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NEVADA WATER NEWS

NWRRI NEVADA WATER RESOURCES RESEARCH INSTITUTE

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PROJECT SPOTLIGHT

"Development and Enhancement of OpenET Software Tools, Datasets, and Planning"

This project is funded through a USGS Coordination Grant under the Water Resources Research Act Program.

Accurate estimates of both water availability and water use are needed to effectively manage water supplies. The goal of the project "Development and Enhancement of OpenET Software Tools, Datasets, and Planning" is to advance and support evapotranspiration (ET) mapping using models based on remote sensing technology to enhance U.S. Geological Survey (USGS) modeling capabilities to estimate consumptive water use on a national scale. Consumptive use is the portion of water applied through irrigation that is no longer available for reuse, so it does not include water that runs off into a waterway or percolates into the groundwater. Water use maps and data generated using OpenET can help communities manage available water supplies and support agricultural water management and efforts in groundwater sustainability, water conservation, and drought mitigation.

DRI is a key member of the OpenET consortium, which includes leading national and international experts in remote sensing of ET, cloud computing, water policy, and water markets partnered with nationally recognized web development teams and leaders in western agriculture and water management communities. The focus of the project is to further enhance the OpenET platform to improve ET data and data access both now and into the future. DRI researchers are actively collaborating with USGS to address national-scale, satellite-based water use estimation and reporting needs.

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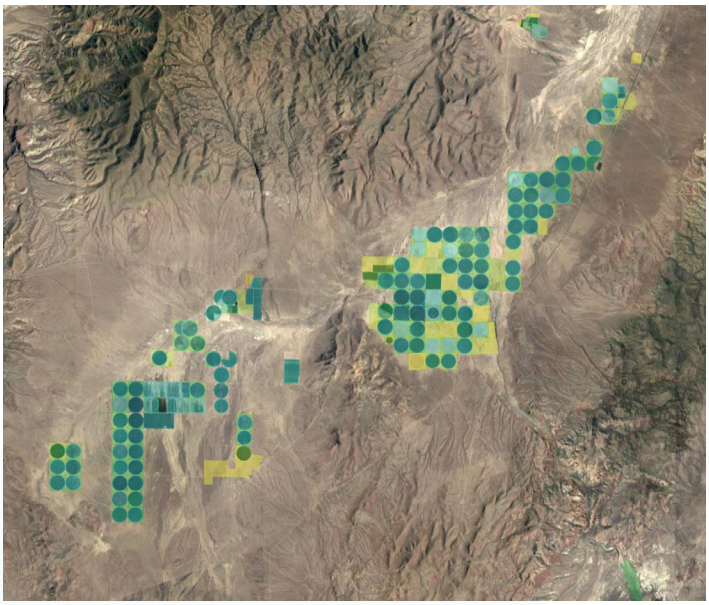
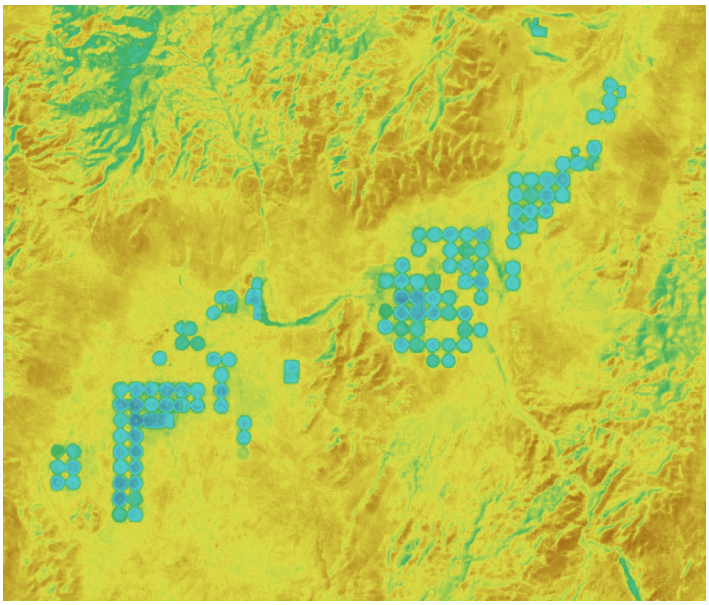
If you have questions about submitting a NWRRI proposal, email Suzanne Hudson at Suzanne.Hudson@dri.edu. Visit the NWRRI website at www.dri.edu/nwrri for current RFP information.





The rates and volumes of water consumption by crops through evapotranspiration (ET) are needed for groundwater modeling and management. OpenET allows users to access satellite-based estimates of consumptive use rates, such as the raster data shown above for agricultural fields in the Middle Reese River Valley in Nevada (blue = high ET) (figures by Jayden Atkin).

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The first phase of the project was to enhance the OpenET operational software and improve how intercomparisons were made. "We developed and documented open software workflows to process new in situ flux tower data, make intercomparisons with OpenET raster (or gridded) data, and enhance existing software to implement new energy balance closure correction approaches," explains Dr. Justin Huntington, the principal investigator of the project. "We also developed water balance and groundwater pumping assessment tools to inform model intercomparisons and groundwater use inventories."

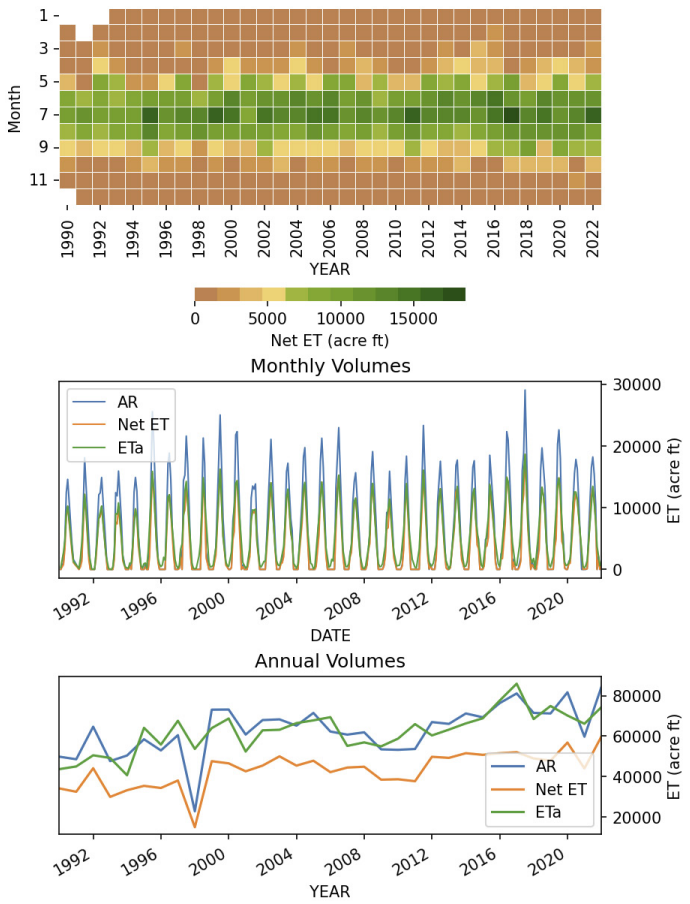
The project team is currently in the process of developing OpenET uncertainty layers using new OpenET data collections and multiple statistical methods, such as the coefficient of variation, identification of models with extreme values, and the three-cornered hat method. "Open-source software is being developed and documented with Google Colab notebooks to visualize and use uncertainty layer information," Huntington says. "We are also advancing the reporting of irrigation water use volumes by comparing multiple irrigated area products, such as LANID, IrrMapper, and others. Comparing classified irrigated areas and ET volumes based on the use of different irrigated area datasets has big implications for reported consumptive use volumes. Through our assessments, we are making recommendations for improvements and next steps for irrigated area mapping and consumptive use volume calculations."

The team is also further developing the OpenET system so that it can provide daily ET summaries for specific watersheds and modeling units. "The quantification

of ET is foundational for quantifying hydrologic budgets, reporting consumptive water use, partitioning surface water and groundwater use, and supporting conceptual and numerical modeling and water management activities at multiple scales," Huntington explains, "because ET is the largest outflow component of the hydrologic budget and the primary determinant of consumptive use and irrigation water requirements for agricultural lands." Calculating field-scale agricultural consumptive use requires information such as satellite and gridded weather data to accurately estimate ET and irrigation water use over large areas. OpenET makes data readily available to USGS and water resource managers for individual fields, which is helpful for determining agricultural consumptive use. OpenET users also have access to gridded data that summarize particular areas of interest, such as watersheds, irrigation districts, or entire states.

Another advancement the researchers developed during this project is automated machine-to-machine data queries for OpenET. The Application Programming Interface (API) allows OpenET users to easily integrate OpenET data into other data and decision support systems. The program also supports data queries for the user's own field boundaries or areas of interest and generates custom data for a specific time period. "The API enables automated and operational use of the data within irrigation scheduling tools, hydrologic models, water accounting or trading platforms, and other farm, ranch, and water management software," Huntington says. "One example is the newly released OpenET Farm and Ranch Management Support (FARMS) tool, which uses the API and makes OpenET data more accessible for the general public."

The team also worked directly with USGS to integrate the OpenET results into the USGS National Hydrologic Model to estimate consumptive water use across the contiguous United States. "This work resulted in numerous data products recently published by USGS, and the peer-reviewed publication being led by USGS with DRI and OpenET colleagues, 'Estimating Irrigation Consumptive use for the Conterminous United States: Coupling Satellite-Sourced Estimates of Actual Evapotranspiration with a National Hydrologic Model' is currently in revision for publication in the *Journal of Hydrology*," Huntington adds.



OpenET data were used to determine the 2012–2023 ET minus precipitation net ET and monthly and annual time series of actual ET (ETa), net ET, and irrigation application rate (AR) for Paradise Valley, Nevada (figure by Peter ReVelle).

The goals of the NWRRI program are to expand our understanding of water and water-related phenomena,

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–JUSTIN HUNTINGTON

and support and sustain Nevada's valuable water resources. The OpenET work addresses those goals through its use in modernizing Nevada's groundwater data by developing a historical groundwater use time series for irrigation water rights. "With advancements in current and future water use estimates that are based on OpenET data, our work is improving assessments of water use and availability, ensuring alignment with current and future water use to promote sustainable water management," Huntington says. "Our progress so far underscores our team's commitment to providing objective and non-biased water resource information, which empowers stakeholders to effectively develop and manage vital water resources in Nevada and beyond."

A key component of the NWRRI program is to train the next generation of scientist. This project has trained many students and early career scientists, including Jayden Atkin (a current student), Thomas Ott (a former student who is now DRI faculty), John Volk (a postdoc who is now DRI faculty), and Blake Minor (a former student who is now DRI faculty). "All these folks have benefitted greatly by doing scientific research that is very needed and the findings of which can be applied right away," Huntington explains. "Our students have also had opportunities to grow as researchers and give interviews about our project, such as the interview Thomas Ott gave to Fox5 Las Vegas."

OPENET

USGS has published data products from the OpenET project, including:

- Irrigation water use reanalysis for the 2000-20 period by HUC12, month, and year for the conterminous United States (ver. 2.0, September 2024).
- Monthly crop irrigation withdrawals and efficiencies by HUC12 watershed for years 2000–2020 within the conterminous United States (ver. 2.0, September 2024).

Articles about OpenET research have also been published, including:

- An article highlighting the new FARMS tool, "FARMing with Data OpenET Launches New Tool for Farmers and Ranchers".
- A news article featuring an interview with researcher Thomas Ott, "NASA satellites measure groundwater in Nevada, West".

NWRRI UNDERGRAD STUDENT INTERVIEW:

Jayden Atkin

We asked Jayden Atkin, an undergraduate student at UNLV who worked on the NWRRI project "Development and Enhancement of OpenET Software Tools, Datasets, and Planning," about his current studies and plans for the future. Here's what he had to say:

Photo by Jayden Atkin

1) What are you currently studying and what sparked your interest in that field?

I'm currently studying earth and environmental sciences at UNLV and will be attending graduate school at Colorado State University (CSU) next semester to study watershed sciences. What sparked my interest in environmental and watershed sciences was the extended drought and the related demands for clean water, especially in cities like Las Vegas that rely heavily on water treatment facilities.

2) You worked on the NWRRI project "Development and Enhancement of OpenET Software Tools, Datasets, and Planning." What did the project entail and how did you participate?

Part of the NWRRI project that I worked on was digitizing and attributing agricultural field polygons using ArcGIS Pro and QGIS. Most of the polygons of each irrigated field were hand-drawn or reshaped depending on current or historical trends. Remote sensing and various datasets such as the Normalized Difference Vegetation Index (NDVI), Place of Use, and USGS Common Land Unit helped guide and fulfill the project needs. As for attributing the field polygons, each field had to be identified with an irrigation type—such as center pivot, controlled flood, uncontrolled flood, wheel line, and drip irrigation—for each year dating back to 1985. This was achieved by manually going through every polygon and historical image to visually determine the irrigation system in use during that year.

> *"This work has provided me with a stronger knowledge of remote sensing and the applications it can be used for."*
>
> **–JAYDEN ATKIN**

3) What did you learn from your experience on this project? Did you find anything particularly interesting/surprising?

I learned about the different types of irrigation systems and the efficiency of each system with the highest efficiency being the center pivot system with an average of 85%. Something that I found very interesting was the amount of field boundaries throughout Nevada considering it is the driest state in the United States. There are approximately 24,000 field boundaries in Nevada, with Carson Desert having 77,113 acres of irrigated land.

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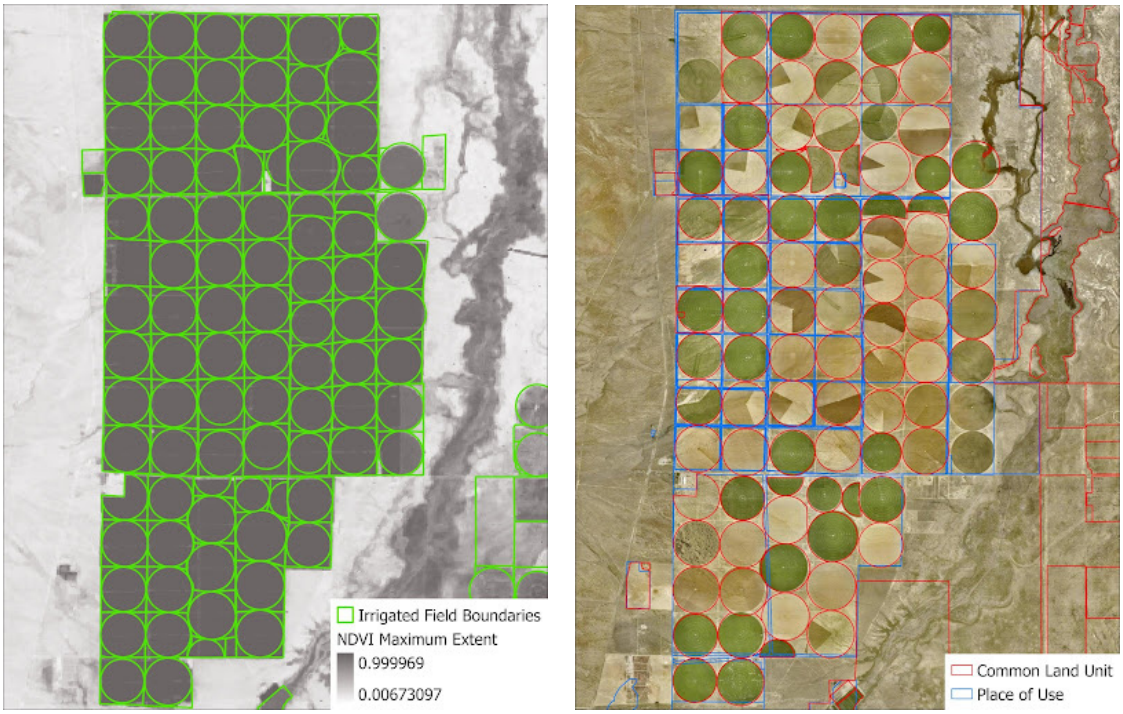

Fields in Paradise Valley, Nevada, that are currently irrigated with central pivot systems (circles) and were historically irrigated with wheel line systems or controlled flooding (squares). (Left) The Google Earth Engine platform was used to analyze the historical (1985-2023) Landsat NDVI maximum for the April–October growing season to verify the configuration of irrigated lands. (Right) Common Land Unit data from USDA (red lines) was compared against place of use data associated with water rights administered by the Nevada Division of Water Resources (blue lines) to develop agricultural field boundaries to be used in OpenET and related research focused on water resources.

4) What do you find most interesting about water resources research, particularly working in an arid/semiarid environment such as Nevada?

I always found the water management of Lake Mead interesting considering it is the primary water source in southern Nevada. With advancements in technology, wastewater treatment facilities have done an excellent job of maintaining and supplying water to Las Vegas.

5) Has working on this project given you any insights into your future studies/research that you may not have had otherwise?

This work has provided me with a stronger knowledge of remote sensing and the applications it can be used for. This knowledge will help me with future research because remote sensing capabilities will only increase.

6) What are some of your goals for the next steps in your studies and career?

I want to continue with my education at CSU focusing on watershed sciences, but I also want to obtain more fieldwork skills that will supplement my computer skills.

7) If you could go on vacation anywhere in the world, where would you want to go, why would you want to go there, and what would you want to do there?

If I could choose to vacation anywhere in the world, I would choose Japan. The people are very friendly, and the public transport is amazing. I would love to visit Mount Fuji and explore the many bustling cities, especially Osaka.

8) What is something that we might not know about you (hobbies, interests, etc.)?

I play both tennis and pickleball competitively!

EVENTS

Please keep an eye on the event websites for changes in conference schedules.

Problematic Contaminant Webinar Series: Microplastics in Groundwater
July 10, 2025; Online
www.ngwa.org/detail/event/2025/07/10/default-calendar/25jul10web

2025 Legislative Updates
July 31, 2025; Virtual
www.nvwra.org/2025-legislative-updates

2025 Floodplain Management Association Annual Conference
September 2–5, 2025; Sacramento, CA
floodplain.org/page/AnnualConference

Chapman Conference: Energy Balance Closure Problem
September 15–19, 2025; Boulder, CO
www.agu.org/chapman-energy-balance-closure

2025 Northern Nevada Dinner Forum
September 16, 2025; Reno, NV
www.nvwra.org/2025nwradinnerforum

2025 Fall Symposium
September 16–17, 2025; Reno, NV
www.nvwra.org/2025-fall-symposium

2025 Tour of the Marlette Water System
September 18, 2025; Carson City, NV
www.nvwra.org/2025-marlette-lake-tour

Viruses and Managed Aquifer Recharge Short Course
September 22, 2025; Denver, CO
www.ngwa.org/detail/event/2025/09/22/default-calendar/25sept22virsc

Managed Aquifer Recharge Conference: Unleashing Resiliency, Protecting Groundwater Quality
September 23–24, 2025; Denver, CO
www.ngwa.org/detail/event/2025/09/23/default-calendar/25Sept5029

National Wetlands Inventory with Lauren Healey
October 15, 2025; Webinar
www.nvwra.org/webinars

GSA Connects 2025
October 19–22, 2025; San Antonio, TX
community.geosociety.org/gsa2025/home

ASA, CSSA, And SSSA Annual Meeting: Where Crop, Agronomic, Environmental, and Soil Sciences Connect
November 9–12, 2025; Salt Lake City, UT
www.sciencesocieties.org/canvas?q=canvas/

AWRA 2025 Annual Water Resources Conference
November 10–12, 2025; Westminster, CO
www.awra.org/Members/Events_and_Education/Events/2025%20Landing%20Pages/01_Annual/Annual2025.aspx

Practical Application and Interpretation of Pumping Tests Short Course
December 8, 2025; New Orleans, LA
www.ngwa.org/detail/event/2025/12/08/default-calendar/25dec8sc

Groundwater Week 2025
December 9–11, 2025; New Orleans, LA
www.ngwa.org/detail/event/2025/12/09/default-calendar/groundwater-week-2025--co-located-with-irrigation-association

AGU25
December 15–19, 2025; New Orleans, LA
www.agu.org/annual-meeting

Lake Powell (photo by DRI Science)

Success and dedication to quality research have established DHS at DRI as the Nevada Water Resources Research Institute (NWRRI) under the Water Resources Research Act of 1984 (as amended). The continuing goals of NWRRI are to develop the water sciences knowledge and expertise that support Nevada's water needs, encourage our nation to manage water more responsibly, and train students to become productive professionals. The work conducted through the NWRRI program is funded through the National Institutes for Water Resources (NIWR), which is supported by the U.S. Geological Survey under Grant/Cooperative Agreement No. G21AP10578. DRI administratively houses and logistically supports the operations of NWRRI.

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