2023 CUAHSI Biennial Colloquium

June 11-14, 2023

Granlibakken Tahoe, Tahoe City, CA

Discovering New Horizons in Water Science

Welcome Everyone!

Welcome all to the 2023 CUAHSI Biennial Colloquium! CUAHSI's Biennial is a symposium that brings together the diverse fields of water science to discuss developments in the hydrology sector of the Earth Sciences; researchers present their latest findings and developments, propose community workshops, and interact with colleagues from different disciplinary fields from all over the country. The Biennial offers a unique opportunity and a casual environment for participants to discuss ideas, network with colleagues, and build new relationships.

The 2023 Biennial will be the first in-person biennial since 2018. The theme for this year's meeting is, "***Discovering New Horizons in Water Science***." The broad field of Water Science is making important strides in addressing critical environmental and societal challenges in the face of growing stressors. As the connector among essentially all key systems on our planet, Water Science continues to reshape and evolve in its own unique way to address disciplinary and interdisciplinary challenges. The 2023 CUAHSI Biennial Meeting will focus on new horizons in Water Science that include: new ways of doing inclusive and collaborative research, new perspectives, new knowledge frameworks, new ways of learning, new tools, and new metrics of success. Please join us in sharing your discoveries and inspirations in Water Science as we continue to build towards sustainable water futures for all.

CUAHSI is committed to advancing the excellence of the water science community by providing high-quality work and a welcoming environment for all. The Biennial is intended to be a safe and accessible event for our community to convene and collaborate in a way that is free from biases and that promotes inclusivity. Our goal is to optimize participation and present an environment where all attendees feel at ease to be their authentic selves.

As a participant in this CUAHSI conference all are expected to abide by CUAHSI's Code of Conduct Policy (CoC). You can find a quick reference copy of the CoC on page 2.

Thank you for helping to uphold our high community standards and facilitate an excellent meeting. Please feel free to reach out to any CUAHSI staff person with any questions.

We look forward to a great meeting together!

Table of Contents

Acknowledgements

CUAHSI would like to acknowledge the contributions, support, and assistance from the following individuals and organizations:

The 2023 Biennial Planning Committee

Safeeq Khan - University of California, Merced
John Knowles - California State University, Chico
Anne Nolin - University of Nevada, Reno
Emily Clark - CUAHSI
Lisa Mucciacito - CUAHSI

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CUAHSI would like to thank Granlibakken and their staff for hosting us and acknowledge that this meeting is being held on the traditional lands of the Cayuse, Umatilla, Walla Walla and the Wašišiw ʔítdeʔ (Washoe) People.

Primary sponsorship for CUAHSI is from the National Science Foundation Award EAR- 1849458.

CUAHSI Code of Conduct

CUAHSI expects all our community members to be respectful, equitable, and inclusive in conduct and treatment of all those engaged or contemplating engagement in CUAHSI's community.

For immediate or serious threat to public safety, contact 911 or locate a house phone and ask for security.
Please report other concerns to CUAHSI staff or leadership.

In Sum

Do:

- Demonstrate fair and honest treatment for all
- Be collaborative
- Make room for diversity - voices, opinions, discussions & decisions

Don't:

- Do not engage in mocking or make jokes that are sexual, racist or of gendered nature
- Do not enforce unwelcome pressure or use power differentials to exert dominance
- Do not demonstrate unwelcome touching

Contact Information:

CUAHSI's Executive Director, Jordan Read: jread@cuahsi.org
CUAHSI's Deputy Director, Deanna McCay: dmccay@cuahsi.org
Confidential mailbox: ethics@cuahsi.org
CUAHSI Board of Director Chair, Jay Zarnetske: jpz@msu.edu

The full Code of Conduct can be viewed on our website:

Agenda

Sessions that take place concurrently are in bold

Sunday, June 11th

Time		Location
4pm	Check-In	Lobby
6-7:30pm	Dinner	Granhall
7:30-9pm	Film Screening: California's Watershed	Mountain-Lake Room

Monday, June 12th

Time		Location
7-8:20 am	Breakfast	Granhall
8:30-8:40 am	Welcome Address	Mountain-Lake Room
8:40-9:40 am	Bascom Keynote Lecture	Mountain-Lake Room
9:40-10 am	Morning Break	Mountain Deck
10-10:30 am	Executive Director's Vision for CUAHSI	Mountain-Lake Room
10:30-12 pm	Navigating NSF's Hydrologic Sciences Program	Mountain-Lake Room
12-1:15 pm	Lunch	Granhall/Garden Deck
1:30-3:30 pm	**Innovative partnerships and applied research to achieve resilient water supply in the Western US**	**Mountain-Lake Room**
1:30-3:30 pm	**Student Centered Research**	**Bay Room**
3:30-4 pm	Afternoon Break	Mountain Deck
4-4:30 pm	Oral Lightning Talks (Part 1)	Mountain-Lake Room
4:30-6 pm	Poster Session (Part 1)	Pavilion
6-7:30 pm	Dinner	Granhall/Garden Deck
7:30-9 pm	Go Fund It! Exploring CUAHSI's Grant Programs	Mountain Lake

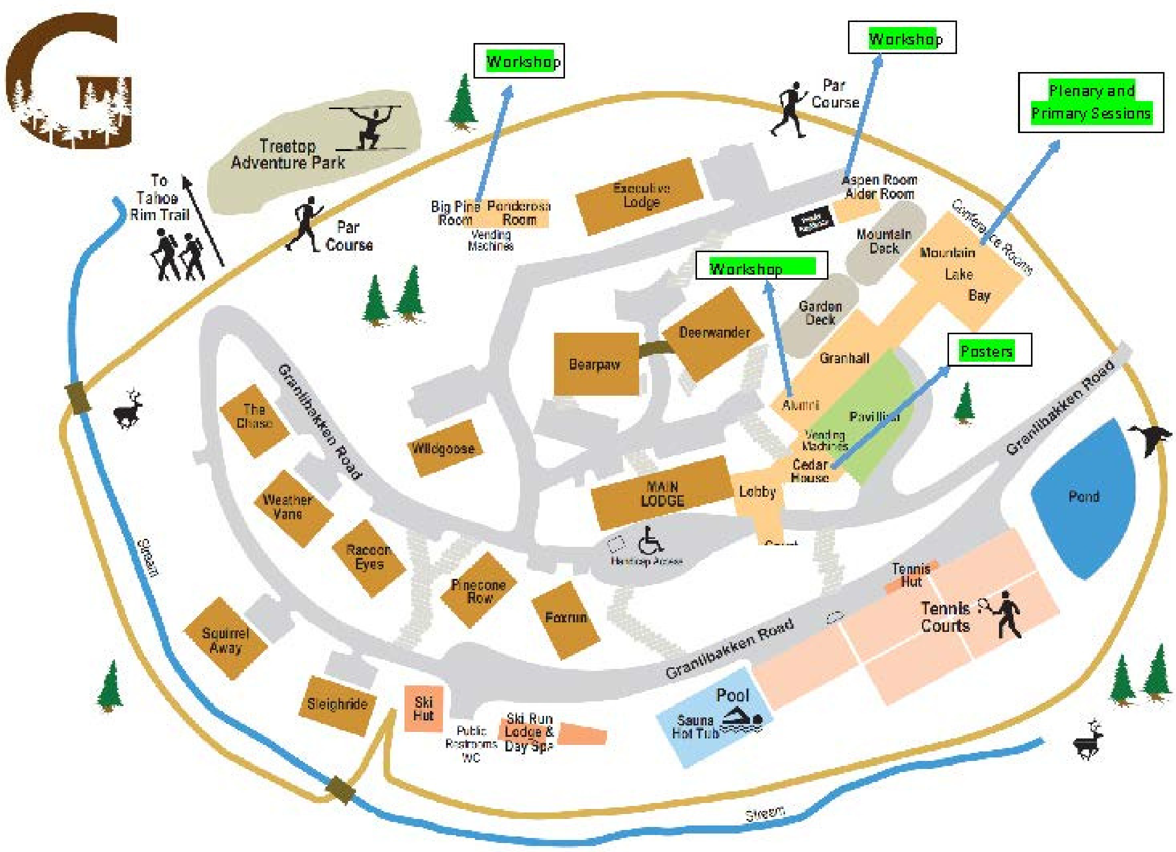
Tuesday, June 13th

Time		Location
7-8:15 am	Breakfast	Granhall
8:30-10:30 am	**Community Observers to Advance Water Science**	**Mountain-Lake Room**
8:30-10:30 am	**Water Science to Promote Environmental Justice and Indigenous Sovereignty**	**Bay Room**
10:30-11 am	Morning Break	Mountain Deck
11-12 pm	Reds Wolman Keynote Lecture	Mountain-Lake Room
12-1:15 pm	Lunch	Granhall
1:30-3:30 pm	**Initiatives Toward Curating Community-Contributed Methodological Protocols and Templates for Reusable Data Products**	**Mountain-Lake Room**
1:30-3:30 pm	**Using Python Packages and HydroShare to Advance Open Data Science and Analytics for Water**	**Big Pine**
1:30-3:30 pm	**CUAHSI Data Infrastructure Overview and Training**	**Alumni Room**
1:30-3:30 pm	**Roundtable Discussion on Strengthening the Talent Pipeline in Support of New Horizons in Hydrologic Prediction and Water Data Science**	**Horseshoe Aspen**
1:30-3:30 pm	**Advances and Future Directions in Hydroinformatics**	**Bay Room**
1:30-3:30 pm	**Self-Guided Field Trip to Tahoe Dam**	**Meet in Lobby**
3:30-4 pm	Afternoon Break	Mountain Deck
4-4:30 pm	Community Awards Ceremony	Mountain-Lake Room
4:30-5 pm	Oral Lightning Talks (Part 2)	Mountain-Lake Room
5-6 pm	Poster Session (Part 2)	Pavilion
6-7:30 pm	Dinner	Granhall/Garden Deck
7:30-9 pm	Collaborative Discussion on CUAHSI Programming	Bay Room

Wednesday, June 14th

Time		Location
7-8:15 am	Breakfast	Granhall
8:30-9:30 am	Eagleson Keynote Lecture	Mountain-Lake Room
9:30-10 am	Morning Break	Mountain Deck
10-12 pm	**Achieving Success in Large Collaborative Research Projects**	**Mountain-Lake Room**
10-12 pm	**The Future of Hydrology Education**	**Bay Room**
12-1:15 pm	Lunch	Granhall/Garden Deck
1:30-3:30 pm	**New Perspectives on Modeling Water in the Critical Zone**	**Mountain-Lake Room**
1:30-3:30 pm	**Hydrologic Prediction**	**Bay Room**
3:30-4 pm	Closing Remarks	Mountain-Lake Room

Granlibakken Campus Map



Community Service Awards

2023 COMMUNITY AWARDS

Congratulations! In recognition of your outstanding vision and leadership in the development of interdisciplinary research and educational opportunities in the water sciences.

BEVERLEY WEMPLE

ADAM WARD

Keynote Abstracts

Florence Bascom Lecture

Florence Bascom was the second woman to earn her PhD in geology in the United States, in 1893. Bascom founded the department of geology at Bryn Mawr College in 1895, and in 1896 Bascom became the first woman to work for the United States Geological Survey. Although most of her work was on the petrography of the Piedmont province, Bascom did produce a USGS Water Supply Paper on the water resources of the Philadelphia district. Bascom mentored numerous women geologists, many of whom also were recognized for their contributions to the field; 8 of the 11 women who were GSA Fellows in 1937 were graduates of Bryn Mawr.

Geophysics for Discovering New Horizons in Water Science

Kamini Singha, Colorado School of Mines

Earth's "critical zone", the zone of the planet from treetops to base of groundwater, is critical because it is a sensitive region, open to impacts from human activities, while providing water necessary for human consumption and food production. Quantifying water movement and stores in the subsurface is critical to predicting how water-driven critical zone processes respond to changes in climate and human perturbation of the natural system. While shallow soils and above-ground parts of the critical zone can be easy to instrument and explore, the deeper parts of the critical zone—through the soils and into rock—are harder to access, leaving many open questions about the role of water in this environment. Here, we will explore a number of key subsurface properties and processes in the hydrologic sciences where geophysics may be able to help serve as a "macroscope", including developing linkages between changes in evapotranspiration and subsurface water stores, mapping water movement in 3-D over large areas, determining connections between geophysical changes and geochemical processes, and testing hypotheses about subsurface weathering and the subsequent controls on hydrogeology. Geophysical tools are central to the quantitative study of these problems in the deeper subsurface where we don't have easy access for observation.

Reds Wolman Lecture

The Wolman Lecture is named after M. Gordon "Reds" Wolman (1924-2010). Wolman was a prominent and much-beloved fluvial geomorphologist who taught at Johns Hopkins University from 1958 until his death in 2010. He advanced the quantitative and interdisciplinary study of rivers, contributed to solving a multitude of water management problems around the world, and was well-known for his insight, humor, and thoughtful mentoring of dozens of graduate students.

Multidisciplinary Approaches to Racialized Urban Hydrology in Atlanta

Richard Milligan, Georgia State University

As in many US cities, Atlanta's urban hydrology is profoundly altered by impervious surfaces and infrastructure-mediated flows that are also thoroughly structured by racism. Since Reconstruction, the development of water infrastructure in Atlanta has been intimately tied to racial segregation and disparity. Couplings of race and urban hydrology have been perennial and profound aspects of life in Atlanta for more than a century. Inadequate water infrastructure at the turn of the 20th century led to an epidemic in disease and skyrocketing death rates in Black communities. Proponents of the earliest segregation ordinances in Atlanta appealed to racist fears blaming high death rates from water borne disease on Black life instead of recognizing the downstream accumulations of waste and risk that were part of white-supremacist development practices. Urban renewal in the mid-20th century razed Black neighborhoods through construction of interstate highways and stadiums that greatly increased urban flooding and combined sewer overflows disparately impacting Black communities. Today, Atlanta's highly segregated Black communities are concentrated in highly impacted watersheds downstream of the central city. As water governance challenges are compounded by climate change and an ongoing interstate water conflict, investments to address inadequate water infrastructure exacerbate green gentrification and contemporary Black displacements. This talk will highlight a number of multidisciplinary collaborations through community-engaged research to better understand and confront the injustices of Atlanta's racialized urban hydrology.

Peter S. Eagleson Lecture

The Eagleson Lecture is named after Peter S. Eagleson, a scientist who integrated ecology and hydrology and redefined hydrology from an ad hoc engineering speciality to a multidisciplinary, global environmental geoscience, in which the green, living features of the ecosystems have an important part to play. He has been seeking to develop new models of dynamic hydrology, looking at the hydrological cycle as the key process linking the physics, biology and chemistry of the Earth system.

Fire and Snow in the West

Kelly Gleason, Portland State University

Snowpacks act like high mountain reservoirs in the western US, where the volume of snow and timing of snowmelt controls the quantity and timing of downstream water resource availability. Snowpacks are vulnerable to warming climate, while forest fires are increasing in seasonal snow zone. Forest fires exacerbate the influence of climate change on snow-water storage through feedbacks of postfire forest-snow interactions. Charred forests shed black carbon and burned woody debris on the snowpack which concentrates on the surface during snowmelt lowering snow surface albedo. These darkened snowpacks are primed to absorb more incoming solar radiation in more open post-fire forests. Using empirical data from in-situ field measurements, long-term monitoring, and geochemical analysis, combined with multi-scale remote sensing, and physically-based snow modeling, we evaluate the spatial and temporal variability of forest fire effects on snow-water storage and snowmelt in the western US. The post-fire radiative forcing on snow decreases snow-water storage, advances the timing of snowmelt, and in high severity burned forests increases the rate of snowmelt for at least 10 years following fire. Regional case studies demonstrate how snow climate, antecedent forest condition, burn severity, and post-fire forest structure together influence the variability of forest fire effects on snow hydrology. Multi-scale coupled snow monitoring, snow remote sensing, and snow modeling integrates forest fire effects on snow-water resources across watersheds and informs water resource management into the future.

Session Descriptions & Abstracts

Navigating NSF's Hydrologic Sciences Program

Chairs: Laura Lautz, Chris Lowry and Hendratta Ali, National Science Foundation

Over the past few years, there have been a number of programmatic changes at the U.S. National Science Foundation (NSF), such as a new focus on innovation and use-inspired science, growth in cross-cutting and interdisciplinary programs, and increasing representation in the scientific enterprise. In this context, we review the scope of the Hydrologic Sciences (HS) Program and other complementary opportunities for the hydrology community.

The HS Program supports fundamental research on continental water processes at all scales, as well as relationships of water with material and living components of the environment. For this workshop, Program Directors will discuss the scope of research supported by the Hydrologic Sciences program and introduce other related disciplinary and cross-cutting programs at NSF. Topics will include the types of awards made through the HS program, the merit review process, guidance on the required proposal elements, and ways to get involved with NSF. The workshop will consist of a presentation, Q&A session, and breakout groups with structured activities.

Innovative partnerships and applied research to achieve resilient water supply in the Western US

Chair: Phil Saksa, Blue Forest Conservation

Abstract 50% of US source water supply originates from forested watersheds, and 73% in the western US. Climate change, population growth, and wildfires in the Western U.S. are increasing pressure on both natural and built infrastructure to reliably provision water supply and renewable hydropower. Changes in these forest ecosystems, through both natural disturbances like disease and wildfire which have become more extreme in recent years, and active forest management, has a direct impact on water security. Understanding how these disturbances and different management scenarios will impact water resources is critical for decision-making but requires new scientific approaches and unconventional research partnerships. This session will focus on several elements of applying hydrologic science and natural systems research to enable a systems-level approach to managing forests, watersheds, and water supply. We will be focusing on 1) the application of science and research to inform policy and management of source watersheds and downstream urban infrastructure, 2) the ability of Earth Observations (EO) to monitor and track ecosystem and watershed health which can motivate long-term support and resources for forest ecosystem management, and 3) the dynamics and interactions between individuals and organizations - a social science perspective that can help inform how to build successful partnerships for holistic management across often-siloed entities. The goal of this session will be to encourage you, as applied researchers and scientists, to think beyond traditional academic partnerships and work more closely with the communities, local organizations, land managers, and utilities in the places where you study hydrologic and other natural system processes. Our desired outcome is to share learnings and drive discussion on how to better leverage findings from applied research to inform partnerships that can effectively motivate collaboration, drive action, and secure resources for improved natural infrastructure management.

Jordyn Wolfand, University of Portland

Title: Oregon's water supply at risk: Assessing natural, built, and social hazards and leveraging machine learning to inform solutions

Water supply challenges in the state of Oregon are representative of those across the Western U.S., where population growth, climate change, land use changes, and aging infrastructure are converging to threaten drinking water supply. As utilities determine the best investments for promoting resilience, understanding how these challenges vary across water agencies and the state can help promote more efficient communication and collaboration between water providers. For example, a public water system that faces high social hazards may require financial assistance programs for customers to increase their esilience. On the other hand, addressing a system facing wildfire risk and other natural hazards may be best suited for state or federal funding dedicated to reducing those risks. Understanding the vulnerability of water suppliers in Oregon to multiple natural, social, and built infrastructure hazards is key to creating resilient infrastructure and systems. Our recent work seeks to better understand the hazards to drinking water source areas; how vulnerable public water systems are to natural hazards, infrastructure vulnerabilities, and social stressors; and how dependencies and collaborations between public water systems could mitigate or exacerbate these vulnerabilities. State, regional, and local agencies in charge of allocating shared resources would benefit from better understanding these linkages, vulnerabilities, and potential interventions across jurisdictions.

Raha Hakimdavar, Zyon Space

Title: Earth Observations (EO) for monitoring and tracking ecosystem and watershed health

There is an untapped opportunity for space-based Earth observations (EO) to support data-driven decision-making in conservation finance. EO can identify and assess landscapes in need of restoration, track the impacts of wildfires and other disturbances over time, and evaluate the effects of restoration activities. These data are not a stand-alone solution but an increasingly relevant tool to enable more rapid, consistent, and repeatable assessments and effectiveness monitoring. These data can complement established land-based measurements for vegetation condition, canopy mapping, carbon accounting, soil quality, hydrological conditions, and burn severity. Given the spatial and temporal coverage they can provide, space-based data could support the prioritization of project areas, guide restoration activities to optimize resources, and facilitate effectiveness monitoring or evaluating restoration activities post-treatment. This is especially helpful in remote and otherwise data-limited areas. This talk will provide an overview of the opportunities and challenges for utilizing EO to monitor and track ecosystem and watershed health under a changing climate.

Gabrielle Boisrame, Desert Research Institute

Title: Forests, Farms, and Fires – Collaborative Studies to Prepare for an Uncertain Water Future

Snow-dominated mountain watersheds are an important source of freshwater to agriculture, municipalities, and natural systems. The Western U.S. has engineered its water supply systems around a hydrologic regime dominated by snow accumulation and melt. The behavior of snowpack and streamflows are already changing, however, and expected to change even more in the coming decades. At the same time, climate change and forest management policies over the last century have combined to create forests that use more water and are more prone to catastrophic wildfires than they have been historically. Addressing these changes requires planning that incorporates everything from the most downstream users to the highest headwaters. This presentation will cover multiple interdisciplinary research projects involving hydrologists, climate scientists, biologists, fire and forest managers, economists, and farmers. These projects range from studying agricultural water use to the ecohydrology of historical fire regimes, but all revolve around understanding how human actions can impact future water resources.

Student Centered Research

Chair: Amanda Donaldson, University of California at Santa Cruz

The session welcomes participants from every career stage to explore the elements of a "student-centered research program" which aims to enhance the ability of students to build meaningful graduate school experiences. The session consists of *student-led* hydrologic research, community-engaged research, interdisciplinary collaborations, and diversity initiatives. A main goal of this session is to give graduate students and other early-career scientists a space to discuss what mindsets, support systems and research structures foster graduate student leaders. Therefore, the session will include a panel discussion to engage both the invited graduate student leaders and session attendees. The discussion will explore themes of building science-identities, developing scientifically and societally relevant research, and aligning graduate school journeys with future career goals.

Kenneth Swift Bird, Colorado School of Mines

Title: Metals, Mining, and Indigenous Communities

There are four C's that have been instrumental to my success as a graduate student: culture, community, collaboration, and co-mentorship. As an Oglala Lakota Tribal citizen, the spark that led me to a career in hydrology was water quality issues—primarily from arsenic and uranium—in groundwater on my Tribal homelands, the Pine Ridge Reservation. The hydrology program at Colorado School of Mines is a community-oriented and collaborative environment where ideas flow freely and people work together to solve problems, which has helped me grow massively as a scientist. Co-mentorship from helpful and supportive advisors has allowed me to combine hydrologic and geochemical insights to assess metal fate and transport in streams and groundwater, and build a foundation as an interdisciplinary scientist. My ultimate goal is to become an expert in metal fate and transport, and work to address water quality issues in Indigenous and other marginalized communities. Here, I detail the factors that have led to success in my graduate career, and highlight two research projects from my early career. These projects include studying arsenic and uranium dissolution in groundwater of the Pine Ridge Reservation in South Dakota, which led to one of the first peer-reviewed publications on hydrogeology for the site, and assessing how surface water-groundwater interactions influence metal fate and transport in legacy mining-impacted watersheds in Colorado.

Julianne Scamardo, University of Colorado

Title: Heterogeneous Environments: Ephemeral Floodplains and Interdisciplinary Collaborations in the Southwest U.S.

Heterogeneity on the landscape as well as in graduate school support networks can provide a number of critical functions. In dryland non-perennial river corridors, the spatial and temporal heterogeneity of geomorphic units is thought to support diverse physical and ecological functions, including flow attenuation and habitat. While studies on the characteristics and drivers of geomorphic heterogeneity have been developed in perennial streams, similar studies in ephemeral streams are lacking. Given the ubiquity of non-perennial streams globally, understanding the magnitude and drivers of geomorphic heterogeneity in ephemeral river corridors is critical to managing drylands. To address these research gaps, geomorphic units were mapped in 30 unconfined river corridors within six non-perennial watersheds in Utah and Arizona, USA. Landscape heterogeneity metrics based on diversity, evenness, and patch density were used to quantify geomorphic heterogeneity within each reach. Metrics were compared with variables that potentially constrain or drive heterogeneity, including floodplain shape, dominant grain size, large wood abundance, and proxies for flood disturbance. While heterogeneity positively correlated with metrics for both morphology and disturbance, statistical models suggest that morphologic context, particularly floodplain width, was a more important predictor for estimating geomorphic heterogeneity. Still geomorphic units reflected aggradation processes indicative of a range of flood energies, suggesting a strong tie between heterogeneity and disturbance. Much in the same way that morphology and disturbance influence geomorphic heterogeneity, structure and change can be strong drivers of a diverse and supportive graduate school landscape. Various supportive units – including advisors, collaborators, and fellowship cohorts – can drive a heterogeneous network critical to navigating the graduate program and pursuing independent and interdisciplinary research interests.

Riley Post, University of Iowa

Title: When it Rains it Pours: My Path to Researching Floods and Finding My Place in Academia

In this talk I will present my background in engineering and the path that eventually led me to pursue a PhD in Civil Engineering at the University of Iowa. This will include a brief discussion of my industry experience as a Water Resources Engineer with the Rock Island District of the US Army Corps of Engineers before outlining my research as a PhD Candidate. My work focuses on flood mitigation using large networks of small ponds that are actively managed with gated outlets, a concept known as distributed storage. Finally, I will discuss my experience with, and perspectives on, “student centered research” as a graduate student.

Go Fund It! Exploring CUAHSI’s Grant Programs

Chaired by: CUAHSI's Standing Committees on Instrumentation, Education & Outreach and Informatics

Speakers:
JP Gannon, Virginia Tech
Aubrey Dugger, NCAR
Robert Payn, Montana State University

CUAHSI supports annual grant competitions aimed at broadening access to instrumentation, software and cyberinfrastructure, and the enhancement of graduate research projects. Learn how to fund a site visit or visit by an expert to receive training on new sensor technologies, develop new hydroinformatics computing capacity, or build a new research site or interdisciplinary collaboration into a graduate project. Students, early career faculty, and established faculty who may serve as mentors or advisors are encouraged to apply. Standing committee members will share their insights on the application process and grant reviews. Recent awardees will describe how their successful grants have enhanced their work.

Community Observers to Advance Water Science

Chair: David Hill, Oregon State University

Water science is advanced and supported through a wide variety of data sources. These include monitoring programs by federal, state, and local governmental agencies, as well public organizations such such as watershed councils and others. These data have intrinsic value, and also serve as ground truth for theoretical models of hydrologic processes. Increasingly, community (or citizen) science programs provide high-quality datasets that complement the data collection programs noted above. In this session, you will hear about several community science programs focused on water and snow. Presenters will describe their programs, and discuss how the community participation has provided for science advances that would not otherwise be possible. Please join us and, afterwards, get involved with these programs or others available in your area!

Ryan Crumley, Los Alamos National Lab

Title: Quantifying the effects of citizen science data collection on snow modeling using the Community Snow Observations dataset

Community Snow Observations (CSO) is a collaboration between snow scientists and snow recreationists and professionals, for gathering, storing, and serving snow depth observations of snowpacks globally (https://communitysnowobs.org). We will review a recent case study from the Chugach Mountains of Alaska that quantified the improvements made when CSO participants' snow depth measurements were incorporated into the snow process model workflow using a simple data assimilation scheme. Additionally, our current research aims to simulate snowpack dynamics in various watersheds in the western U.S. where participants are submitting measurements. We are extending our research questions and methods to include: 1) quantifying the differences between assimilating community-based measurements versus assimilating instrument-based SWE measurements, and 2) investigating the effects of the spatial distribution of the assimilated CSO measurements on model output. Initial results from these new study areas reveal that adding more data to the assimilation, either more community-based measurements or additional instrument-based SWE measurements, improves model performance. Particular attention will be given to the development of methods to constrain measurement uncertainty, to acquire high quality measurements from participants, and to validate of community-based measurements. This ongoing research has implications for use in remote, mountainous environments where high resolution (in time and space) snow information and weather data are often unavailable but snow sports athletes, snow professionals, and the general public access these locations for work and recreation.

Benjamin Hatchett, Desert Research Institute

Title: Precipitation Phase Observations from the People and for the People: The Mountain Rain or Snow Program

The phase of precipitation–liquid, frozen, or mixed–during storms governs the type and impact of both immediate and delayed hydrologic responses. These responses are particularly impactful in mountains, which act as natural water towers but also present hazards to life and property. Despite its importance, observing and estimating precipitation phase using near-surface meteorological data from standard instrumentation is inherently limited as there exists a range of atmospheric conditions during which precipitation of different phases occurs. To address this limitation, we started the citizen science project "Mountain Rain or Snow" to provide direct precipitation phase observations across the continuum of space and time in mountain regions across the United States. Mountain Rain or Snow exemplifies the potential for citizen science projects to address scientific questions and build community engagement in the hydrosciences. Since 2021, nearly 700 community observers have submitted over 35,000 precipitation phase observations through a web-based app. Participants join Mountain Rain or Snow through subscriptions to a messaging service based on regionally relevant keywords (e.g., “Winter”, “ColoRainOrSnow”, or “Lake Effect”). We then send text messages to specific regional subscriptions during storms of interest. Observers enter data via a web app and we perform quality control on the backend. The rain, snow or mixed precipitation observations submitted to Mountain Rain or Snow support science outcomes such as: 1) constraining the temperature and humidity conditions at which precipitation phase transitions occur in different regions, 2) quantifying the ability of satellites to skillfully partition precipitation phase, and 3) connect meteorological conditions with hydrologic outcomes to provide an atmosphere-through-bedrock perspective of rain-on-snow events.

Angelica Maria Gomez, University of North Carolina at Chapel Hill

Title: Citizen science monitoring of lake water levels helps to improve the understanding of water dynamics from space

Worldwide, there are over 2 million lakes, wetlands, and reservoirs with an average area of less than 100 square km. These systems regulate temperature, energy, and flow, support biodiversity, act as sentinels of climate and environmental changes, and can provide additional benefits to communities (e.g., drinking water supply, food production, and cultural activities). Continuous water level monitoring is generally uncommon, which challenges the evaluation of factors impacting water dynamics, and limits the understanding of key ecosystem functions that inform water management decisions. To help address this lack of monitoring, the project Lake Observations by Citizen Science and Satellites, LOCSS (https://www.locss.org/) was created in 2017 and funded by the NASA Citizen Science for Earth Systems (CSESP) Program. LOCSS engages citizen scientists in regularly monitoring lake water and combines those measurements with satellite data to better understand lake water dynamics. I will share experiences with the implementation and operation of LOCSS covering three aspects: 1) the different connections with local partners and communities, 2) the applications of integrating water level ground observations and satellite data, and 3) the ongoing opportunities. LOCSS currently has 256 gauges distributed in nine countries (the U.S., France, Bangladesh, India, Pakistan, Nepal, Canada, Chile, and Colombia) and more than 55,000 lake height measurements.

Water Science to Promote Environmental Justice and Indigenous Sovereignty

Chair: Ryan Emanuel, Duke University

Water research can be motivated by intellectual curiosity, management needs, or other factors, including a desire to promote environmental justice (the fair treatment and meaningful involvement of all people in environmental decisions) or Indigenous sovereignty (the rights of Indigenous peoples to govern their communities, their territories, and information about these things). Indigenous peoples face especially pressing water-related challenges that stem from the colonial exploitation of land and water - both historically and in the present. Research that is ethically grounded and informed by an understanding of colonialism and its impacts can help to address pollution, climate change, and other water-related challenges in ways that also promote justice and empowerment for Indigenous peoples. This session highlights various approaches to ethically grounded research that aims to address pressing water challenges for Indigenous communities in North America. Speakers highlight some of the way ways that modeling, experiments, data analysis, and policy analysis can answer important technical questions while also promoting environmental justice and Indigenous sovereignty.

Kelsey Leonard, University of Waterloo

Title: Advancing Water Justice: Earth Law and Rights of Water

In an era marked by escalating environmental crises and growing concerns about equitable access to water, this presentation aims to explore the transformative potential of Earth Law and the Rights of Water in advancing water justice. By examining the intersection of legal frameworks, Indigenous Science, and sustainability principles, this presentation delves into the emerging paradigm of recognizing the inherent rights of water for planetary healing. Through case studies and interdisciplinary perspectives, the session illustrates how the adoption of Earth Law principles can drive meaningful change, foster community engagement, and pave the way for a more just and sustainable relationship with water, ensuring its protection and availability for present and future generations.

Ranalda L. Tsosie, New Mexico Institute of Mining and Technology

Title: Applying Innovative Technologies to Facilitate Environmental Justice for Tribal Water Sources

Tó Éí Ííná Át'é (Water is life). Throughout the world many Indigenous communities are facing water challenges, from lack of and access to adequate infrastructure, water rights, climate change and affects from mining legacies. This study used a Diné core philosophies to guide the research in a respectful manner and establish a cohesive and cooperative study that combines western science, traditional knowledge, and community involvement. Most importantly promoting environmental justice, Indigenous sovereignty and capacity building through innovative approaches to address the long-standing water contamination issues in Diné communities. And offers a temporary solution for Indigenous communities facing similar water challenges. Current research efforts are focused on optimizing a handheld point of use filter unit with a filter casing design that is customizable to a community's needs and/or household through a cartridge system that is easily removable and exchangeable.

Parisa Sarzaeim, University of Wisconsin- Madison

Title: From Indigenous Climate and Water Databases Sovereignty to Environmental Justice

The inadequacy of hydroclimate and water-related (quality and quantity variables) databases following the FAIR and CARE data principles limits water resources management research on U.S. tribal lands. The FAIR principles support the data's Findability, Accessibility, Interoperability, and Reusability, and the CARE principles include the tribal data's Collective benefits, Authority to control, Responsibility, and Ethics. In our group, we have initiated research on tribal hydroclimatic and water resources databases to evaluate the data's availability, discoverability, and sufficiency, focusing on minorities' rights in their data sovereignty with the goal of achieving environmental justice for Native Americans.

Collaborative Discussion on CUAHSI Programing

Chair: Veronica Sosa Gonzalez, CUAHSI

This workshop will provide attendees information about CUAHSI's current programs. Participants will have the opportunity to engage with one another through a collaborative brainstorming exercise about CUAHSI programming that is intended to shape ideas, for example, propose a new workshop, start drafting a grant proposal or ideas for CVU courses. Goals for this workshop are for participants to meet other members of the CUAHSI community, and potentially new collaborators; and to enable participants to collaborate with CUAHSI on programming.

Achieving Success in Large Collaborative Research Projects

Chair: Helen Dahlke, University of California, Davis

Getting started on writing or managing multi-institutional, multi-investigator collaborative projects can be a daunting challenge! In this session, we will have three invited speakers who will share their approaches on how they manage large-collaborative projects to yield successful and innovative research and broader impact. The session will address how to put a large collaborative project proposal together and how to select a successful team. We will l learn what approaches are most useful to ensure successful collaboration, what challenges large collaborative projects might encounter, and what advice leaders of large collaborative projects would give to others who want to lead such projects.

Amy J. Burgin, University of Kansas

Title: Team Science Approaches to Building the Aquatic Intermittency effects of Microbiomes in Streams (AIMS) Project

Despite their ubiquity, understanding how flow intermittency impacts stream ecosystem processes and downstream water quality remains elusive. Addressing this challenge requires integrating hydrology, biogeochemistry and microbial methods to untangle the interactions and effect on water quality. The Aquatic Intermittency effects on Microbiomes in Streams (AIMS) project integrates datasets on hydrology, microbiomes, and biogeochemistry in three regions (Southeastern Forests, Great Plains, Mountain West) to test the overarching hypothesis that physical drivers (e.g., climate, hydrology) interact with biological drivers (e.g., microbes, biogeochemistry) to control water quality in intermittent streams. AIMS' solution to build scientific capacity and workforce development is to: 1) create a network of instrumented sites to quantify and predict how intermittency controls downstream water quality, 2) educate and train scientists from diverse backgrounds in collaborative science and interdisciplinary methods to study intermittent streams, and 3) provide workforce training in environmental "big data" tools. Building the AIMS team (>50 scientists, including undergraduates, graduate students, postdocs, technicians, professors, research scientists, and librarians) required focused communication, consensus building, policy development, and creation of shared protocols all of which support our vision and project goals. This talk will share lessons learnt from building the project team, writing the proposal for funding, training student cohorts, and solving problems that are inherent to large collaborative efforts.

Sarah Naumes, Secure Water Future

Title: Priming Success Through Team Collaboration Planning

Secure Water Future is a collaborative of over 80 investigators from across the semi-arid western US aiming to improve agricultural and environmental water resilience. This talk focuses on collaboration planning as an iterative approach to optimizing success with large, distributed interdisciplinary water science teams. Collaboration planning establishes details surrounding team functioning, conflict prevention and management, and quality improvement activities. Secure Water Future has laid the groundwork for future success by intentionally foregrounding a team approach in our work.

Baskar Ganapathysubramanian, Iowa State University

Future of Hydrology Education

Chair: JP Gannon, Virgina Tech

This panel will focus on ways we can improve our teaching in hydrology. These improvements may come from technical advances in content delivery and active learning, new analog strategies for the classroom and field, and/or expanding hydrology topics to include climate change, human impacts, race/racism, social justice, indigenous issues and knowledge, and more.

Alexandra Lutz, Desert Research Institute

Title: Overview of the Graduate Program of Hydrologic Sciences at UNR

Matt Ross, Colorado State University

Title: Integrating Large Language Models (like ChatGPT) into the data-driven hydrology classroom

With stunning speed, large language models and their derivatives like ChatGPT or GitHub Copilot, went from a far-distant theoretical advance to a real and potentially disruptive part of teaching. Here, I will discuss some of the benefits and pitfalls of integrating ChatGPT into some data-driven hydrology classes at Colorado State University. As with all university instructors, I was faced with the choice of integrating ChatGPT into the class, ignoring it, or begging students to not use it. I chose to integrate it in two of my data driven courses: “Watershed Problem Analysis” a senior level capstone for our watershed major and “Environmental Data Science Applications: Water Resources” a graduate course for analyzing water resource data. In both courses, I was frequently delighted by the ability for ChatGPT to act like a co-teacher and answer some of the students’ basic questions. However, I was also frequently frustrated by how ChatGPT would send students down rabbit-holes that ultimately made the lesson harder. The difference between ChatGPT being useful and actively harmful primarily came down to how much knowledge the student had prior to asking for help. While I enjoyed using this new tool in the classroom, I also find ChatGPT and the rapid progress of large language models generally, quite destabilizing. Leaving me with some core questions about my teaching and teaching hydrology generally.

Crystal Ng, University of Minnesota

Title: Incorporating Indigenous Perspectives and Environmental Justice in Hydrology Education (as a Settler Scientist)

New Perspectives on Modeling Water in the Critical Zone

Chair: Adrian Harpold, University of Nevada, Reno

The Critical Zone (CZ) is the skin of the earth that stores and releases the freshwater that humans and ecosystems depends on. CZ properties therefore, offer potential to improve and transform ecohydrological modeling. The presentations in this session will address how CZ processes can inform predictive models and help address water management challenges, such forest management, water supply planning, and ecosystem disturbance.

Xiaonan Tai, New Jersey Institute of Technology

Title: Tree mortality as a lens to investigate lateral groundwater flow

Lateral redistribution of subsurface groundwater is a critical hydrological process that is notoriously difficult to observe directly. Spatial analysis of drought induced tree mortality offer a useful perspective to reveal insights about the systematic variations in soil water and plant traits across the landscape. This talk will focus on how spatial analysis and process-based modeling can be combined with various ground and spatial observations to investigate the role of lateral groundwater flow on forest ecosystem mortality.

Paul Brooks, University of Utah

Title: Hydrologic partitioning in the critical zone (revisited): How CZ structure informs hydroclimatological modeling for a changing climate

Efficient and equitable management of water resources in a rapidly changing climate requires incorporating recent advances in the fundamental understanding of hydroclimate and catchment water balance into existing decision making frameworks.

The last two decades have seen tremendous advances in understanding how precipitation is partitioned between evapotranspiration, groundwater recharge, and streamflow. These advances have resulted in an evolution of the conceptual and perceptual models used in the basic research community that increasingly are at odds with management models. This presentation will focus on ongoing efforts to develop tools, metrics, and simple models that incorporate these advances into existing predictive frameworks used by resource managers in the western US. We focus on how critical zone structure both above and below ground highlights the need for nuanced spatial and temporal representations of both water storage and energy availability and how these nuanced representations greatly improve predictive capability. Examples include how fine-scale understanding and models of vegetation’s influence on energy balance explain the growing body of surprising results on how forest disturbance alters snowpack, streamflow, and vegetation recovery. Similarly, observations, hydrochemistry, water age tracers, and models of catchment-scale hydrologic partitioning demonstrate the importance of multi-year climate on groundwater storage and runoff efficiency. Translation of these models into decision support tools provides managers with advanced, much more accurate and earlier predictions of both streamflow amount and timing. Partnering with colleagues in atmospheric science, observations of long-term, regionally-coherent patterns in groundwater/CZ storage have led to the development of new understanding and models of interactions between the El Nino Southern Oscillation (ENSO) and the Atlantic Ocean which control regional precipitation and snowfall anomalies. The resulting climatological models provide managers with advanced predictions of precipitation and temperature in seasonally snow-covered mountains of the western US months before winter begins. We hope these findings generate discussion on how our community can more rapidly propagate new understanding into water resource management where the need is great and the consequences are high.

Naomi Tague, University of California, Santa Barbara

Title: Some interesting things we know and don't know about critical zone hydrology from a forest's perspective.

Hydrologic Prediction

Chair: Witold F. Krajewski, University of Iowa

This session will emphasize the forecasting, as in the future, aspect of hydrologic processes. The three invited talks will address the short-term (hours to days), medium-term (weeks to months) and long-term (years to decades) forecast time horizon. The short-term horizon will focus on our ability to forecast streamflow in a river network. The talk will address the question of the skill of the current models and systems and the critical obstacles to improving it. The medium-term horizon will be about droughts, our ability to predict them and the necessary information, including satellite remote sensing. Both physics- and data-based approaches will be discussed. Finally, the long-term horizon will be about the ability of climate models to provide actionable information about the future hydrologic processes relevant to planning, improving and maintaining broadly understood infrastructure.

Author: Fred Ogden, NOAA/NWC
Presented by: Steve Burian, University of Alabama

Title: Continental Scale Hydrologic, Hydraulic, and Water Quality Forecasting: Limits on Predictability and Their Influence on Modeling Expectations

Provided perfectly forecast weather and precipitation, what remains is a classic "wicked" environmental prediction problem. The broad hydrological sciences literature contains many examples of contradictory conclusions and surprising field observations that upend widely held theories. Much of the contradiction comes from the uniqueness of place, and the fact that this uniqueness is not described by scale. While the contributing area is often a dominant predictive variable in regression of hydrologic observables, local details such as soil texture and structure, land-use/cover, underlying geology, anthropogenic effects, channel network, climate, etc. all matter. This presentation begins by considering highly predictable situations, as well as considers the prevalence of these situations. The remainder of the hydrophysiographical state space and number of low-observability parameters required to apply models of differing complexity represents the true challenge. This presentation provides a set of science questions that the hydrologic science research community can use to help quantify predictability in a way that will benefit continental scale water resources predictions.

Hamid Moradkhani, University of Alabama

Title: Recent Developments on Drought Monitoring by means of Physically-Based Modelling, Remotely-Sensed Data Assimilation and Deep Learning

Droughts are among the costliest natural hazards that occur annually worldwide. Their socioeconomic impacts are significant and widespread, affecting the sustainable evelopment of human societies. Satellite remote sensing provides unprecedented information enabling a wide range of studies including drought monitoring and forecasting. This presentation demonstrates the combined use of real time satellite soil moisture and evapotranspiration as key terrestrial variables for drought monitoring across the continental US while benefiting from state-of-the art data assimilation as an effective means to integrate multivariate observations across spatial and temporal scales with land surface models to characterize droughts probabilistically. Additionally, we show how forcing data, in particular precipitation, obtained from different satellites or reanalysis products can significantly influence the accuracy of drought monitoring. Benefiting from these massive data sets and model runs, we demonstrate an integrated drought index to more reliably detect drought events and compare that with operational US drought monitor. Finally, we present our more recent development to detect rapidly developing type of droughts, the so-called flash drought, by means of deep learning and show how we can capture fine- and coarse-scale spatial flash drought patterns and abrupt changes in the standardized soil moisture temporal patterns that is important for flash drought identification.

L. Ruby Leung, Pacific Northwest National Laboratory

Title: Modeling Extreme Events and Their Future Changes

Some of the most consequential outcomes of global warming for societies and ecosystems are changes in extreme events. Comparing 2000-2019 with 1980-1999, extreme temperature and flood events have more than doubled globally while the number of disastrous storms and droughts has increased by 30-50%. While the nonlinear increase in latent energy with warmer surface air temperature may explain the global increasing trends in weather extremes, credible projections of the regional changes in extreme events and changes in different types of extreme events remain challenging, partly because of model limitations in simulating the extreme events. In this presentation, I will discuss some recent advances in modeling extreme events and their future changes, including examples of modeling mesoscale convective systems, atmospheric rivers, and hurricanes, and connecting future storm changes to changes in the storm environments and their hydrologic impacts.

Workshop Descriptions

CUAHSI Data Infrastructure Overview and Training

Clara Cogswell, CUAHSI

This workshop will present an overview of CUAHSI data infrastructure and an introduction to HydroShare and CUAHSI apps.
This workshop will increase participant familiarity with CUAHSI data tools such as HydroShare, MATLAB online, CUAHSI Jupyterhub, HydroShare on Jupyter, and HydroClient.
Intended audience: Data managers, PIs, graduate students, Water Managers.

Initiatives Toward Curating Community-Contributed Methodological Protocols and Templates for Reusable Data Products

CUAHSI's Standing Committee on Instrumentation
Speakers:
Rob Payn, Montana State University
Margaret Zimmer, University of California, Santa Cruz

This session will consist of a panel discussion and listening session on ideas for building community around shared methodological protocols and generation of reusable data products.The session will start with an overview of the motivation for changing the name of the instrumentation committee (tentative new name: Data Acquisition, Monitoring, and Methods committee) and an overview of the committee's initial ideas on how to proceed with a community-led initiative under their updated scope.

The panel discussion will be followed by a listening session. We encourage session participants to come prepared with their own insight about challenges or successes in building community around methodology. Most of us have a story about how we have spent more time than should be necessary to get from an instrument manual to a useful data product, and would be excited about participating in a community of sharing knowledge on protocols if it had critical mass and infrastructure to make it useful and practicable. The questions we would pose to the session participants are: how do we change the culture to reach that critical mass and how do we use existing infrastructure or find resources for new infrastructure to allow a platform for curation?

Using Python Packages and HydroShare to Advance Open Data Science and Analytics for Water

Jeff Horsburgh, Utah State University

Scientific and management challenges in the water domain require synthesis of diverse data. Many data analysis tasks are difficult because datasets are large and complex. Overcoming barriers to accessing, organizing, and preparing datasets for analyses can transform the way water scientists work.

Building on the HydroShare repository's cyberinfrastructure, we have advanced two Python packages that make data loading, organization, and curation for analysis easier, reducing time spent in choosing appropriate data structures and writing code to ingest data. These packages enable automated retrieval of data from HydroShare and the USGS's National Water Information System (NWIS) (i.e., a Python equivalent of USGS' R dataRetrieval package), loading data into performant structures that integrate with existing visualization, analysis, and data science capabilities available in Python, and writing analysis results back to HydroShare for sharing and publication. While these Python packages can be installed for use within any Python environment, we will demonstrate how the technical burden for scientists associated with creating a computational environment for executing analyses can be reduced and how sharing and reproducibility of analyses can be enhanced through the use of these packages within CUAHSI's HydroShare-linked JupyterHub server.

Workshop participants will learn how these two Python packages can be used to more easily access data and to build, share, and publish more reproducible scientific workflows following Findable, Accessible, Interoperable, and Reusable (FAIR) principles. The HydroShare Python Client hsclient and USGS NWIS dataretrieval packages can be installed in a Python environment from the Python Package Index using the PIP utility or they can be used online via the CUAHSI JupyterHub server (https://jupyterhub.cuahsi.org/) or other Python notebook environments like Google Collaboratory. Source code, documentation, and examples are available in GitHub at https://github.com/hydroshare/hsclient/ and https://github.com/USG-python/dataretrieval.

Participants should have at least some rudimentary knowledge of Python or another programming language. Knowledge of Jupyter Notebooks would be helpful, but not required.

Roundtable Discussion on Strengthening the Talent Pipeline in Support of New Horizons in Hydrologic Prediction and Water Data Science

Steve Burian, University of Alabama

Many employers have expressed concerns about the challenges facing the water sector talent pool serving planning, engineering, forecasting, management, and operations. Projected retirements, departures from the water profession, and reduced interest from youths is increasing the future risk across professional organizations. This session will provide a forum for participants to examine the implications of new horizons in hydrologic prediction and water data science on the needs for educating the talent pool. Facilitators will provide background and thoughts from the perspective of USGS, the NOAA Cooperative Institute for Research to Operations in Hydrology (CIROH), and others. Participants will be led through workshopping exercises to develop lists of needed knowledge, skills, and competencies and approaches to build a diverse workforce and prepare the next generation for practice.

Advances and Future Directions in Hydroinfomatics

CUAHSI's Standing Committee on Informatics
Speakers:
Aubrey Dugger, NCAR
Elnaz Pezeshki, East Carolina University

Hydroinformatics has offered novel solutions for water-related challenges that can meaningfully provide integration among hydrology, data science, system engineering, and computational intelligence. The focus of this session is on highlighting advances and future directions in hydroinformatics, particularly leveraging CUAHSI services. We welcome innovative and collaborative approaches to implementing hydroinformatics techniques in rainfall-runoff modeling, analysis of hydrologic data, and complex coupled modeling systems (e.g., numerical weather prediction, coastal models with hydrologic models, earth system models), among others. The CUAHSI Standing Committee on Informatics particularly encourages contributions from early-stage researchers, students, women, and minority groups, as well as from previous Hydroinformatics Innovation Fellowship (HIF) awardees and informatics blog contributors.

Poster & Lightning Talks

Advances in Water Forecasting

Travis Dantzer, University of Michigan - Poster #1
Generating interpretable rainfall-runoff models automatically from data
*Lightning talk on Tuesday June 13

Anshika Kandhway, University of California, Merced - Poster #2
Quantifying climate change impacts on crops growing in Merced, California

Daniel Lassiter, University of Virginia - Poster #3
19 Years of High-Resolution Radar Rainfall Made Model-Ready

Building Resilience through Multi-Benefit Water and Watershed Management

Eli Boardman, University of Nevada, Reno - Poster #4
Modeling the Impact of Large-Scale Forest Structure Disturbance on Droughts and Floods in the Tahoe-Central Sierra Region
*Lightning talk on Monday June 12

G. Aaron Alexander, University of Wisconsin-Madison - Poster #5
Better representation of urban hydrologic processes alters surface water and temperature cycles in regional coupled climate models
*Lightning talk on Monday June 12

Adrian Harpold, University of Nevada, Reno - Poster #6
Tools and tradeoffs in water supplies from forest management in the Sierra Nevada

Rachel Zobel, University of Delaware - Poster #7
Identifying the Current State of Stormwater Management and Green Stormwater Infrastructure on Public University Campuses in the Chesapeake Bay Region

Community Observers to Advance Water Science

Jan Seibert, University of Zurich - Poster #8
Can the public observe what models need? – Experiences from the CrowdWater project

Critical Zone Science

Antonio Alves Meira Neto, Colorado State University - Poster #9
Effects of Forest Cover on Extraneous Fluxes at the Catchment Scale

Alexandria Kuhl, Michigan State University - Poster #10
Assessing the effect of grazing management on field scale water and nutrient fluxes on pasture and rangeland

Meagan Tobias, University of Michigan - Poster #11
Fast stream sediment load estimation via soft sensing and machine learning

Russell Callahan, University of California Santa Cruz- Poster #12
Deep weathering in the California Coast Range: Implications for water movement and storage in the critical zone

Melinda Martinez Gonzalez, University of California Santa Cruz - Poster #13
Hillslope-scale biophysical and microclimate controls on non-perennial streamflow generation

Annika Hjelmstad, University of California Irvine - Poster #14
Attribution of Sea-Level Rise-Induced Roadway Flooding to Anthropogenic Emissions
*Lightning talk on Monday June 12

Lazaro Perez, Desert Research Institute - Poster #15
High-performance hydrological model of Lake Tahoe's headwater basin

Eric Wineteer, University of California, Riverside - Poster #16
Estimating Mountain Aquifer Recharge: A Generalized Recession-based Technique

Mariana Webb, Desert Research Institute - Poster #17
Determining sensitivity and thresholds of antecedent soil moisture amplifying flood response from atmospheric rivers
*Lightning talk on Monday June 12

Omowumi Erukubami, University of Delaware - Poster #18
Assessment of Sea Level Rise Impacts on Aquifer Systems in Coastal Environments: A Case Study of Bowers Beach, Delaware

Inclusive and Collaborative Research

Sarah Ledford, Georgia State University - Poster #20
Is there a place for urban beaver? Comparing hydrologic and nutrient impacts of urban beaver ponds to stormwater ponds

Ed Maurer, Santa Clara University - Poster #21

Climate change forecasts, information, and adaptation in Central American smallholder communities through participatory and student centered research

Matthew Ross, Colorado State University - Poster #22

Making Data Sing - The Present and Future of Water Data Harmonization Efforts

Daniel Saftner, Desert Research Institute - Poster #23

Using Emerging Contaminants and Geochemistry to Inform the Management of Hot Springs in the Black Rock Desert, Northern Nevada

*Lightning talk on Monday June 12

Monica Arienzo, Desert Research Institute - Poster #24

Naturally Occurring Metals in Unregulated Domestic Wells in Nevada, USA

*Lightning talk on Tuesday June 13

Multi-Institutional Collaborative Projects

Andy Rost, University of Nevada, Reno - Poster #25

River-based Immersive Education and Research (RIVER) Field Studies: Connecting rivers, people, and science through immersive field education

Octavia Crompton, USDA ARS Hydrology and Remote Sensing Lab - Poster 26

Upscaling the hydrologic signature of berms and check-dams to catchments

Yishen Li, U.S. Global Change Research Program - Poster #27

Advancing Community Capabilities in Integrated Water Cycle Modeling, Research, and Operations Under Global Change

New Perspectives, Knowledge Frameworks, Ways of Learning and Metrics of Success

Ashley Heath, NASA/GSFC/GES DISC/Adnet Systems, Inc. - Poster #28

Hydrological Data at the NASA GES DISC: Current Capabilities and New Opportunities

Merhawi GebreEgziabher GebreMichael - Poster #29

Access and suitability of fossil aquifers in the United States

*Lightning talk on Tuesday June 13

Zachary Nickerson, National Ecological Observatory Network, Battelle - Poster #30

Continental-Scale Continuous Discharge Data from The National Ecological Observatory Network (NEON) is Open: Open Access, Open Source, Open for Integration, and Open for Collaboration

Rocky Talchabhadel, Texas A&M AgriLife Research - Poster #31
Sustainable water management in an arid US-Mexico transboundary region
*Lightning talk on Tuesday June 13

Other Research

Mac Beers, Boise State University - Poster #19
Multiscale controls of stream drying in a semi-arid watershed

Martin Seul, CUAHSI - Poster #32
CUAHSI HIS Modernization

Adam Price, University of Washington - Poster #33
Analyzing modeled representations of no- and low-flow in the Pacific Northwest
*Lightning talk on Tuesday June 13

Olivia O'Donnell, Boston University - Poster #34
Microplastic Accumulation in the Great Marsh, MA
*Lightning talk on Tuesday June 13

Anna Grunes, University of Vermont - Poster #35
Summit-to-Shore Snow Observatory Network in Vermont

Casey Iwamoto, Mississippi State University - Poster #36
Sustainable Pathways for Shortleaf Pine (Pinus echinata) Restoration in Uncertain Climates

Irene Garousi-Nejad, CUAHSI - Poster #39
Subsetting of Continental-Scale Hydrological Modeling Data in the Cloud

Student Centered Research

Evan Choquette, University of Vermont - Poster #37
Effects of in-stream process-based restoration on the geomorphology of a New England headwater stream

Paige Becker, Oregon State University - Poster #38
Going Beyond the Reach-Scale a Headwater Stream
*Lightning talk on Monday June 12

Poster & Lightning Talk Abstracts

Advances in Water Forecasting

Generating interpretable rainfall-runoff models automatically from data

Presenter: Travis Dantzer, University of Michigan
Co-Author: Branko Kerkez, University of Michigan

Hydrologic sensor networks are expanding rapidly and generating more data every day. As the volume and resolution of these data sets grow, manual analysis, model calibration and quality control become infeasible. Few existing approaches can transform raw data into interpretable results. Process-based models are not designed to consume large amounts of real-time data, while machine learning models are typically uninterpretable, limiting insight and trust. To address this gap of automation and interpretability, we present a scalable approach that discovers differential equations and latent state estimations in water systems using only rainfall and runoff measurements. This method generates approximations of watersheds as nonlinear, time invariant dynamical systems automatically from measurements. We capture rainfall-runoff relations for catchments and combined sewers of all scales using between five and thirty parameters. We also demonstrate the method's potential for surrogate modeling by replicating the dynamics of a large process-based model at a small fraction of the computational complexity. This parsimonious representation of watershed dynamics provides theoretical insight and the computational efficiency to enable automated predictions across large sensor networks.

Quantifying climate change impacts on crops growing in Merced, California

Presenter: Anshika Kandhway, University of California, Merced
Co-Authors: Fabio Scarpare, Mingliang Liu, Roger Nelson, Jennifer C Adam, (all Washington State University), Martha H Conklin, Mohammad Safeeq Khan, (both University of California, Merced)

During multi-year droughts in California, declines in surface water have led to the over-

extraction of groundwater. The Sustainable Groundwater Management Act (SGMA) passed in 2014 in California requires local agencies to meet certain requirements to improve the management of groundwater by giving up a portion of land under crop production. Climate change, in addition, is altering climatic biophysical factors, which poses threat to agriculture by changing water availability for crops and their growth responses. To make strategic decisions in response to uncertainties in future climate compounded by potential restrictions on groundwater withdrawal, an improved understanding of changes in future agricultural water demand can reduce potential production risks and increase the profit of farmers. With this motivation, we made a case study to quantify the change in crop water use and yield in future climatic conditions by 5 main crops grown in Merced County. The crops chosen are corn, processing tomato, alfalfa, almond, and pistachio. These crops differ in their physiology, phenology and are grown under distinct management practices as well as climatic conditions. Thus, they respond differently to climate change. We are using a state-of-the-art VIC-CropSyst model to simulate hydrological and crop growth responses due to future climatic warming. The outcomes include the quantification of crops' responses associated with maturity period, annual evapotranspiration, and yield. The anticipated shortening of growing periods for annual crops and lengthening periods for perennial crops due to warming will have distinct effects on these responses.

19 Years of High-Resolution Radar Rainfall Made Model-Ready

Presenter: Daniel Lassiter, University of Virginia

The National Oceanic and Atmospheric Administration publishes a radar-derived Surface Precipitation Rate product with a 2- to 5-minute temporal resolution on a 0.01-degree (approximately 1 km) grid. A record of this data exists from 2001 to 2011 and from 2015 to the present, but due to the number of files (approximately 3.3 million, or one for each timestep) and slight formatting variations, this data is challenging to leverage in applications benefitting from the full record. To make the dataset more accessible to researchers and practitioners, I have developed and implemented an open-source workflow that leverages high performance computing to download, quality check, and reformat the data into well-documented daily netcdf files. Upon request, I can provide a public Globus endpoint, and I am seeking long-term public storage solutions for the 4.5TB dataset. Easy access to the full radar rainfall record can especially benefit any hydrologic analysis in the continental United States requiring high temporal and spatial resolutions such as urban pluvial flood risk assessment and flood mitigation design.

Building Resilience through Multi-Benefit Water and Watershed Management

Modeling the Impact of Large-Scale Forest Structure Disturbance on Droughts and Floods in the Tahoe-Central Sierra Region

Presenter: Eli Boardman, University of Nevada, Reno
Co-Authors: Adrian Harpold, University of Nevada Reno Samuel Flake, North Carolina State University Matthew Sloggy, U.S. Forest Service

Thinning over-dense forests in the Sierra Nevada may provide numerous benefits including fire prevention, ecosystem restoration, increased water yield, and economic stimuli. However, anticipating the cascading hydrological effects of unprecedented, catchment-scale forest structure disturbances requires a nuanced approach to modeling the mountain water cycle. We deploy the Distributed Hydrology Soil Vegetation Model (DHSVM) to forecast the potential effect of several proposed Forest Service treatment scenarios on water yield and peak flows in the Tahoe-Central Sierra Initiative study area, which includes the Truckee, Yuba, and American River watersheds. We propagate uncertainties in the physical hydrology model using a multi-objective machine-learning calibration framework to robustly examine the statistical significance of forest treatment effects on the return interval of flood-stage flow events in the future climate. We hypothesize a potential tradeoff between water yield benefits and increased reservoir management challenges for winter peak flows resulting from the complex dynamics of snow-forest interactions after canopy disturbance.

Better representation of urban hydrologic processes alters surface water and temperature cycles in regional coupled climate models

Presenter: G. Aaron Alexander, University of Wisconsin-Madison
Co-Authors: Carolyn B. Voter, University of Delaware, Daniel B. Wright, University of Wisconsin-Madison, Steven P. Loheide II, University of Wisconsin-Madison

Urbanization substantially modifies surface water and energy cycles. Compared to natural vegetation, low-permeability urban surfaces produce more runoff, trap more heat, and lower evapotranspiration. Further, the “double whammy” of increases in extreme rainfall and heat generated by climate change are further amplified by the urban heat island effect and it's feedback on precipitation processes. One way cities are adapting to regional climate hazards is through adopting nature-based solutions or green infrastructure, which reduces the hydrologic impacts of urbanization and more closely mimics surrounding natural watersheds. Management practices like depaving or adding tree canopy can enhance evaporative cooling and provide shade for pavements, which also contribute to urban heat. Current efforts to represent urban hydrology in city-to-regional scale climate models are too simplistic to fully capture the hydrologic impacts of these fine-scale management efforts, yet they must be resolved if we hope to understand the holistic effects that nature-based solutions provide to the urban climate and water and energy cycles. To this end, we present regional climate simulations centered on Milwaukee, Wisconsin. An initial simulation uses a traditional representation of urban areas while a second simulation uses a custom land surface model to explicitly represent the fine-scale lateral movement of surface water amongst the highly heterogeneous land cover types common in urban areas. We show that the inclusion of urban vegetation and lateral surface water transfers associated with green infrastructure practices alters water budgets across the city and simultaneously increases evapotranspiration and decreases sensible and ground heat fluxes on daily time scales. These changes reduce air temperatures within the city and change regional atmospheric processes such as lake breeze coupling during warm days. We also show that urban environments respond differently within regional climate models after rainfall events in non-negligible ways. This work highlights the need to explicitly represent fine-scale urban water and energy cycle components in regional climate simulations, especially when considering the implications of widespread adoption of green infrastructure.

Tools and tradeoffs in water supplies from forest management in the Sierra Nevada

Presenter: Adrian Harpold, University of Nevada, Reno
Co-Authors: Eli Boardman (UNR), Gabe Lewis (UNR), Aidan Manning (UNR), Cara Piske (UNR), Sebastian Krogh (University of Concepcion, Chile)

Forest disturbances from fire and insects and human-caused treatments have uneven effects on water supplies that remain hard to predict. The promise of increased water supplies from thinning overstocked forests relies on a lack of compensating evaporative losses in that water and that it can be captured by water supply infrastructure (i.e. reservoirs). Regional-scale forest restoration projects are underway in the central Sierra Nevada in California/Nevada where water supplies are stressed. In this area, we show that potential increases in snowpack following thinning are possible, but only in areas with less windy and cooler temperatures that have existing dense canopy. The forest regrows relatively slowly,

suggesting 10-20 year thinning frequency can have continued positive effects on water availability. The fate of that melting snow may have some beneficial impacts on reservoir inflows if done with high intensity, but can also increase winter peak flows in smaller basins due to lack of canopy cover. Our results point to tradeoffs in thinning on snowpack and streamflow, with over-thinning having the potential to reduce water yields while also increasing peak flows. At a smaller stand scale, tradeoffs between thinning the forest for more open gaps versus more shading can impact snow accumulation and how the remaining forest responds to water stress. The complexity of these results suggests that regional decision support tools are needed to ensure that effective stand-scale treatments are applied across the larger landscape.

Identifying the Current State of Stormwater Management and Green Stormwater Infrastructure on Public University Campuses in the Chesapeake Bay Region

Presenter: Rachel Zobel, University of Delaware
Co-Author: Carolyn Voter, University of Delaware

Stormwater runoff impacts, like urban flooding and water pollution, directly affect watershed hydrology and are exacerbated by rapid urbanization, climate change, and aging infrastructure. As a result, public entities in defined urban areas are required to mitigate and manage stormwater runoff through the Environmental Protection Agency's (EPA) National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) program. Many entities are increasingly utilizing green stormwater infrastructure (GSI) as a strategy to manage rainfall at the source through a nature-inspired approach. Stormwater management and the success of GSI are primarily studied on public land within municipalities but less is understood about the current state of stormwater management and GSI on public university campuses and the role universities play in regulatory compliance. To address this, we present data collected from the Association for the Advancement of Sustainability in Higher Education (AASHE) Sustainability Tracking, Assessment, and Rating System (STARS) report and a comprehensive review of stormwater management plans for four public universities in the Chesapeake Bay region. This research will lay the groundwork for additional interdisciplinary investigations of stormwater management and GSI on university campuses.

Community Observers to Advance Water Science

Can the public observe what models need? – Experiences from the CrowdWater project

Presenter: Jan Seibert, University of Zurich
Co-Authors: Ilja van Meerveld, Mirjam Scheller, Sara Blanco, Franziska Schwarzenbach (all University of Zurich)

CrowdWater is a citizen science project in which we investigate how the public can be involved in collecting hydrological data, such as stream water levels, soil moisture conditions and the presence of water in temporary streams. Another essential part is to study the value of the collected data for hydrological modeling. Therefore, in several studies, we have evaluated the potential value of citizen science observations, which might be uncertain and spotty in time. The project's long-term goal is to collect many observations and thus improve the prediction of hydrological events, such as drought or flooding, by using data collected by the public in hydrological model calibration. Here, we present experiences from the CrowdWater project with regard to app-based data collection and evaluation of these data. We also highlight methods to ensure data quality, including a gamified approach and machine learning for analyzing the photos submitted through the app. Additionally, we will give an update on new activities in the CrowdWater project.

Critical Zone Science

Effects of Forest Cover on Extraneous Fluxes at the Catchment Scale

Presenter: Antonio Alves Meira Neto, Colorado State University
Co-Authors: André Ballarin, University of São Paulo, David Litwin, Johns Hopkins Univeristy

Understanding the role of forests on water balance partitioning is of paramount importance for different water-related ecosystem services. Altough local-scale, single-catchment studies point out to forest cover as driver of enhanced evapotranspiration at the catchment scale, such finding has not been confirmed at large-sample, comparative hydrology studies. Here, using a global large-sample dataset, we explore how forest cover is linked with catchments' extraneous fluxes and how it can affect long-term water balance partitioning. Our analysis adopts an open water balance assumption, and our results include the use of different evapotranspiration products, which enable us to elucidate our findings based on the assessment of hydrological assumptions embedded in each product. Finally, our results are carried forward, as we assess large-scale implications of forests on the water balance partitioning using the Budyko framework.

Assessing the effect of grazing management on field scale water and nutrient fluxes on pasture and rangeland

Presenter: Alexandria Kuhl, Michigan State University
Co-Authors: Jeremiah Asher, Andrey Guber, Cole Kelley, Quinton Merrill, Glenn O'Neil, Jason Rowntree, (All Michigan State University)

Grazing lands are one of the largest terrestrial ecosystems globally, and a vital part of the landscape for humans. In addition to supplying the area needed for livestock to feed, these lands are a powerhouse of ecosystem services, sequestering carbon, capturing nutrients, and providing habitat for a diversity of plant and animal species. Despite their critical importance, mismanagement of grazing lands and land use changes have led to a vast degradation in soil quality and the loss of some of these benefits. Several long term studies have indicated that adapting grazing management to optimize vegetation recovery between periods of intensive grazing can help restore soil health, improve infiltration, reduce erosion and nutrient runoff, and reverse decades of soil carbon loss. Despite the increasing popularity of adaptive grazing, few studies have investigated these effects at producer-scale ranches and there is a need for scalable results to help ranch managers make informed decisions regarding their grazing practices. The 3M (Metrics, Management, and Modeling) Project is a new multi-institute, cross-discipline effort to quantify and model the effect of a spectrum of grazing management approaches on the coupled land-water-human ecosystem and deliver those results directly back to the ranching community. To assess the impacts on the water balance and nutrient fluxes, we've established a network of water content sensors and eddy-flux covariance towers along with twice-annual infiltration experiments at study sites spanning three ecoregions of the interior United States. Utilizing this dataset, we are developing a suite of unsaturated zones models in HYDRUS-1D to estimate recharge and runoff across our sites. Insights from these models will be used to inform larger-scale SWAT models and complementary ecosystem models which will eventually drive stakeholder decision support tools. In this presentation we will show preliminary results from the 2022 growing season and a broad overview of our modeling framework.

Fast stream sediment load estimation via soft sensing and machine learning

Presenter: Meagan Tobias, University of Michigan
Co-Author: Branko Kerkez, University of Michigan

With the growing interest in continuous water quality measurements, there is a need for reliable sensors to measure various parameters of interest. However, the development of specialized sensors cannot keep up with the growing list of desired parameters. Even relatively common continuous measurements, such as sediment concentrations, are difficult to come by due to the need to calibrate sensor measurements with laboratory samples. These problems fall under the broader umbrella of soft sensing, wherein surrogate sensor measurements are paired with field samples to subsequently make continuous predictions of an underlying parameter. A major challenge relates to quantifying the amount of samples needed to calibrate a model, taking just sufficient samples to make reliable predictions, without spending unnecessary time and resources on laboratory analyses and field work. Here, we focus on how to quickly make stream sediment concentration predictions by pairing a continuous acoustic sensor with an automated sampler. The automated system uses Gaussian Process (a machine learning regression model) and an information theoretic sampling algorithm to direct the automated sampler to take only those samples that improve the accuracy of the predictions. We show that this real-time methodology reduces the number of samples required to calibrate a stream sediment concentration model by 50%, when compared to a traditional flow-based sampling approach. We also discuss how our methodology provides a strategy for the creation of other soft-sensor models by using less resources and time without sacrificing accuracy.

Deep weathering in the California Coast Range: Implications for water movement and storage in the critical zone

Presenter: Russell Callahan, University of California Santa Cruz
Co-Authors: Mong-Han Huang, University of Maryland; Amanda Donaldson, University of California Santa Cruz; Nerissa Barling, University of California Santa Cruz; Daniella Rempe, University of Texas Austin; Margaret Zimmer, University of California Santa Cruz

Subsurface weathering controls the movement and storage of water within hillslopes, impacting water availability for terrestrial ecosystems and management of water resources. Here we quantify subsurface weathering across different topographic positions from borehole measurements and near-surface geophysics surveys that extend to unweathered bedrock at Arbor Creek, a zeroth-order catchment in the California Coast Range. Arbor Creek is underlain by greywacke with some areas of interbedded shale. Climate at the site is characterized by hot-dry summers and cool-wet winters with a mean annual precipitation of 600 mm and a mean annual temperature of 14° C. P-wave velocities from seismic refraction surveys show deep weathering beneath ridgetops and shallower weathering in valley bottoms, which were confirmed by borehole drilling observations. Geochemical measurements and visual observations from core retrieved from boreholes show chemical alteration and oxidation at 25-37 meters below the surface suggesting the cycling of oxygen-rich meteoric water deep beneath the ridgetops. Below the chemical weathering front the rock is highly fractured down to at least 40 m depth possibly due to the regional geologic and tectonic environments. Here we further discuss the mechanisms that may drive deep weathering in this landscape. We also discuss the implications of deep weathering for understanding water movement through the critical zone at Arbor Creek.

Hillslope-scale biophysical and microclimate controls on non-perennial streamflow generation

Presenter: Melinda Martinez Gonzalez, University of California Santa Cruz
Co-Authors: Amanda Donaldson, Margaret Zimmer, (both University of California, Santa Cruz)

Roughly two-thirds of rivers in the United States are classified as non-perennial, providing vital hydrological and ecological functions such as nutrient cycling, sediment transport, groundwater recharge, and wildlife habitat. Yet despite their prevalence and significance, non-perennial streams are often understudied and overlooked. This study contributes to a better understanding of non-perennial streamflow generation by quantifying how biophysical and hydroclimatic properties influence hillslope hydrologic response to incoming precipitation. Our study site is Blue Oak Ranch Reserve, an oak savannah landscape located in central coastal California. Here, we focused on two hillslopes with uniform subsurface structure (e.g., soil/saprolite depth, lithology) and contrasting aspects (north and south facing), allowing for a comparative analysis of the impact of vegetation, solar radiation, and antecedent soil moisture on hillslope hydrologic response. We installed soil moisture probes at three different landscape positions (near-stream, mid-slope, near-ridge) and two depths (5 cm and 50 cm). We co-located shallow groundwater wells (3-5 m deep) at these landscape positions and installed a flume at the watershed outlet. Preliminary results showed variation in soil moisture response relative to depth and landscape position during the initial precipitation events of the new water year, with no groundwater or streamflow response until a baseline saturation was achieved at both the north and south-facing slopes during later precipitation events. We also compared runoff with variability in storage capacity and how the aspect-dependent factors influence continuous streamflow. These results highlight the complexities of streamflow generation drivers in non-perennial systems and the necessity for water management policies to encompass regulation against the exploitation of these systems.

Attribution of Sea-Level Rise-Induced Roadway Flooding to Anthropogenic Emissions

Presenter: Annika Hjelmstad, University of California Irvine
Co-Author: Amir AghaKouchak, University of California Irvine

Existing climate change attribution studies quantify the extent to which anthropogenic forcing has increased the frequency and severity of a host of climate phenomena known to cause flooding and its associated impacts. However, these analyses do not extend to an assessment of the relevant impacts, such as loss of life and infrastructure damage. Here we will apply a model of the relationship between roadway flooding and sea level rise to CMIP6 counterfactual scenarios focused along the California coast. Doing so will allow us, within the uncertainties imposed by each model, to track the impact of changes in sea level rise due to human emissions on changes in the frequency and severity of roadway flooding. We will additionally identify crucial impact-based thresholds of sea level rise with respect to roadway flooding, which we can use to benchmark rates of sea level rise in future climate scenarios from an impact perspective. We place this work more broadly in the context of a move toward an impact-based approach to attribution, to the end of understanding more fully the implications of human emissions and pinpointing which climate processes are responsible for the most pressing and disastrous consequences.

High-performance hydrological model of Lake Tahoe's headwater basin

Presenter: Lazaro Perez, Desert Research Institute
Co-Authors: Nicholas Engdahl, Washington State University, Rosemary Carroll, Desert Research Institute

This study explores the complex interactions between surface and subsurface hydrologic regimes in mountain systems for improved quantification of water outputs in a changing climate. To do so, we build on recent advances in computational hydrology and construct the first high-performance, integrated hydrologic model (IHM) at fine spatial and temporal resolutions for seven mountainous Lake Tahoe headwater basins with different bedrock conditions. Observed stream discharge magnitude and timing are highly variable between these basins, suggesting that geologic controls may be significant in dictating water partitioning between forest water use, groundwater recharge, and streamflow generation. We will present preliminary IHM results exploring hydrologic pathways through each of the watersheds with analysis focused on first-order controls related to stream water outputs. In

Taddition, we will discuss the challenges and opportunities of building IHM in mountain environments and provide associated workflows for use by the CUAHSI hydrologic community.

Estimating Mountain Aquifer Recharge: A Generalized Recession-based Technique

Presenter: Eric Wineteer, University of California, Riverside
Co-Author: Hoori Ajami, University of California, Riverside

Mountain watersheds are a significant source of recharge to valley aquifers. Mountain aquifer recharge (MAR), an indirect source of valley aquifer recharge, consists of precipitation and streamflow infiltration to mountain bedrock. However, the relative contribution of each source in recharging valley aquifers is poorly understood, particularly in California. We have developed a generalizable data-based method of estimating dynamic diffuse MAR to better understand the role of mountain aquifers in California's hydrology. We used daily river gauge data from 24 catchments in the Sierra Nevada to quantify changes in diffuse MAR in the past 20 years. To estimate MAR, we tested five recession analysis methods based on global and event-based recession analysis techniques where recession events are isolated based on meteorological observations, changes in streamflow data or both. We performed a detailed global sensitivity analysis to determine parameters that impact MAR estimates. The results of the sensitivity analysis were used to create a framework for generalized MAR estimation that can be applied elsewhere. Finally, the MAR estimates were used to investigate spatiotemporal changes in MAR in the Sierra Nevada, and the causes of said changes. This research will enable better characterization of the Sierra Nevada's mountain aquifers, and highlight the role of mountain system recharge processes in recharging California's Central Valley aquifer system.

Determining sensitivity and thresholds of antecedent soil moisture amplifying flood response from atmospheric rivers

Presenter: Mariana Webb, Desert Research Institute
Co-Authors: Christine Albano, Desert Research Institute, Adrian Harpold, University of Nevada, Reno

Atmospheric rivers along the west coast of the United States are simultaneously an important water resource supply and a potential flood hazard risk. Under a warming climate, atmospheric river precipitation magnitudes and variability are expected to increase, while soil moisture regimes may also be altered due to changing precipitation patterns and increased evapotranspiration. Therefore, there is a growing need to better understand how flow-generation mechanisms may be affected by these changes. Antecedent soil moisture conditions can play an essential role in mitigating or amplifying flood impacts for the same precipitation input. However, quantitative studies on the role of antecedent conditions in enhancing flood response across diverse watersheds are not widely available. In this study, we combine observational data and model outputs to estimate watershed sensitivity to –and determine critical thresholds of– antecedent soil moisture in 111 West Coast watersheds. We then use machine learning to characterize the physiographic watershed characteristics driving streamflow sensitivities to antecedent soil moisture. We hypothesize that while flood response is primarily moderated by precipitation input, in watersheds where soil moisture varies more during the flood-generating season, antecedent soil moisture status can cause significant variations in peak flow magnitudes. This study contributes to a larger body of research that can potentially help to inform water resource management and mitigate flood risk.

Assessment of Sea Level Rise Impacts on Aquifer Systems in Coastal Environments: A Case Study of Bowers Beach, Delaware

Presenter: Omowumi Erukubami, University of Delaware
Co-Author: Carolyn B Voter, University of Delaware

As the sea level rises, high tides and storm surge increasingly push the saltwater-freshwater interface inland, thereby leading to saltwater intrusion into freshwater aquifers in coastal communities. Well-known consequences include the salinisation of drinking water and agricultural fields. Stormwater management and wastewater conveyance and treatment facilities may also be impacted by the rise of shallower, more saline groundwater. For example, when saline water infiltrates leaky sanitary sewer systems, this may reduce the integrity and effectiveness of wastewater conveyance and treatment. Similarly, when groundwater rises, infiltration-based stormwater best management practices may not work effectively because the vertical hydraulic gradient becomes weaker, which impedes infiltration. Through this research, we aim to holistically assess how sea level rise (SLR) impacts water infrastructure. Here, we use MODFLOW to simulate scenarios of SLR to investigate how much saline water intrusion and groundwater level rise is experienced by the freshwater aquifers in Bowers Beach, Delaware, a small coastal community with a history of flooding and saltwater intrusion concerns. This is the first step in our research that is geared towards understanding risks to stormwater, sanitary sewers and wastewater treatment facilities in the face of SLR, changes in precipitation patterns and groundwater level rise.

Future modelling work of Bowers Beach will be channelled towards coupling this groundwater model with SWMM, a stormwater management model, to holistically simulate how these scenarios will impact stormwater systems and sanitary sewers in coastal environments.

CUAHSI and the Water Science Community

Multiscale controls of stream drying in a semi-arid watershed

Presenter: Mac Beers, Boise State University
Co-Authors: Anna Bergstrom, Kevin Roche, (both Boise State University)

Over half of the global stream network is intermittent, drying for at least one day of the year. Climate change is increasing the duration and spatial extent of intermittency in arid and semi-arid climates, impacting stream ecology, water quality, and streamflow. The physical characteristics that control the location and relative timing of stream drying depend on scale, where characteristics such as elevation and contributing area influence stream drying at the network scale, while characteristics such as subsurface structure and channel morphology influence stream drying at the local scale. Yet, there is limited research connecting drivers of stream drying across spatial scales within a single watershed. We hypothesize that the physical characteristics and processes that control drying across scales are not independent; finer scale processes only control the timing and location of drying once climate and watershed scale physiography create the conditions that allow drying to occur. This work aims to connect the physical characteristics and processes that control stream drying at the watershed, reach, and local scales in the Dry Creek Experimental Watershed (DCEW), southeastern Idaho. We synthesize a suite of data collected at DCEW, including analysis of streamflow data, topographic analyses of a 1m DEM, intermittency mapping, and continuous observations of surface flow persistence around breaks in channel slope. Analysis of watershed scale topographic characteristics shows that intermittency occurs in a section of the main stem near the watershed outlet where there are relatively small increases in contributing area per unit length of channel, suggesting surface water inflows are less than outflows when drying occurs. This is supported by observations of streamflow in a study reach within this section, which indicate that surface flow is lost to groundwater across the study reach during low summer flows. Mapping results show that the total amount of stream drying varies from year to year and that the return of streamflow is coincident with decreasing temperatures and early fall precipitation events. Local scale observations indicate that surface water persists longer where the stream channel slope breaks. We contextualize these findings with 23 years of weather and streamflow data, finding that drying at the watershed outlet is correlated to maximum yearly SWE and date of last observed snowpack. This work agrees with recent research which suggests climate determines if there will be stream drying, while physical characteristics determine the location and relative timing of drying. These results improve our understanding of how physical watershed characteristics and processes control stream drying across spatial scales.

Inclusive and Collaborative Research

Is there a place for urban beaver? Comparing hydrologic and nutrient impacts of urban beaver ponds to stormwater ponds

Presenter: Sarah Ledford, Georgia State University
Co-Authors: Alisha Guglielmi, Julian Sheppy, Claire Wadler, Luke Pangle (all Georgia State University), Elizabeth Sudduth, Georgia Gwinnett College, Sandra Clinton, University of North Carolina, Charlotte, and Diego Riveros-Iregui, University of North Carolina, Chapel Hill

Beaver are prevalent across Piedmont urban areas, but understanding where they are living and their impact on hydrologic functioning or nutrient cycling has not been well assessed. Understanding the potential benefits of beaver to water issues in cities is needed to effectively manage beaver-human conflicts that arise from their need to dam flowing waters. This is especially critical in urban areas where beaver may play a similar hydrologic role as human-made green stormwater infrastructure. We have been measuring the locations and impacts beaver ponds have on hydrologic retention and nutrient dynamics across Atlanta, GA, and Charlotte and Durham, NC. In Atlanta, we have found they preferentially live in parks and their location is not tied to nearby culverts, which are one major cause of flooding. We did not observe differences between transit times through pond types but instead found that short term weather dynamics seem to control hydrologic retention in both beaver and stormwater ponds. However, urban beaver ponds are smaller than stormwater ponds, and they are not able to build large wetland complexes like they can in less anthropogenically-impacted areas. We also found that DOC concentrations increase below urban stormwater ponds, driven by increases within the pond, but beaver ponds do not cause a change in concentration. However, both pond types cause a shift towards more aromatic carbon. All of these findings point to an important role for managing urban beaver in the urban landscape without conflict, allowing for hydrologic retention of water on the landscape with less impact on water quality compared to stormwater ponds, all at a much lower financial cost.

Climate change forecasts, information, and adaptation in Central American smallholder communities through participatory and student centered research

Presenter: Ed Maurer, Santa Clara University
Co-Authors: Iris Stewart-Frey, Alex Avila, Turner Uyeda, Briana Guingona, Gautam Chitnis, Allan Báez Morales (all Santa Clara University)

Many parts of Central America have experienced warming over recent decades, accompanied by greater frequency of drought and more arid conditions during the time of boreal summer (June-August). This has the capacity to disrupt critical crop cycles and contribute to food insecurity in the region, which is already highly susceptible to drought and its impacts. A multidisciplinary team of undergraduate and graduate students, faculty and staff at Santa Clara University, partnered with a Nicaraguan NGO, has been working with rural communities in Northern Nicaragua to help provide short-term and seasonal rainfall forecasts to assist smallholder farmers in planning when to plant and harvest, especially during the critical June-August period. Focus groups and interviews with community members in Nicaragua motivated this focus on precipitation forecasts, since farmers face a daunting challenge of anticipating when the typical lull in the wet season (typically occurring from mid-July to mid-August) will occur in any year. As a response, our team has developed an automated system to download forecasts for individual communities, based on short-term (through 15 days) global ensemble forecasts and seasonal forecasts based on the U.S. National Oceanographic and Atmospheric Administration's North American Multi-Model Ensemble Project. We produced a lightweight app that can operate on a mobile phone that delivers graphical and text summaries of the forecasts. Ongoing user surveys and focus groups provide feedback on how the probabilistic information is received and what might be more useful. As climate change amplifies the extremes already being experienced in this region, the aspiration is that accessible, skillful, and effectively communicated climate forecasts can help with climate change impact mitigation strategies.

Making Data Sing - The Present and Future of Water Data Harmonization Efforts

Presenter: Matthew Ross, Colorado State University

Over the past several years, my colleagues and I have tried to produce "harmonized" datasets that make it easier to work with large-scale water quality observations. Our hope is that we can greatly expand the number of people using existing data to augment their research, and to make that a more inviting process. We are attempting to do this by making diverse hydrological and biogeochemical data easier to find, easier to connect to other data, Over the past several years, my colleagues and I have tried to produce "harmonized" datasets that make it easier to work with large-scale water quality observations. Our hope is that we can greatly expand the number of people using existing data to augment their research, and to make that a more inviting process. We are attempting to do this by making diverse hydrological and biogeochemical data easier to find, easier to connect to other data, and easier to visualize. Here I will present my own personal philosophies of data harmonization, insights we can gain from democratizing data at a large scale, and where harmonization efforts are headed. I'm inspired by successful efforts like CAMELS, CARAVAN, LAGOS, and many other efforts that come before, but I will focus my discussion on two datasets that I've help build: AquaSat and Macrosheds. AquaSat is a dataset that pairs in-situ water quality observations with optical satellite imagery to enable large-scale remote sensing estimation of water quality. Macrosheds is a dataset that pulls small-scale watershed-ecosystem data from LTER, CZO, USFS, and other datasets. Both of these datasets are actively being updated and I will share particulars of these datasets and some initial research we are using them to conduct. If a talk, I will also attempt to give a musical performance on the difficulties of converting dissonant, disparate datasets into a singing harmonious whole.

Using Emerging Contaminants and Geochemistry to Inform the Management of Hot Springs in the Black Rock Desert, Northern Nevada

Presenter: Daniel Saftner, Desert Research Institute
C-Authors: Lamoni Mora, Bureau of Land Management, Yeongkwon Son, Monica M. Arienzo, (both Desert Research Institute)

Hot springs of the Black Rock Desert of northern Nevada are located on public lands and at risk of water quality and ecological degradation from increased tourism and geothermal exploration. The springs are fed, in part, by groundwaters from deep thermal reservoirs that are potential targets for geothermal energy. Recreational bathers may introduce per- and polyfluoroalkyl substances (PFAS) to hot spring waters from soaps, clothing, cosmetic products, and sunscreen, while the breakdown of clothing may also contribute microplastics. Inputs of long-lasting, emerging contaminants (i.e., PFAS and microplastics) to the hot springs may pose human and ecological risks. To inform public land management, water samples from five spring systems were collected in June and November 2022 and analyzed for PFAS compounds, microplastics, trace metals, and stable isotopes to assess adverse effects to spring water quality from recreational usage and geothermal exploration. Data from June 2022 show that at all three recreational hot springs, total PFAS concentrations increase

downstream from the spring source, suggesting potential inputs from recreational activities. PFAS were also detected at locations not used for recreation, suggesting other contaminant sources, which may include PFAS-contaminated groundwaters or atmospheric deposition. Initial results highlight the importance of collaborations between researchers and land managers to minimize human impacts to sensitive aquatic systems of remote desert environments.

Naturally Occurring Metals in Unregulated Domestic Wells in Nevada, USA

Presenter: Monica Arienzo, Desert Research Institute
Co-Authors: Daniel Saftner, Steven N. Bacon, Erika Robtoy, Iva Neveux, Karen Schlauch, (all Desert Research Institute), Michele Carbone, University of Hawai‘i, Joseph Grzymski, Renown Health

The dominant source of drinking water in rural Nevada, United States, is privately-owned domestic wells. Because the water from these wells is unregulated with respect to government guidelines, it is the owner’s responsibility to test their groundwater for heavy metals and other contaminants. This is a public health concern because elevated levels of these metals are known to have negative health effects. We recruited individuals through the Healthy Nevada Project population health study, to submit domestic well water for testing. Water samples were returned from 174 households with private wells. We found 22% had arsenic concentrations exceeding the EPA maximum contaminant level (MCL) of 10 µg/L. Additionally, federal, state, or health-based guidelines were exceeded for 8% of the households for uranium and iron, 6% for lithium and manganese, 4% for molybdenum, and 1% for lead. A logistic regression model developed during this study shows that the probability of elevated arsenic in domestic wells is strongly influenced by tectonic and geothermal processes, and that approximately 49 thousand (64%) of the alluvial-aquifer domestic well population in the region may have elevated arsenic (>5 µg/L) in untreated well water. These results show the pressing need for continued education and outreach on regular testing of domestic well waters, proper treatment types, and health effects of metal contamination.

Multi-Institutional Collaborative Projects

River-based Immersive Education and Research (RIVER) Field Studies: Connecting rivers, people, and science through immersive field education

Presenter: Andy Rost, University of Nevada, Reno
Co-Authors: James Vonesh, Virginia Commonwealth University, Matthieu Brown, Prescott College, John McLaughlin, Western Washington University, Denielle Perry, Northern Arizona University, Sarah Yarnell, University of California, Davis

Field studies have a rich history in higher education with effective active learning pedagogy that immerses students in the environment, helping transform them into the next generation of scientists. Yet, despite these successes, overall participation in undergraduate field education is declining due to numerous impediments. Our NSF funded Research Collaborative Network project, River-based ImmersiVe Education & Research (RIVER) Field Studies Network, targets rivers as a shared medium because they are universal landscape features that provide vital ecosystem services, host remarkable biodiversity, facilitate accessible field studies programs, and are among the most imperiled ecosystems globally. Our network programming seeks to enhance undergraduate river field education by building instructor capacity, broaden participation, promote safety, health, equity and inclusion, develop an open-source library, and build a framework for communication and exchange. These efforts build towards creating a sustainable network of universities, non-profit organizations, and agencies focused on river field studies to enhance undergraduate education. We invite individuals and organizations to join our network (riverfieldstudies.com) to help train the next generation of river scientists and stewards to tackle the broad range of challenges facing riverine ecosystems.

Upscaling the hydrologic signature of berms and check-dams to catchments

Presenter: Octavia Crompton, USDA ARS Hydrology and Remote Sensing Lab
Co-Authors: Mary Nichols, Dana Lapides, (both USDA-ARS Southwest Watershed Research Center)

In an attempt to make efficient use of runoff and to restore degraded rangelands in the western US, thousands of structures such as check dams, water spreaders, and contour berms were built in the 1930s and 1940s to control water and sediment. However, many of these soil and water conservation structures were built without the benefit of local hydrologic data or technical design guidance. Although many structures remain intact, those that are structurally compromised, abandoned, or unmaintained alter surface runoff and sediment transport processes in ways contrary to that intended when constructed and can exacerbate channel incision and erosion. Quantifying these impacts is required for natural resource management. While the impacts of these structures have been assessed at site scales, efforts to scale site-level impacts to larger, catchment-scale hydrologic effects is challenging. One challenge is resolving rainfall runoff during intense but infrequent storms typical of the US southwest, where complex topography, highly variable rainfall, and heterogeneous soils and surface cover are not adequately described by coarser, watershed-scale models. Here, the Saint Venant Equations are used to characterize the hillslope-scale effects of berms across storm properties, landscape attributes, and berm shape and condition (intact versus breached). We estimate how the hydrologic impact of these structures may scale from hillslope to catchment scales, and discuss potential methods for representing soil and water conservation structures within coarser-scale hydrologic models.

Advancing Community Capabilities in Integrated Water Cycle Modeling, Research, and Operations Under Global Change

Presenter: Yishen Li, U.S. Global Change Research Program
Co-Authors: Bob Vallario, DOE, David Lesmes, USGS, Jared Entin, NASA, Laura Lautz, NSF, Austin Scheetz, USGCRP

This presentation will: 1) give an introduction to the U.S. Global Change Research Program (USGCRP), 2) outline its water cycle science activities, and 3) highlight how its upcoming workshop focused on Integrated Hydro-Terrestrial Modeling (IHTM) will advance community science needs and capabilities. Understanding the effects of global change on the water cycle, including its alterations, impacts, and interactions across scales, requires interdisciplinary approaches. The USGCRP's Integrated Water Cycle Group (IWCG) coordinates research that will help us better understand the effects of global change on the water cycle and the impacts of those changes through interagency collaboration on interdisciplinary approaches. The IWCG seeks to advance fundamental understanding and produce actionable science and results related to the water cycle. We maintain a holistic approach, utilizing a multi-scale perspective that connects agencies' fundamental research with applied research and capabilities. This approach ensures that scientific insights are translated into actionable information communicated to decision-makers. This year, IWCG will hold an IHTM workshop for U.S. Federal and non-Federal scientists and managers, with an aim to advance community modeling and integrated water resources management capabilities using open science principles. This workshop will develop national and regional use cases that employ state-of-the-art modeling approaches. These use cases will explore how to better represent hydrologic processes, where discussions will focus on the limitations and opportunities for improving model extensibility across scales. We aspire to move beyond conceptual underpinnings to pursue strategic advances in use-inspired basic research and accelerate translational science. We also hope to forge connections among the science, applied research, planning, and decision-making communities.

New Perspectives, Knowledge Frameworks, Ways of Learning and Metrics of Success

Hydrological Data at the NASA GES DISC: Current Capabilities and New Opportunities

Presenter: Ashley Heath, NASA/GSFC/GES DISC/Adnet Systems, Inc.
Co-Authors: Stephanie Stettz, Christopher Battisto, Alexis Hunzinger, (all NASA/GSFC/GES DISC, Adnet Systems, Inc), Christine Smit, NASA/GSFC/GES DISC, Telophase Corp

The NASA Goddard Earth Sciences Data and Information Services Center (GES DISC) is one of twelve NASA Earth science data centers that document, process, archive and distribute data from Earth observation missions and projects. GES DISC maintains an archive of several hydrology datasets, including the Land Data Assimilation Systems (LDAS) and the Gravity Recovery and Climate Experiment (GRACE) Data Assimilation for Drought Monitoring (GRACE-DA-DM) data products. These datasets include model output of heat fluxes, rain, snow, soil temperature, soil moisture, and runoff; and observational forcing data, including surface pressure, temperature, precipitation, downward shortwave and longwave radiation, humidity, and wind.The temporal resolution of the hydrology data at GES DISC ranges from hourly to monthly, and spatial resolutions range from 0.1° to 1.0°. The GES DISC provides services which enable users to aggregate, temporally and spatially subset, regrid, and visualize archived data including the GES DISC Subsetter, Hydrology Data Rods, and the Geospatial Interactive Online Visualization and Analysis Infrastructure (GIOVANNI). The Hydrology Data Rods service optimally reorganizes large hydrological data sets as extended time series, providing more efficient access for the hydrological community. The time series data (aka “data rods”) were integrated into hydrology community tools, such as the Data Rods Explorer on HydroShare. Furthermore, the GES DISC is in the process of migrating its data and services to the cloud. Hydrological data available at the GES DISC are now available in the Amazon Web Services (AWS) cloud (us-west-2 region) providing users Direct S3 data access and the capability for cloud computing operations. In this presentation, the hydrology data products and services currently available at the GES DISC will be summarized. Also discussed are the migration to the cloud, user support through this transition, and the status of migrating the data rods service to the cloud.

Access and suitability of fossil aquifers in the United States

Presenter: Merhawi GebreEgziabher GebreMichael

Co-Authors: Scott Jasechko, Debra Perrone, (both University of California, Santa Barbara)

Fossil groundwater, groundwater that was recharged more than 12,000 years ago, is an important water resource across the United States. Despite its importance, fossil groundwater quantity and quality remain imperfectly understood due to uncertainties in the spatial distributions of various aquifer conditions and in groundwater level responses to long-term pumping. Nevertheless, there is no comprehensive analysis of the prevalence and usage of fossil groundwater at a continental scale. To understand environmental controls on fossil groundwater distributions, we (1) digitized the boundaries of aquifer systems and developed a new 'US Aquifer Database', (2) confirmed the presence of fossil groundwaters by reviewing primary literature, and (3) analyzed millions of well drilling records and hundreds-of-thousands groundwater level time series in monitoring wells. We show that wells drilled deep enough to tap fossil groundwater are widespread and increasing in number. Our analysis reveals that areas accessing fossil groundwater are not necessarily linked to areas experiencing depletion, reinforcing that groundwater age is not linked directly to sustainability. Many, but not all, fossil aquifers exemplify long term stability in groundwater levels, a stability likely arising due to local hydrological and geological conditions, climate variations, and land uses.

Continental-Scale Continuous Discharge Data from The National Ecological Observatory Network (NEON) is Open: Open Access, Open Source, Open for Integration, and Open for Collaboration

Presenter: Zachary Nickerson, National Ecological Observatory Network, Battelle
Co-Authors: N.H. Harrison, K.M. Cawley, R.T. Hensley, (all National Ecological Observatory Network, Battelle)

Accurately estimating discharge is foundational to understanding the hydrology of a stream or river and interpreting physical, biological, and geochemical phenomena that occur in flowing bodies of water. The National Ecological Observatory Network (NEON) is a project funded by the National Science Foundation to collect high-quality standardized data from atmospheric, terrestrial, and aquatic ecosystems over a 30-year lifetime. NEON collects, processes, and publishes 59 aquatic data products from 34 sites across the United States, including the Continuous discharge (DP4.00130) data product at 28 sites (streams, rivers, and a flow-through lake). The Continuous discharge data product integrates instrumental and observational hydrology data with Bayesian modelling techniques to develop stage-discharge rating curves that translate into 1-min resolution stage and discharge data. Data published by NEON is open access, meaning this foundational aquatic data product can be easily accessed by any student, educator, or researcher and downloaded with all pertinent metadata and documentation. This high-level derived data product is open source because NEON provides transparent, complete, and quantitative information to end users in the form of model inputs (raw data, model coefficients), outputs (prior and posterior uncertainties), and data processing code, which produces an interoperable and reusable data product. Additionally, this data product is open to integration, both within the NEON project and across collaborative projects. Within the NEON project, standardized data product structure allows for continuous discharge data to be easily joined to other observational or instrumental aquatic data products allowing users to, for example, assess concentration-discharge (C-Q) curves, observe the effect of hurricanes on fish communities, or monitor changes in microbial community composition in an intermittent stream. Across projects, NEON desires to expand the use of the observatory's continuous discharge data through collaboration, be it collaborative repositories (e.g., HydroClient), the NEON Assignable Assets program (research conducted in NEON sites using NEON assets), or other forms of collaborative projects. To carry out its mission, NEON aims to increase the exposure of high-quality standardized discharge data to the user community and develop partnerships that enhance the interpretation and understanding of hydrologic data in a time of rapid environmental change.

Sustainable water management in an arid US-Mexico transboundary region

Presenter: Rocky Talchabhadel, Texas A&M AgriLife Research

The Southwest United States is one of the hottest and driest regions on the planet. Irrigated agriculture over the region still uses various water sources such as groundwater, rivers, and even marginal-quality water. Unfortunately, numerous hydroclimatic stresses, like heat waves, water scarcity, poor water quality, and poor soil conditions, have posed significant challenges to the sustainability of regional agriculture. Overdrafting groundwater resources for urbanization and agricultural purposes has led to an unsustainable aquifer in the region. This study provides an overview of the Hueco Bolson aquifer (a binational aquifer shared by the United States and Mexico) and argues for the need for future modeling and binational engagement efforts to address transboundary water management issues related to water quality and quantity. Research indicates that the aquifer's hydraulic gradients and flow directions have changed due to the high groundwater withdrawal rates from the two major cities—El Paso (USA) and Ciudad Juarez (Mexico). A graphical quantitative modeling framework (Bayesian Network) in conjunction with physically-based numerical models

(SWAT, and MODFLOW) is proposed, which includes experts' opinions and enhances stakeholders' participation, and could provide new strategies to manage the transboundary aquifer.

Other Research

CUAHSI HIS Modernization

Presenter: Martin Seul, CUAHSI
Co-Author: Collin Bode, University of California, Berkeley

The CUAHSI Hydrologic information System has been a key component for publishing and sharing timeseries data for many years. To adapt the system to changing needs and to extend the functionality to allow real time ingestion and enhanced quality control a new approach was needed. CUAHSI partnered with the developers of Dendra, a cyber-infrastructure project for real-time sensor data storage, retrieval, management, and curation to modernize the existing System. This poster will show the current status and plans for the modernization effort.

Analyzing modeled representations of no- and low-flow in the Pacific Northwest

Presenter: Adam Price, University of Washington
Co-Author: Kendra E. Kaiser, Boise State University

Globally, and within the Pacific Northwest, there are an abundance of non-perennial rivers and streams, which are predicted to increase due to climate change and anthropogenic influences. However, most modeled representations of streamflow have been constructed with perennial systems in mind, leaving a gap in our understanding and representation of non-perennial systems. To adapt to future challenges, there is a need to determine what modeled representations of low- and no-flow in non-perennial systems do well and where uncertainties may lie in the internal representations of hydrologic proxies and processes. Here we compare a suite of process-based hydrologic models to better understand these uncertainties, analyze how well these models represent low- and no-flow across space and time, and identify how to use flow/no-flow observations to benchmark process-based models. Preliminary results suggest that process-based models display varying degrees of accuracy at representing non-perennial systems and matching observations. The ability to accurately model non-perennial systems is paramount to understanding the connections between hydrologic characteristics of low- and no-flow and the potential ecological, biogeochemical, and societal implications of these important systems. Improving our predictive understanding of low- and no-flow periods in non-perennial systems within the Pacific Northwest will fill critical gaps and better target the timing and location of future research, management, and conservation efforts.

Microplastic Accumulation in the Great Marsh, MA

Presenter: Olivia O'Donnell, Boston University
Co-Author: Duncan FitzGerald, Boston University

Microplastics (MP) emanating from urban environments have contaminated coastal habitats and organisms globally (Thompson et al. 2009), and MP numbers appear to be increasing. Salt Marshes can effectively record microplastic (<1mm) abundance by capturing the particles as the marsh accretes vertically over time. The vertical distribution of MP was investigated in 10 sediment cores located throughout the Great Marsh in northern Massachusetts. The cores were examined to a depth of 30 to 40 cm, where the particles were no longer found. Bioturbation only occurs at the very surface of The Great Marsh (<1 cm) so that peat depth can be translated to age (average accretion rate = 3.14 mm/year, FitzGerald et al 2021). For analysis, each core was divided into 20 one-centimeter layers with each layer representing approximately three years of accretion. Samples were dried and analyzed under a high magnification microscope, and the type (fiber, fragment, or film), morphology, and color were recorded for each microplastic. Microplastics were found in all cores with an inverse relationship to the core depth () with an average of ~ MP at the surface. Higher levels of microplastics are more abundant near river outlets or settlements. Lower levels of microplastics occurred at sites estuarine waters were diluted by ocean tidal prism. Using the accretion rates for the Great Marsh, the occurrence of plastics is estimated to have begun in the 1950s.

Summit-to-Shore Snow Observatory Network in Vermont

Presenter: Anna Grunes, University of Vermont
Co-Authors: Arne Bomblies, Beverley Wemple, Kate Hale, (all University of Vermont)

Here we present the design of a Summit-to-Shore observational snow network designed to capture forest influences on snow accumulation and melt in the mixed deciduous-coniferous forests of the northeastern U.S. This network aims to monitor snowpack characteristics and meteorological variables at a high spatial and temporal resolution across an elevational transect in the Green Mountains of Vermont. Forests within seasonal snow zones influence snow accumulation through canopy interception and snow ablation by enhancing or diminishing radiative inputs and altering turbulent heat transfer. Predicting where and under what conditions heterogeneous forest cover will influence snow accumulation and disappearance remains a key research gap for mountain regions. Although forest canopy influences on snowpacks are well studied in the mountain west, fewer studies have been performed in deciduous forests, such as those that cover the seasonal snow zone of eastern North America. Traditional meteorological measurements combined with detailed snowpack accumulation and melt measurements will provide high resolution data as validation for snowpack models. By combining data from this observational network and remote sensing efforts, we hope to characterize snowpack evolution in response to varying forest cover, topography, and thermodynamic drivers. Generally, this will help to augment research in the spatial heterogeneity of snowpack across varying terrain and vegetation cover, in an environment that is understudied with respect to snow research.

Sustainable Pathways for Shortleaf Pine (Pinus echinata) Restoration in Uncertain Climates

Presenter: Casey Iwamoto, Mississippi State University
Co-Authors: Courtney Siegert, Joshua Granger, Krishna Poudel, Adam Polinko, (all Mississippi State University)

Throughout the southeastern US, strip mining has left degraded and low productivity soils. Combinations of organic (OA) and microbial (MA) soil amendments can enhance restoration through improving water availability, reducing erosion, and increasing carbon sequestration. In the face of climatic uncertainty and changes to precipitation, there is a need to understand how the sustainability of current restoration efforts may be impacted in the future to protect water quality and soil health. Future precipitation changes may challenge the effectiveness of our existing restoration techniques. This study represents a comprehensive greenhouse experiment to inform future reforestation efforts using shortleaf pine (Pinus echinata) with consideration to climate change under different moisture regimes: dry, average, and wet. Replicates across moisture treatments received the following amendments: OA, MA, OA+MA, unamended control, or control with no trees. Soil-water fluxes (dissolved organic carbon (DOC), specific ultraviolet absorbance at 254 nm (SUVA)), soil health indicators (electrical conductivity, pH, carbon content, nitrogen content), and tree growth parameters (survival, ground line diameter, height) were measured throughout the study.

Subsetting of Continental-Scale Hydrological Modeling Data in the Cloud

Presenter: Irene Garousi-Nejad, CUAHSI
Co-Authors: Scott Black, Anthony Castronova, CUAHSI

Identified as a grand challenge in hydrology, high-resolution, continental-scale simulations are essential to addressing and predicting hydrologic response to a range of stressors on spatial and temporal scales previously unattainable. Modeling at this scale requires large, labor intensive, input datasets that are curated by teams of interdisciplinary scientists. Enabling community scientists to align their research with these efforts at local and regional spatial scales is necessary to facilitate knowledge sharing among the local and regional communities focusing on localized water issues. The Consortium of Universities for the Advancement of Hydrologic Sciences has maintained a public web service (CUAHSI Model Domain Subsetter) for accessing subsets of large-scale modeling hydrofabrics. The objective of this work is to enable a software ecosystem to overcome scientific and technological barriers that restrict community hydrologic collaboration at continental scales. The Model Domain Subsetter provides a service for extracting the data necessary to execute WRF-Hydro (configured as the National Water Model) and Parflow (PF-CONUS), on-demand at regional scales. We enhance the Model Domain Subsetter capabilities by leveraging modern cloud services to separate the web interface from the computationally expensive subsetting algorithms. This approach enables us to extend support for more models, additional data processing routines, and larger spatial scales with high scalability and maintainability. Our contribution includes a new cyberinfrastructure design and supporting tools that facilitates access to continental scale model domain and parameter datasets. Additionally, we showcase potential use cases for future research.

Student Centered Research

Effects of in-stream process-based restoration on the geomorphology of a New England headwater stream

Presenter: Evan Choquette, University of Vermont
Co-Authors: Beverley Wemple, University of Vermont, Allaire Diamond, Vermont Land Trust, Shayne Jaquith, The Nature Conservancy in Vermont

Headwater streams, comprising as much as 80% of river networks, substantially influence the hydrological regimes, ecological character, and sediment and nutrient fluxes associated with the river networks in which they exist. Historic stream degradation across the United States, however, has altered the geomorphology of streams, consequently compromising their ability to store incoming nutrients and water as well as foster healthy ecological communities. Process-based restoration (PBR) approaches have been increasingly implemented to address the needs of degraded streams. Twenty-nine in-stream structures were installed in a degraded headwater stream in northwestern Vermont to reduce water velocity, induce streambed aggradation, and restore floodplain connectivity. The structures, along with 12 cross-sections of the stream, were monitored over the course of a year to assess the capacity of the structures to cause geomorphic changes in the channel. A repeated LiDAR survey of the study site also provided information on channel changes after one year. These data show that about one-third of the cross-sections experienced streambed aggradation, and that low slopes may have played a role in this outcome. Most installed structures also remained intact over the duration of the study period. The results not only have implications for the form and function of this stream, but also for the role of PBR in the greater context of river restoration, particularly in headwaters. The low-tech nature of this practice also presents the opportunity for community involvement in river restoration.

Going Beyond the Reach-Scale a Headwater Stream

Presenter: Paige Becker, Oregon State University
Co-Authors: Adam Ward, Oregon State University, Steve Wondzell, US Forest Service, Pacific Northwest Research Station Skuyler Herzog, Oregon State University

Field studies of the river corridor are often conducted at the reach scale, typically tens of meters in length, often due to practical reasons such as limited accessibility or time and budget constraints. However, these reach scale studies are often used to predict fluxes and transit times across entire river networks. Because of this, information on longer timescales and fluxes is likely missed which may be necessary for accurate water quality and quantity predictions. This study aims to understand what information is lost when we only use reach scale studies to make predictions within the hyporheic zone. In WS01 of the HJ Andrews (HJA) LTER, we conducted a series of solute tracers in combination with a channel water balance. Five salt tracers in series were conducted along a single larger segment in which a constant rate injection of fluorescent dye was also conducted. This study compares fluxes and transit times between the individual reaches and the larger segment to understand what nformation is missed from just using reach scale studies. Additionally, this study estimates what proportion of total fluxes and transit times are reach vs segment scales. This research builds on past studies in the HJA to provide a new perspective on conducting field research for river corridor research and upscaling from field sites to entire river networks.

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