



2022 Annual Report

Western Water Application Office

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2022 was WWAO's sixth year of operation. As we continued to forge partnerships, build solutions, and extend the reach of NASA data, the world around us underscored more than ever the need for scientists and decision makers to come together to solve pressing environmental issues. Amidst the thirst for improved water management, for new insights driven by remotely-sensed data, and for innovative collaborations, WWAO works to make a difference.

Water is becoming increasingly scarce. The year was marked by the worst megadrought in 1,200 years playing out across vast swathes of the Western U.S. 2022 tied with 2015 as the fifth warmest year on record, according to NASA analysis. In arid Western states, as the climate grows warmer and drier, the demand for water is increasing – from both humans and ecosystems – posing unprecedented challenges to those who manage water.

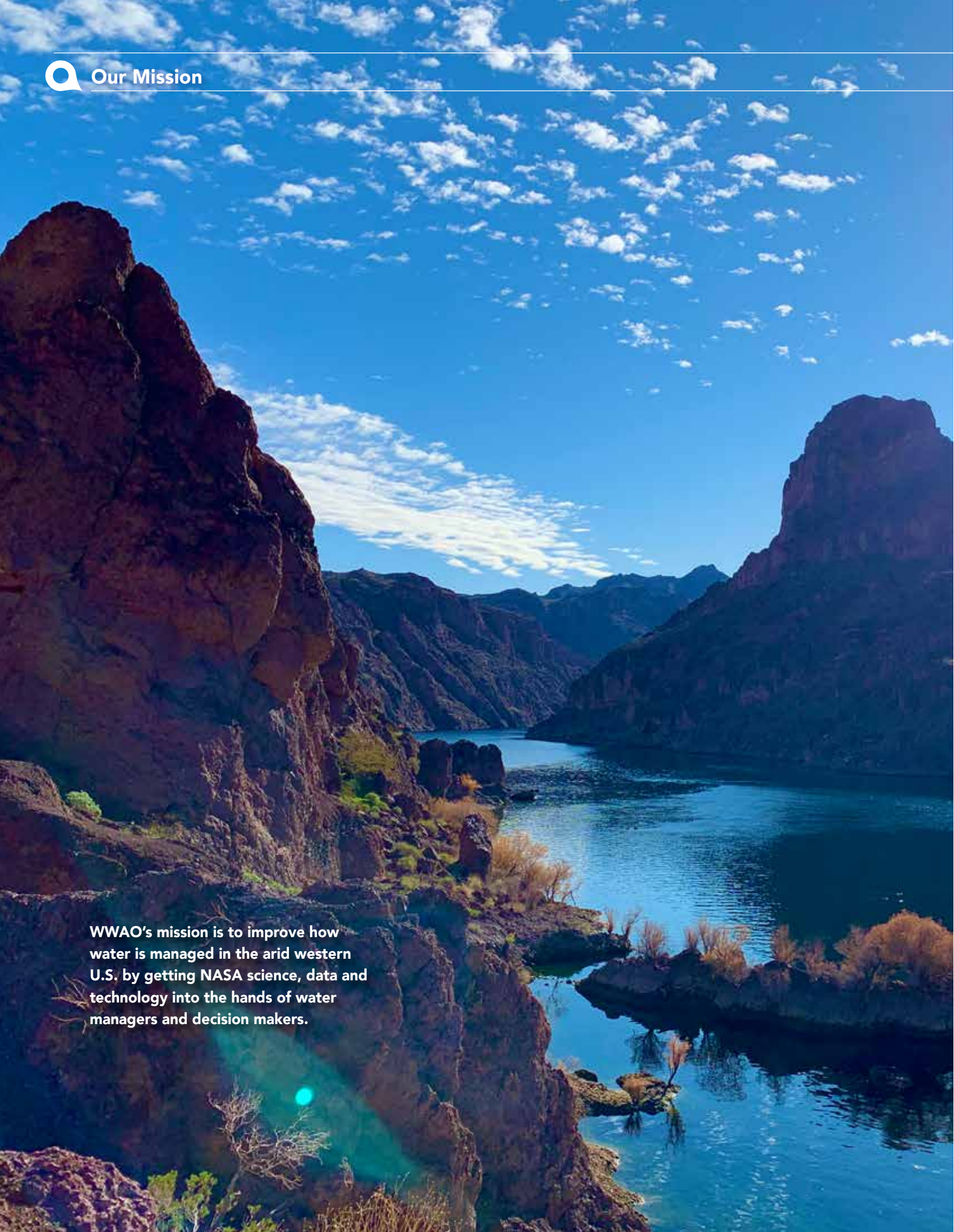
The drought conditions of 2022 saw Western reservoirs reach critically low levels. Yet in the same year, parts of the West and Midwest witnessed record rains that delivered flash floods and landslides. Increasingly the story we hear is one of whiplash weather – extremes of drought and deluge – that signifies the new climate era in which we live.

Adapting to a changing climate means building resilience, and NASA has tools to help. This includes gauging the water in snowpack and under the ground; helping food producers improve how we use water to grow food in the face of a dwindling supply; working with decision makers to strengthen our drought responses; and setting out roadmaps for how environmental research and stewardship can come together on the national level.

We are better together, with a diverse range of voices. I'm grateful to everyone WWAO works with – water managers, scientists, decision makers, technologists and more – for their dedication to finding ways to improve the way we manage water, one of the most precious resources we have.



Indrani Graczyk
Western Water Applications Office Director,
February 2023



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The Western U.S. faces growing water challenges, mostly related to increasing demand, unpredictable supply in the face of climate change, and ageing infrastructure. The region is generally defined as the part of the U.S. west of the 100th meridian. NASA has been partnering with Western water agencies for decades, and WWAO was set up to continue that work.

Our program involves three main thrusts:

- identify water decisions in the west where NASA's unique capabilities can have an impact
- connect NASA's science and technology to water organizations through new projects and initiatives
- transition water tools and data to decision makers to infuse into their operations over the long-term

2022

>IDENTIFY

water decisions in the west where NASA's unique capabilities can have an impact.

- 3 Major Basin Needs Assessment Workshops Completed
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- 35+ Use Cases Documented
- 120+ Participants in Workshops / Surveys

>CONNECT

NASA's science and technology to water organizations through new projects and initiatives.

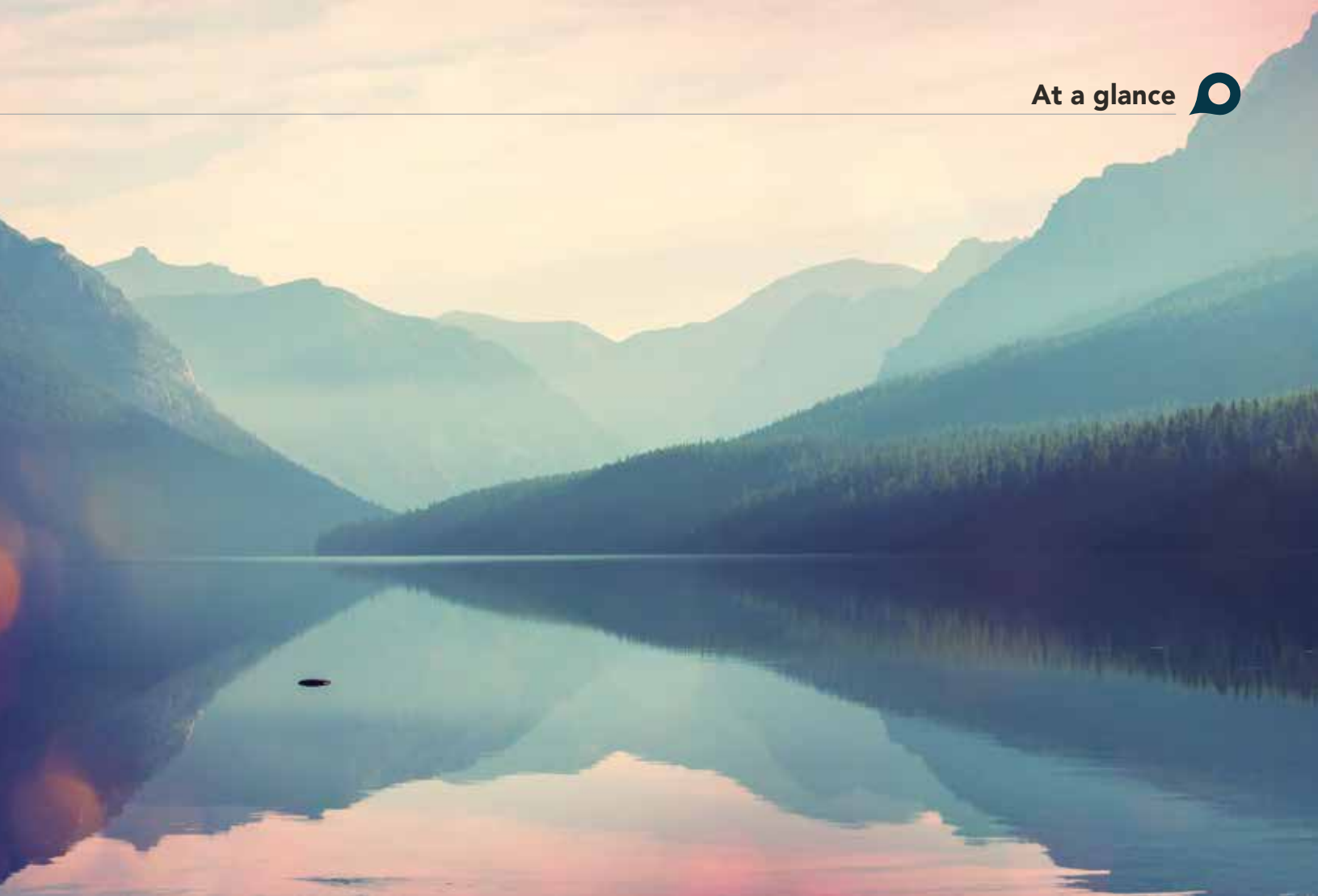
- 4 Award Rounds
- 8 Completed Projects
- 10 Active Projects
- 11 Project Partner
- 4 Impact Assessments Underway

>TRANSITION

water tools and data to decision makers to infuse into their operations over the long-term.

- 3 Capabilities Transitioned
- 1 New Company Formed
- 1 Research to Operations Workshop
- 1 Research to Operations Paper





WWAO continued to expand its reach in the Western U.S. Our water projects in the Columbia River Basin, led by stakeholders from Idaho, Oregon and Washington continued to deliver insights and data that can help water managers. With eight completed projects and ten active projects as of 2022, WWAO identified promising synergies and connections between water solutions across river basins in the West.

WWAO completed its third major Needs Assessment Workshop in the Rio Grande River Basin. The program continued to focus on building pathways to sustainability for several of its water applications and tools. WWAO led the publication of a Research to Operations best practices paper, working in tandem with the Western States Water Council, Environmental Protection Agency, and Airborne Snow Observatories, Inc. NASA gained representation on the Water Subcabinet, which works to improve water infrastructure and access to water supplies across the U.S., thanks in part to WWAO's efforts. With WWAO's support, NASA embarked on an exciting new National Space Council study to measure the economic value of using Earth Observing data in water management.

Our focus on Science to Action continued through discussions with the private sector, partnerships with key federal, state and local players, and by leading technical water sessions at science meetings such as the American Geophysical Union's Fall Meeting.

"Partnerships take time to establish and nurture ... and should begin with the belief that an important need can best be fulfilled through partnership."

– Brian O’Neill, Former Superintendent,
Golden Gate National Park, CA

Partnerships are at the heart of what WWAO does. They help us to build an understanding of water issues in the Western U.S.; to identify critical gaps in information and decision-support tools that, if filled, would offer value to water managers; and to co-develop solutions with stakeholders.

WWAO continued to grow and sustain relationships with water players at national, state, tribal and local levels including:

- State and federal entities with mandates in water management
- Boundary organizations
- Academia
- NGOs
- The private sector.

RIO GRANDE NEEDS ASSESMENT

WWAO completed its third Needs Assessment focused on the Rio Grande River Basin. More than 40 percent of the Rio Grande watershed experienced exceptional drought in early summer 2022, and the Rio Grande River, which provides water for 6 million people and irrigates 2 million acres of land, has been taxed by recent heat waves and continued water demands.

WWAO's three-day virtual workshop brought together federal, state, local and tribal stakeholders to dig into the water issues facing the region, prioritize them, and develop use cases that can help form subsequent water projects, which were published in our latest Needs report.

Stakeholders talked, and we listened. Key takeaways included the need for more data, monitoring and analysis; better forecasting of streamflow; improved access to computational modeling outputs; and the importance of collaboration across the entire basin.

Rapid Needs Assessment

- Western U.S.
- 2 Categories
- 8 Use Cases
- 4 Project

Colorado River Basin

- 7 States
- 8 Categories
- 14 Use Cases
- 2 Projects

Columbia River Basin

- 3 States
- 4 Categories
- 13 Use Cases
- 6 Projects

Rio Grande River Basin

- 3 States
- 4 Categories
- 12 Use Cases
- Projects TBD

Needs Assessments
Completed
2022



Snow

Communities in the American West rely on snowpack from nearby mountains as an important source of water. For those who get their water from runoff from melting snow, snowpack monitoring is drought monitoring.

In California, while the water year got off to a promising start in late 2021 with heavy rains, 2022 began with the driest January and February in recorded history for the watersheds that provide much of the state's water supply. Knowing how much water from snowpack will be available is critical for water managers. NASA satellite data and remote-sensing technology are helping.

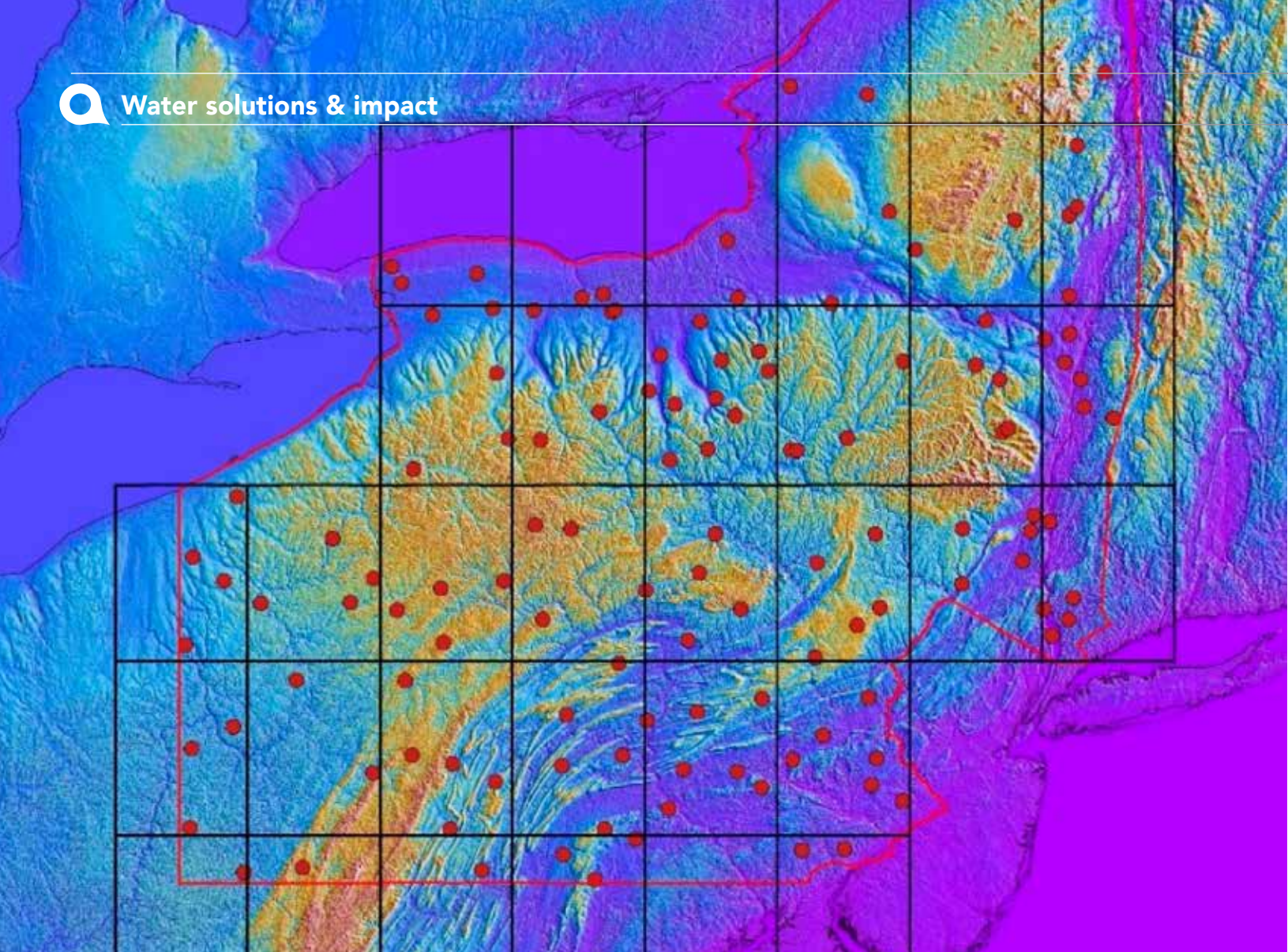
NASA's Airborne Snow Observatory (ASO), which uses airborne sensors to measure water in snowpack, was spun off into a private public-benefit company that is working with the U.S. Bureau of Reclamation – the largest wholesaler of water in the country – as well as California and Colorado to improve their water-supply forecasts. WWAO helped support ASO's work prior to its spin-off, and is continuing to work with the Natural Resources Conservation Service to integrate NASA satellite data into its river prediction and forecasting system.

Drought

In the face of climate change, better drought information is needed across the Western U.S. WWAO's Navajo Nation Drought Severity Evaluation Tool (DSET) continued to gain traction as a key tool for drought and land management. In 2022, DSET was featured on drought.gov and the USDA Southwest Climate Hub as part of its path to engage water managers and the community.

WWAO continued its project with the Colorado Climate Center to build a Western Land Data Assimilation System (WLDAS) that will feed finer-grained drought data into the Center's critical weekly drought reports, which is due to come to a close in 2023. The Center is now using WLDAS-provided groundwater estimates for improved drought reporting.





VIRGO GROUNDWATER TOOL

In 2022, WWAO collaborated on the launch of NASA's new California groundwater tool, which is slated to go live in 2023. VIRGO (Visualization of In-situ and Remotely-Sensed Groundwater Observations) is a new online mapping tool that enables water managers and end-users to explore groundwater changes in California.

The interface visualizes data from a variety of sources – in-situ wells and GPS stations as well as remotely-sensed gravity and InSAR (interferometric synthetic aperture radar) data, enabling groundwater trends to be assessed. By bringing together both satellite and in-situ data, VIRGO offers deeper context to NASA's data and reveals the impact of changing groundwater levels within Groundwater Sustainability Agencies. The tool is the fruit of a collaboration between the U.S. Geological Service, California Department of Water Resources, NASA's Jet Propulsion Laboratory, and the University of Washington.

Water for Food

Hundreds of ranches and producers are enrolled to use the tool. In 2021 (impact data collected in 2022), thousands of irrigation recommendations were made using the app, with nearly 21,000 acres of land impacted, leading to thousands of acre-feet in water savings per year. The SIMS-CropManage team has actively engaged new partners, held many new trainings, and delivered an estimated 20 percent in water savings for users in the Salinas Valley, one of the most productive agricultural regions in California. The tool's uptake is expected to grow over the next five years and beyond, as California's Sustainable Groundwater Management Act is fully implemented. The team is also looking into expanding SIMS-CropManage to Oregon and Washington in the near future, with the help of the OpenET platform.

SIMS-CROPMANAGE IRRIGATION APP >

CropManage is a free, online tool operated by the University of California Cooperative Extension that supports on-farm irrigation scheduling and fertilizer application decisions. With WWAO's support, satellite data have been folded into CropManage (SIMS-CropManage), leading to major water savings and improvements in understanding of crop health.

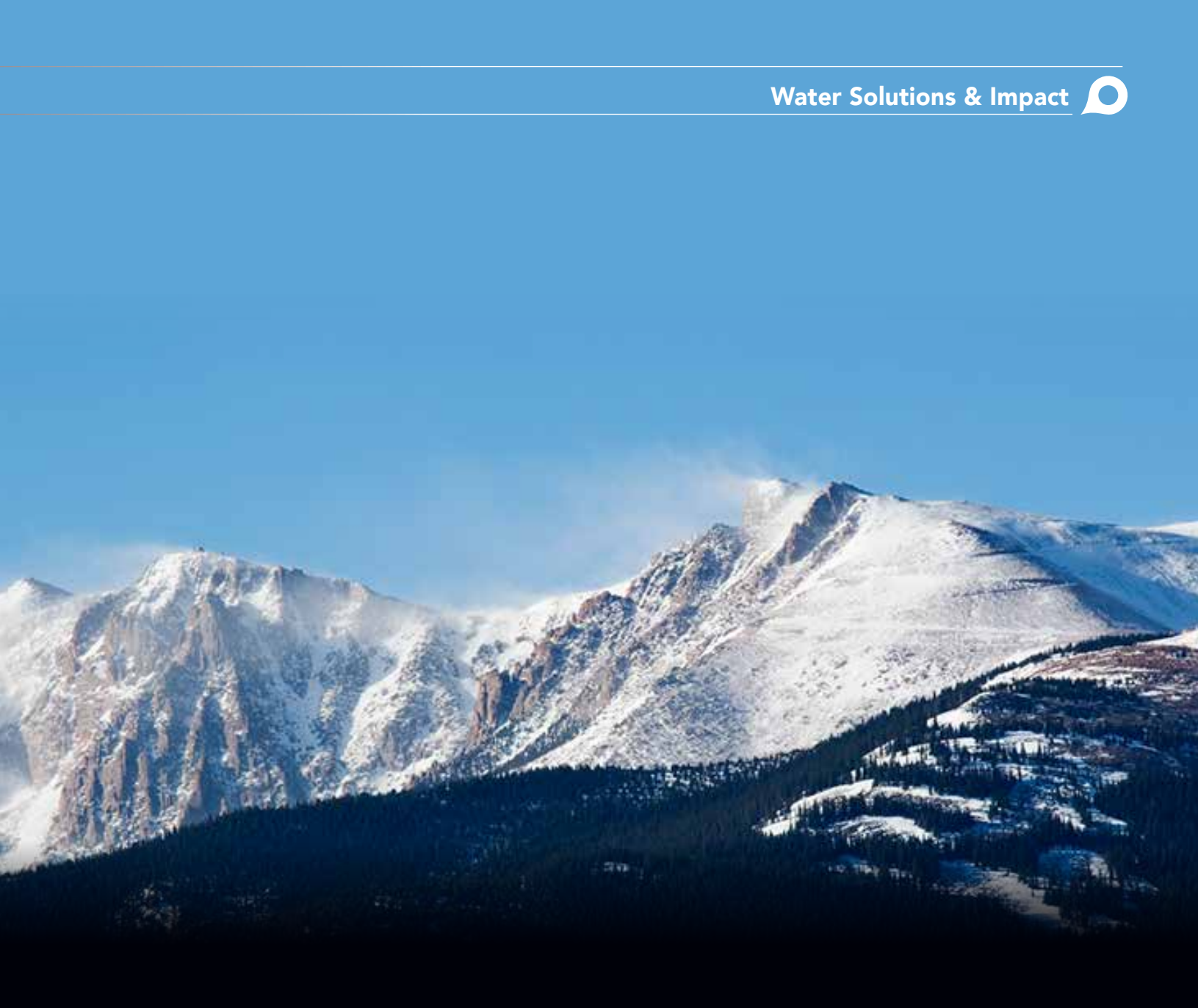


Evapotranspiration (ET)

WWAO investments in the Pacific Northwest began to deliver key impacts. Data quantifying water use through ET on irrigated lands across the Columbia River Basin are now available via a readily accessible ET Mapping Tool, with the opportunity to sustain this impact into the foreseeable future. The effort – led by the Oregon Water Resources Department, Desert Research Institute, Idaho Department of Water Resources, and Washington Department of Ecology – aims to improve water management in the Columbia River Basin by creating consistent, accepted, and readily available watershed-scale summaries of ET and irrigated lands.

As 2022 ended, the ET data were integrated into the Oregon Data Explorer, and will be maintained long-term by the Institute for Natural Resources and Oregon State University.

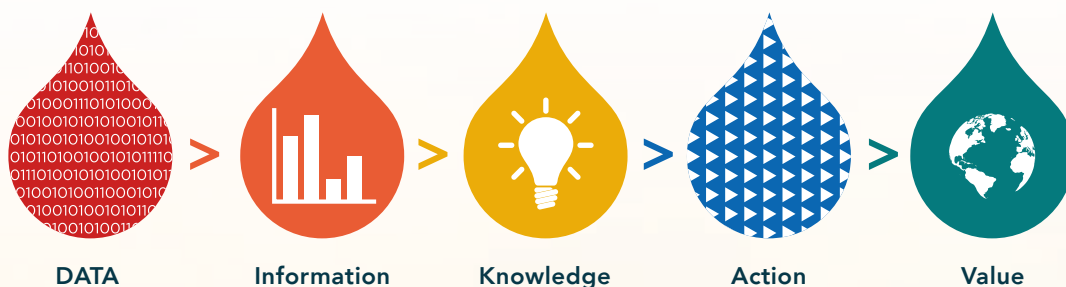




CONSUMPTIVE USE IN THE UPPER COLORADO

In 2022, this WWAO project continued to work with the U.S. Bureau of Reclamation (USBR) to evaluate the use of additional ET models for quantifying consumptive water use over irrigated agriculture in the Upper Colorado River Basin. Historically the modified Blaney-Criddle approach has been used, but estimates are inconsistent.

As a result of the water shortage declaration for the Colorado River in 2022, USBR requested a summary of results to date, in collaboration with the Desert Research Institute and the OpenET project. The team provided a summary to USBR of results from comparing six ET models against flux towers within the Upper Colorado River Basin. The results were included in USBR's report to the Upper Colorado River Commission, and the Commission's resolution adopted the use of satellite-based ET (eeMETRIC in 2022) for reporting consumptive water uses and losses – ultimately improving how all four Upper Colorado Basin States and the USBR account for water.

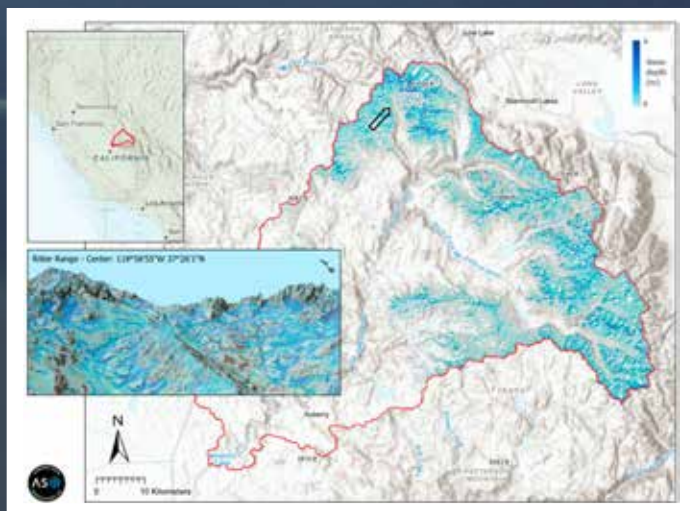


VALUE OF EARTH OBSERVATIONS

In 2022, WWAO supported NASA's new study to assess the value of Earth observations from space. The effort is undertaking an analysis of the economic value derived from NASA and NOAA Earth observation data used to support freshwater applications. The study follows an "information value chain" approach, recognizing the various stages that occur between data being disseminated and subsequently generating value. Phase 1, which was completed in 2022, identified case studies that will be quantitatively analyzed in Phase 2 in 2023. The effort is being conducted by RTI International and supported by the National Space Council and NASA.

RESEARCH TO OPERATIONS ROADMAP

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WWAO has another busy year ahead in 2023. The program will complete its fourth major water management Needs Assessment – this time in the Missouri River Basin – with an in-person workshop in Nebraska in March. A new cohort of projects is planned for the Rio Grande River Basin, with an open funding opportunity in early 2023 and a focus on co-developing solutions with partners. As the Western U.S. grows drier and hotter, WWAO will continue to support drought initiatives at the national level.

An important thrust for WWAO continues to be advancing the field of Research to Operations (R2O) at the NASA level and beyond. A second R2O workshop is planned for 2023, which will gather together scientists, stakeholders, and data gurus to focus on how to build sustainable Science to Action pathways between scientists and decision makers. WWAO also plans to host an R2O town hall at the American Geophysical Union Fall Meeting in December.

Our partnership building will continue apace, through ongoing stakeholder engagement, new water projects, and the Missouri Needs Assessment. WWAO also plans to expand its Water Alliance of private-sector and non-profit partners with the goal of building lasting, innovative partnerships that can bring NASA capabilities and data to the water community in the Western U.S. Working with Esri, WWAO will update its Water Portal to fold in more of NASA's water portfolio and to add deeper context to, and engagement with, WWAO's insights and mission.

We look forward to what 2023 brings.

