BUREAU OF RECLAMATION

Knowledge Stream

Research and Development Office

Advancing the Use of Artificial Intelligence in Reclamation

U.S. Department of the Interior

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Message from R&D

Welcome to the Fall 2024 issue of the *Knowledge Stream*! In this issue, we highlight activities related to the use of Artificial Intelligence (AI) in carrying out Reclamation's mission. AI is ubiquitous in the mainstream technology discussion – from the latest smartphone to use in big business. Keeping up with this rapidly evolving field and its role for a government agency can be overwhelming. Over the past year there has been a flurry of activity related to the use of AI in the federal government, beginning with the Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence, issued October 30, 2023. Several months later, OMB issued M-24-10: Advancing Governance, Innovation, and Risk Management for Agency Use of Artificial Intelligence. On August 9, 2024, Interior's Chief Information Officer issued a memo titled "Risk Managed Use of Generative AI." Through Reclamation and Interior, there have been multiple training and workshop opportunities to learn more about AI. Efforts to consolidate information on AI policy, tools, and training include a Reclamation SharePoint site and an Interior SharePoint site. We hope that these will provide context and future reference as the AI field continues to evolve and become more integrated in the work we do.

In this issue you'll read about ongoing innovation activities at Reclamation that leverage AI for a range of applications – from more skillful streamflow forecasts to condition monitoring and predictive maintenance for hydropower equipment. We hope you find these articles timely given the current attention to this topic and perhaps serve as inspiration for how AI might have a role in the work you do!

About the *Knowledge Stream*

The *Knowledge Stream*, published by the Bureau of Reclamation's Research and Development Office, is a quarterly magazine bringing mission-critical news about the agency's innovations in the following:

- Science and Technology Program
- Desalination and Water Purification Research Program
- Prize Competitions Program
- Snow Water Supply Forecast Program
- Open Water Data Program
- Reclamation Geographic Information System Program
- Technology Transfer...and more

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Front & Back Cover: Images generated with Google Gemini.

Community Needs

The Current State and Future Directions of Artificial Intelligence in Reclamation

By DOI ChatGPT
https://chatgpt.com/g/g-R099dB6fJ-doi-interior-ai

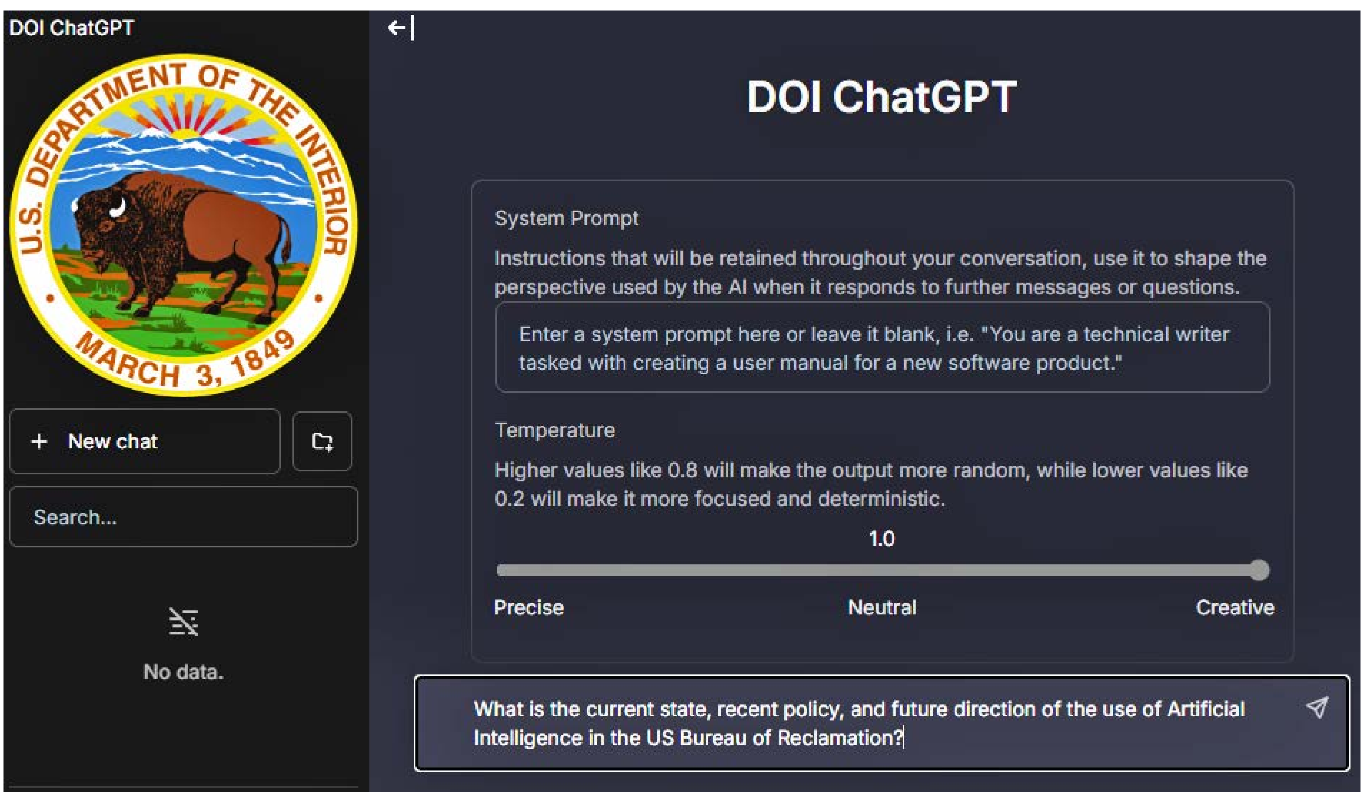
This article was entirely written by DOIChatGPT (https://doichatgpt.doi.net/) to demonstrate the capabilities of generative Artificial Intelligence (AI) for information summarization and content development.

The Bureau of Reclamation (Reclamation) has recognized the transformative potential of AI in managing water resources and supporting sustainable practices. Recent history and policy developments include:

Technology Adoption: Reclamation has been exploring AI applications to enhance water management, improve forecasting, and optimize operations. This includes using predictive analytics for water availability and demand forecasting.

Innovation Strategy: Reclamation's Innovation Strategy encourages the adoption of new technologies, including AI, to address challenges in water resource management. The strategy promotes collaboration with other agencies, academic institutions, and private sector partners.

Sustainability Goals: Reclamation's commitment to sustainability aligns with the use of AI to improve environmental monitoring and resource conservation. AI tools are being explored for wildlife tracking and habitat assessment.



To enhance the delivery of its missions, the Bureau of Reclamation (Reclamation) could focus its efforts on several key areas for advancing the use of artificial intelligence (AI):

1. **Data Integration and Management**
   Investing in robust data infrastructure is crucial. Reclamation should focus on integrating various data sources (e.g., hydrological, meteorological, and ecological data) to create comprehensive datasets. This will enable more effective AI applications and improve decision-making processes.

2. **Predictive Analytics for Water Management**
   Enhancing predictive analytics capabilities can help in forecasting water availability, demand, and drought conditions. Investment in machine learning models that analyze historical data can improve resource allocation and operational planning.

3. **Automation of Operations**
   Reclamation could invest in AI-driven automation tools to optimize operations in water delivery systems, including real-time monitoring and control of water flows. This would increase efficiency and reduce human error.

4. **Environmental Monitoring and Management**
   AI can be utilized for monitoring ecosystems and assessing the impacts of water management practices. Investments in AI tools for wildlife tracking, habitat assessment, and environmental impact analysis can enhance conservation efforts.

5. **Stakeholder Engagement Tools**
   Developing AI-driven platforms for stakeholder engagement can facilitate better communication and collaboration with local communities, farmers, and other stakeholders. These tools can help gather feedback and improve transparency in decision-making.

6. **Training and Capacity Building**
   Investing in training programs for staff to enhance their understanding of AI technologies and their applications is essential. Building internal capacity will enable Reclamation to leverage AI effectively and foster innovation.

7. **Collaborations and Partnerships**
   Forming partnerships with academic institutions, private sector companies, and other federal agencies can accelerate AI research and development. Collaborative projects can lead to innovative solutions tailored to Reclamation's specific challenges.

8. **Ethical AI Use and Governance**
   Establishing frameworks for the ethical use of AI, including considerations for data privacy and algorithmic bias, is vital. Investments in governance structures will ensure that AI applications align with Reclamation's mission and values.

By focusing on these areas, the Bureau of Reclamation can effectively advance the use of artificial intelligence to enhance its mission of managing water resources and supporting sustainable practices. These investments will lead to improved operational efficiency, better resource management, and enhanced environmental stewardship.

Key Perspectives

A Simple Framework for Understanding and Applying Artificial Intelligence

By Marshall Moutenot, UpstreamTech
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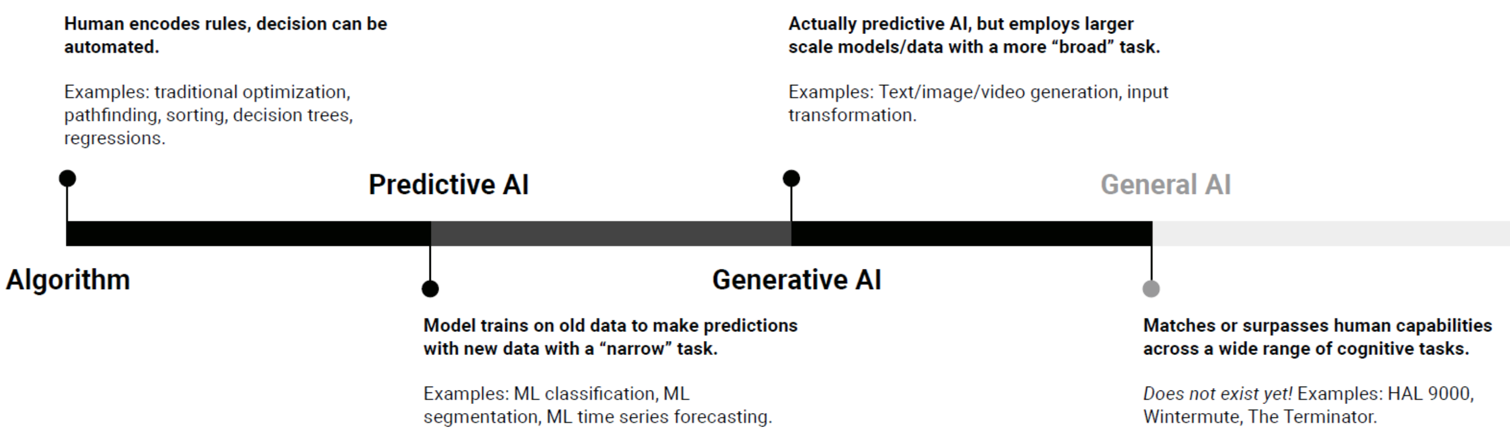
The spectrum of Artificial Intelligence (AI) technologies is vast, ranging from tried and true algorithms to ‘don’t-worry-it’s-still-science-fiction’ Artificial General Intelligence. This vastness makes it challenging to rapidly determine if an AI technology is a suitable solution for a given problem. One might ask:

- “Can I trust a Large Language Model (LLM) to analyze historical weather patterns?”
- “Is this machine learning model reliable enough to detect anomalies in vibration data?”
- “How can I ensure that a predictive forecast model won’t just perform well against historical data, but also operate accurately in real-world conditions?”

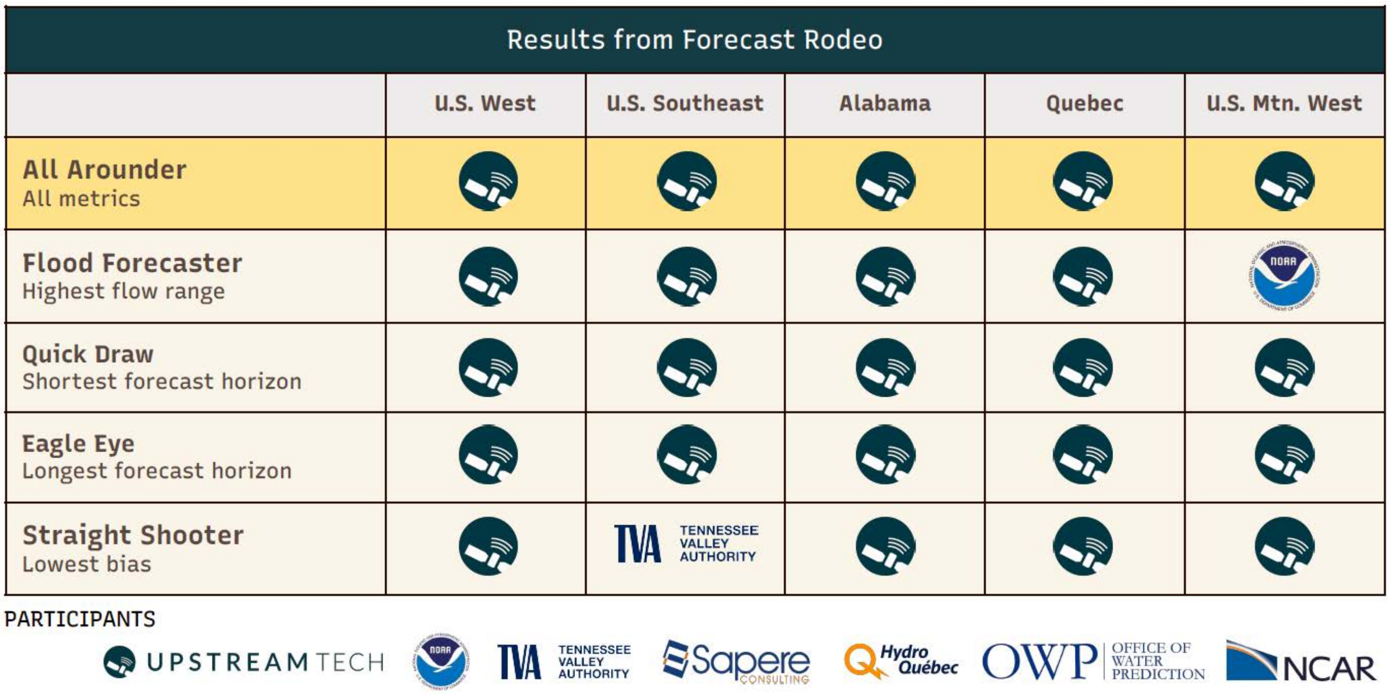


When viewed through the lens of adaptive evolution – the iterative process by which an intelligence, in this case AI, continuously learns and improves based on its environment – we gain a clearer understanding of where and how a particular AI technology can succeed. By questioning the goals, constraints, and inputs that shape the development of AI models, we can better judge their fitness for specific applications. Let’s explore this concept further by examining two opportunities for applying AI in the waterpower sector: LLMs and predictive AI for hydrological forecasting.

At their core, LLMs are a type of Predictive AI model, but they’re distinguished by the scale of computational power and the immense amount of data used for learning. When trained, LLMs are measured against their ability to comprehend input (prompts) and produce reasonable and probable output. When used in applications aligned with this objective – such as text transformation and summarization, creative idea seeding, or chatbots, they present a transformative new way to interact with and leverage computers. When used outside of the context of their adaptive evolution, such as retrieving facts, performing mathematics, or automating processes prone to bias, Generative AI models are unfit and present pitfalls.

HydroForecast, a predictive AI model developed by Upstream Tech, focuses on a very different challenge: forecasting streamflow across diverse timescales. When assessing HydroForecast's deployment in real-world scenarios, operators tend to raise several key concerns:

- Can the model reliably forecast general conditions across a wide range of watersheds?
- How accurate is it during extreme weather events, where precision is most critical?
- Will it perform well under unprecedented conditions, outside the bounds of historical data?



This matrix from Reclamation's Streamflow Forecast Rodeo prize challenge shows the top performing streamflow forecast technologies for predicting different streamflow characteristics..

While this model has proven itself in competition – including a year-long contest sponsored by the Bureau of Reclamation, where it outperformed utilities' in-house forecasting teams, public entrants, and government agencies, winning 23 of 25 categories – a demonstration is valuable in building trust, but not sufficient in fully earning it. To gain full confidence, operators must understand the objectives and environment in which learning occurred.

The model is trained across hundreds of basins with diverse hydrological characteristics, and the objective function is finely tuned to balance overall accuracy with the ability to capture critical metrics for practitioners, such as peak timing and volume during extreme weather events. Input selection is grounded in physical scientific principles. Taking this physics-driven, foundational approach results in a model that is accurate in general conditions, robust to nonstationarity, and reliable during extreme weather events.

In engineering school, we joked that hardware is just software petrified in silicon. In much the same way, AI represents "learning" frozen in bytes. Whether we are working with a simple algorithm or something on the path to General AI, understanding the learning process – how a model has adapted and evolved its intelligence – is essential to being both better users and better creators of AI.

Note: Reclamation has engaged UpstreamTech on AI innovation activities. The views shared by the author do not represent Reclamation policy but do reflect perspectives gathered during Reclamation AI innovation activities.

Innovation in Reclamation

Predictive AI focuses on analyzing historical data to forecast future outcomes or trends. It utilizes statistical models and machine learning algorithms to identify patterns, enabling end-users to anticipate future conditions, such as weather, hydrology, resource needs, wildlife behaviors, or equipment maintenance. Generative AI, on the other hand, creates new content or data based on learned patterns from existing datasets. Generative AI is still emerging, with potential applications being explored. In Reclamation, predictive AI is more commonly applied. Past and near-term focus remains on leveraging predictive capabilities to enhance decision-making and operational efficiency. The following articles highlight current activities in Reclamation that are developing and demonstrating applications of predictive AI.

Piloting Machine Learning Inflow Forecasts Across Reclamation

By Lindsay Bearup, Laura Read; Noe Santos, Joel Fenolio, Levi Johnson, Susan Behery & Claudia Leon-Salazar
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Partner(s): Upstream Tech

The Research and Development Office's Facilitated Adoption Program recently funded an activity to pilot machine learning based inflow forecasts across a diverse sample of Reclamation reservoirs. This project continues the demonstration of the top performing technology in Reclamation's Streamflow Forecast Rodeo Prize Competition (2020-2021). The developer of this technology, Upstream Tech, will deploy their Hydroforecast 10-day operational forecasts for two reservoir locations in each of Reclamation's five regions for the next two years. The AI in this technology learns to represent hydrologic processes by identifying relationships between satellite observations, basin characteristics, meteorological forecasts, and streamflow measurements. HydroForecast uses a novel implementation of a Long Short Term Memory (LSTM) model that divides basins into sub-units in which the LSTM

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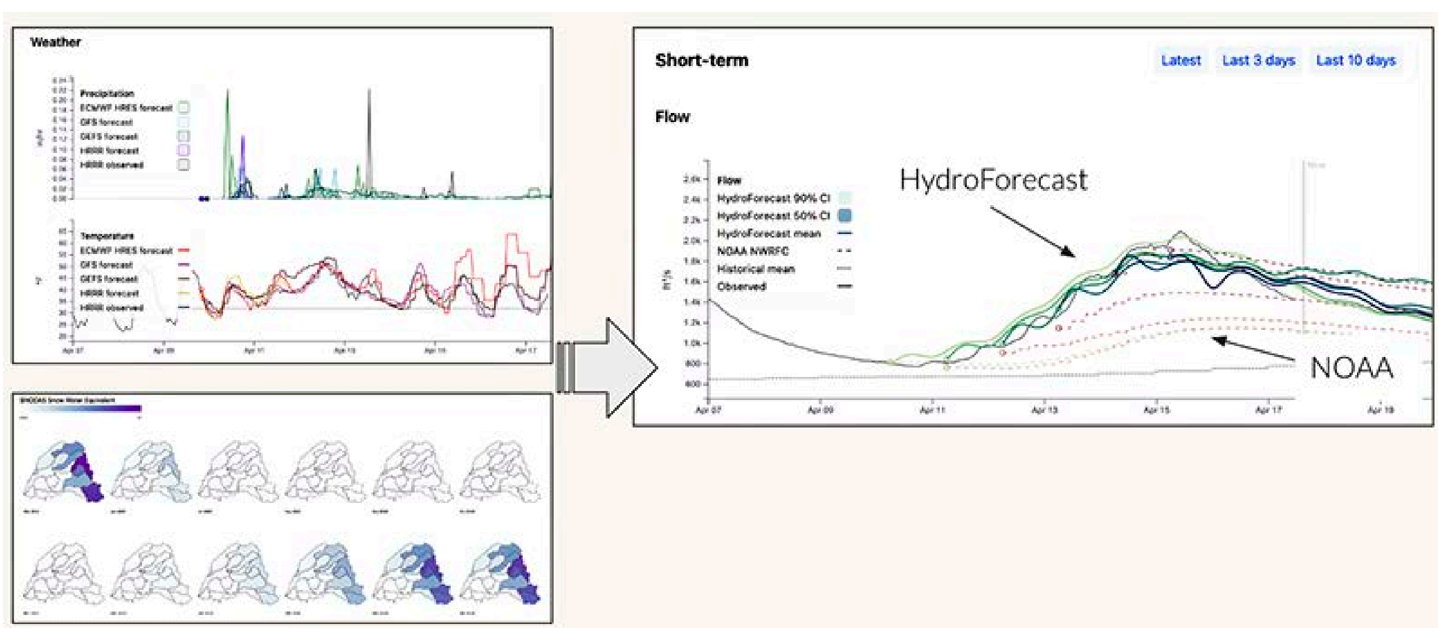

Demonstration of the inputs and outputs of the Hydroforecast streamflow forecast model. Forecasts are compared with observations and forecasts from a NOAA River Forecast Center.

–continued Piloting Machine Learning Inflow Forecasts

predicts flow and routing parameters all within its neural network. The modeling platform is designed to be flexible to assimilate upstream observations and rapidly add/experiment with new inputs. Collaborators in Reclamation's water management groups of Regional and Area Offices will 1) evaluate the forecasts through comparisons with existing operational forecast guidance products, 2) evaluate opportunities to leverage the forecasts in operations decisions, and 3) evaluate potential labor savings from efficiency improvements through modernizing tools and workflows.

Improving the Skill of Reservoir Inflow Forecasts Over the Colorado River Basin Using High-resolution Snow Monitoring Data and Explainable Artificial Intelligence Models

By Sarah Baker, Reclamation Ph.D. & Tiantian Yang Ph.D.
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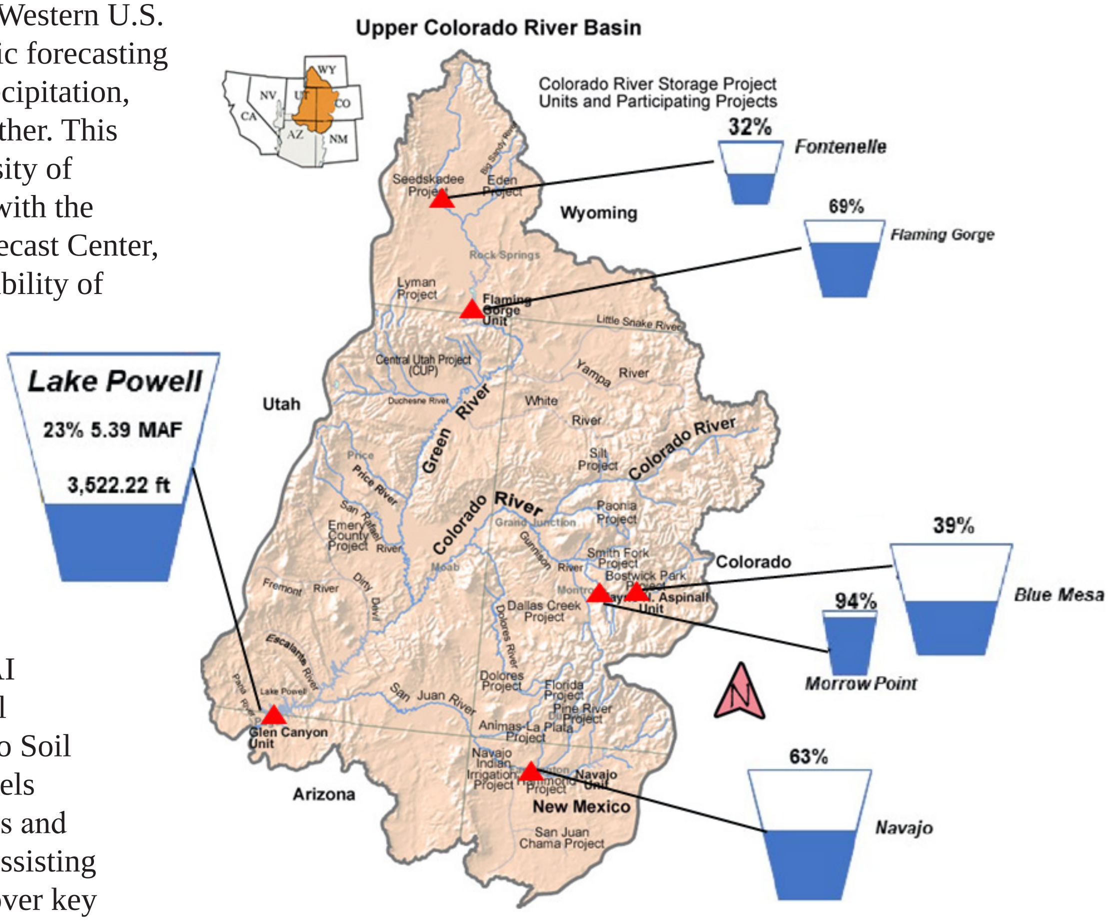
Partner(s): University of Oklahoma, National Weather Service Colorado Basin River Forecast Center

Reservoir planning in the Western U.S. relies on precise hydrologic forecasting based on conditions of precipitation, snowpack, and future weather. This project, led by the University of Oklahoma in partnership with the Colorado Basin River Forecast Center, is testing the existing capability of advanced Artificial Intelligence (AI) and deep learning models in hydrologic forecasting over the Upper Colorado River Basin. By leveraging high-resolution snowpack data, the project team is benchmarking advanced AI models against operational SNOW-17 and Sacramento Soil Moisture Accounting models to unravel the effectiveness and limitations of AI tools in assisting water supply forecasting over key forecast sites.



Forecast domain and locations where forecasts are being developed and evaluated.

Machine Learning in the Colorado River Basin Post-2026 Operations Exploration Tool (Web Tool)

By H.B. Zeff, Rebecca Smith, Nathan Bonham & Alan Butler
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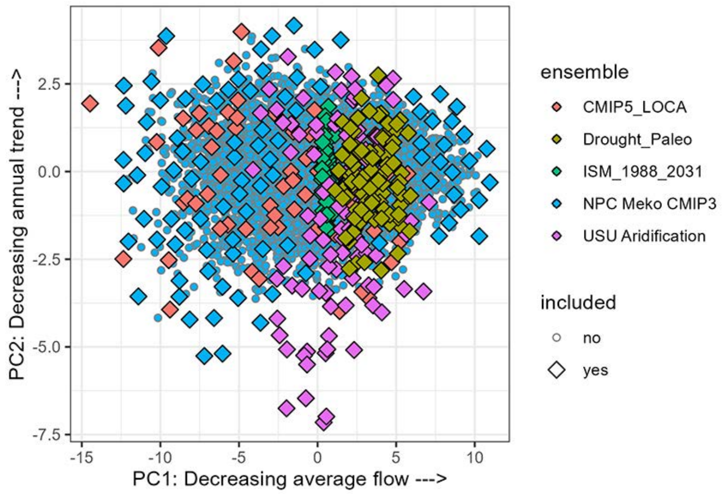
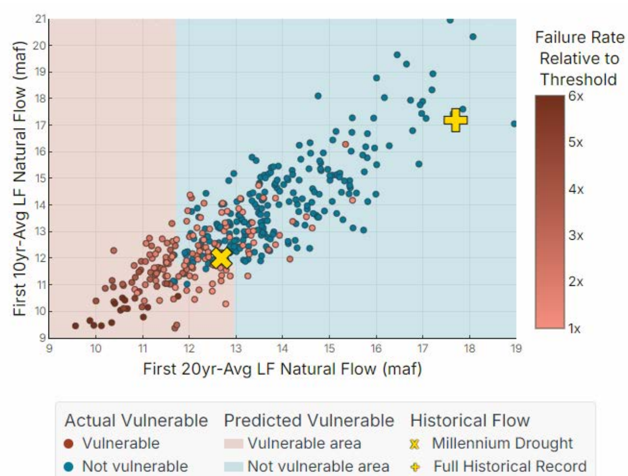
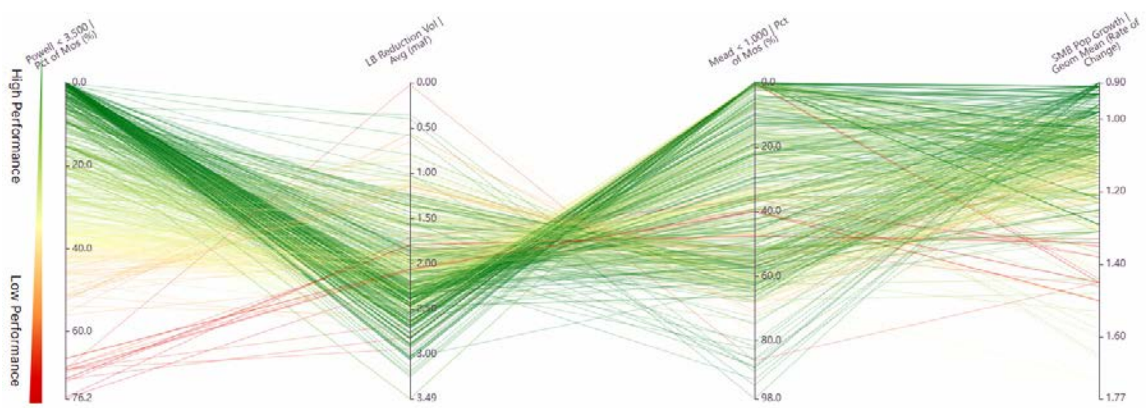
In support of ongoing planning efforts in the Colorado River Basin, Reclamation's Upper and Lower Basin Regions developed the [Web Tool] to allow stakeholders and the public to explore operational strategies for Lake Powell and Lake Mead as part of the Post-2026 National Environmental Policy Act (NEPA) Process. Multiple ML approaches were used to develop data for the Web Tool, and to analyze the operational strategies within the Web Tool. First, a multi-objective evolutionary algorithm was used to efficiently search for potential operational strategies to seed the Web Tool with ideas for users to start from. Next, ML-based clustering algorithms helped Reclamation select a computationally tractable and representative uncertainty ensemble with 400 members (out of thousands of possibilities) representing a variety of physical and statistical methods of estimating future hydrology. These potential futures were then used to drive a web-based, interactive simulation tool that let stakeholders create and test their own operational strategies. Under the hood, the web tool deploys ML algorithms in real-time to select the most important hydrologic characteristics for each user-generated policy, highlighting the specific conditions that could lead to user-defined adverse outcomes in the future. To date, over 200 registered users have generated over 500 unique operational strategies using the Web Tool.



Kennard Stones sampling of individual streamflow traces from various physically and statistically generated streamflow ensembles creates a space-filling design to improve accuracy of vulnerability analysis.



Web tool vulnerability data illustrating the two most important hydrologic characteristics (average streamflow in the next ten and next 20 years) that explain the failure of a sample reservoir operation strategy to attain specific performance objectives during a 30-year simulation period.



Hundreds of strategies, created via multi-objective optimization and built-in user creation tools, are shown on a parallel axis plot to show key performance tradeoffs between user-selected performance metrics.

Machine Learning for Crack Mapping Concrete on Reclamation's Water Control Structures

By Matthew Klein, Ph.D., P.E.
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One aspect of determining the cause of deterioration and consequently applying the correct repair on a concrete structure is to map the cracks related to the damage. This map pattern is then analyzed to help define the cause of deterioration. Historically, crack mapping has been done by hand and is difficult to get accurate results and tracking. Recently, utilizing uncrewed aircraft system (UAS) and high-resolution camera, a high-accuracy mosaic of the pictures of the concrete surface can be generated and inspected for cracks. Currently, the cracks are drawn in over the mosaic and the process is tedious. However, applying object detection with Machine Learning techniques has the potential of reducing cost by using a computer to identify and mark the crack locations. Engineers at Reclamations Technical Service Center have been exploring Machine Learning applications for crack mapping since 2019 including investigating third-party vendors and academic institutions for solutions. Some of the challenges to implementing Machine Learning solution for crack mapping the high-resolution UAS data are data security, capital cost, and ensuring that the solution can be accessible long-term for comparison with future inspection data.

Example of manual crack mapping on a high-resolution orthomosaic generated from data collected by UAS.

Machine Learning Applied to Geotechnical Engineering: Liquefaction Triggering Analysis

By Navead Jensen
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Soil liquefaction occurs when soil loses significant strength during or after a seismic event which can lead to reduced soil resistance and potentially catastrophic failure. Liquefaction is a primary concern for structures made up of susceptible soil or structures built on a susceptible soil. A case history data set from the geotechnical engineering community exists which captures different characteristics of a site that has been subjected to an earthquake, including if there was observed evidence of liquefaction. The case history data set was used to create three machine learning models that predicted the probability of liquefaction in a forward analysis (a neural network, a logistic regression model, and a support vector machine).

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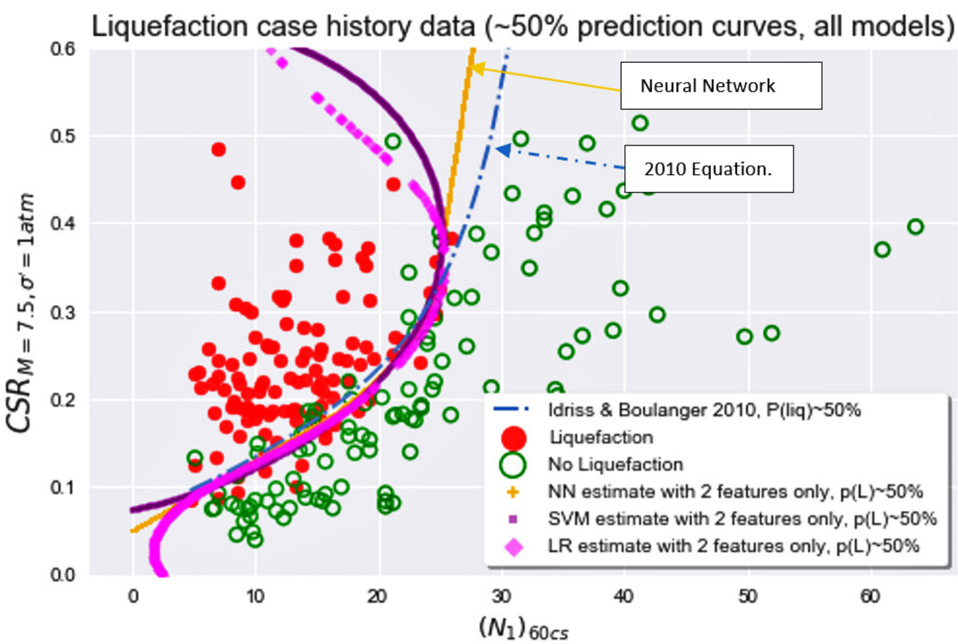
–continued Liquefaction Triggering Analysis

The models were evaluated against objective metrics and also against a solution that exists within the industry (Idriss & Boulanger, 2010). The neural network machine learning model outperformed the industry solution in all metrics and gave reasonable answers from an engineering perspective. The case history points are plotted on the figure below along with the solution of the machine learning models and the 2010 equation. This type of effort and analysis is on the rise within the industry and there are a variety of applications that the community is advancing towards to help put "tech" back in geotechnical engineering.



Decision boundary plots for the neural network (NN), support vector machine (SVM), and logistic regression (LR) machine learning models, and the equation from the 2010 Idriss and Boulanger report [1]. All curves based on the two feature inputs of corrected blow count (x axis, measure of soil resistance) and adjusted cyclic stress ratio (y axis, measure of earthquake stress in soil). Circular markers represent case-history sites that liquefied or not after a seismic event.

Data-Driven Fault Detection and Process Control for Potable Reuse with Reverse Osmosis

By Neal Gallagher, Kyle Thompson & Andrew Salveson
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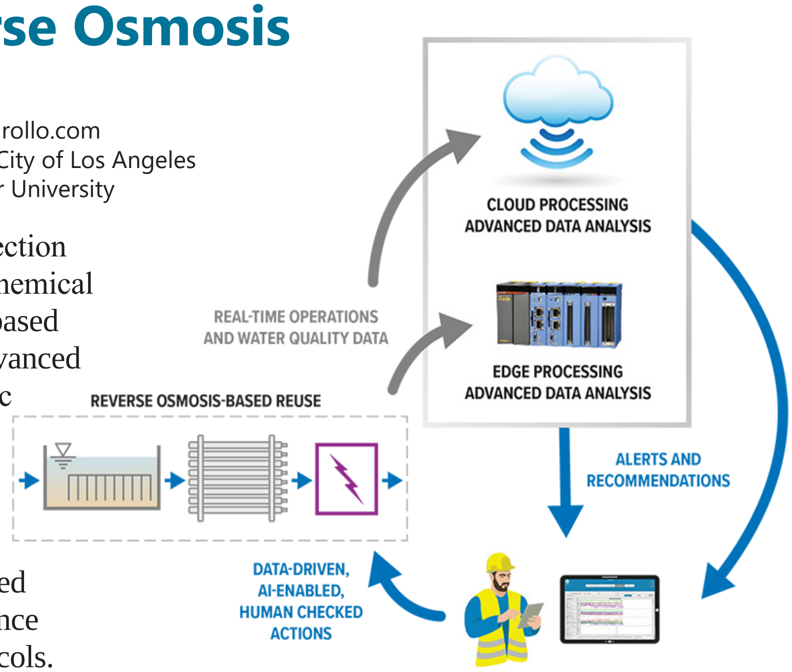
Partner(s): Carollo Engineers, Inc., Metropolitan Water District, City of Los Angeles Bureau of Sanitation, Yokogawa Corporation of America, Baylor University

In reverse osmosis (RO) based water reuse, fault detection is based on fixed threshold on single variables, and chemical dosing and chemical cleaning is often implemented based upon schedule and simplicity, not need. Applying advanced supervised machine learning (ML) and nonparametric hypothesis testing to provide adaptive, integrated fault detection and process control optimization with online sensor networks presents an opportunity to save cost, optimize energy usage, reduce down times, and reduce public health risks through improved reliability. The results of this project include a Guidance Document for ML in Reuse and benchmarking protocols. These outcomes will pave a path for future innovation of ML applications in water purification markets.



Edge- or cloud-based semi-autonomous fault detection & process control.

Hydropower Monitoring and Analytics

By James DeHaan
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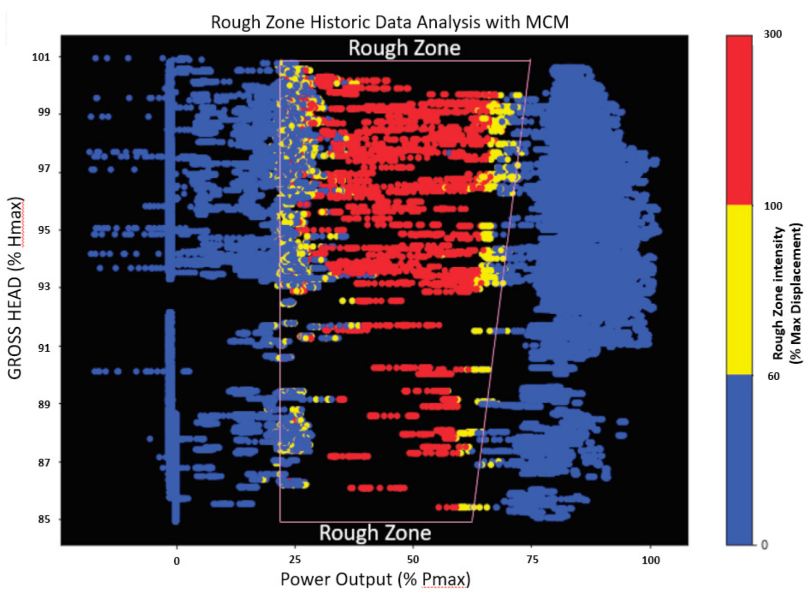
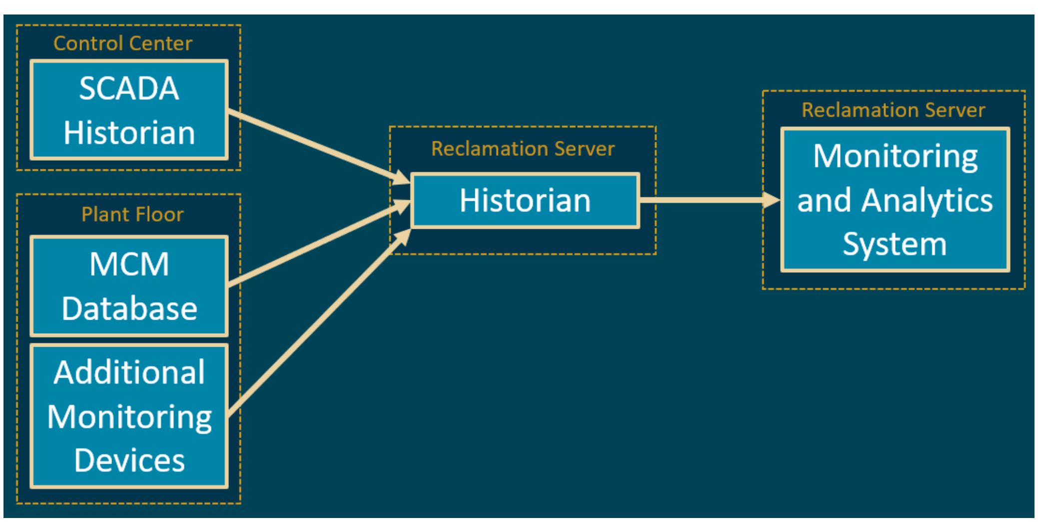
Partner(s): Power Resources Office, Columbia-Pacific Northwest Region, Lower Colorado Basin Region

A pilot project is being pursued to demonstrate a commercial predictive Artificial Intelligence (AI) monitoring and analytic system to reduce and prevent failures and guide maintenance at the Bureau of Reclamation (Reclamation) hydroelectric power generation plants. With the data already collected at these plants, this system will identify and monitor useful relationships between multiple data streams to identify deterioration, impending failures, or other operational issues, as well as to identify likely preventative actions when anomalies occur. The system will be evaluated using historic data from four Reclamation generators. The current plan is to use the lessons learned from this research effort to deploy the AI system to provide real time monitoring and analytics initially for ten Reclamation powerplants encompassing 66 generating units.

Collecting Generator Monitoring Data using Reclamation Developed MCM System.



Turbine Rough Zone Analytic Data.



Powerplant Monitoring and Analytics Data Flow.

Machine Learning for Chemical Savings at Reverse Osmosis Plants

By Saied Delagah & Mark Donovan
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Partner(s): GHD, Water Replenishment District


Reverse osmosis water treatment.

Chemical use for cleaning membranes in reverse osmosis (RO) water treatment facilities can contribute significant costs to the treatment process. Reclamation's Desalination and Water Purification Research Program (DWPR) funded GHD to apply machine learning techniques to optimize clean-in-place chemical usage at RO plants. The techniques analyze data such as normalized permeate flow and normalized pressure differential to inform application of chemicals and result in less chemical per unit of water produced without sacrificing operational uptime or membrane life. The project was implemented at full scale operational facilities of the Water Replenishment District located in Southern California. The project demonstrated that machine learning can be a useful tool to optimize cleaning frequency of RO system.

Machine Learning Refines Quagga Habitat Suitability

By Amy Yarnall, Sherri Pucherelli; Thomas Ashley, Yale Passamaneck, Jacque Keele, Annie Quattlebaum, Safra Altman & Todd Swannack
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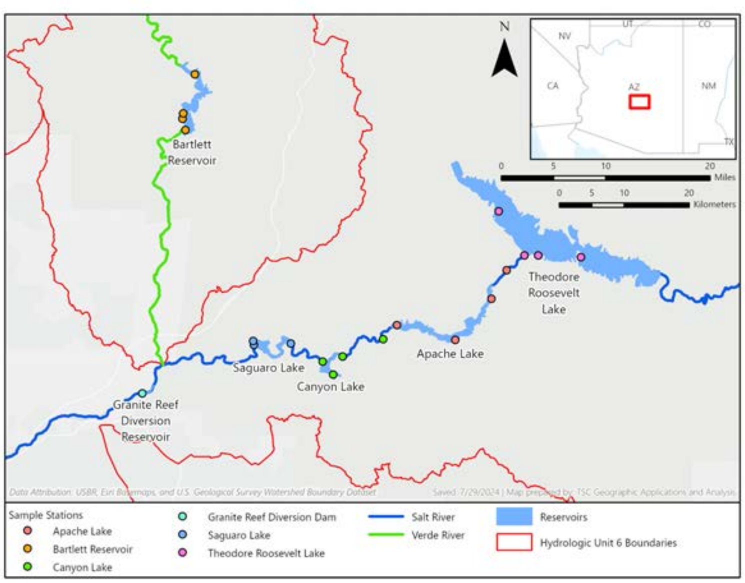
Partner(s): US Army Engineer Research and Development Center

Extensive research has been conducted to prevent the spread of quagga mussels, a costly and damaging invasive species. Notably, several detected introductions failed to establish populations in hypothetically suitable waterbodies by pH and calcium levels. To better parameterize quagga habitat suitability, we collected ecological data at 20 stations across four invaded and two uninvaded, connected waterbodies in Arizona during 2021-2023. Data were analyzed by gradient boosted machine, an ensemble machine learning algorithm that aggregates iteratively optimized decision trees. Results identified water conditions and plankton taxa that further differentiated quagga-invaded from uninvaded stations, within a system of pH- and calcium-suitable waterbodies.


Collection of water quality samples from Salt River Project Reservoirs.



Map of the Salt River Project, Arizona. Twenty sampling stations are upstream of and within six waterbodies of established (Apache Lake, Canyon Lake, Saguaro Lake, and Granite Reef Diversion Reservoir) and negative (Bartlett Reservoir and Theodore Roosevelt Lake) quagga population statuses.

Partner Activities

U.S. Geological Survey Harnesses Artificial Intelligence to Accelerate Science

By Janice Gordan
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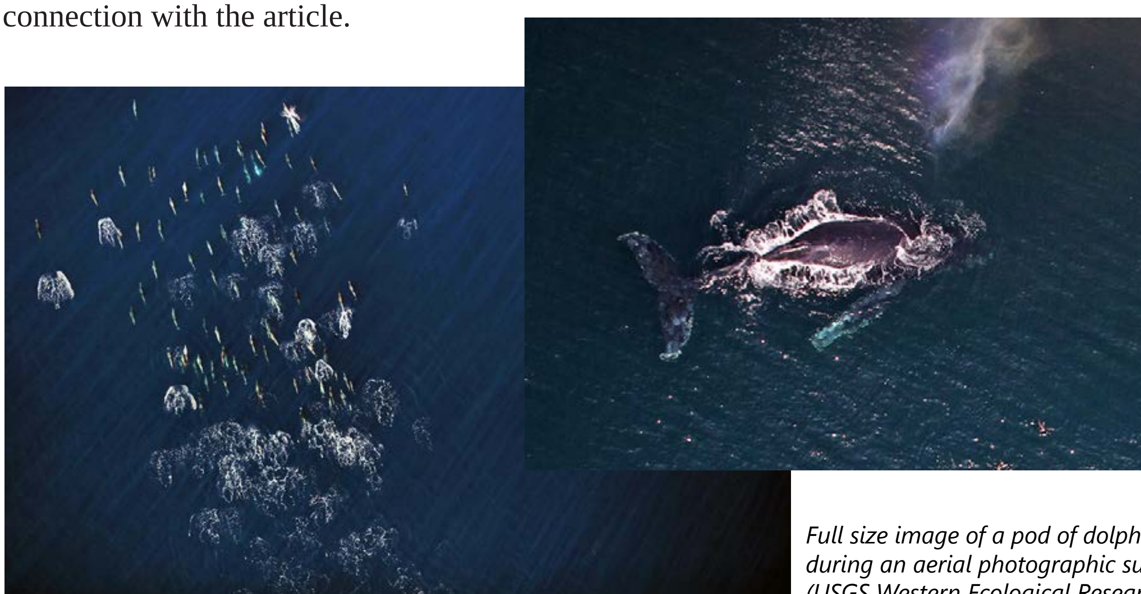
USGS uses AI in autonomous monitoring via cameras at Pacific walrus haulout beaches to send real-time updates to wildlife managers to prevent stampedes from human disturbances.

Artificial Intelligence (AI) is an important component of much of the science produced by the U.S. Geological Survey (USGS), and the opportunities AI continues to provide will help enhance both the science and operations missions of the agency now and into the future. The USGS is using AI to make predictions or classifications based on input data to inform decision-making for our partners that range from science and discovery to resource management and policy decisions. Examples of USGS use of AI technologies include habitat suitability models, counting marine avian species during aerial surveys for population estimates and in wildlife surveys in areas of offshore wind energy development, processing ground, drone, and satellite imagery, water availability and quality assessments, land use change monitoring and mapping, critical minerals surveys, coastal change monitoring, wildland fire fuels and burn probability analysis, and creating intelligent maps with GeoAI. There are other areas where AI could assist USGS scientists in the future, such as with some types of communications, meeting transcription, metadata development, and code development and editing. Motivated by recent advancements and public concerns of AI technologies, the USGS is developing a comprehensive AI strategy in accordance with government policies (i.e., the Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence). The USGS vision is to continue to integrate AI to deliver valuable science for the public good, while maintaining high ethical standards, scientific quality, and integrity. Machine learning assists image processing for these aerial surveys" to make a direct connection with the article.



Zoomed image of a Humpback Whale (Megaptera novaeangliae) and a group of shearwaters feeding in southern California. (Laney White/ USGS Western Ecological Research Center)

Full size image of a pod of dolphins captured during an aerial photographic survey Fall 2018. (USGS Western Ecological Research Center)

Supporting Resources

Risks & Benefits of Generative Artificial Intelligence at Reclamation

By Alex Bahramzadeh, Ahmad Najee-Ullah
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Artificial Intelligence (AI) is transforming how Reclamation completes our mission with remarkable advancements, but it also presents several notable risks to our reputation. These risks include:

Privacy and Security:

AI systems rely on extensive data, often including personal and sensitive information. This raises significant privacy concerns that can lead to data breaches, where sensitive information may be exposed or misused.

Bias and Discrimination:

AI algorithms learn from historical data, which can embed biases. If the data used to train AI systems includes biased patterns, the AI may replicate or even exacerbate these biases and lead to unfair results in data output.

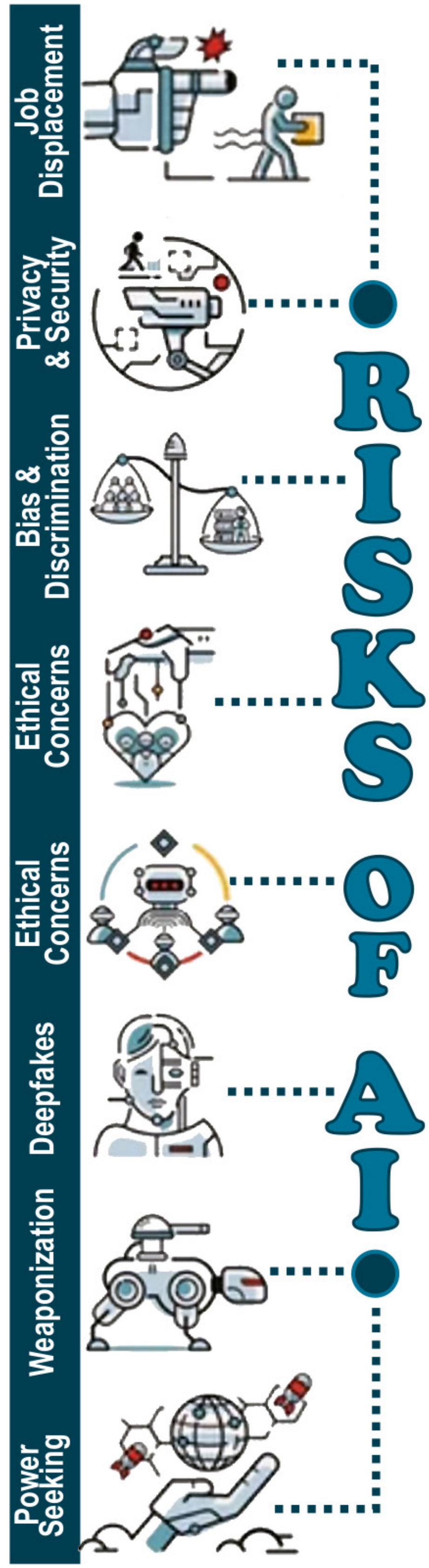
Ethical Concerns:

The deployment of AI in decision-making processes introduces ethical challenges. AI systems often operate as "black boxes," where their decision-making processes are not transparent. This lack of transparency can hinder accountability and make it difficult to address errors or injustices.

Dependence on AI:

As businesses become increasingly reliant on AI, there is a growing risk of over-dependence. This could lead to vulnerabilities if AI systems fail or produce erroneous outputs, potentially disrupting critical services and decision-making processes.

Addressing these concerns is essential to ensuring AI continues to benefit Reclamation while mitigating potential risks. Employees are encouraged to explore and test AI tools but MUST NOT upload or input any sensitive or restricted information, data, or materials managed by Reclamation to publicly accessible AI tools or applications.



On Potential Further Uses of AI Tools

Potential Use Cases for Freely Available AI Tools:

1. Training and Education
   a. Develop realistic training scenarios for government employees using AI-generated content.
   b. Develop instructional content, presentations, or explainer texts on non-sensitive topics like cybersecurity awareness or ethics training.
2. Analysis of Public Data
   a. Submit/train AI tools on publicly available datasets, policies, or regulations and ask for summarization or high-level reporting.
3. Problem Solving and Work Assistance
   a. Use AI to generate standardized templates for official documents, non-sensitive reports, and memos. Use generative AI to create graphics, posters, or other visual materials for internal or external campaigns

Unacceptable Uses of Freely Available AI Tools:

The following information is prohibited for use in AI tools.

1. **Personally Identifiable Information**
2. **Controlled Unclassified Information**
3. **Sensitive data relating to internal processes or pre-decisional materials**
4. **Information that is exempt from release under the Freedom of Information Act**
5. **Any data that is not already considered to be available within the public domain**

High-Performance Computing for Artificial Intelligence

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High-performance computing (HPC) is transforming the field of artificial intelligence/machine learning (AI/ML) by providing the necessary computational power to process vast amounts of data and execute complex algorithms. As AI applications become increasingly sophisticated, the demand for faster and more efficient computing resources has grown.

HPC systems, which consist of interconnected processors working in parallel, enable researchers and developers to train deep learning models more quickly and effectively. These systems leverage advanced hardware, such as graphics processing units (GPUs) and tensor processing units (TPUs), specifically designed for parallel processing tasks. This capability allows for the handling of large datasets, making it feasible to develop AI/ML solutions in areas like natural language processing, computer vision, and predictive analytics.

The Bureau of Reclamation (Reclamation) is working to make HPC resources available for AI/ML activities. The Reclamation Technical Service Center (TSC) in collaboration with the Hydrology and Hydraulics Community of Practice, have established an agreement for low-cost access to USGS HPC resources. The USGS HPC systems have a mix of central processing unit (CPU) and GPU resources to support workflows from physics-based models to AI/ML training. Additional resources are also being explored, such as Google Earth Engine (GEE) and Microsoft Azure, to increase computing resources and support additional workflows. The importance of computing resources for AI/ML is growing in scientific and engineering practice, and Reclamation continues to adapt to meet its water management mission.

The Hovenweep High Performance Computing (HPC) system located at the USGS Earth Resources Observation and Science (EROS) Center in Sioux Falls, South Dakota.

Featured Faces

Navead Jensen

Geotechnical Engineer
Geotechnical Division, Technical Service Center

Navead Jensen is a Geotechnical engineer for the Geotechnical Division at the Technical Service Center. Navead has 19 years of experience performing Geotechnical earthquake engineering analysis with an emphasis on numerical modeling for Reclamation. He authored the "FLAC practical guide" documenting Reclamation's efforts in the use of the software program FLAC for seismic response analysis. More recently his work has included the application of machine learning analysis to the needs of Reclamation and is the co-lead of the Dam Safety funded Machine Learning Working Group. Navead has an M.S. in Science in Civil Engineering from the University of Colorado – Boulder.

Sarah Baker

Civil Engineer
Research & Modeling Group, Upper Colorado Basin Region

Sarah Baker is a Team Lead and civil engineer in the Bureau of Reclamation's Upper Colorado Basin Region Research and Modeling Group. She holds a Ph.D. in Civil Engineering from the University of Colorado – Boulder. At Reclamation, she supports planning, research, and environmental compliance studies of Colorado River operations. She focuses on mid- to long-term modeling of water management and streamflow forecasting in the Colorado River Basin.

James Dehaan

Senior Electrial Engineer
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James DeHaan is a senior electrical engineer for the Hydropower Technical Services and SCADA Group at the Bureau of Reclamation. He is registered professional engineer and has been with Reclamation for 33 years. His present responsibilities include research and field work in the areas of large rotating machine testing and diagnostics, power apparatus testing and diagnostics, hydro plant monitoring and analytics, and specialized power system instrumentation development. Mr. DeHaan has a B.S. degree in electrical engineering from Dordt University and a M.S. degree in electric power from Iowa State University.

Harrison "HB" Zeff

Civil Engineer
Lower Colorado Basin Research and Modeling Team

Harrison "HB" Zeff is a civil engineer with the Lower Colorado Basin Research and Modeling Team in Reclamation. Prior to his time with the Reclamation, he spent time in California working on agricultural issues as a research scientist with the University of North Carolina, taught courses at Tubingen University in Germany and spent time as a research fellow at the Property and Environment Research Center in Bozeman, Montana. He holds a Ph.D. and an M.S.E.E. in environmental science and engineering from the University of North Carolina, Chapel Hill and a B.S. in civil and environmental engineering from Pennsylvania State University.