

# Science for a Changing World: Collaborative Problem Solving in the Colorado River Basin

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# Today's Discussion

- Grand Science Challenges
- Why Collaborate?
- Assisting Decision-Making across Landscapes

Hoover Dam Intake Tower, Lake Mead. April 2023  
Photo by USGS



# Cascading natural disasters

- Risk of cascading natural disasters is on the rise<sup>1</sup>
- Cascading event: events that occur as a direct or indirect result of an initial event<sup>2</sup>
- Cascading effects: the overall impact or hazard, which includes the chain of events and resulting damage from the events<sup>3</sup>



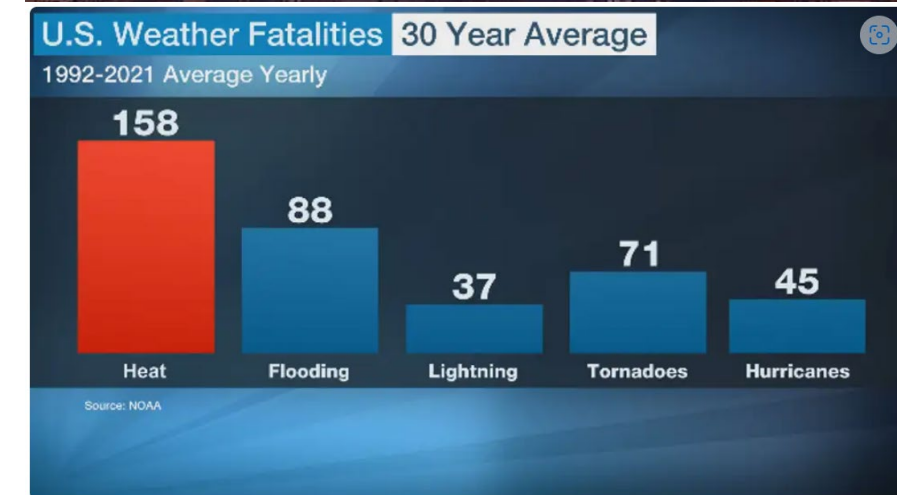
<sup>1</sup>[The risk of 'cascading' natural disasters is on the rise \(theconversation.com\)](https://theconversation.com)

<sup>2</sup>FEMA Independent Study Course, IS 230, Principles of Emergency Management

<sup>3</sup>Zuccaro and others, 2018

# Cascading effects in the Colorado River Basin

- Coupled weather events are becoming more common and severe with climate change
- In the Colorado River Basin, extreme heat couples with drought conditions
  - Drought leads to dry soils, less evaporation and surface warming. Coupling with extreme heat exacerbates these conditions.
  - Has far reaching effects on wildfire, potential for landslides and flooding, snowmelt, ecosystems, food web, air quality, crops, human populations
  - Extreme heat is the leading cause of weather-related fatalities, topping fatalities from tornadoes, hurricanes, flooding and lightning.

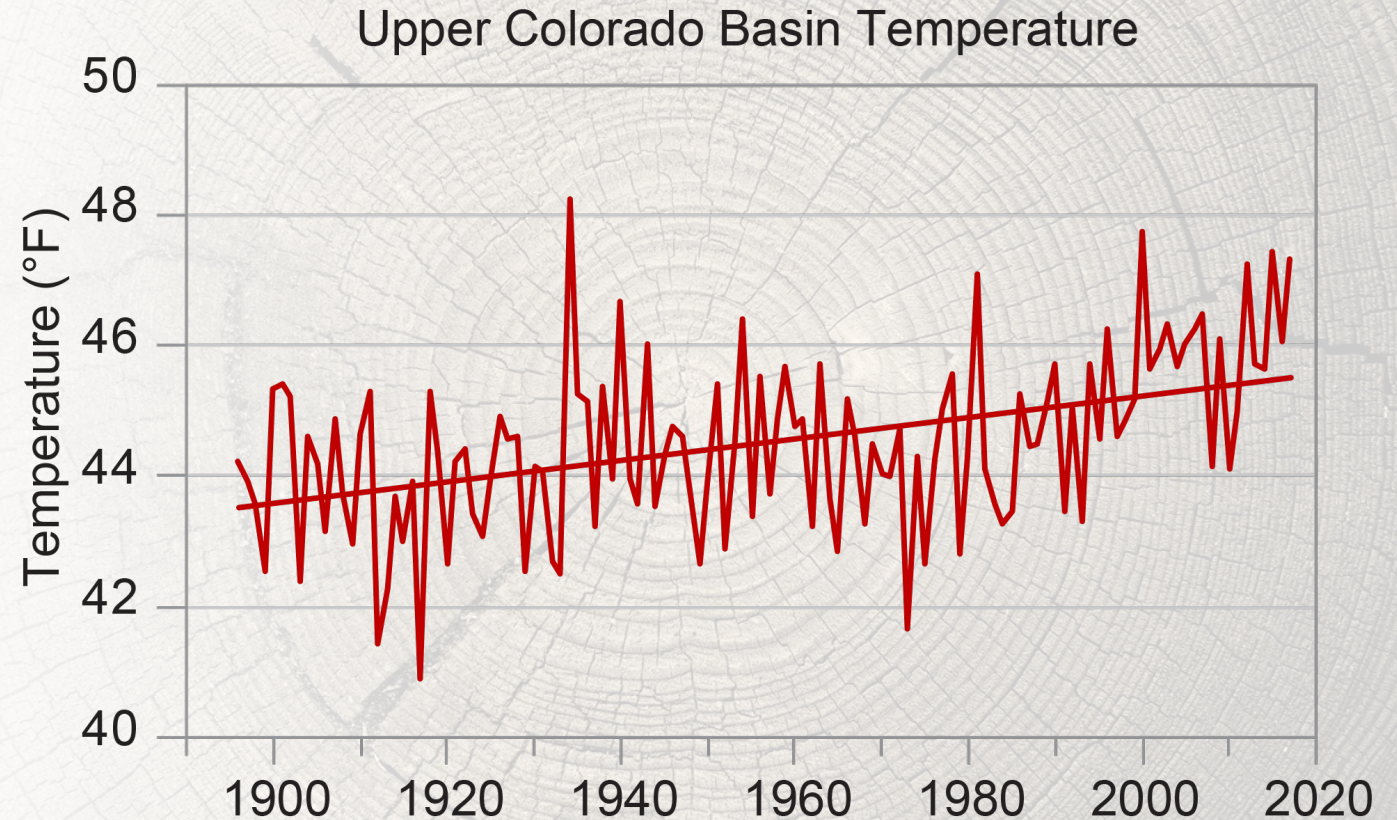


Data: CDC via NOAA

# Climate Change and Drought

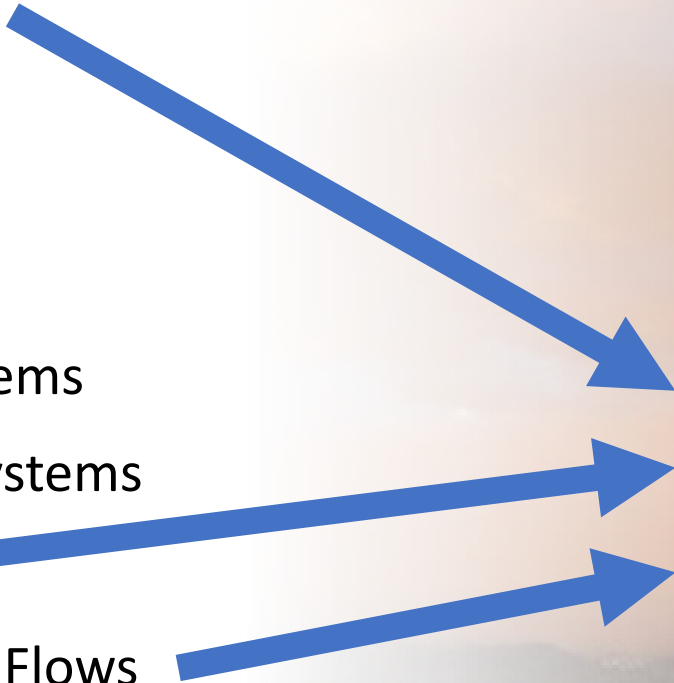
- Aridification and drought observations and models
- Decision making with uncertainty
- Monitoring, analysis, and prediction of changes
- USGS Ecosystems and Core Science Systems Mission Areas, Regional Climate Adaptation Science Centers, Geosciences and Environmental Change Science Center, Earth Resources Observation and Science (EROS), and Geology, Minerals, Energy, and Geophysics Science Center

Since 2000, **drought was intensified by long-term trends of higher temperatures** due to climate change.<sup>1</sup>



# The Environment

- Climate Change
- Snowpack
- Water Budgets
- Water Quality
- Aquatic Ecosystems
- Terrestrial Ecosystems
- Wildfire
- Post Fire Debris Flows
- Environmental Health
- Energy and Mineral Resources



**The Cascade**

# Wildfires

- Wildfire risk increasing and burn severity
- Fire potential and prediction
- Mitigation and remediation
- Capital accounting and ecosystem services
- USGS Ecosystems Mission Area, Wildland Fire Program and Interagency Community of Practice, Geosciences and Environmental Change Science Center

April relative humidity was the most important covariate in providing **insight to the climate suitability of large wildfires** in Colorado and Wyoming.<sup>8</sup>

# Post-Fire Debris Flows

- Landslides and debris flows
- Post-fire impacts
- Water quality impacts
- Soil property changes
- Revegetation limitations
- Infrastructure risk
- Post-fire recovery
- USGS Natural Hazards and Water Mission Areas, Geologic Hazards Science Center, Geosciences and Environmental Change Science Center

In New Mexico, fire-climate relationships have been **informed by tree-ring data that extend centuries prior** to the onset of fire exclusion in the late 1800s.<sup>9</sup>



# Data and Information Analysis, Interpretation and Synthesis

- Working with federal, state, and local partners
- Delivering actionable science at appropriate time and space scales
- Advanced technology applications (e.g. high performance computing, artificial intelligence, machine learning, etc.)
- USGS Core Science Systems Mission Area, Community for Data Integration, and USGS Office of the Associate Chief Information Officer

**80% of a scientist's effort is spent discovering, acquiring, documenting, transforming, and integrating data, whereas only 20% of the effort is devoted to analysis, visualization, and making new discoveries.**<sup>12</sup>

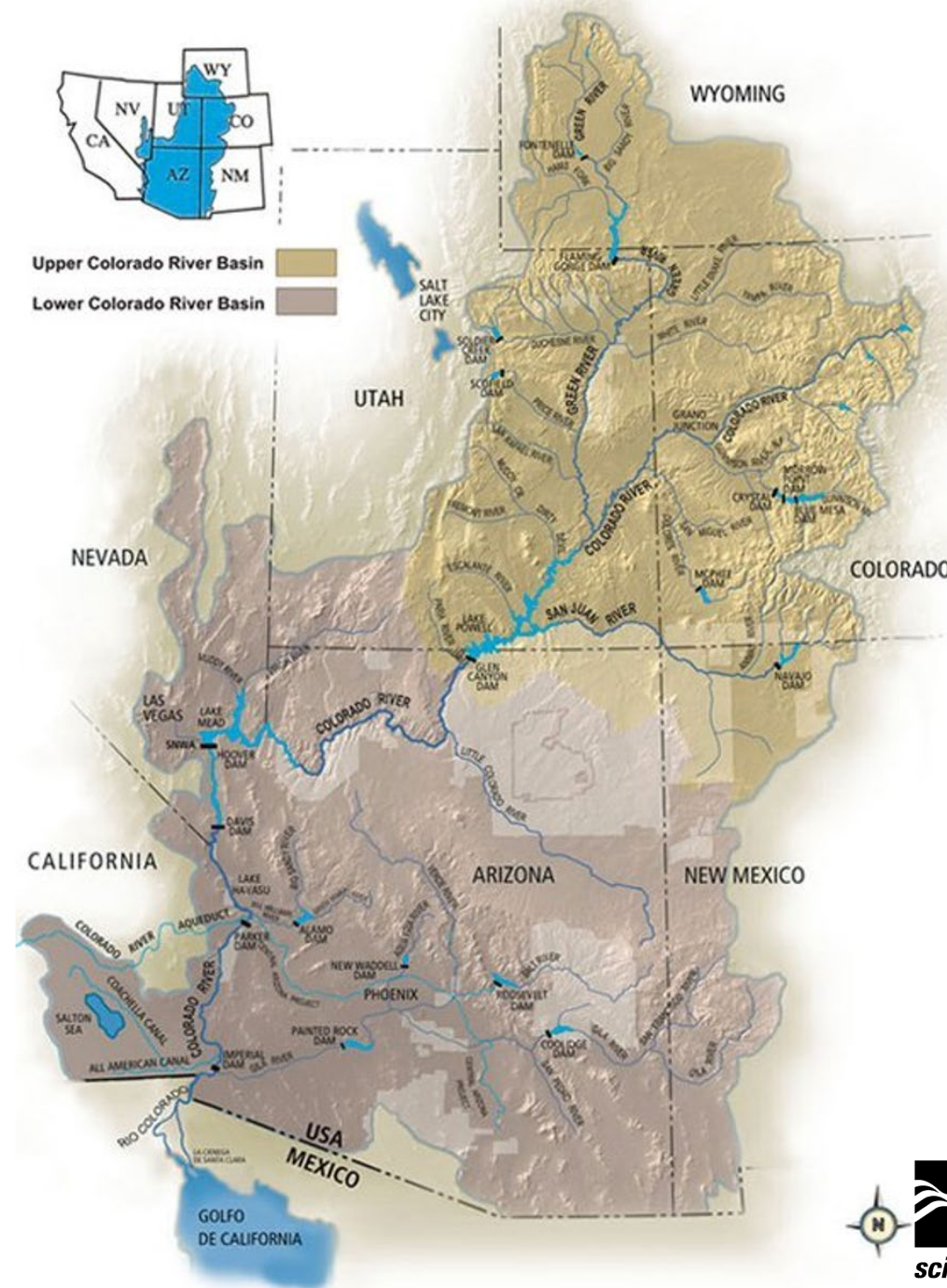
# Grand Challenges

Prolonged Drought → Cascading Impacts

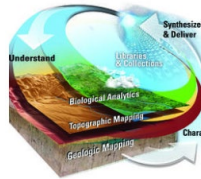
- Water availability & use
- Habitat quality, species loss
- Agricultural production
- Cultural resources
- Recreation opportunities

## Complex Management Challenges

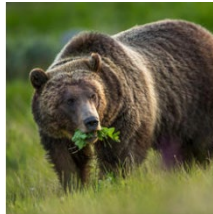
- Multiple states, agencies & Tribes
- International boundaries agreements
- Human and natural systems
- Shifting baselines



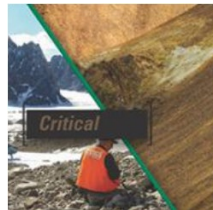
# USGS Science Resources



**Core Science Systems:** High quality maps and satellite remote sensing information of land conditions



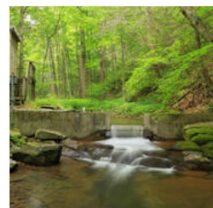
**Ecosystems:** Climate, drought, land use change, and environmental health research in freshwater, terrestrial and marine ecosystems



**Energy and Minerals:** Economic and environmental effects of resource extraction and use

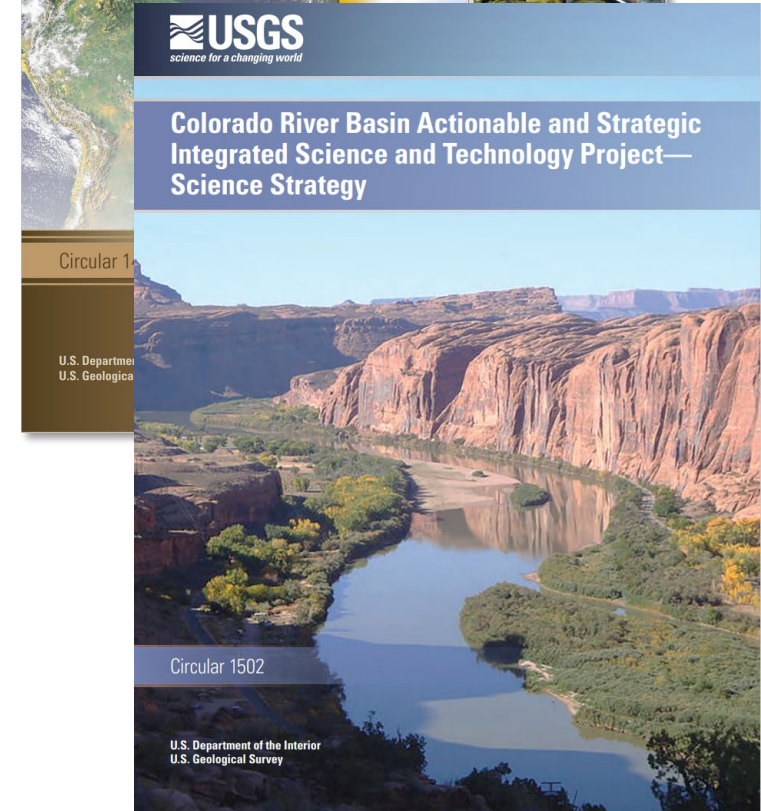


**Natural Hazards:** Monitoring and assessment of cascading social, ecological, and economic consequences of natural disasters



**Water Resources:** Information on drought impacts to groundwater, surface water resources, and water quality

<https://www.usgs.gov/science/mission-areas>



# Actionable and Strategic Integrated Science and Technology (ASIST)

Landscape scale effort to accelerate interdisciplinary science and application of advanced information management technology for complex stakeholder driven challenges



# USGS Actionable and Strategic Integrated Science and Technology (ASIST) Initiative



USGS science for specific management decisions, objectives, partners, disciplines, and scales

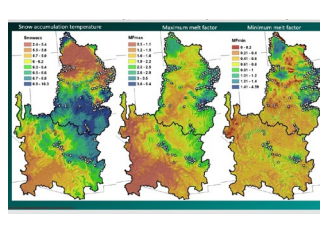
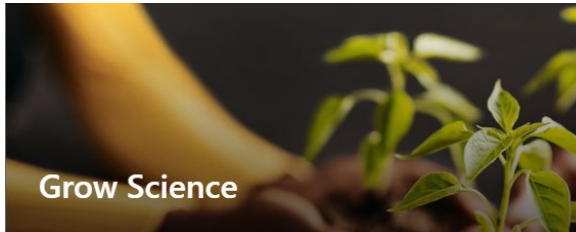
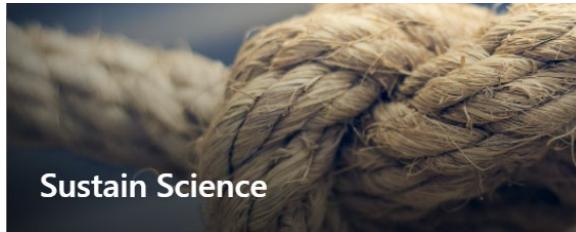
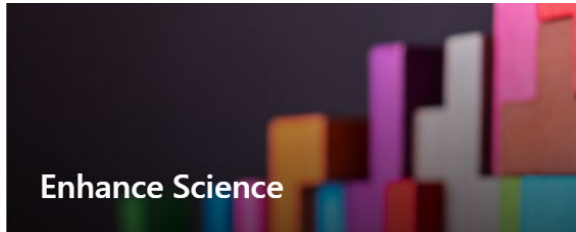
ASIST is exploring opportunities to support the space in between existing efforts

ASIST science and technology framework focuses on connecting programs, partners, and projects

Outcomes focused on landscape level integrated science and USGS-wide science delivery for partners

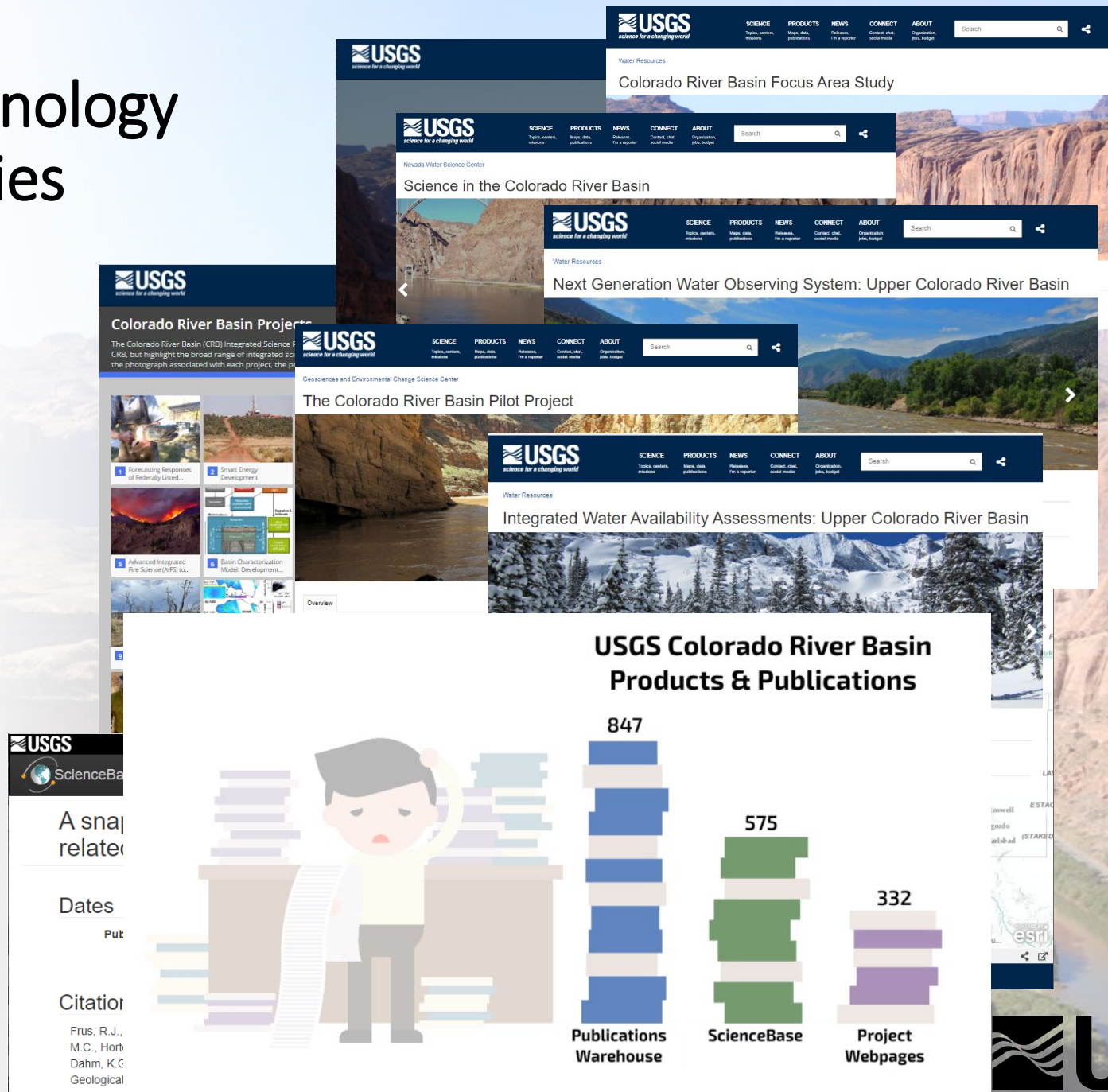
# Supporting Partners, Projects, and Programs

Structured collaboration space for partners, scientists, and technology specialists to co-develop and connect projects to improve science in the Colorado River Basin through collaboration.

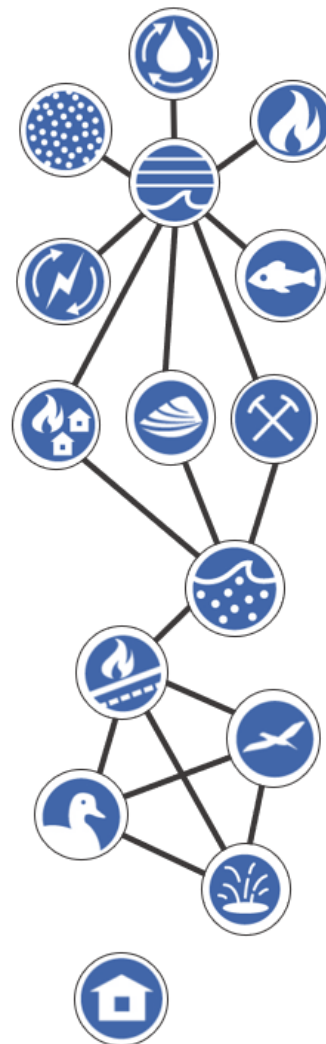
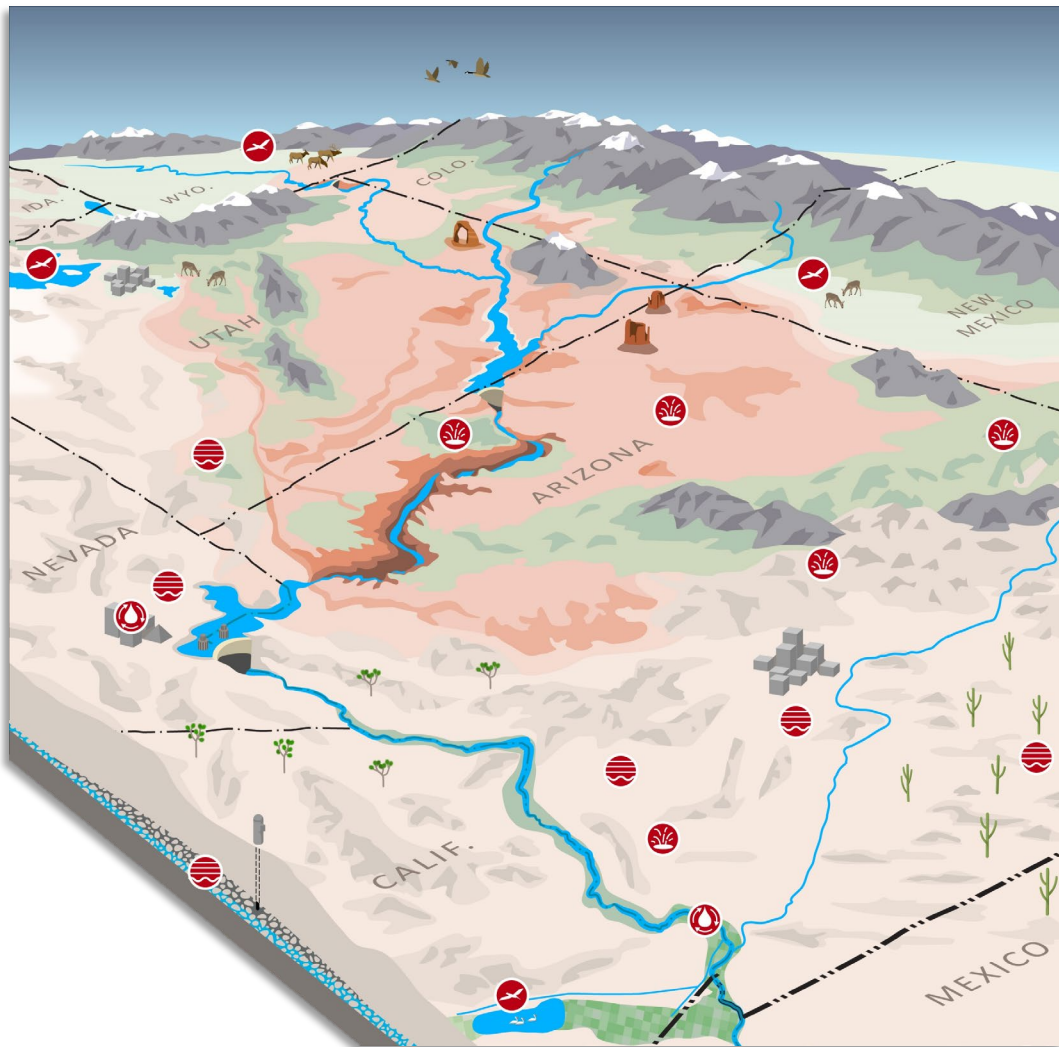


# USGS Science and Technology Integration Opportunities

- Integration of monitoring and observation systems
- Analysis-ready data to support integrated applications
- Establish integrated model connections across science disciplines
- Multidisciplinary coordination to synthesize interpretations
- Utilize whole USGS organization knowledge base



# Science Co-Production Partnerships



Where is drought impacting the landscape?

What factors multiply the risk of this hazard impacting my community?

How do I connect with other organizations with similar challenges?

Who is left out of science conversations in my community?



# Building on Existing Partnerships

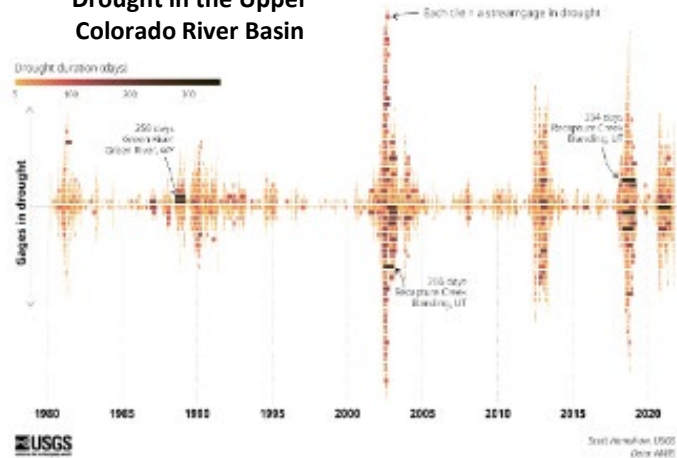
- Snapshot of Stakeholder Science Needs
- USGS Science and Technology Collaboration Meetings
- Conferences and Meetings
- Listening Sessions
- One-on-one Discussions
- Basin-wide Partnerships
- ASIST-ed Projects
- Priorities for Science Delivery



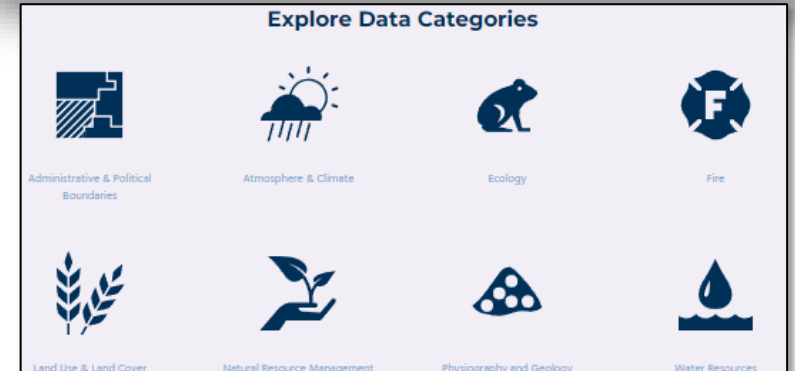
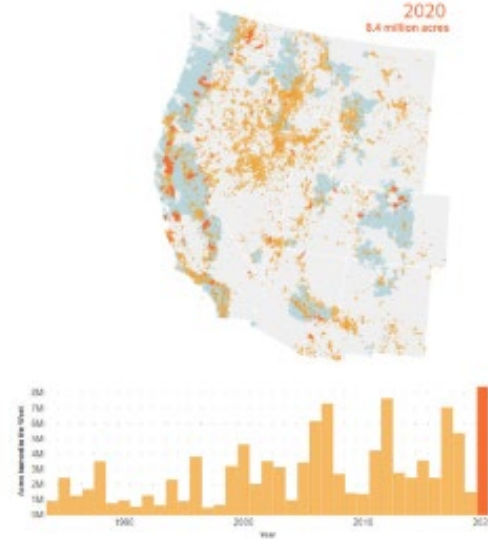
# Connecting Science to Help Mitigate Drought

- Science Interpretation, Synthesis, and Story Telling
- Platforms Supporting Communities and Two-way Communications
- Timely, Findable, and Accessible Science Delivery

40+ Years of Streamflow Drought in the Upper Colorado River Basin



Wildfire Threats to US Water Supply



# Initial Portal Content: Communities

[Home](#) [Data Catalog](#) [Communities-](#) [Events](#) [Get Involved](#) [About USGS Integrated Science](#)

## Drought Science for Indigenous Communities

This community is designed to support engagement with indigenous communities on science issues related to the Colorado River Basin. We are excited to use new tools such as this platform to promote dialog and co-design of science for Tribal natural resource management needs. The content of this Community will be driven by its members, so we hope to participate with you in development of information, tools, and training to meet your objectives.

This platform and the community are committed to Findability, Accessibility, Interoperability, and Reuse (FAIR) as well as Collective benefit, Authority to control, Responsibility, and Ethics (CARE) data principles. While our US Geological Survey Fundamental Science Practices that govern our unbiased, objective and impartial scientific information products require us to make available to all information we collect and manage publicly accessible, we are looking forward to using this platform to allow Indigenous data to remain controlled and solely owned by Tribes in order to fulfill our Federal Indian Trust Responsibility.

## Different Ways To Engage

1

### Explore

Learn more about USGS science in the Colorado River Basin and discover new communities to help tackle local environmental challenges.

2

### Find Data/Tools

Search for data and tools within your community, or across all Colorado River Basin communities.

[Search All Data](#)

3

### Discuss

Start Discussions—focused, private conversations around community content.

[Learn More](#)

4

### Collaborate

Add your own content, invite collaborators, and share only with your trusted community members.

## Partnerships

### Tracking the Source of Metals to the San Juan River

The Navajo Nation Environmental Protection Agency (NNEPA) regularly tests surface water within their territory and has identified elements exceeding NNEPA surface water standards. These concerning constituents can pose risks in elevated concentrations and must be monitored in the environment. Notably, the San Juan River has shown elevated levels of certain metals, including arsenic, lead, and aluminum, which may originate from natural sources or human activities, impacting the well-being of people, plants, and animals. Identifying the individual contributions of these sources and their relative impacts on San Juan River water quality is vital for safeguarding human health and the environment along the river. The USGS collaborates with NNEPA to pinpoint sources of metals and trace elements entering the San Juan River from its tributaries within the Navajo Nation's jurisdiction. This ongoing three-year project initiated in spring 2021 aims to determine where concentrations of metals exceed safe surface water standards by examining the chemical characteristics of water in major tributaries of the San Juan River.

[Project Info](#)



### Tribal Workshop of bat monitoring

The Southwest Native American Workshop on Bats took place in Albuquerque in 2018 and 2022, in collaboration with the Bureau of Indian Affairs (BIA) and Isleta Pueblo. The workshop in 2022 also included a partnership with the Bureau of Indian Education-Southwestern Indian Polytechnic Institute (SIPI) to hold the workshop on the college campus. Both workshops were dedicated to tribal biologists, resource managers, and college-level students from SIPI and other colleges with indigenous students. These workshops were free of charge and featured expert speakers covering various bat-related topics. In addition to imparting technical skills for identifying and managing bat threats on tribal lands, the workshops addressed the connection between bat population decline due to these threats and the loss of traditional ecological knowledge (TEK) among indigenous people in the Southwest. Attendees from more than 10 tribes across multiple states participated in each workshop. There were presentations by bat experts representing various organizations, both governmental and non-governmental. Field trips to the Pueblo of Santa Ana were also offered for hands-on bat methodology demonstrations. These workshops fostered dialogue and potential collaborations between tribal lands and governmental and non-governmental entities.

[Project Info](#)

### Cultural Site Monitoring Along the Colorado River in Grand Canyon

For more than a decade, USGS Grand Canyon Monitoring and Research Center scientists have been studying and monitoring the effects of Glen Canyon Dam operations on Native American archaeological sites and the broader terrestrial landscape along the Colorado River in Grand Canyon. This monitoring approach was originally designed to be responsive to concerns raised by tribal stakeholders within the Glen Canyon Dam Adaptive Management Program (GCDAMP), including the Hopi, Hualapai, Navajo, Kaibab Southern Paiute, and Zuni tribes. Considering these tribal perspectives, we developed a monitoring program for cultural sites primarily using remote sensing methods like terrestrial lidar surveys, photogrammetry, and automated weather stations. To further explore the role of dam operations in shaping archaeological site conditions, we're currently collaborating with the National Park Service and tribal members of the Ancestral Lands Conservation Corps. Together, we're experimenting with the removal of riparian vegetation in selected areas and monitoring changes downward.

[Project Info](#)



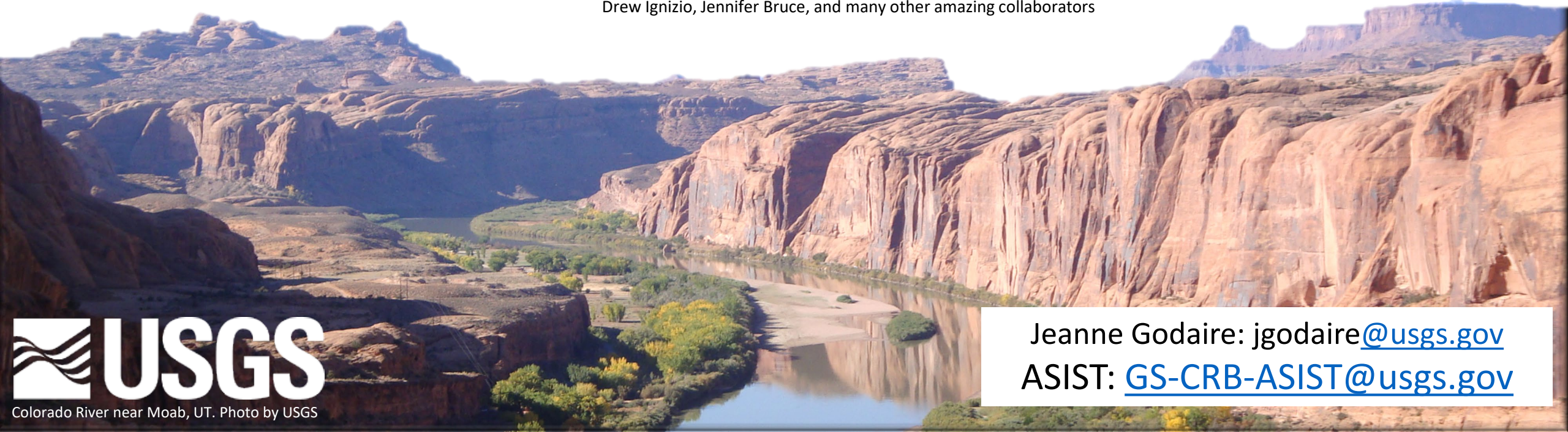
Welcome back to the Indigenous Community

[View Content](#)

# Actionable & Strategic Integrated Science & Technology



Not pictured: Jessica Driscoll, Jill Cress, Jeanne Godaire, Jeremy Havens, Amber Hari, Pam Nagler, Ken Bagstad, Olivia Miller, Drew Ignizio, Jennifer Bruce, and many other amazing collaborators



Colorado River near Moab, UT. Photo by USGS

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# Thank you!

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