



5th Annual Upper Colorado River Basin Water Forum October 28-29, 2015

PROGRAM, ABSTRACTS & BIOS

(Click on Speaker's name to go to their biography, abstract and presentation)

Wednesday, October 28, 2015

7:30am – Breakfast and Registration

8:00 - Welcome

8:10 – Morning Keynote

Extreme Conditions Across the West

[Kevin V. Werner, NOAA Western Region Climate Services Director](#)

8:45 – Panel of State Climatologists: Extreme Weather in the Colorado River Basin

Moderator: [Jim Pokrandt](#), Colorado River District

- [Robert Davies](#), UT Climate Center, Utah State University
- [Nolan Doesken](#), CO Climate Center, Colorado State University
- [David Dubois](#), NM State Climatologist, New Mexico State University
- [Nancy Selover](#), AZ State Climatologist, University of Arizona

10:25 – Strange weather: what does it mean for our future?

Moderator: [Gigi Richard](#), Colorado Mesa University

- Winter Weiriding of 2014/2015
[Chris Landry](#), Center for Snow & Avalanche Studies
- What does El Niño mean for the Colorado River Basin in 2015/2016?
[Klaus Wolter](#), NOAA-Earth System Research Lab, University of Colorado at Boulder
- The dynamics of vulnerability: why adapting to climate variability will not always prepare us for climate change
[Lisa Dilling](#), Western Water Assessment, University of Colorado at Boulder

11:30 – Lunch/ Poster Session

1:00 – Managing for Multiple Purposes under Challenging Conditions

Moderator: [David Graf](#), Colorado Parks & Wildlife

- The Clock is Ticking: An Occupancy-based Assessment of Regional Vulnerability for Desert Fishes of the SW USA
[Phaedra Budy](#), US Geological Survey and Utah State University
- Managing Flows for Multiple Purposes in Colorado: Effects to Riparian Plant Communities
[Barbara Galloway](#), ERO Resources Corporation
- A scalable ecological decision support framework for optimizing water resource use and management
[Seth Mason](#), Lotic Hydrological, LLC

2:05 – Managing for Multiple Purposes: Case Studies

Moderator: [Jeff Sellen](#), Western State Colorado University

- An experimental habitat enhancement effort for desert rivers: San Rafael River restoration project
[Brian Laub](#), Utah State University
- Managing for multiple purpose reservoir releases and irrigation diversion under increasingly extreme hydrologic conditions: Little Snake River Case Study
[Dawn Arnell](#) and [Larry Hicks](#), Little Snake River Conservation District
- Farmers looking ahead & working with multiple stakeholders on efficiency: the No Chico Brush project
[Perry Cabot](#), Colorado Water Institute, Colorado State University; [Cary Denison](#), Trout Unlimited; Tom Kay, No Chico Brush

Wednesday, October 28, 2015 (cont'd)

3:45 – Communicating Water Challenges and Solutions

Moderator: [Corey Beaugh](#), Colorado Division of Water Resources

- Storytelling to address Water Conflicts
[Constance Holland](#), Storyteller
- Living Landscapes: Personal Accounts of Water Conservation in a Modern Day American Home
[Natalie Sullivan](#), Center for ReSource Conservation
- Water Fluency Course Impact
[Jayla Poppleton](#), Colorado Foundation for Water Education

4:45 – Reception and Afternoon Keynote

Delta Dawn short film by Peter McBride
followed by remarks from [Taylor Hawes](#) of The Nature Conservancy

6:00 – Adjourn for the day

Thursday, October 29, 2015

7:30 – Breakfast & Registration

8:00 – Welcome

8:10 – Morning Keynote

Colorado Climate Plan
[Taryn Finessey](#), Colorado Water Conservation Board

8:45 – Alternative Water Allocation & Governance Strategies

Moderator: [Laurian Unnevehr](#), University of Illinois at Urbana-Champaign

- Who wins, who loses? Water markets under imperfectly competitive conditions
[Chris Goemans](#), Colorado State University
- Transitioning to a New Era in Western United States Water Governance: Examining Sustainable Water Policy in the Colorado River Basin
[John Berggren](#), University of Colorado Boulder

9:45 – Adaptation Strategies in Storage and Urban Land Use

Moderator: [Jessie Pahler](#), Western Water and Land

- Shifting the water resource management paradigm by increasing adaptive capacity for water storage in the American Southwest
[Dagmar Llewellyn](#), Bureau of Reclamation
- Integrating multiple strategies to achieve a more sustainable water future
[Eric Hecox](#), South Metro Water Supply Authority
- The Colorado Water & Growth Dialogue: tools for integrating land-use strategies into water supply planning
[Marc Waage](#), Denver Water

10:50 – Adaptation Strategies in Agriculture

Moderator: [Rusty Lloyd](#), Tamarisk Coalition

- Update on CO Water Bank Project: first year of results on agronomic impacts & measurements of water savings
[Perry Cabot](#), Colorado State University; [Paul Kehmeier](#), Farmer; and [Joe Bernal](#), Bernal Farms
- Young farmers at the helm: New findings on adaptation and stewardship
[Kate Greenberg](#), National Young Farmers Coalition
- Meeting Long-term Agricultural Demands – More than Water is Needed!
[Charles Howe](#), University of Colorado (for John Wiener, University of Colorado)

12:00 - Lunch

Thursday, October 29, 2015 (cont'd)

1:30 - **Renegotiating the Interim Guidelines for Managing Lakes Powell and Mead** (panel)

Moderator: [Eric Kuhn](#), Colorado River District

- [Angela Rashid](#), Colorado River Board of California
- [Chuck Cullom](#), Central Arizona Project
- [Steve Wolff](#), Wyoming State Engineer's Office
- [Ted Kowalski](#), Colorado Water Conservation Board

3:05 – **Extremes, Averages, or Both: Where Do the Risks Lie?**

[Doug Kenney](#), Chair, Colorado River Research Group

3:30 – Adjourn

4:00 – **Outing to Colorado River**

Visit Watson Island for a short walk and tour of riparian restoration project along the Colorado River, followed by an informal happy hour at the Edgewater Brewery. Transportation is not provided. Meet at the Western Colorado Botanical Gardens, 641 Struthers Ave, Grand Junction, CO.

Poster Presentations:

- **East River Health Headwaters Nonconsumptive Needs Assessment**
[Briant Wiles](#), Graduate Candidate for Master of Environmental Management, Western State Colorado University
- **Understanding hydro-meteorological variability and trends of streamflow droughts in the headwater basin of Colorado River**
[Maryam Pournasiri Poshtiri](#)* and [Indrani Pal](#), College of Engineering and Applied Science, University of Colorado Denver
- **Exploring Climate Change Driven Shifts to Water Rights and Policy Along the Colorado River**
[David Jacob Scarr](#), University of Colorado, Boulder Geography Department
- **River Studies and Leadership Certificate: An Inter-university partnership with the River Management Society**
[Gigi Richard](#), Colorado Mesa University, [Joel Barnes](#), Prescott College, and [Risa Shimoda](#), River Management Society
- **Measuring Water Table and Carbon Storage in Mountain Fens**
[Rod A. Chimner](#) and [John A. Hribljan](#), Michigan Technical University; [Tim Cutter](#) and [Marcie Bidwell](#), Mountain Studies Institute
- **Quantifying Proximate Body Composition in Catostomids Using Bioelectrical Impedance Analysis**
[Kristine Crippen](#) and [Eriek S. Hansen](#), Department of Biological Sciences, Colorado Mesa University

BIOGRAPHIES AND ABSTRACTS
(in order of appearance in the program)

October 28 Morning Keynote: Extreme Conditions Across the West

Kevin V. Werner, NOAA Western Region Climate Service Director

Biography

Current Position: NOAA Regional Climate Services Director, Western Region, Seattle, WA

In his role, Kevin works to connect climate science to application and decision makers in the western United States. In the past, Kevin has worked in other parts of NOAA including the National Weather Service and the NOAA commissioned officer corps. In the NWS, Kevin worked primarily at the Colorado Basin River Forecast Center where he worked to connect water predictions and science with people and organizations that benefit from forecasts and understanding of the region's hydrology. Kevin has also worked to infuse new science and technology into river forecast operational procedures and methodologies. Kevin holds degrees in atmospheric science, mathematics, and public administration from the Universities of Washington and Utah. Kevin has also been active in his communities most recently serving on the library board in Salt Lake City.

Abstract

Extreme conditions across the West

As water year 2016 begins, people across the western US are facing challenges managing to the climate conditions. Historic drought continued and developed across much of the region in 2015 challenging water managers, land managers, and agricultural producers in a myriad of ways. As we look toward 2016, an historic El Niño event is developing in Pacific Ocean bringing with it potential for extreme weather across the region. This talk will describe recent climate anomalies, the outlook for the 2016 and the potential challenges it poses.

Panel of State Climatologists

Moderator: Jim Pokrandt, Colorado River District

Biography

Jim Pokrandt works for the Colorado River District as the community relations director. He has been with the River District since 2005. Prior to joining the Colorado River District, Jim worked in community-level newspapers for 30 years, the last 13 in various ski resort communities in Western Colorado. The Colorado River District was founded in 1937 to protect western Colorado water in the face of transmountain diversions. The central issue of its founding was to strike balanced agreements as Front Range interests have pursued West Slope water for agricultural and municipal use. In that vein, nothing has changed. More can be learned at ColoradoRiverDistrict.org.

Jim is a graduate of the University of Maryland's College of Journalism and lives in Glenwood Springs, Colo., the home base for the Colorado River District. Jim is also the chair of the Colorado Basin Roundtable, one of the nine Roundtables in Colorado created in 2005 by the General Assembly to discuss and help solve a projected water supply shortage in Colorado -- when the population could grow to as many as 10 million people. The Basin Roundtables along with the Colorado Water Conservation Board are working on Colorado's first water plan. More can be learned at ColoradoWaterPlan.com.

Robert Davies, Utah Climate Center, Utah State University

Biography

Rob Davies is a physicist and educator whose work for the past decade has centered on climate change and sustainability. Rob is an Associate of the Utah Climate Center and co-creator of The Crossroads Project, a transdisciplinary communications project bringing the performance art to bear on the public discourse of human sustainability.

Nolan Doesken, Colorado Climate Center, Colorado State University

Biography

Nolan Doesken is a life-long weather enthusiast. Born and raised in rural central Illinois, he brought his passion for weather and climate with him to Colorado where he has worked at the Colorado Climate Center in the Department of Atmospheric Science at Colorado State University since 1977. He was appointed State Climatologist in 2006 and is responsible for monitoring the climate of Colorado, gathering and archiving data, conducting applied climate research and sharing information and expertise with the citizens of Colorado. He also serves as director of the historic Fort Collins Weather Station at Colorado State University with 125 years of complete data to help track long term variations and changes in Colorado's climate.

In 1998, Nolan helped create the Community Collaborative Rain, Hail and Snow network (CoCoRaHS) to engage people of all ages and interests in tracking and mapping Colorado's precipitation resources. This project has spread nationwide and has become one of the largest 'Citizen Science' projects in the U.S.

Abstract

The Climate of Western Colorado -- Tendencies, Trends and Extremes

Data from Colorado's long-term weather stations from western Colorado will be investigated. Basic patterns defined by many years of monitoring will be described. Temperatures are systematically, but not dramatically warmer than 50 to 100 years ago. Growing seasons are longer in some places but erratic but not clearly different in others. Precipitation continues to go through wet episodes and dry ones but with no clear long-term trend. As for extreme events that impact lives and livelihoods -- droughts, floods, blizzards, heatwaves, etc., we'll let you know what the data show.

David Dubois, NM State Climatologist, New Mexico State University

Biography

Dave DuBois has been the New Mexico State Climatologist since February 2010 and is the director of the New Mexico Climate Center in Las Cruces. Dr. DuBois teaches and trains students in the Plant and Environmental Sciences Department at New Mexico State University. For his role as State Climatologist, he provides climate and climate change information and education to policy makers, the agricultural community, industry, educators, and the public. Dr. DuBois maintains an active research program in air quality and climate, conducting studies to understand the nature and origins of atmospheric pollutants that we breathe. He is also the New Mexico Community Collaborative Rain, Hail and Snow state coordinator and looking for more volunteers to join. Although he is a native New Mexican, he grew up on a farm in rural southern New Jersey and collected weather data as a child. Dr. DuBois holds BA in physics from Rutgers, a MS in physics from NMSU, and a doctorate in Atmospheric Sciences from the University of Nevada Reno.

Faculty page at NMSU: <http://aces.nmsu.edu/academics/pes/david-w-dubois.html>

New Mexico Climate Center: <http://weather.nmsu.edu>

Personal webpage: <http://web.nmsu.edu/~dwdubois/>

Nancy Selover, AZ State Climatologist, Arizona State University

Biography

Nancy Selover has been the State Climatologist for Arizona since 2007, and serves as co-chair of the Monitoring Technical Committee of the state Drought Task Force, and participates in the statewide Flood Warning Task Force and the state and county Hazard Mitigation Plan Update team. The State Climate Office is located at Arizona State University and provides climate data and information to researchers, government and non-government agencies, and the public. Dr. Selover's research interests include the urban heat island, evaporation, drought, monsoon and climate adaptation.

Abstract

Extreme weather in Arizona includes winter storms both blizzards and rain-on-snow, monsoon rain events, dust storms, and heat waves. Impacts on communities include shutdown of transportation corridors due to debris, erosion, snow, and flooding; isolation of residents, lack of access to supply chains for businesses; inability of workers to get to work;

loss of tourism; and in extreme cases loss of life. Our biggest questions with regard to how to mitigate against these impacts are: “How bad will it get in the next 5-10 years? What should we expect?” Mitigation against extreme weather events requires actionable information and currently no one in the climate/weather community is providing any.

Strange weather: what does it mean for our future?

Moderator: Gigi Richard, Colorado Mesa University

Biography

Gigi Richard is currently a Professor of Geology at Colorado Mesa University (CMU) in Grand Junction, CO in the Department of Physical and Environmental Sciences and the Faculty Director of the Water Center at CMU. She holds an M.S. and Ph.D. from Colorado State University in hydraulic engineering and a Bachelor of Science in civil engineering from the Massachusetts Institute of Technology. Dr. Richard created the Watershed Science program at CMU and teaches water science and environmental geology classes. Her research on human impacts on rivers systems includes the study of downstream impacts of dams and levees on rivers in Colorado, New Mexico and New Zealand. Recent work has focused on better understanding the hydrology and morphology of intermittent streams in western Colorado and on the need for peak flows to maintain the channel form of the Yampa and Dolores Rivers in western Colorado. A resident of Colorado for 23 years, she has experience in private engineering consulting and served on water quality and land use planning commissions in Summit County, Colorado from 1990 to 1996.

Chris Landry, Center for Snow & Avalanche Studies

Biography

Chris Landry served as the Executive Director for the Center for Snow and Avalanche Studies since its founding in 2002, in Silverton, CO until his succession by Jeff Derry in the fall of 2015. As founder of CSAS, Landry identified and then developed the CSAS’s Senator Beck Basin Study Area on Red Mountain Pass in the San Juan Mountains, at Red Mountain Pass. CSAS and its Senator Beck Basin have become a venue for long-term mountain system monitoring with published datasets, for interdisciplinary American and international snow system research, for field education, of an international dust-on-snow workshop, and the home base for the Colorado Dust-On-Snow program (CODOS), a state-wide dust-on-snow and mountain snowmelt monitoring program providing operational snowmelt monitoring and analysis services to the Colorado water management community. CSAS continues to seek wider engagement with stakeholders throughout the Colorado River, Rio Grande, and other major river basins who rely on mountain system processes in a changing environment.

Abstract

Winter Weirding in 2014/2015

Winter 2014/2015, as documented through integrated monitoring at the Senator Beck Basin Study Area at Red Mountain Pass, presented Southwestern Colorado and other Western Colorado mountain locales with an unusual combination of snowpack formation and ablation conditions and processes. Departures from normal behaviors that complicated water supply forecasting included: heavy September rains, saturating soils and near surface aquifers and auguring well for spring 2015 runoff efficiency; a very low winter storm count through April and overall poor snowpack formation; two significant mid-winter droughts with extensive snowcover ablation on solar aspects; early snowpack ripening and snowmelt runoff onset, despite no dust-on-snow in March and minimal dust in April; finally, heavy May precipitation that prolonged the runoff cycle. Several questions emerge from this ‘weird’ winter. Do these unusual weather patterns and snowpack processes of winter 2014/2015, including a significant reduction in the number and intensity of dust-on-snow events, reflect increasingly erratic interactions among regional climate drivers including ENSO, PDO, and the Arctic Oscillation? What indicators enabled the NOAA Climate Prediction Center to correctly forecast May precipitation? Do these behaviors conform to expected changes in the Colorado snowmelt energy budget and climate-driven changes in Colorado snowpack water supplies?

Klaus Wolter, NOAA-Earth System Research Lab, University of Colorado at Boulder

Biography

Klaus Wolter's main research interests lie in empirical climate research, in particular the application of statistical methods to climate problems, such as the impact of ENSO (El Niño/Southern Oscillation) on world-wide climate. He has developed and refined a "Multivariate ENSO Index" (MEI) based on tropical Pacific observations of sea level pressure, near-surface wind fields, sea – and air surface temperatures, as well as total cloudiness. The MEI is more reliable than conventional indices in monitoring the ENSO phenomenon. A simplified and extended version of the MEI (Wolter and Timlin, 2011) just won a prize from the Royal Meteorological Society. Monthly updates and discussions of the MEI as well as relevant publications can be found under <http://www.esrl.noaa.gov/psd/enso/mei/>

In the last decade, Dr. Wolter has been able to devote more attention to the prediction of U.S. climate, most recently funded through NIDIS (National Integrated Drought Information System). In this context, he has developed statistical tools that allow me to make seasonal climate predictions, such as documented at the Colorado Water Conservation Board (<http://cwcb.state.co.us/public-information/flood-water-availability-task-forces/Pages/main.aspx>), and recognized by the Governor's Award in 2013.

Dr. Wolter has been involved in recent regional and national assessments of extreme climate events as well as overall climate change (see references above). A 2014 report to the Governor is the 2nd for Colorado (1st: <http://cwcb.state.co.us/public-information/publications/Documents/ReportsStudies/ClimateChangeReportFull.pdf>).

Dr. Wolter is also part of the 'Climate Scene Investigation' team at the NOAA-ESRL Physical Science Division (<http://www.esrl.noaa.gov/psd/csi/>) that attempts to sort out how much if any of recent climate and weather extremes can be attributed to anthropogenic forcing (e.g., Wolter et al., 2015, in press).

Dr. Wolter has a Ph.D. from the Department of Meteorology, University of Wisconsin – Madison and a "Diplom" (equivalent of M.Sc.) from the Department of Meteorology, University of Hannover, Germany.

Abstract

What does El Niño mean for the Colorado River Basin in 2015/2016?

The current El Niño event is the strongest El Niño since 1997-98, and will impact the Upper Colorado Basin well into 2016. There are both seasonal and regional differences in typical ENSO impacts around the basin, as well as some interesting differences between strong and weaker Niños and their footprints. In particular, I will cover which regional expectations can be justified for moisture during the fall, winter, and spring season, as well as typical anomalies in snowpack and runoff. I will also assess to what extent this year's El Niño event has already fulfilled expectations.

Lisa Dilling, Western Water Assessment, University of Colorado at Boulder

Biography

Lisa Dilling is Associate Professor of Environmental Studies, a Fellow of the Cooperative Institute for Research in Environmental Sciences (CIRES) and a member of the Center for Science and Technology Policy Research at the University of Colorado, Boulder. Dr. Dilling is Director of the Western Water Assessment, a NOAA Regional Integrated Sciences and Assessment project that studies and facilitates the use of climate information in decision making in the Intermountain West. Her scholarship focuses on decision making, the use of information and science policies related to climate change, adaptation, carbon management and geoengineering. Her current projects examine drought in urban water systems, water governance and climate change, municipal adaptation to hazards, decision making in public lands management, and knowledge for adaptation among pastoralists. She has authored numerous articles and is co-editor of the book, "Creating a Climate for Change: Communicating climate change and facilitating social change" from Cambridge University Press.

Abstract

The dynamics of vulnerability: why adapting to climate variability will not always prepare us for climate change

Recent reports and scholarship suggest that adapting to current climate variability may represent a "no regrets" strategy for adapting to climate change. Addressing "adaptation deficits" and other approaches that target existing vulnerabilities are helpful for responding to current climate variability, but we argue that they may not be sufficient for

adapting to climate change. In this talk, we identify why the dynamics of vulnerability matter for adaptation efforts. We draw on vulnerability theory and the natural hazards and climate adaptation literatures to outline how adaptation to climate variability, combined with the shifting societal landscape can sometimes lead to unintended consequences and increased vulnerability. We conclude by suggesting the need for greater engagement with various publics on the tradeoffs involved in adaptation action and for improving communication about the complicated nature of the dynamics of vulnerability.

Managing for Multiple Purposes under Challenging Conditions

Moderator: David Graf, Colorado Parks & Wildlife

Biography

David Graf currently works as Regional Water Specialist for Colorado Parks and Wildlife in Grand Junction. In this capacity he roughly splits time between overseeing a portfolio of CPW water rights used on State properties on the western slope, and integrating hydrologic expertise with general knowledge in aquatic species conservation, riparian restoration, and fluvial geomorphology to promote water stewardship on behalf of aquatic species. He currently serves as CPW liaison to the four western slope Basin Roundtables (Colorado, Yampa/ White, Gunnison, and Southwest), and serves as an Advisory Council member to the Water Center at CMU.

Phaedra Budy, US Geological Survey and University of Utah

Biography

Phaedra Budy is the Principle Investigator for Fish Ecology Lab at the University of Utah and is the Unit Leader of the U.S. Geological Society, Utah Cooperative Fish and Wildlife Unit as well as a Professor of fisheries management and aquatic ecology in the Department of Watershed Sciences at Utah State University (USU). In that capacity, she helps the Utah Division of Wildlife Resources and the many federal partners of the Intermountain West meet their research needs, for more informed management of aquatic natural resources in Utah. She serves as a full member of the Watershed Sciences faculty, and her research spans food web dynamics in lakes and reservoirs to conservation biology in streams and large rivers, and geologically from western Texas to the North Slope of the Brooks Mountains, Alaska. She has a Ph.D. in Aquatic Ecology from Utah State University and a B.S. in Limnology from the University of California, Davis.

Abstract

The Clock is Ticking; An Occupancy-based Assessment of Regional Vulnerability for Desert Fishes of the SW USA

Desert fishes are some of the most imperiled vertebrates worldwide due to their low economic worth and because they compete with humans for water. An ecological complex of fishes, 2 suckers (*Catostomus latipinnis*, *Catostomus discobolus*) and a chub (*Gila robusta*) (collectively managed as the so-called three species) are endemic to the U.S. Colorado River Basin, are affected by multiple stressors, and have allegedly declined dramatically. We built a series of occupancy models to determine relationships between trends in occupancy, local extinction, and local colonization rates, identify potential limiting factors, and evaluate the suitability of managing the 3 species collectively. For a historical period (1889–2011), top performing models (AICc) included a positive time trend in local extinction probability and a negative trend in local colonization probability. As flood frequency decreased post-development local extinction probability increased. By the end of the time series, 47% (95% CI 34-61) and 15% (95% CI 6-33) of sites remained occupied by the suckers and the chub, respectively, and models with the 2 species of sucker as one group and the chub as the other performed best. For a contemporary period (2001–2011), top performing (based on AICc) models included peak annual discharge. As peak discharge increased, local extinction probability decreased and local colonization probability increased. For the contemporary period, results of models that split all 3 species into separate groups were similar to results of models that combined the 2 suckers but not the chub. Collectively, these results confirmed that declines in these fishes were strongly associated with water development and that relative to their historic distribution all 3 species have declined dramatically. Further, the chub was distinct in that it declined the most dramatically and therefore may need to be managed separately. Our modeling approach may be useful in other situations in which targeted data are sparse and conservation status and best management approach for multiple species are uncertain.

Barbara Galloway, ERO Resources Corporation

Biography

Barbara Galloway, senior hydrologist, has a BA in biology and an MS in Water Resources, and 30 years of experience as a regulator and consultant. Barbara has assisted clients with water supply for and protection of water dependent ecosystems, including riparian areas, wetlands, and aquatic ecosystems. She has been involved with surface and ground water quantity and quality data collection, analysis and modeling, water rights and administration, water supply studies, environmental impact analyses, and hazardous and non-hazardous site investigations and remediation. Barbara has prepared surface and ground water monitoring and management plans. She has evaluated impacts to surface water from storm runoff, erosion and sedimentation, and assisted clients with 401 quality certification, permitting for construction, stormwater and treated water discharges, and preparation and review of stormwater management, erosion control, and drainage plans. Barbara has prepared augmentation plans, substitute water supply plans, and changes of water rights for public and private water users, and evaluated water yields and consumptive use. She has participated in the preparation of the hydrology, water quality, water rights, stream morphology and floodplain sections of numerous environmental impact statements and assessments.

Abstract

Managing Flows for Multiple Purposes in Colorado: Effects to Riparian Plant Communities

As much as 90 percent of Colorado's wildlife depend on riparian habitats, which are very biologically diverse. Other functions and values of riparian areas include nutrient cycling, transport of organic matter, reduction of flood peaks, bank stabilization and erosion reduction, water quality improvements, aquatic habitat improvements, and fishing, hunting and recreation. Maintaining the water supply needed for riparian corridors in Colorado is considered important by many, as discussed in Colorado's draft Water Plan, but it is a challenging task, particularly where surface water and shallow ground water are over-appropriated. Water administration in Colorado is becoming more complex in the 21st century due to ever increasing population and water demands, unnatural hydrologic conditions in streams and shallow aquifers due to diversions, quickly changing water availability along a stream, and climate change effects.

With the exception of instream flow rights, Colorado's water courts have not considered, when approving a water rights decree, water that is needed by water-dependent vegetation communities (and associated wildlife) along a stream. In addition, instream flow rights are junior to most other water rights on streams, and cover only a small percentage of the streams in Colorado. Studies show that changes in stream flow and shallow ground water levels along a stream corridor, and the timing of surface and subsurface flows can have very significant effects to riparian areas. This presentation will focus on studies completed about the effects of changes surface flows and shallow ground water availability to Plains cottonwood riparian ecosystems with regards to seedling recruitment, growth, composition, abundance, and survivorship.

An innovative arrangement has been struck to leave water in the Little Cimarron River in late summer instead of using it for agriculture. It is the first deal of its kind in Colorado, but has yet to be approved in Water Court. Leaving water in the river in late summer may not be particularly beneficial for maintaining the riparian habitat along the Little Cimarron River. However, the split-season concept exemplifies the idea that a water right can be used for more than one purpose. This arrangement is evidence of a mindset shift among irrigators, environmentalists and water regulators in Colorado. Given the complexities of water administration in Colorado in the 21st century, and the intricacies of water needs by riparian vegetation, it is uncertain whether these types of arrangements will be able to successfully maintain Colorado's riparian areas.

Seth Mason, Lotic Hydrological, LLC

Biography

Seth Mason received his M.S. in Land Resources and Environmental Sciences from Montana State University and his B.A. in Environmental Studies from the University of Colorado, Boulder. He specializes in hydrological modeling; stream characterization; deployment and operation of data collection and management systems; and development and coordination of water quality monitoring and assessment activities. Seth works extensively with city and county governments, federal agencies, and 501(c)3 organizations. Seth currently serves on the Board of Directors of Eagle Mine Ltd., a non-profit organization established to monitor and disseminate information about the Superfund cleanup efforts

at the Eagle Mine Site near Red Cliff, Colorado.

When he's not finger painting, eating dirt or jumping in puddles with his two young sons, Seth enjoys getting outside on skinny skis, fat skis, mountain bikes and various types of river craft. A retired member of the U.S. Men's Whitewater Raft Team, Seth still spends many summer days seeking out whitewater or floating through one of Colorado's scenic river canyons. In the winter, you will often find him Nordic skiing on the Roaring Fork valley's numerous cross-country skiing trails, or chasing face shots in the Aspen Highlands Bowl. Seth serves as a board member on the Mount Sopris Nordic Council and the United States Rafting Association—organizations focused on making frozen and liquid water sports more accessible and enjoyable to the communities they serve.

Abstract

A scalable ecological decision support framework for optimizing water resource use and management

There is a growing need for scalable decision support tools that help stakeholders and resource managers better understand the interplay between hydrology, hydraulics, channel form, alternative water use/management strategies, and measures of ecological function. The proposed assessment framework quantitatively evaluates the ecological benefits realized by alternative actions that reduce consumptive water use, improve water efficiencies or modify the structure of the stream channel. The current absence of such tools severely constrains stakeholders' ability to identify, prioritize, and implement those actions most likely to support existing water uses while producing meaningful improvements in aquatic ecosystem function.

Managing for Multiple Purposes: Case Studies

Jeff Sellen, Western State Colorado University

Biography

Jeff Sellen is an associate professor in and director of the Environment and Sustainability program at Western State Colorado University, where he is also the director of the Colorado Water Workshop, now beginning its fifth decade.

Brian Laub, Utah State University

Biography

Brian Laub graduated from the University of Montana in 2004 with a B.S. in fisheries management. He earned a Ph.D. from the University of Maryland in 2011, researching the geomorphic and ecological impacts of restoration projects in urban streams. Brian is currently working as a Research Scientist at Utah State University, developing restoration techniques for native fish habitat on desert river systems and involved in reviewing monitoring programs for conservation agreement species in Utah and for aquatic biota in the Big Bend region of the Rio Grande.

Abstract

An experimental habitat enhancement effort for desert rivers: San Rafael River restoration project

Co-authors: Justin Jimenez², Phaedra Budy^{3,1} Department of Watershed Sciences and The Ecology Center, Utah State University, ²Bureau of Land Management Utah State Office, ³U.S. Geological Survey, Utah Cooperative Fish and Wildlife Research Unit

The native fish fauna in the upper Colorado River Basin desert rivers is severely threatened by a suite of factors including water development, habitat degradation, and non-native species. Given the multiple threats, conservation of these sensitive species will likely require a combination of management approaches including managed flow regimes and active habitat enhancement efforts. The extensive development of many desert systems has driven an ecological regime shift from braided, laterally-unstable and actively migrating systems towards entrenched, canal-like systems with low habitat complexity and replacement of native with non-native fish and vegetation communities. Thus, simple placement of habitat structures is unlikely to recover properties of dynamic river systems, and restoration will instead need to incorporate approaches that enhance active river processes. Based on several years of biological and geomorphic research, we have designed and implemented a process based, experimental, and adaptive restoration plan for the San Rafael River, a desert river system in southeastern Utah. Activities included systematic removal of non-native tamarisk

trees, placement of gravel in the river channel, installation of beaver-dam mimicking structures, and pursuit of managed high flows. Tamarisk removal is predicted to decrease bank stability and enhance lateral channel migration during high flows. Placement of gravel is intended to mimic tributary junctions, which provide gravel for sediment transport and formation of riffle-pool complexes. Installation of beaver-dam structures is predicted to alter flow patterns and promote scour pool development, enhance sediment accretion and promote river-floodplain connection, and facilitate dam-building activity by existing beaver populations. Each of these activities is designed to take advantage of the scour and sediment transport processes driven by natural and managed high flows. An extensive monitoring campaign is currently being carried out to document the effectiveness of these strategies and provide guidance for future desert river restoration projects in the region.

Dawn Arnell and Larry Hicks, Little Snake River Conservation District

Dawn Arnell Biography

Dawn Arnell has been the Little Snake River Conservation District's Assistant Coordinator since 2004. She was certified in Water Quality 2010 and manages districts water quality program. She also works with the State Engineer's office in administration of water; administers 14 temperature sensors for fisheries in conjunction with Game and Fish, Federal Land Management, Trout Unlimited and landowners; coordinates Adopt a Trout with Trout Unlimited, Little Snake River Valley School and partners; and works with 54 water development projects that involve wells, small reservoirs, pipelines, solar systems, wetlands. From 1999-2004, she worked as the Laramie Rivers Conservation District Manager.

Larry Hicks Biography

Larry Hicks has served 24 years as Natural resource Coordinator for the Little Snake River Conservation District.

1. In that capacity lead several nationally recognized watershed restoration projects on over 1 million acres.
2. Schedule and manage irrigation releases from High Savery Dam on 20,000 acres of irrigated lands.
3. Developed and managed largest fish passage - irrigation diversion rehab and modification project in WY.

He has actively been involved in water policy issues at the local, state, and national levels having served on the National Association of Conservation District Water Resources Committee in addition to the Family Farm Alliance Advisory Board.

In 2010, he was elected to the WY Senate and serves on the Judiciary Committee, Agriculture - Public Lands and Water Committee, Select Federal Natural Resources Committee, Chairmen of the Select Natural Resource Funding Committee.

Abstract

Managing for multiple purpose reservoir releases and irrigation diversion under increasingly extreme hydrologic conditions. A case study in collaborative reservoir management for environmental, municipal, and agricultural water supplies and modification in irrigation infrastructure to address both cold and warm water fisheries in the Upper Colorado River Basin

The Little Snake River is a tributary to the Yampa and Green Rivers. The Little Snake Basin contains the most intact cold and warm water native fish assemblages in the Upper Colorado River Basin. Species of primary concern include Colorado River Cutthroat Trout, Flannel-mouth suckers, Blue-head suckers, and Rountail Chub. There are over 24,000 acres of irrigated lands, two towns with drinking water river infiltration galleries, and the largest municipal trans-basin diversion in Wyoming. High Savery Dam first came on line in 2007 with a capacity of 22,433 acre feet with allocation of 5,724 ac ft. minimum fisheries pool, 2,709 ac. ft. environmental account, and 14,000 ac. ft. irrigation & municipal account. Prior to High Savery during drought the Little Snake River was dry at the town of Baggs requiring the town to temporarily acquire agricultural water. Savery Creek routinely was dry at the confluence with the Little Snake. Fisheries in both Savery Creek and the Little Snake River prior to High Savery Dam where marginal as a result of nonexistent flows and excessive high water temperatures at low flows < 40 cfs. Habitat fragmentation was exacerbated by numerous irrigation diversion structures. In 2011 the Little Snake incurred significant flooding with the third greatest peak discharge (10,300 cfs) and in 2012 experience the third lowest (1,530 cfs) discharge in 92 years. Both extremes created significant and unique challenges to reservoir management and irrigation diversion while attempting to maximize fisheries benefits for cold and warm water species. Extensive flood damage occurred to irrigation diversion in 2011 and Section 404 permitted minimum flow releases from High Savery Dam proved inadequate to maintain sufficiently low water temperatures in 2012 for cold water fisheries. Through a collaborative effort stream temperature monitoring, irrigation and municipal

releases, use of the environmental pool, and encroachment into the minimum reserve pool below permit requirements resulted in higher releases at longer duration thereby maintaining and enhancing fisheries for 40 miles below High Savery during the record low flow year of 2012. Over ten million dollars has been invested to reconstruct 15 irrigation diversion dams with fish passage and nineteen miles of stream restoration to improve aquatic habitat and river stability on the Little Snake and its tributaries. A multitude of partners including federal and state agencies, irrigators and canal companies, and nonprofit organization assisted in the funding of this restoration and irrigation infrastructure project.

***Perry Cabot, Colorado Water Institute, Colorado State University;
Cary Denison, Trout Unlimited, and Tom Kay, No Chico Brush***

Perry Cabot Biography

Perry Cabot is a Research Scientist and Extension Specialist within the Office of Engagement for Colorado State University. He based at the Orchard Mesa Agricultural Experiment Station in Grand Junction. His primary research interests include agricultural water management, irrigation systems and sustainable fuels. He has co-authored several academic papers on agricultural issues, published in Applied Engineering in Agriculture, Journal of Soil and Water Conservation and the journal Fuel. He received his Ph.D. in Agricultural Engineering and Land Resources from the University of Wisconsin-Madison and B.S. in Civil Engineering from Colorado State University. He has conducted international work through Engineers Without Borders and was a Fulbright Scholar (2009) in collaboration with the University of Zambia on research related to soil sustainability, irrigation practices, and bioenergy cropping. He is a Faculty Affiliate of the Department of Civil and Environmental Engineering at Colorado State University.

Cary Denison Biography

For the last four years Cary has worked as project for Trout Unlimited's Colorado Water Project in the Gunnison Basin. His work is focused on assisting land and water rights owners, state and federal agencies and local TU chapters develop on-the-ground water conservation projects that reconnect and restore streams and rivers. Cary, a graduate of Colorado State University, was raised in the North Fork Gunnison River valley where he worked on farms and ranches and gained valuable knowledge about water use and conservation. He later worked as a State of Colorado water commissioner from 2001 to 2006. After working for the State, Cary owned and operated a water and land consulting firm where he managed numerous river improvement, restoration, water rights and water diversion projects. When not at work Cary spends time working in his property, rafting, fishing, hunting and generally enjoying western Colorado with his family.

Tom Kay Biography

Tom Kay is a farmer involved with No Chico Brush.

Abstract

No Chico Brush is a proactive farmer-led group promoting improved stewardship of agricultural water to secure the future of farming in the Gunnison Basin. One component of their effort is a study of on-farm research regarding irrigation efficiency. The presentation will weave together the vision behind research funded by the Colorado Water Conservation Board and the new Lower Gunnison Basin Resource Conservation Partnership Program project funded, in part, through the 2014 USDA Farm Bill. Some western Colorado farmers have identified the need for increased on-farm and off-farm irrigation efficiency as preferable to the alternatives of "Buy and Dry", "System Conservation" or "Lease and Cease". Western Colorado agriculture and community sustainability, in an uncertain water and climate future, is the driving force behind this vision. Environmental values are also present in their thinking. The presentation before the CMU Water Forum will focus on both the applied research and new financial resources that will benefit the adoption and expansion of this vision. The presentation will also highlight the broadness of the collaborative approach seeking this future.

Communicating Water Challenges and Solutions

Moderator: Corey Beaugh, Colorado Division of Water Resources

Biography

Corey has been a Water Commissioner with the Division of Water Resources for almost 5 years, and is responsible for the administration of water rights and reservoir operations in some tributaries of the Lower Colorado River in Colorado. He has a Master's Degree in Rangeland Ecology and Watershed Management from the University of Wyoming, where he researched fluctuating E. coli levels in the streambed and water column in the Greybull River. He has previously been employed as a Hydrologist with the Arizona Department of Water Resources monitoring groundwater levels. Corey enjoys living in the high desert of Western Colorado and all the unique year-round recreational opportunities available, and spending time with his wife and two year-old son.

Constance Holland, Storyteller

Biography

Constance Holland taught water policy at Mesa State College (CMU) and Embry Riddle Aeronautical University, Prescott, AZ. She worked with environmental nonprofits on water issues in both California and Colorado. She is a professional oral storyteller having told in schools, libraries, living museums, bookstores and arts festivals on the Front Range. She is currently working on a Chautauqua performance of Mary Austin, the first woman author to write about western water conflicts.

Abstract

Storytelling to address Water Conflicts

Water disputes have often been resolved through a financial settlement or court decision. Both these solutions ignore the social values of water and they do little to resolve the enmity that may continue to divide communities, states or regions. Storytelling has been a valued means of communication for thousands of years. The value of storytelling is that it is how we share who we are when meeting new people, finding our commonalities; it allows the listener to see themselves in foreign situations; and it has long been used in various societies to teach values. Thus storytelling may be a valuable tool in communicating the social values of water and helping stakeholders to put themselves in each other's place thus reducing the enmity that makes it difficult to find satisfying dispute resolutions and leaves communities and regions divided.

Natalie Sullivan, Center for ReSource Conservation

Biography

Natalie is the Water Programs Manager for the Landscape Programs at the Center for ReSource Conservation, a Colorado-based non-profit striving to put conservation into action. Having earned her MA in Environmental Leadership from Naropa University, Natalie is trained to address the environmental challenges and injustices of our time with an open mind and a holistic, systems-based, sustainability-minded approach.

Abstract

Living Landscapes: Personal Accounts of Water Conservation in a- Modem Day American Home

Founded in 1976 by a group of citizens concerned by our increasing dependence on non-renewable resources, the Center for ReSource Conservation (CRC) has been tackling issues of sustainability and expenditure of natural resources for nearly 40 years. CRC's mission is, "to put conservation into action," with a vision of, "thriving communities living sustainably." Through a robust portfolio of water conservation, waste diversion, and youth engagement programs, CRC empowers 65,000 Coloradans each year, helping them to live more sustainably in practical, cost-effective, and measurable ways.

Established more than fifteen years ago, Garden in a Box is one of CRC's most popular and widely-known water conservation programs. Garden in a Box offers a simple approach to learn about and plant water-wise gardens. Regardless of expertise, community members can save water and beautify their properties by purchasing professionally designed perennial gardens that use Xeric (low water) plants. Gardens are offered in partnership with local and regional water utilities throughout the Eastern and Western slopes of Colorado in support of their

commitment to water conservation. In 2014, CRC distributed 2100 gardens, which covered about 172,000 square feet of land. When Xeric, low water usage gardens replace existing turf, the water savings are especially significant, using up to 60% less water than traditional turf.

Over the years, thousands of Garden in a Box participants throughout Colorado have been impacted, transformed, and touched by this program in their own unique way. This presentation will introduce Garden in a Box through the lens of its participants: how it has changed their view of water conservation, the value it has added to their lives, the insights they have gained through their hands-on experience, tales of empowerment, and more. Garden in a Box offers a unique alternative for those who are ready to take the next step when it comes to water conservation: landscape change. The personal stories shared in this presentation are essential for our own deeper understanding and appreciation of the relationship that Colorado residents form with their landscapes and how this critical relationship impacts water conservation efforts in our communities at large. Olivia Lucas, a past Garden in a Box participant, states, "We feel like we are a part of the City by using Garden in a Box. We wanted and got simplicity. We are so much happier about how the front yard looks, and that makes us motivated to do more care for our yard. We recommend them all the time to friends, neighbors, and those walking by." A conservationist at heart, Lorie Menke shares that, "With our gardens we've just done what made sense with the least impact on the land; we are stewards of our land." This presentation will give an informative overview of the shifting paradigm of water conservation as told by engaged citizens.

Jayla Poppleton, Colorado Foundation for Water Education

Biography

Jayla Poppleton manages the content program for the Colorado Foundation for Water Education, the only statewide, non-advocacy organization devoted to helping Coloradans speak fluent water. She is also the senior editor for Headwaters magazine, CFWE's flagship publication covering pressing challenges and promising trends in Colorado water. The journalist within is always on the lookout for a good story to tell, and Jayla finds water—and the people who work with it—inspiring and passionate subjects. Based in Denver, she enjoys getting out of town to experience Colorado's vast, varied and beautiful places in her free time with her husband and three sons.

Abstract

Water Fluency Course Impact

The Colorado Foundation for Water Education launched its inaugural course of the Water Fluency program in 2015. This is a unique educational experience for local government officials, community leaders and emerging water professionals to understand and analyze water's influence on daily issues and current public policies in order to evaluate creative solutions and lead with confidence.

The program delivers high-quality, interactive adult education through three main components:

1. Customized online classroom to access course readings, lectures, videos, quizzes, moderated discussion forum and other resources (in partnership with Colorado State University)
2. Field visits and guided tours of water infrastructure and project sites for on-the-ground application of learning
3. Four half-day sessions of in-class discussions with expert lectures and facilitated dialogue to gain in-depth understanding of course topics and learning objectives

The course curriculum builds off the current statewide water dialogue, focusing on the competing demands and opportunities for change within the social and economic values of water, legal and institutional frameworks, watershed health and protection, and water resource management for Colorado's future.

The 2015 offering has witnessed substantial support from program partners and presenters plus a high level of interest from participants. CFWE over-sold this year's course at 32 participants coming from around the state, young and old, representing a diversity of sectors and positions, resulting in dynamic and meaningful professional development. The class graduates in August but CFWE will promote their continued learning and involvement in Colorado water.

This presentation will highlight results from the inaugural course, including an evaluation of the achievement of learning objectives, how Water Fluency graduates are utilizing course skills and networks and how CFWE will adjust the program design for future offerings. The presentation will also showcase initial plans for a West Slope offering in 2016, ideally in

the Grand Junction area. Audience input for curriculum development will be solicited on the most critical water management and policy issues in the local community with the goal of helping program candidates “speak fluent water.”

October 28 Evening Keynote

Delta Dawn short film by Peter McBride followed by remarks from Taylor Hawes of The Nature Conservancy

Delta Dawn: Paddling a River Run Free

This short film is about the 2014 Colorado River Pulse Flow, the result of a binational, multi-state agreement to release a pulse of water to reconnect the Colorado River to the sea. Of the 260 rivers that cross international borders, this is the first binational agreement of its kind. This short film highlights the first crossing of the delta via watercraft (self-supported Standup Paddle Board) in over two decades.

The film can be previewed here: <http://www.petemcbride.com/FILM-MOTION/delta-dawn/1>

Taylor Hawes Biography

Taylor Hawes serves as the Colorado River Program Director for The Nature Conservancy. The Program’s goal is to conserve the freshwater biodiversity of the Colorado River Basin while also meeting human demands for water. Her responsibilities include coordinating TNC’s freshwater conservation efforts across the Colorado River Basin, synthesizing priority strategies, working with key stakeholders who are critical to conservation success across the Colorado River Basin and fundraising. Taylor has worked on Colorado River issues for more than eighteen years. She practiced water, local government, water quality, and land use law on Colorado’s Western Slope before joining the Conservancy. She currently serves as a Governor appointee to Colorado’s Inter-basin Compact Committee and is the co-chair of the Basin Study’s Environmental and Flows Workgroup. Originally from Atlanta, Georgia, Taylor received a B.A. in political science from University of North Carolina and her Juris Doctorate degree from Vermont Law School.

October 29 Morning Keynote: Colorado Climate Plan

Taryn Finessey, Colorado Water Conservation Board

Biography

Taryn Finessey works on Climate Change adaptation, and natural hazard risk management for the Colorado Water Conservation Board. She is responsible for developing approaches for quantifying and considering uncertainties and vulnerability in water resource planning & management, focusing primarily on climate change and implementation of water management strategies. Taryn is also responsible for the implementation of HB 13-1293, Colorado’s climate change efforts and manages the Colorado State Drought Mitigation and Response plan. She holds a B.A. in Earth and Environmental Science from Wesleyan University, and a M.A. in Global Environmental Policy from American University.

Abstract

Colorado has warmed substantially in the last 30 years and even more in the last 50 years, with projected temperatures rising an additional 2.5 degrees by 2050. By mid-century typical Colorado summers will be as warm as the hottest we have experienced over the last century. With this Colorado is facing a potential increase in both the number and severity of extreme weather events, from heat waves and drought to wildfire, presenting a considerable set of challenges for the state, our residents, and our way of life. In response to these risks, the state developed a plan for mitigating and adapting to a broad range of possible impacts from multiple sectors. The Colorado Climate plan puts forth our commitment from the state and sets the groundwork for the collaboration needed to make sure Colorado is prepared. The goal of this document is to promote state policy recommendations and actions that help to improve Colorado’s ability to adapt to future climate change impacts and increase Colorado’s state agencies level of preparedness, while simultaneously identifying opportunities to mitigate greenhouse gas emissions (GHG) at the agency level.

Alternative Water Allocation & Governance Strategies

Moderator: Laurian Unnevehr, University of Illinois

Biography

During a thirty-plus year career as an agricultural economist, Dr. Unnevehr has served on the faculty of the Department of Agricultural and Consumer Economics at the University of Illinois (where she is now a Professor Emerita), and has held positions at the USDA's Economic Research Service, the International Food Policy Research Institute, and the International Rice Research Institute. Dr. Unnevehr is a Fellow of the Agricultural and Applied Economics Association (AAEA), recognized for original contributions in the economics of food policy and demand. Dr. Unnevehr received her Ph.D. from the Food Research Institute, Stanford University and her B.A. in Economics from the University of California at Davis. She is now an independent consultant, with the good fortune to live in Grand Junction, Colorado.

Chris Goemans, Colorado State University

Biography

Christopher Goemans is an associate professor in the Department of Agricultural and Resource Economics at Colorado State University. Dr. Goemans holds a Ph.D. in Economics from the University of Colorado. In addition to his current position, his past work experience includes consulting on projects focused on topics ranging from the cost-benefit analysis of proposed water projects to forecasting urban demands for water to evaluating the impacts of reallocating water among competing uses. He also spent time researching water markets in New Zealand while serving as a visiting scholar at Victoria University of Wellington, New Zealand. Dr. Goemans selected past research includes investigating: the impact of water transfers from agricultural to non-agricultural use, the relationship between climatic variability and the effectiveness of various water management schemes, optimal demand management strategies during periods of drought, and most recently, using experimental economics techniques to evaluate the performance of water markets under different institutional settings. Relevant publications include: "Western Water Markets: Effectiveness and Efficiency.", "Estimating the Economic and Social Impacts from the Drought in Southern Colorado", "The Interaction of Water Restriction and Pricing Policies: Econometric, Managerial, and Distributional Implications", "Western Households' Water Knowledge, Preferences, and Willingness to Pay", and "Water Transfers and Their Impacts: Lessons from Three Colorado Water Markets".

Abstract

Who wins, who loses? Water markets under imperfectly competitive conditions.

Most of the previous studies evaluating water markets as a means of reallocating water across uses assume that perfectly competitive conditions exist; however, this typically is not the case. Water markets tend to be highly regional, have a few dominant buyers, suffer from substantial physical and institutional transactions costs, and involve heterogeneous goods. Because data on water market activity is limited we use laboratory experiments together with simulated market activity under different institutional settings to evaluate the performance of water markets when perfectly competitive conditions don't exist. The results provide insights into the overall performance of markets under different settings as well as evidence of who wins and who loses.

John Berggren, PhD Candidate, University of Colorado – Boulder

Biography

John is a Ph.D. student in Environmental Studies and a research affiliate with Western Water Assessment at the University of Colorado - Boulder. His research is on western water policy, with a focus on Colorado River governance. His specific research interests include analyzing the adaptability of water institutions, understanding and reflecting societal values, and identifying the narratives used to frame problems and solutions. Overall, he hopes to help contribute useful knowledge for decision-making in the Colorado River Basin while balancing changing demands and hydrological-climate impacts. John holds a M.H.S. in Environmental Health from the Johns Hopkins Bloomberg School of Public Health and a B.A. in Public Health Studies from the Johns Hopkins University.

Abstract

Extensive water policy research has been conducted on two broad topics in recent years – the call for water management reform as demands increase and supplies diminish, and the seemingly inflexibility of existing water institutions. These two topics are particularly salient in the Colorado River Basin, where demands have recently surpassed supplies and there are complex governance systems that manage water throughout the Basin. Additionally, there have been extensive contributions to the field of sustainable water policy, which attempts to reconcile these two potentially conflicting topics. What is lacking, however, is robust empirical scholarship into holistic sustainability frameworks, particularly at the basin-scale, that may support decisionmakers in water supply planning and operations. There are a variety of reasons for this research gap, including complexities and complications at the basin-scale such as politics, boundary definitions, and historical institutional and infrastructural path dependencies. As such, much of the sustainable water policy focus has been on compartmentalized practical guidelines or more broad theoretical frameworks. It is important to not only examine and evaluate criteria for basinscale sustainability, but to also understand for whom these criteria are applicable and how individual actors or governments would weigh the criteria. Water policy, like any public policy, is dependent on individuals' values and therefore "successful" water management can often be subjective and dependent on where an individual is located within that water system. Understanding basin-scale sustainability and evaluating criteria that incorporate the different actors in water management are the motivation for this research project.

This presentation will present the results of a comprehensive literature review on sustainability criteria and frameworks with a focus on implications for basin-scale criteria, particularly for the Colorado River Basin. Understanding that sustainability has multiple meanings and many different evaluative criteria, a framework allows for the systematic review of sustainability for a given water system. Several frameworks have been developed and will be included in this literature review (e.g., Hedelin 2007; Weik and Larson 2012). The Weik and Larson framework, for example, is a recent attempt to employ a holistic sustainability framework, overcoming many of the barriers discussed above to integrated water management. The framework does this by not only incorporating criteria such as actor-oriented governance, interactions between social-ecological systems (including infrastructure), incorporation of uncertainty, and inter-generational concerns, but also by utilizing an integrated approach. This is just one approach, however, and it is unclear how successful this framework would be at the basin-scale – the framework has only been utilized at the municipality level. At the basin-scale, issues such as inter-state compacts and institutions provide a different set of issues to be incorporated into a framework. Different levels of government and power relations are also important at the basin-scale (e.g., the role of the federal government). Therefore, this literature review will be focused on what has been done at this basin-scale and how this work could be incorporated into sustainability frameworks.

Adaptation Strategies in Storage and Urban Land Use

Moderator: Jessie Pahler, Western Water and Land

Biography

Ms. Pahler is a Project Scientist with Western Water & Land, Inc., currently specializing in the collection, analysis, validation, and management of environmental data. She has over 8 years of experience as an environmental scientist, and has a strong background in surface and groundwater quality monitoring. Current projects include baseline water quality studies that include unregulated and emerging contaminant analyses.

Education:

- M.A.S., Environmental Policy and Management: Energy and Sustainability, Denver University, 2013
- B.S., Environmental Science: Restoration and Waste Management, Colorado Mesa University, 2007

Training:

- Mine Safety and Health Administration (MSHA) Surface and Underground (current)
- Occupational Health and Safety Administration (OSHA) 40-Hour HAZWOPER (current)
- Certified Hazardous Materials Manager (CHMM)

Dagmar Llewellyn, Bureau of Reclamation

Biography

Dagmar Llewellyn is a hydrologist, with an educational background in geosciences and civil engineering, and post-graduate studies in climate dynamics, paleo-climatology, river restoration, GIS, and water law and management. For the past 15 years, her work has focused on water-management and endangered-species issues in the Upper Rio Grande Basin. Her work has involved water supply and demand evaluation, groundwater/surface-water interaction, irrigation efficiency, habitat and hydrologic requirements of endangered species, accounting under the Rio Grande Compact, and Reclamation project operations. After 25 years in environmental and water-resource consulting, her interest in working for the federal government was sparked by the passage of the SECURE Water Act, which assigned to the Bureau of Reclamation a west-wide evaluation of the potential hydrologic implications of climate change. Since 2010, she has worked at the Bureau of Reclamation on programs authorized under the SECURE Water Act, as well as on Middle Rio Grande and Rio Grande Project water management and endangered species / environmental compliance issues. Dagmar is a member of the West-Wide Climate Risk Assessment (WWCRA) Implementation Team, and has served on a variety of WWCRA teams, including ecological resources, feasibility study guidance, groundwater resources impact evaluation, and development teams for the SECURE reports to Congress. She is lead author of the Upper Rio Grande Impact Assessment, which provides projections of the impacts of climate change on the hydrology of the Upper Rio Grande in Colorado and New Mexico, as well Reclamation's lead on the Santa Fe Basin Study, which evaluates adaptation options for the Santa Fe water supply, and serves as Reclamation's project manager for the Pecos Basin Study. Ms. Llewellyn managed a project to enhance operations modeling for the Middle Rio Grande to support climate-change analysis. She has participated in several National Science Foundation / EPSCOR innovation working groups, including on the potential impacts of climate change on agriculture in the southwest, social-ecological resilience in the face of climate change, and the New Mexico water budget, and is a regular speaker at the University of New Mexico and in our community on issues related to climate change and water resources.

Abstract

Shifting the water resource management paradigm by increasing adaptive capacity for water storage in the American Southwest Co-authors: Melinda Harm Benson, University of New Mexico, Department of Geography and Environmental Studies; Peggy Johnson, New Mexico Bureau of Geology, New Mexico Tech; Katherine Yuhas, Albuquerque-Bernalillo County Water Utility Authority

Temperatures in the American Southwest are increasing at rates about double the global average.^{1,2} Even with uncertainties relating to projected changes in precipitation, rising temperatures resulting from global climate change will have dramatic consequences on water supply and allocation. Impacts from temperature rise include (1) increased evaporation from open water, (2) increased vegetative transpiration, and (3) reduced groundwater recharge and subsequent baseline surface flows. All of these factors will trigger greater demands on water supply, including increased groundwater pumping to compensate for surface shortages. The collective result is greater demand on an already limited supply. These demands will require a shift in management paradigms, including reexamining current model of surface reservoirs as the main approach to water storage. Although technologies are being explored to decrease evaporation from surface reservoirs, subsurface water storage provides a superior buffer against evaporative losses.

This manuscript is the result of an interdisciplinary team of scholars and practitioners taking on the challenges associated with water supply for the City of Albuquerque, New Mexico. After examining projected environmental impacts from increased temperatures on both surface and groundwater supplies, it notes the cultural, legal, and institutional barriers that can limit application of aquifer storage and recovery (ASR). While located in the Rio Grande Basin, the water at issue is from the Upper Colorado Basin and is delivered to the Albuquerque Water Utility Authority via the San Juan Chama Project. This case study highlights both the obstacles and opportunities for ASR as one of many adaptive strategies needed to manage for extremes.

References:

¹U. S. Army Corps of Engineers, 2013, Observed Climate Trends in the Upper Rio Grande Basin; prepared by the USACE Climate Change Adaptation Program, and the Albuquerque District, December 2013 (This report is presented in its entirety as Appendix C of the Upper Rio Grande Impact Assessment).

²Llewellyn, Dagmar, Seshu Vaddey, Jesse Roach, and Ariane Pinson, 2013. Upper Rio Grande Impacts Assessment: An Activity of the West Wide Climate Risk Assessment. Bureau of Reclamation, Albuquerque, New Mexico.

Eric Hecox, South Metro Water Supply Authority

Biography

Eric serves as the Executive Director of South Metro Water Supply Authority (South Metro Water). As Executive Director, Eric is responsible for leading South Metro Water in its efforts to bring renewable water supplies to the South Metro area of Denver. South Metro Water's mission is to secure a sustainable water future for the South Metro region. South Metro Water and its 13 member water providers promote water efficiency, partnerships, and investment in water projects in order to diversify and increase the region's water supply. The members of South Metro Water collective serve about 80% of the population of Douglas County and 10% of Arapahoe County. The area is home to 7 of Colorado's 9 Fortune 500 companies, produces 30% of Colorado's earned income, and is home to approximately 300,000 people, which is expected to grow to 550,000 by 2050.

Prior to joining SMWSA in 2012, Eric was the Section Chief of the Water Supply Planning Section at the Colorado Water Conservation Board (CWCB). In this capacity, Eric implemented Colorado's state-wide water supply planning process. He oversaw the analysis of Colorado's current and future water supply needs and potential projects to meet those needs. He also managed the state's Basin Roundtable process.

Prior to joining the State, Eric served as a Natural Resource Specialist to the Bureau of Land Management's National Science and Technology Center under a Presidential Management Fellowship.

Eric received his B.A. in biology from Lawrence University and prior to graduate school was a Fulbright Scholar at the University of Zimbabwe. He earned a Masters of Science in Environmental Science in Water Resources and a Masters of Public Affairs from Indiana University's School of Public and Environmental Affairs.

Abstract

Integrating multiple strategies to achieve a more sustainable water future

In semi-arid Colorado, as in many desert communities, there is a delicate balance between water supply and demand. Beneath the communities that make up much of the greater Denver Metro area lies a tremendous groundwater resource - the Denver Basin Aquifer System. This aquifer system is a series of bedrock aquifers that serve as a bank of stored water held in the pores of sandstones and siltstones that are more than 50 million years old. Studies show that it took tens of thousands of years or more for nature to fill these pores with water.

Today this groundwater supply is in rapid decline. Fourteen different communities rely on this groundwater for their primary water supply. These communities, which are not only home to over 300,000 people but headquarter several Fortune 500 companies and collectively generate over 30% of Colorado's earned income, tap this resource with 100's of wells that are 500 to 2,000 feet deep. In the 1990's water level declines of more than 30 feet per year were observed in primary aquifers used for public water supply in densely populated and economically important areas. Studies showed that these rates of decline were not sustainable into the future and the region must develop a more secure and sustainable supply to protect these communities and economies.

In 2004 13 different communities with their own independent water providers came together to form a partnership organization with the purpose of developing regional renewable water supply projects. This entity, the South Metro Water Supply Authority, and its members are actively pursuing water supply projects and conservation, efficiency, and reuse programs to provide a secure water future for the region. These efforts are being recognized for their innovations and held up as examples for the types of projects Colorado and the Western United States should pursue in the future.

This discussion will focus on two of these innovative approaches including integrating land-use strategies into water efficiency programs, and the storage of water in underground aquifers through Aquifer Storage and Recovery (ASR).

Marc Waage, Denver Water

Biography

Marc Waage leads the water resources planning, watershed planning and climate adaptation planning for Denver Water. Prior to working in water resources planning, Marc directed the operation of Denver Water's extensive water collection system for twenty years. Marc has a Bachelor's and a Master's degree in Civil Engineering from Colorado State University and is a professional engineer.

Abstract

The Colorado Water & Growth Dialogue: tools for integrating land-use strategies into water supply planning

The Colorado Water and Growth Dialogue is attempting to explore and demonstrate how the integration of water and land use planning should be utilized to reduce water demand from the development and re-development associated with the projected population increase. This approach to planning aims to direct and incentivize smart, water-wise growth in lieu of allowing pure market conditions to guide how Colorado grows.

The purpose of the Colorado Water and Growth Dialogue is three-fold:

- To demonstrate how much water can be saved through the integration of water and land use planning for homes and neighborhoods that will be developed or redeveloped in the future;
- To develop a consensus-based set of water-saving strategies for communities that can be incorporated into their planning that recognizes the uncertainties of how and where people in the future will want to live; and,
- To develop and disseminate to local communities, an implementation plan for these strategies that includes a demonstration of real water savings that can be achieved through land use planning decisions while still meeting the current and future needs of the community.

Adaptation Strategies in Agriculture

Moderator: Rusty Lloyd, Tamarisk Coalition

Biography

Rusty Lloyd, who is based in Grand Junction, Colorado, joined the Tamarisk Coalition team in January of 2011. He moved to Colorado in May of 2000 shortly after completing a Bachelor of Science in Park Resource Management at Kansas State University. Rusty began his career as a ranger for Colorado State Parks, before transitioning to natural resource management and wildland firefighting with the Bureau of Land Management and U.S. Forest Service. From 2004 to early 2011, he was the director for a youth and young adult employment program called Western Colorado Conservation Corps. He currently oversees Tamarisk Coalition's programs and works closely with the staff to support them and the partnerships they are involved with. He also works with the Executive Director on some of the administrative components of the organization. He is passionate about spending time in the outdoors any chance he gets with his wife Jami and three children.

Perry Cabot, Colorado Water Institute, Colorado State University; Paul Kehmeier, Farmer; and Joe Bernal, Farmer

Perry Cabot Biography

Perry Cabot is a Research Scientist and Extension Specialist within the Office of Engagement for Colorado State University. He based at the Orchard Mesa Agricultural Experiment Station in Grand Junction. His primary research interests include agricultural water management, irrigation systems and sustainable fuels. He has co-authored several academic papers on agricultural issues, published in Applied Engineering in Agriculture, Journal of Soil and Water Conservation and the journal Fuel. He received his Ph.D. in Agricultural Engineering and Land Resources from the University of Wisconsin-Madison and B.S. in Civil Engineering from Colorado State University. He has conducted international work through Engineers Without Borders and was a Fulbright Scholar (2009) in collaboration with the University of Zambia on research related to soil sustainability, irrigation practices, and bioenergy cropping. He is a Faculty Affiliate of the Department of Civil and Environmental Engineering at Colorado State University.

Paul Kehmeier Biography

Paul Kehmeier farms on his family farm near Eckert, Colorado. His main crops are alfalfa and grass hay. He has been participating with CSU for several years in the study of deficit irrigation of alfalfa. Mr. Kehmeier holds a Masters of Science degree in Range Ecology. He is active on a variety of agricultural boards in his area.

Joe Bernal Biography

Joe Bernal is the Managing Partner of Bernal Farms in Loma Co. and has been a Farmer since Graduating from Fruita Monument H.S. in 1981. Joe is President of the Grand Valley Water Users Association, and has served on its board for the past 10 years. He has also served on the Western Colorado Vegetable Growers Association board, Fruita Co-op Member Relations Board, and other Agriculture planning and advisory committees. Joe has also gained experience working in construction of some nearby water projects, such as Mcfee project in Cortez, CO and the Salinity Control projects here in the Grand Valley in the Early 1980's. He has also installed over 8 miles of underground and gated pipe systems on his own family farm. Joe is a 4th generation Farmer in Loma, and farms with his son Bryan and his parents Jim and Helen Bernal.

Abstract

Update on CO Water Bank Project: first year of results on agronomic impacts & measurements of water savings

The Colorado River Basin has experienced a severe drought since the late 1990s. If the drought continues, and if no collaborative action is taken to mitigate the effects of the drought, every sector is at risk. There are no easy answers and we will need a range of options to reduce water use in the region on a temporary basis to help get through these dry times.

The Water Bank Work Group (WBWG) is a representative group of stakeholders that consists of the Colorado River District, Southwestern Water Conservation District, The Nature Conservancy, the Front Range Council, and the State of Colorado. Together, the WBWG is exploring the use of a voluntary and compensated market approach to temporarily reduce consumptive uses in Colorado in the event of extreme shortages that significantly affect Lake Powell's operations or our ability to meet the Colorado River Compact obligations. Currently, the group is working on the many technical, social and economic questions that must be answered before we can design an approach that works for all sectors.

A large part of this work is focused on how a temporary reduction in water use can work for the agricultural sector. To accomplish this, the group has partnered with Colorado State University on a multi-year field study to assess the water savings potential and impacts to the agricultural operation from reduced irrigation. Dr. Perry Cabot will provide an overview of the study and its objectives and will be joined by two participating producers who will offer their perspectives on the overall water bank effort and their direct experience with reduced irrigation.

Kate Greenberg, National Young Farmers Coalition

Biography

Kate Greenberg is the Western Organizer for the National Young Farmers Coalition (NYFC), a national network of thousands of young farmers, ranchers, and consumers working together to reduce the barriers to young farmer success. Kate organizes young farmers and ranchers across the West to forge farmer networks and advocate for supportive policy and land and water stewardship. Over the last eight years she has worked on vegetable farms and volunteered on western wineries and ranches. Between farm jobs she lived in northern Mexico restoring native habitat in the Colorado River Delta and managed a traveling field program, Semester in the West, through her Alma matter Whitman College. In 2014, she helped produce a short film for NYFC called [“Resilient: Soil, Water and the New Stewards of the American West”](#). Kate participates in the Bureau of Reclamation Colorado River Basin Study Agricultural Conservation, Productivity, and Transfers working group. She sits on the Board of Directors of the Quivira Coalition and the Southwest Farm Fresh Cooperative. Originally from Minnesota, Kate now calls Durango, CO home.

Abstract

Young farmers at the helm: New findings on adaptation and stewardship

In an era defined by increasing climatic extremes, young farmers and ranchers face new challenges for which history provides no straightforward answers. The challenges are many, from climate change and extended drought to population growth and a rapidly aging farming population. As food producers, land stewards, and the creative

practitioners of tomorrow's solutions, young farmers and ranchers need a voice in shaping policy and management and in forging resilience.

This year the National Young Farmers Coalition (NYFC) surveyed over 500 young farmers and ranchers across the Colorado River Basin and the arid West to hear what they think about water. From the Imperial Valley to the headwaters of the Colorado River, young farmers expressed an incredibly diverse array of concerns and insights, with a number of key themes connecting them across scale, region, and operation type. NYFC held eight focus groups in four Basin states and reached hundreds of producers via an online survey to collect this data.

In this presentation NYFC western organizer Kate Greenberg will present on the findings of this research. The presentation will include a discussion on how young farmers and ranchers in the West are thinking about water; how they are managing for increasing complexity; what support they need to be successful in producing food, stewarding natural resources, and adapting to new extremes; and stories from the field that illustrate what all this means from the farmers' perspectives.

Charles Howe, University of Colorado

Biography

Charles Howe is Professor Emeritus in the Department of Economics and Faculty Research Associate at the Institute of Behavioral Science at the University of Colorado-Boulder. He received his Ph. D. from Stanford. His research interests include water resources planning and management; water law and economic efficiency; water markets; role of water and natural resources in economic development.

Abstract

Meeting Long-term Agricultural Demands – More than Water is Needed!

Author: John D. Wiener, Institute of Behavioral Science, University of Colorado, website:

www.colorado.edu/ibs/eb/wiener/

Upper Colorado River Basin agriculture, in common with much of the West and Colorado, faces a wide array of threats to continued viability of small and medium-sized farming, and thus to farm families and legacies. The rates of loss of farmers and the best farm land have been too high for too long, and are under-appreciated as a problem for land and soil conservation, which are critical to meeting urban population preferences, and achieving long-term agricultural productivity in conditions of rapid changes in climate, weather extremes, and market conditions for agricultural land and water. These conditions seem certain to include even greater pressure on senior agricultural water rights, as well as conversion of the best farmland to other uses.

Major international and national assessments call "transformational change" rather than only incremental improvements in existing farming systems. The basic characteristics of more sustainable and financially viable farming will be noted, from strong scientific work. The essentials are farming with better use of soils, terrain, aspect, drainage and mixed crops, filter and buffer areas, and lower levels and costs of off-farm sourced inputs to production, using landscape scales to take advantage of improved rotations of crops, capital equipment cost control, and risk reduction.

One model of steps toward such a transformation will be outlined, within existing water and land law, working with the existing cooperative basis of ditch companies and municipal water supply firming and financial capacity to capitalize transition to a stabilized and productive set of farming enterprises that offer long-term resilience and security of interests in the many ecosystem services, amenities, and values from viable farming. The role of cities as partners in achieving permanence of interests for both municipal water supply and the many other urban interests, and stability and capacity to make changes for farmers will be argued.

Renegotiating the Interim Guidelines for Managing Lakes Powell and Mead

Moderator: Eric Kuhn, Colorado River District

Biography

Eric is the General Manager of the Colorado River District, a position he has held since 1996. He earned his Bachelor's Degree in Engineering from the University of New Mexico and a Master's Degree in Business Administration from Pepperdine University in California. Prior to working for the Colorado River District, he served as an engineer officer aboard nuclear submarines in the U.S. Navy and worked as start-up engineer for Bechtel Power Corp. Eric started employment with the Colorado River District in 1981 as Assistant Secretary-Engineer. He has served on the Engineering Advisory Committee of the Upper Colorado River Compact Commission since 1981. From 1994-2001, he served on the Colorado Water Conservation Board representing the Colorado River mainstem. In 2006, Eric was appointed by Governor Owens as an at-large representative on the Colorado Interbasin Compact Committee, a position he continues to hold.

Angela Rashid, Colorado River Board of California

Biography

Angela Rashid is a water resource engineer with the Colorado River Board of CA (CRB). She has been with the CRB for two and half years. Prior to joining the CRB, Ms. Rashid worked as a civil engineer at a private consultant firm designing site layouts, as well as, water resources and storm water management systems. Ms. Rashid has an undergraduate degree in civil engineering from San Jose State University and a Masters in Urban and Regional Planning from the University of California, Los Angeles.

Chuck Cullom, Central Arizona Project

Biography

Chuck Collum is the Colorado River Program Manager for the Central Arizona Project.

Steve Wolff, Wyoming State Engineer's Office

Biography

Steve Wolff is the Colorado River Program Manager in the Interstate Streams Division of the Wyoming State Engineer's Office. This position serves as the primary technical representative for the State of Wyoming and Wyoming State Engineer's Office to numerous interstate bodies responsible for ensuring Compact compliance and other water management activities within the Colorado River Basin. Steve serves as the lead technical representative for Wyoming to the Upper Colorado River Commission, is Wyoming's Governor appointed member to the Glen Canyon Adaptive Management Working Group and serves on the Management Committee of the Upper Colorado Endangered Fish Recovery Program. Steve attended school at the University of Montana, University of Wyoming and Virginia Tech, where he studied natural resource management and policy.

Ted Kowalski, Colorado Water Conservation Board

Biography

Ted Kowalski is the Chief of the Interstate, Federal and Water Information Section of the Colorado Water Conservation Board. Ted manages this section, which oversees the Platte River, Upper Colorado River, and San Juan River Recovery Implementation ESA Programs, the Decision Support Systems, and a variety of other water programs for the State of Colorado. He is also a senior negotiator on federal, interstate, and international issues related to the Colorado River. Ted has testified before U.S. Congress and before the Colorado General Assembly. He has presented at dozens of water conferences and seminars, and written articles for the Denver Water Law Review, the Water Report, and the Colorado Water Law Benchbook. Previously, Ted was employed by the Colorado Office of the Attorney General. Ted graduated from the University of Colorado, School of Law, and he obtained his undergraduate degree from Cornell University. Ted lives in Louisville, Colorado with his wife Jessie and their children, Ben and Ellie.

Extremes, Averages, or Both: Where Do the Risks Lie?

Doug Kenney, Chair, Colorado River Research Group

Biography

Doug Kenney is Director of the Western Water Policy Program and its Colorado River Governance Initiative, located within the University of Colorado Law School in the Getches-Wilkinson Center for Natural Resources, Energy and the Environment. He is also founder and current chair of the Colorado River Research Group. He has written extensively on several water-related issues, including law and policy reform, river basin and watershed-level planning, climate change adaptation, and water resource economics. Dr. Kenney has served as a consultant to a variety of local, state, multi-state, and federal agencies, including several Interior Department agencies, EPA, the US Forest Service, and special commissions (e.g., the Western Water Policy Review Advisory Commission); and national governments and NGOs in Asia and Africa. Additionally, he has made presentations in 20 states (and the District of Columbia), 7 nations, and 4 continents. He has a B.A. in biology from the University of Colorado, a M.S. in Natural Resources Policy and Administration from the University of Michigan, and a Ph.D. in Renewable Natural Resource Studies from the University of Arizona.

Poster Presenters

Briant Wiles, Western State Colorado University

Biography

Briant grew up in Wyoming where he was immersed in outdoor activities. Snow and the mountains led him to Colorado where he perused his passion of snowboarding while working in the ski industry. His desire to further his career led him here to Gunnison where he completed his undergraduate in Entrepreneurship and Outdoor Recreation. The outdoor opportunities that abound here have kept him busy in the valley. After a hiatus from school spent working in civil engineering and a climate change research project he has returned to Western for the MEM graduate program. He was awarded the Clark Environmental Fellowship to work with Cold Harbour Institute where he has assumed a leadership role overseeing the property and conservation easements on Tomichi Creek. His extensive experience with the people and landscapes of the mountain states has given him a desire to have a say in their future. He understands that in many ways water is the key to the west. Briant is working towards understanding how to sustain and improve our use of water resources so as to protect the values inherent in western landscapes. When not working on course work or documenting wildlife on Cold Harbour property he can be found snowboarding in the Crested Butte backcountry, teaching avalanche courses, fishing, or just spending time with his wife and their young son Salix.

Abstract

East River Healthy Headwaters Assessment: A holistic approach to a non-consumptive use needs assessment East River Drainage, Gunnison County, Colorado

Comprehensive understanding of environmental and recreational non-consumptive water use is fast becoming a major challenge in a new era of water resource management. By identifying specific issues surrounding non-consumptive use of water as well as projects that address those issues can lead directly and indirectly to a healthier and more resilient watershed in social, economic, and environmental measures. Beyond recreation and environmental use more generally consumptive users of water like M+I and irrigation also benefit from a healthier watershed in numerous ways.

There has not been a widely adopted holistic approach to identifying non-consumptive needs at a watershed scale. The Colorado State Wide Water Supply Initiative, conducted in 2010, while effective in forwarding the importance of recreation and environmental values was by necessity broad in scope. To increase the adaptive capacity and resilience at a watershed scale specific issues and areas of concern need to be addressed.

The East River Healthy Headwaters Assessment is a study uses a comprehensive approach to a non-consumptive needs assessment. Through a unique process of stakeholder engagement and in depth analysis the study plans to develop a list of actionable projects. Activities include interviews, surveys, hosting events, on sight investigation, utilizing water quality information and climate change projections. The study takes place during the summer and fall 2015 and winter 2016. The study is being conducted with the guidance of faculty at Western State Colorado University and several community sponsors.

This study is one step towards building resilience at the watershed scale. Once identified the projects can be prioritized and opened to different sources of funding. Local organizations as well as state and federal agencies will be able to gain valuable insight into future planning and goal attainments. Beyond the obvious implications for the East River Watershed the project hopes to establish a model for conducting a non-consumptive needs assessment. The driving purpose of the study is to understand how a realistic assessment can be done on a larger geographic scale. Opportunities, successes, and challenges of the study can be utilized by taking a “lessons learned” approach. The resulting template can then be used to inform other basins and watersheds as they look to address environmental and recreational needs

In a time where traditionally extractive values are evolving into wider recognition of the interconnections of natural systems, a process to more efficiently evaluate environmental and recreational values of water is essential. The current scale of such efforts is too broad to have tangible and consistent outcomes. The East River Healthy Headwaters Assessment makes an attempt to comprehensively identify specific issues and concerns in a watershed through a bottom up approach. This approach includes heavily utilizing stakeholder engagement and on sight investigation. The goal of the study is to find a workable and repeatable model that can be scaled up across other river basins. All persons, visitor and resident alike, have the potential to see the benefits of the study through clean water and the host of benefits from ecosystem services we enjoy everyday.

Maryam Pournasiri Poshtiri, College of Engineering and Applied Science, University of Colorado Denver

Biography

Maryam Pournasiri Poshtiri is a third year PhD student in the field of Environmental Engineering and Sustainability at University of Colorado Denver. My current research is focused on streamflow droughts in major watershed regions of the conterminous U.S. I am interested in understanding the evolution of historic changing patterns of streamflow droughts, and their hydro-meteorological characteristics. My previous work experiences included a number of studying and designing stream stabilization and river restoration projects, as well as board experience in performing cost and budget analysis, documenting & reporting, and coordinating with different project disciplinarians.

Abstract

Understanding hydro-meteorological variability and trends of streamflow droughts in the headwater basin of Colorado River Co-author: Indrani Pal, College of Engineering and Applied Science, University of Colorado Denver

Hydro-climatology of low streamflows (low flow henceforth) describes the vital part of water scarcity in a headwater basin. It is important to understand the variability of streamflow droughts because minimum available amount of water in a given time period often leads to serious societal repercussions. This concern is significant in the arid territory like Colorado River Basin (CRB) located in the southwestern United States. Unlike mean and high flows, there has been a relative paucity of research considering how large-scale climatic patterns in atmospheric circulation is connected to streamflow droughts characterized by low flow hydrology in the Upper CRB (UCRB). This research aims to identify temporal changes and systematic variability of *natural* low flows and their associations with large-scale atmospheric circulation patterns using a range of statistical approaches. Towards that aim 17 stream gauge locations are selected, which are identified as “undisturbed” meaning that these stations represent near-natural river flow regimes providing a useful resource for assessment of large-scale atmospheric patterns and local hydrology associations without the confounding factor of major direct (e.g. water abstraction) or indirect (e.g. land-use change) human modification of flows. Detailed diagnostic analyses provided a fair understanding on the variability and temporal changes in low flow magnitudes characterizing the streamflow droughts that are explained by the large-scale atmospheric circulations. Most notably, eastern and western parts of UCRB indicated opposite trending patterns—the west (east) showing drier (wetter) conditions. Further, the low flow magnitudes were found to be having multi-decadal variability revealing close associations with Interdecadal Pacific Oscillation (IPO) and Pacific Decadal Oscillation (PDO) patterns, which likely influence the monotonic trending patterns observed.

David Jacob Scarr, University of Colorado, Boulder

Biography

Jacob Scarr moved to Colorado in 2011 to attend the University of Colorado, where he graduated with a Geography and Biology degree, writing an undergraduate thesis on Colorado River Water Rights. He is currently working a few other water related projects and applying to graduate schools for the coming year.

Abstract

Exploring Climate Change Driven Shifts to Water Rights and Policy Along the Colorado River

This study is intended to evaluate the current discussion on how climate driven shifts in hydrology will affect water rights and policy on the upper Colorado River. Global and local temperatures have been increasing steadily. In certain areas of Colorado snowmelt has shifted earlier and is likely to continue to do so. Precipitation as snow is decreasing at certain elevations in the Rocky Mountains. Focusing on water users in the western slope of Colorado, these environmental changes suggest a number of shifts in river hydrology. There will likely be less overall storage as snowpack and possibly earlier more pronounced peak flows. It is expected that earlier flow timing could reduce the ability of senior agriculture users to apply water to crop irrigation. This in turn could increase the value of temporary transfer or fallowing strategies proposed to meet anticipated municipal and industrial water needs. Reduction of agricultural production in certain crops, or shifts to crops that use less water or can be irrigated earlier in the season could also be expected. Junior holders will be affected in potentially different ways. Initially as peak flows shift earlier junior rights holders such as fishing or kayaking industries may see a potential benefit in more water available earlier in the season. However, late season shortages as a result of flow shifts have the potential to exacerbate the value of senior rights. My approach is to combine a review of scientific literature, policy literature, and discussions with professionals and experts on these issues to produce an overview that identifies the most prominent issues and consequences concerning these shifts.

Gigi Richard, Colorado Mesa University

Biography

Gigi Richard is currently a Professor of Geology at Colorado Mesa University (CMU) in Grand Junction, CO in the Department of Physical and Environmental Sciences and the Faculty Director of the Water Center at CMU. She holds an M.S. and Ph.D. from Colorado State University in hydraulic engineering and a Bachelor of Science in civil engineering from the Massachusetts Institute of Technology. Dr. Richard created the Watershed Science program at CMU and teaches water science and environmental geology classes. Her research on human impacts on rivers systems includes the study of downstream impacts of dams and levees on rivers in Colorado, New Mexico and New Zealand. Recent work has focused on better understanding the hydrology and morphology of intermittent streams in western Colorado and on the need for peak flows to maintain the channel form of the Yampa and Dolores Rivers in western Colorado. A resident of Colorado for 23 years, she has experience in private engineering consulting and served on water quality and land use planning commissions in Summit County, Colorado from 1990 to 1996.

Abstract

River Studies and Leadership Certificate: An inter-university collaboration with the River Management Society

Co-authors: Barnes, Joel, Ph.D., Prescott College and Risa Shimoda, River Management Society

The River Management Society (RMS) is taking an active role in cultivating a future generation of river leaders and professionals who possess a basic foundation of knowledge, skills, and experience in river-based management, science, policy, conservation, education, and recreation. To this end, RMS has initially partnered with two universities to create a River Studies and Leadership Certificate. This certificate is designed for undergraduate students and is currently being offered at Prescott College and Colorado Mesa University.

The certificate is designed to train and empower students to address real world challenges facing our nation's rivers, so a professional experience component is required in addition to six university courses. All students undertaking the certificate program are required to study basic river science, Geographic Information Systems, and swiftwater rescue. Students must also choose one of the following three emphasis areas: river science; river-based policy/management; or river-based recreation, education and tourism. As students complete the certificate they are

encouraged to use RMS as a source for their river studies and professional networking, and will get a special invitation to attend a River Management Society Symposium or sponsored-conference. Students will be required to share aspects of their river studies with the RMS community by a presentation at the annual RMS Symposium or by publishing an article in the RMS Quarterly Journal. The River Studies and Leadership Certificate will equip students to become informed river professionals and stakeholders, help them to make sustainable decisions about future uses, research, and management of our nation's river systems, and integrate them into the RMS community.

Tim Cutter, Mountain Studies Institute

Biography

Tim Cutter is MSI's Wetland Project Manager. He has three years of experience monitoring, planning, and implementing wetland restoration projects, including the Chattanooga and Ophir Pass Fens. He manages and conducts field work, permitting, and data collection.

Abstract

Monitoring Water Table and Carbon Storage to Assess Mountain Fen Restoration Potential

Mountain Studies Institute and Michigan Technological University are quantifying the natural upper and lower limits of fen water table position as an indicator for fen functioning and need for restoration. We are comparing carbon cycling and storage from 14 sites, representing fens ranging from natural to disturbed conditions. This effort will leverage long-term data collected in the San Juan Mountain fens, establish new carbon monitoring sites in Grand Mesa, and build upon many years of collaborative research on mountain fens in southwest Colorado.

Eriek S. Hansen, Department of Biological Sciences, Colorado Mesa University

Biography

Eriek S. Hansen received both a Bachelor of Science and Master of Science from Utah State University before going on to earn his PhD from the University of Wyoming. During that time, he taught science classes with students from preschool to college age. He attended the Institute for Inquiry at the Exploratorium in San Francisco, Calif. and has 16 years of experience studying fish ecology with research ranging from physiological experiments to large scale riparian restoration projects. He is an adviser for the Fish and Wildlife Club and teaches General Human Biology, Anatomy and Physiology, Fish Biology and Aquatic Biology.

Abstract

Quantifying Proximate Body Composition in Catostomids Using Bioelectrical Impedance Analysis

Co-author: Kristine Crippen, Department of Biological Sciences, Colorado Mesa University

Methods for determining the condition of organisms are valuable tools for assessing the health of populations. Traditionally, length-weight relationships are used to quantify fish condition, but this method cannot differentiate among the components of proximate body composition (water, lipid, and lean masses). Current methods used to quantify proximate body composition are lethal. Many fish species in the Colorado River are classified as imperiled and nonlethal techniques are needed to quantify proximate body composition. Bioelectrical impedance analysis (BIA) is nonlethal method which measures resistance and reactance, and has been used to quantify human proximate body composition. Our goal is to develop BIA techniques for studying sensitive and endangered species. Our objectives are 1) refine BIA techniques for Catostomids and Cyprinids, 2) compare effects of invasive needle electrodes versus noninvasive surface electrodes, 3) develop a multiple regression model for predicting proximate body composition, 4) evaluate if the model is species specific or can be used for multiple species or among families. We will report on the development of a BIA protocol, a comparison between needle and surface electrodes, and on models for quantifying the proximate compositions of white suckers (*Catostomus commersonii*; a representative for the native Catostomids).