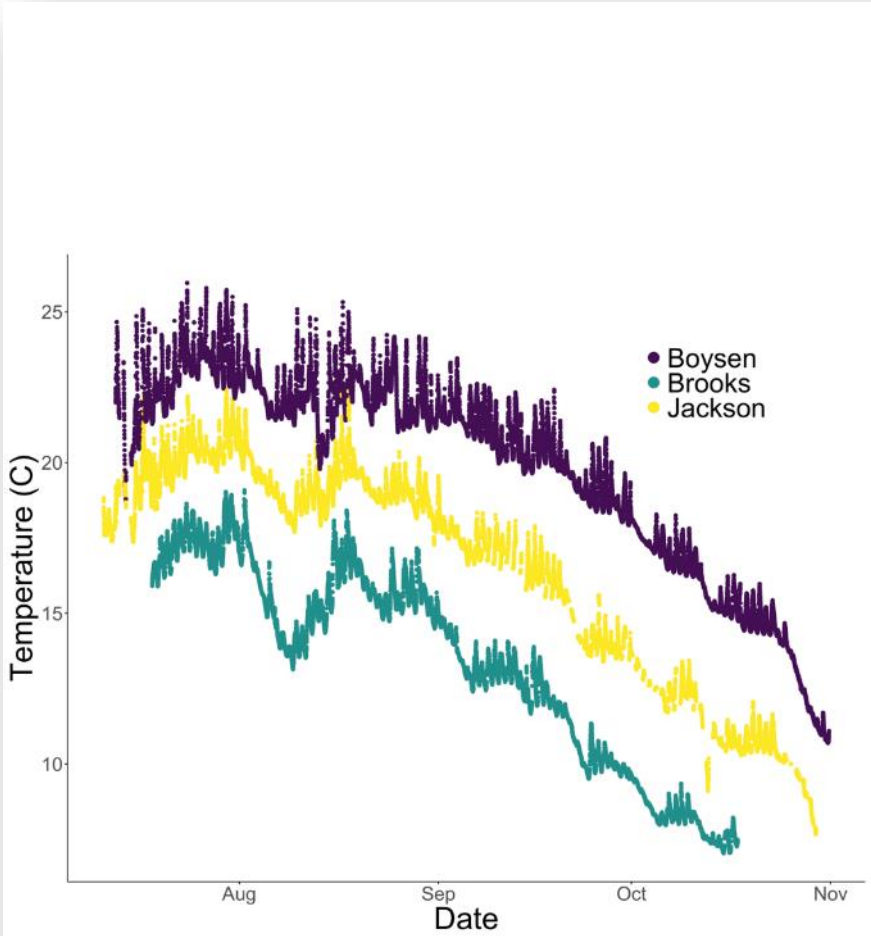
Other Data Collection

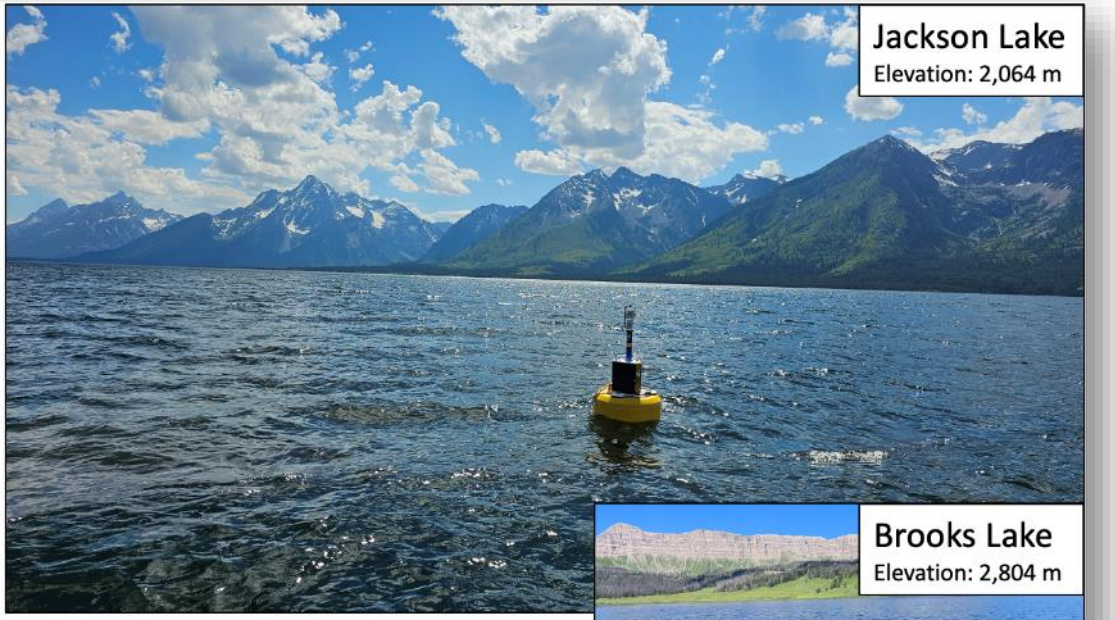
- Socio-economics surveys
- Story-maps and narratives
- Cell phone datasets
- Demographic (e.g. Census or ACS)
- Physical samples (e.g. stream invertebrates, fish, soil, veg plots, etc.)
- Drone sorties

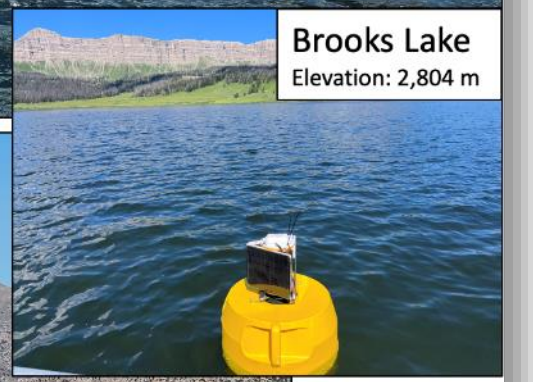
SEaSON observations



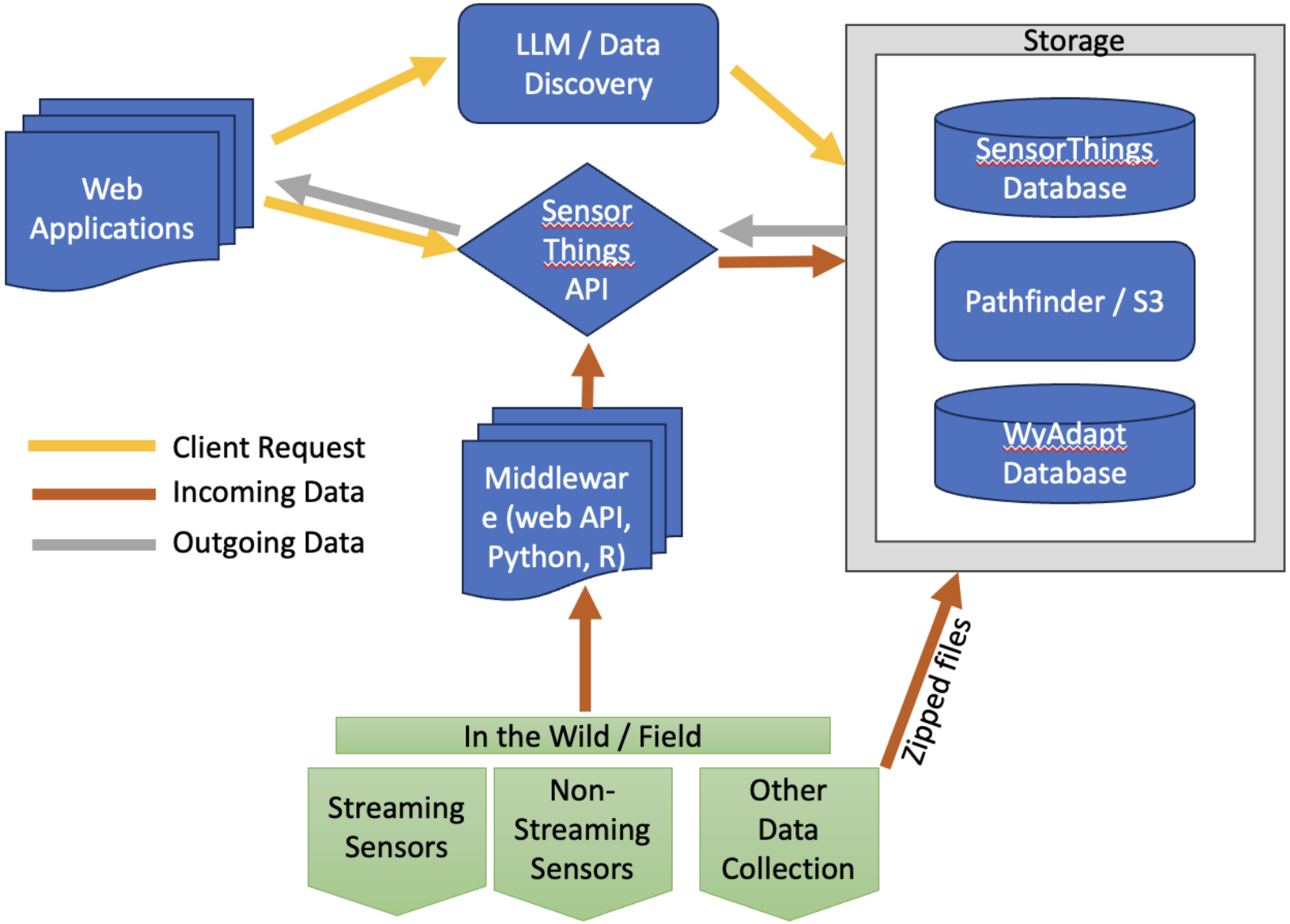
SEaSON observations







SEaSON cyberinfrastructure



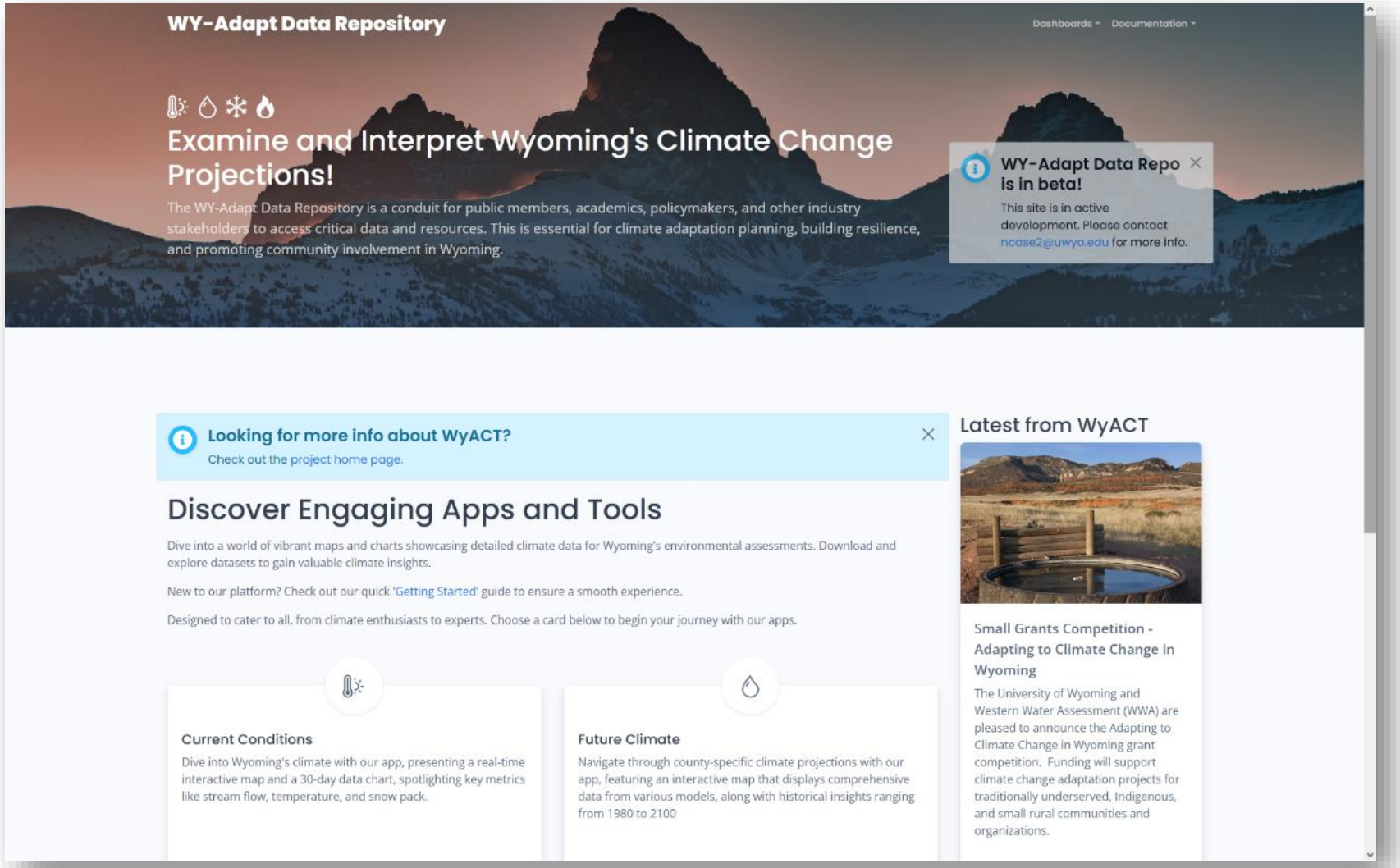
Cyberinfrastructure Middleware

- Middleware: Translating Expert Knowledge for All
  - Serving: Policy makers, educators, public, students.
  - Navigating data uncertainty and scenario planning.

- Data Handling Challenges:
  - Preprocessing in the face of vast data volumes.
  - Addressing bandwidth constraints:
    - User, I/O, and internet speed.

- Wy-ADAPT application for exploratory analytics

WY-Adapt Overview



wyadapt.org

WY-Adapt Applications

User-friendly interfaces for both researchers and lay users.

'Current Conditions': map-based reference for easily accessible climate and water data.

'Future Climate': visualization tools for future climate scenarios.

Streamflow Summary

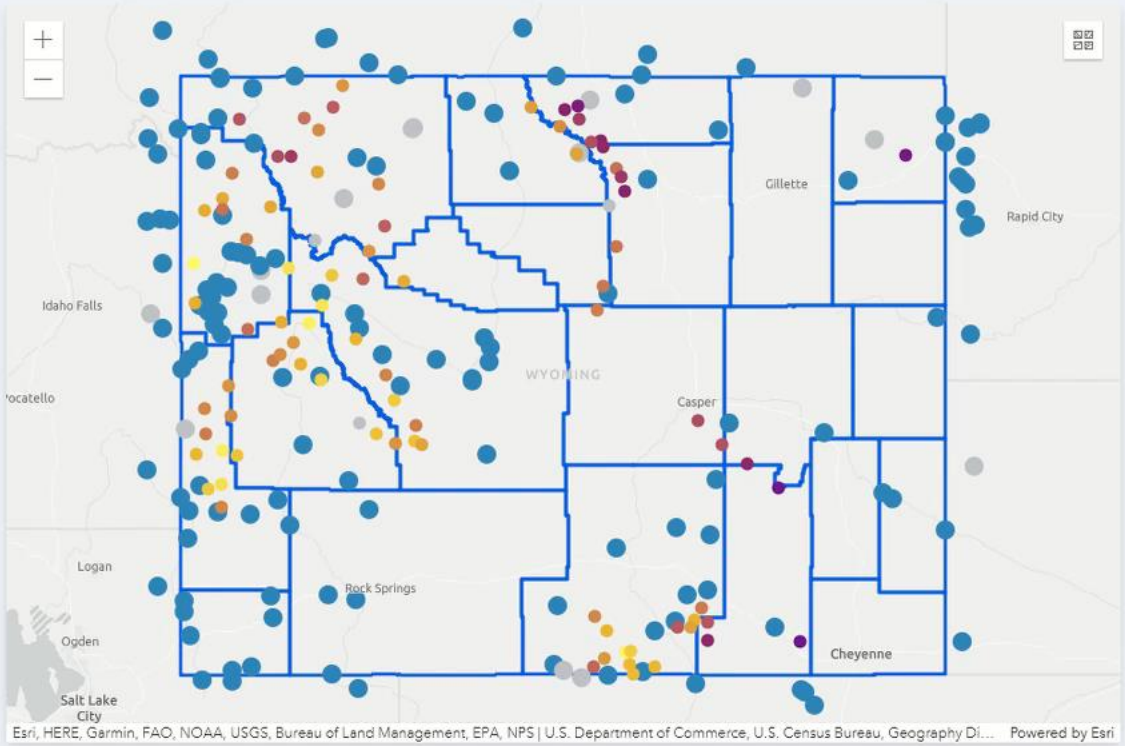
Stream Gages

135 reporting flow

149 total gages

No Flow

Flow



Map Controls

Layers

SNOTEL Temperature

Range (F°)

> 59.7

46.5

< 33.3

Current Stream Flow

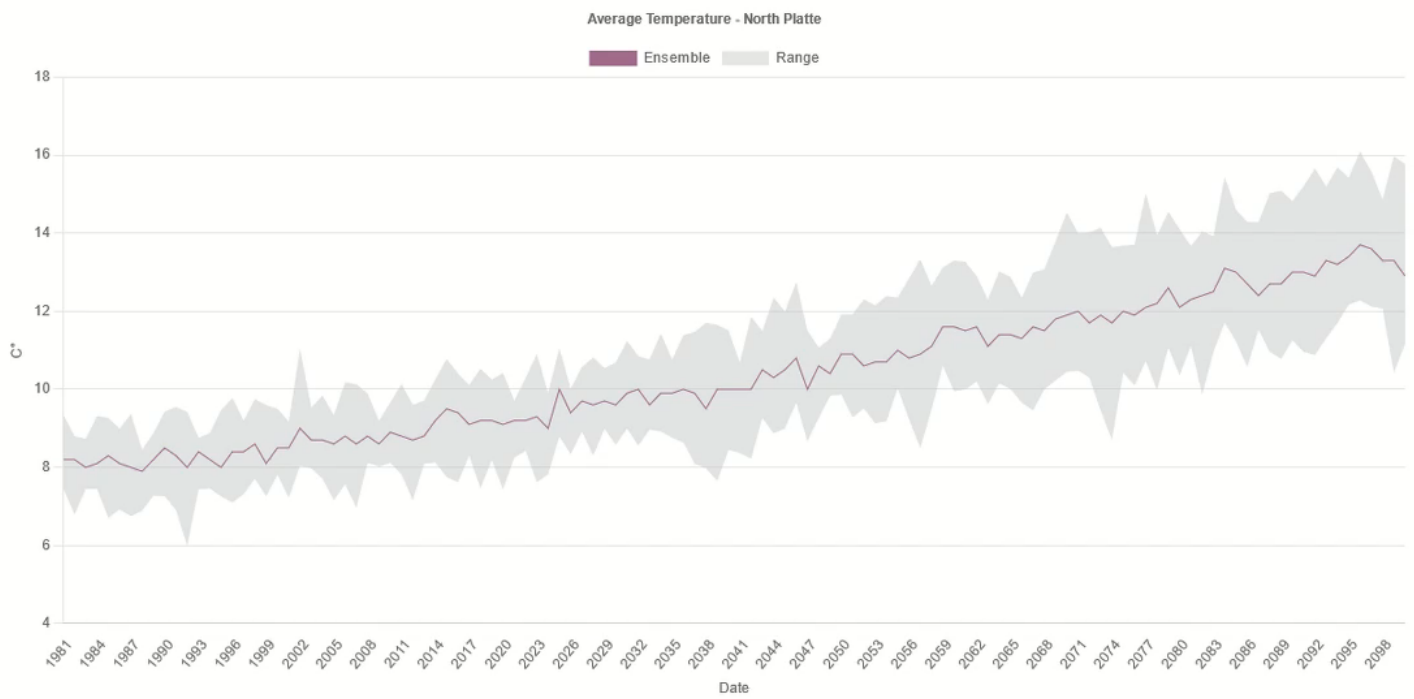
Counties

North Platte (1018)

Projected changes in **Average Temperature** under the **ssp370, which represents the medium to high end of the range of plausible future forcing pathways** scenario.

MODELED HISTORICAL	FUTURE PROJECTIONS	FUTURE PROJECTIONS
Baseline (1981-2010)	**Mid-Century (2035-2064)**	**End-Century (2070-2099)**
Change Period	Change Period	Change Period
30 YEAR AVG: 8.4 C°	30 YEAR AVG: 10.6 C°	30 YEAR AVG: 12.6 C°
30 YEAR RANGE: 7.9-9 C°	30 YEAR RANGE: 9.5-11.6 C°	30 YEAR RANGE: 11.7-13.7 C°
Learn more	Learn more	Learn more

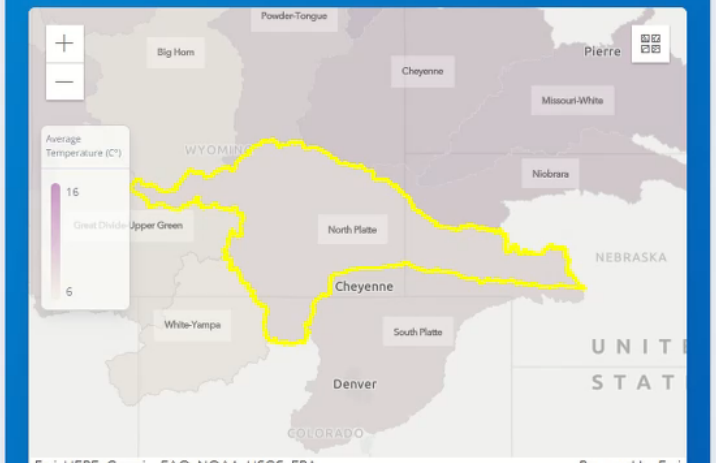
Time Series



Start at zero

Select Unit Type

Map Selections



10/1/2030

1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090

9/30/1980 9/29/2099

Make your selections

Choose a spatial element: HUC 4

Select a HUC: North Platte (1018)

Select a GCM: Ensemble

Select a Climate Variable: Average Temperature

WyACT Cyberinfrastructure Implications and Importance

- ***Bridging the gap*** between complex data and actionable insights.
- Importance of ***responsive spatial queries of time-series data***.
- ***Empowering communities*** with tools for the future.

Other Connections

- Data governance
  - E.g., tribal data sovereignty
- Partnerships
  - Building State SDIs
- Co-production / Adaptive Capacity