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About this issue
Issue theme: Water Science State of the Art: Present and Future
Guest Editor: Michael E. Campana

Eight provocative articles by an extraordinary cadre of authors give us a glimpse into not only traditional water science but also related topics such as planning, water law, communication, neuroscience and the water resources/environmental consulting industry. The topics treated are not all-inclusive. I took a different approach to the theme: instead of creating a ‘shopping list’ of all facets of water science, I identified those individuals who were experts in a few areas and turned them loose. In some cases these experts identified collaborators. The articles by Jerad Bales and Bill Battaglin et al. are more traditional than most of the others. The former looks at hydrology and the latter tackles contaminants of emerging concern (CECs). They tell us what to expect. Lara Fowler and Bob Caccese address an important, timely, but often overlooked issue: the interface between law and science. Can they work together to achieve harmony and equity? John H. Matthews tells a delightful story of a dinner invitation that led to resilience, infrastructure and then drops CRIDA on us. Former classmate, friend and colleague Dan Stephens’ unique perspective as a successful academic and business leader produces a thoughtful, insightful piece on the industry. Water economics? How could that be excluded? Noel Gollehon, recently retired from USDA, and Susanne M. Scheierling of the World Bank use humor and expertise to assess progress in the measurement of water productivity in agricultural production. Planning? John Tracy channelled Aldous Huxley and then traces the evolution of the socio-technologic approach to water planning. Lisa Beutler wraps up the issue by wondering if “it” will eat us and then gets deep into the realm of neuroscience and effective communication in the water sector, or lack thereof.

About the Cover: A reflection of Mt. Timpanogos in Tibble Fork Reservoir, located in the Wasatch Mountains of northern Utah.
Photo credit: Gary Whitton, www.ultimateplaces.com
IT HAS BEEN a privilege to serve as AWRA’s president during 2018, a year of significant transition. AWRA presidents serve a one-year term, and this has been a busy one! I have enjoyed meeting so many talented people who are well equipped and who truly care about the future of our water resources. In particular, I am struck by the number of our members who speak so articulately and passionately about their work and the health of our planet.

This issue of IMPACT focuses on science. I’m proud to be part of an association that has always placed a premium on scientific content. From the Journal of the American Water Resources Association (JAWRA), to specialty conferences and webinars, the AWRA board, staff and members have always understood that providing a scientific underpinning is crucial to the development of sound policies, programs and practices.

Recognizing the role of science, AWRA’s Policy Committee is working on a policy statement regarding “The Criticality of Science in Water Resources Decision-Making” for the board’s consideration and adoption this fall. My greatest interest, professionally, is to strengthen the linkage between science and water resources policy, so I’m looking forward to adopting this particular policy statement. The water resources profession—and AWRA specifically—can further demonstrate its commitment to science by promoting: long-term data sets; sustained investment in studies and analysis; programs designed to train scientists and engineers across a variety of disciplines; robust peer reviews; and a community of practitioners ready to interpret and make use of the results.

Now more than ever, those in the policy arena need to call upon the training and expertise of scientists and engineers. Likewise, scientists and engineers have a responsibility to communicate findings and consequences clearly and compellingly to decision-makers.

One person who has helped to link the scientific and policy communities over the years is AWRA’s Executive Vice President Ken Reid. A connector and communicator by nature, he has worked constantly during his 37-year tenure to help colleagues make the necessary connections that benefit us all. In my January column, I noted that 2018 would be a year of transition for AWRA, as Ken is retiring and handing the reins to a new Executive Vice President.

Those who have experienced his larger-than-life laugh and his bear hugs over the years know that Ken is a force of nature—one who leaves a deep and abiding imprint on the AWRA family. Ken and Pat have purchased a lovely property and have launched their efforts to grow gardens, create art and enjoy the company of their friends. I want to take this opportunity to thank Ken for his friendship and leadership over the years. I also want to acknowledge the retirement of Patricia Reid and Jacque Towner, two of AWRA’s long-time staff members. You will all be missed!

AWRA has been conducting a search for the next Executive Vice President this fall and plans to have a new Executive in place before the New Year. Stay tuned for further announcements and introductions.

This is the time of year when the President hands the gavel to her successor. I want to welcome Lisa Beutler of Stantec to the role of AWRA’s 2019 President. Lisa has been a wonderful friend and colleague over the years and has a passion for the people of this association and the work they do. Please give her the same welcome and support you have given me. It has been an honor.

Brenda Bateman is the 2018 president of AWRA. Contact: president@awra.org.

The following officers and directors begin their terms of service on January 1, 2019:

President – Lisa Beutler, Stantec, Sacramento, CA
President-Elect – Betsy Cody, Consultant, Arlington, VA
Secretary-Treasurer – Jared Bales, Consortium of Universities for the Advancement of Hydrologic Science (CUAHSI), Arlington, MA
Director – Claire Bleser, Riley Purgatory Bluff Creek Watershed District, Chanhassen, MN
Director – Zhenxing Zhang (Jason), Illinois State Water Survey, Champaign, IL

Continuing their remaining terms as AWRA Board members for 2019 are:

Past-President – Brenda O. Bateman, Oregon Water Resources Department, Salem, OR
Director – Lisa Engelman, LB Engelman Consulting, LLC, Rockville, MD
Director – Scott Kudlas, Virginia Department of Environmental Quality, Richmond, VA
Director – Sharon Megdal, University of Arizona, Tuscon, AZ
Some Brief Musings on Hydrologic Science in the First Half of the 21st Century

Jerad Bales

There never is a shortage of ideas on science questions and data needs in hydrology and water resources. Many have thought deeply about this issue, and some insightful commentaries recently were published in a special section of Water Resources Research (WRR) on the 50th anniversary of WRR (2015). The International Association of Hydrological Sciences, through their “Panta Rhei—Everything Flows” initiative, is leading a conversation on 23 unsolved problems in hydrology that could revolutionize research in the 21st century—questions that must relate to observed phenomena, are universal and can be solved. I will borrow from these collections and others as I put forward a few ideas.

Observational breakthroughs, however, need not depend solely on new measurement techniques. Creative applications of long-existing technologies can lead to new insights. For example, precision (e.g. LiDAR measurements of land-surface topography), greater frequency (e.g. in situ continuous water-quality sensors), or in the field rather than the laboratory (e.g. field spectrophotometers for measurement of water, carbon and nitrogen isotopes) all are leading to new insights into natural systems and human impacts on those systems.

The relatively small market represented by the water resources community, however, can limit the widespread availability of sophisticated, yet inexpensive, water sensors. In contrast, consider, for example, the health-care community in which very low cost, rapid diagnostic tests are available because of the widespread demand for this information and because of the premium we place on our health. An analog to the 25-cent dipstick for measuring urine glucose levels is not available to the hydrology community. The acoustic Doppler current profiler, which has revolutionized stream velocity and discharge measurements, initially was developed for the defense industry to measure ship and submarine speed, but ultimately was adopted for stream measurements through the diligent efforts of a handful of individuals. I’m not sure that there is a real solution to this challenge, other than for the water community to continue to work with the research community and vendors to identify and advocate for new technologies.

Sydney Brenner, the South African geneticist and Nobel Laureate said, “Progress in science depends on new techniques, new discoveries and new ideas, probably in that order.” Dennis Lettenmaier, in one of the WRR commentaries on new hydrologic measurements, noted that “observational breakthroughs lead the way to improved hydrological predictions.” New measurements made at greater scales (e.g., remotely-sensed soil moisture), higher

VOVANIVANOV/SHUTTERSTOCK.COM
In 1962, Rachel Carson’s book *Silent Spring* alerted the nation to the dangers of manmade chemicals and indiscriminate use of pesticides. DDT was the culprit and its use threatened a variety of wildlife, including the national bird, bald eagles. In 1969, pressured by scientists and the public, the United States banned almost all uses of DDT; however, DDT was just the tip of the chemical iceberg. In 1996, Theo Colborn’s book, *Our Stolen Future*, again alerted the public to the dangers of chemical exposure. Endocrine-disrupting chemicals were identified as concerns because exposure to extremely small concentrations can have adverse effects on people and wildlife by interfering with chemical messaging systems, affecting things like sexual development and reproduction.

In 2002, the chemical iceberg became bigger when contaminants of emerging concern (CECs) such as pharmaceuticals in United States streams were brought to the public’s attention by the U.S. Geological Survey and others (Kolpin et al., 2002, *Pharmaceuticals, hormones and other organic wastewater contaminants in U.S. streams, 1999-2000: A national synthesis*, https://bit.ly/2N9NMX9). Research related to CECs has experienced a near exponential increase since that seminal research paper (see Figure 1).

From the time of *Silent Spring* up until the mid-1990s, environmental chemistry techniques for organic contaminants focused on compounds that could be
On January 8, 2018, the U.S. Supreme Court heard two interstate water cases, including a long-awaited hearing between Georgia and Florida. In reviewing the oral arguments, we were struck by how the justices found the U.S. Army Corps of Engineers’ modeling “incomprehensible,” with much argument about whether water saved in Georgia would actually flow to Florida (Florida v. Georgia 2018; https://bit.ly/2CDuODk). Given improvements in science—for both surface water and groundwater—over the past 150 years, this discussion was dishearteningly similar to the Ohio Supreme Court’s 1861 decision which noted that groundwater was “occult” and therefore could not be easily regulated (Frazier v. Brown 1861).

While the scientific understanding of water has improved, the legal basis for allocating, and more broadly managing, water in the United States is slow to adapt. Yet the need to come together to find solutions to water management is acute—both in the western and eastern United States. Although we may have what seem like insurmountable challenges, the opportunity for collective action on water is now, especially if law and policy implications are considered at the same time as scientific and financial factors.

Even as water use efficiency has increased, water resources are under increasing pressure. Common challenges across the U.S. include growing population and land use changes, new uses, failing infrastructure, water quality impacts, endangered species and the need to meet other types of rights, including tribal rights. In addition, extreme weather conditions are causing huge impacts: more frequent and severe floods, more and longer droughts, earlier runoff. California’s recent drought exemplifies the uncertainty caused by such extremes; the five-year drought was “cured”
Climate Change: Resilient Infrastructure or Infrastructure for Resilience?

John H. Matthews

Recently I was invited to an informal dinner in Europe with investors and groups that interact with investors. I’m a freshwater scientist, working on climate change and water management issues for about 15 years. I had been seated across from a smartly dressed woman from southern Africa, affiliated with a group funded by British foreign aid to support resilient infrastructure in the region.

I was intrigued. Infrastructure is especially exposed to climate change risks. By its nature, infrastructure lasts a long time, but we typically evaluate success/failure and “sustainability” over much shorter periods. Worse, our ability to predict future impacts in a shifting climate with confidence and certainty is limited—especially for investments that interact with the water cycle, that require a quantitative evaluation framework such as engineering or economics, or that have low tolerance for failure. Climate models provide limited and often weak confidence and conflicting projections about conditions 10 years from now, much less 50 or 100. Worldwide, we see many pieces of twentieth-century infrastructure in cities, along rivers and on shorelines that no longer match their climate conditions. Some, like the Hoover and Glen Canyon Dams in the United States, require billions in retrofitting or demand adjustments in order to maintain their fit with current and emerging patterns.
Perspectives from a Water Resources and Environmental Consultant

Daniel B. Stephens
For those of you hoping for a nice clean table on the value of water to use for your next project, we have bad news. That is not what this piece is about. Instead, we would like to share some thoughts on the progress being made in measuring the productivity of water in agricultural production. With increasing water scarcity in many regions, often caused by agriculture using a high share of the water, this measure is becoming a key variable for directing policy. It determines the value of water (either from observed market activity or based on estimates if prices do not exist in any market or do not reflect true social values), and helps to guide investment decisions and assess tradeoffs from reallocating water from one location or use to another.
A Brave New World for Water Planning

John C. Tracy

There have been significant advances in resource planning in recent decades with the advent and adoption of the Adaptive Management and Integrated Water Resources Management (IWRM) approaches. These advances built upon investments that the United States made in water resources planning and infrastructure over the last century, which have allowed us to understand, and to some degree control, our water resources. We have been able to develop innovative technology to address our most pressing water resource challenges, resulting in the design and construction of infrastructure that has provided significant economic and social benefits, for example:

- extensive reservoir, levee, pump and drainage systems to protect communities from flooding;
- water storage and conveyance systems in arid and semi-arid regions that allowed for highly productive agricultural economies to develop, which serve as the basis for population and economic growth across the western United States;
- sustainable energy generation and transmission systems through hydropower production in entire watersheds managed by regional authorities, such as the Bonneville Power Administration and the Tennessee Valley Authority, that have been drivers of regional and national economic development; and
- design and construction of advanced water supply systems and wastewater treatment infrastructure.

The approach exemplified by the above items can best be described as technology-focused, or technology-driven, and has been the state of practice for water resources planning for years. It has underpinned much of the United States’ economic and population growth, and when exported, throughout the world. However, as the competition for water resources has intensified in recent years, it is clear that this technology-driven approach is reaching its limits, and in some cases is proving to be counterproductive from an environmental, social and economic perspective. For example:

- levee and canal systems that permitted agricultural and municipal development in southern Florida also created an environmental disaster for the Everglades, where measures to mitigate the damage done have exceeded $16 billion in remediation efforts (see https://politico.com/2022/06/16);
- levee and pump systems constructed to protect New Orleans from flooding produced a false sense of security, a lack of awareness of the threat of large hurricanes, and the neglect of flood protection infrastructure, all of which were large factors in the more than 1,800 deaths and more than $100 billion in damage resulting from Hurricane Katrina (see https://bit.ly/2x8Wpq6);
- the Columbia Basin project, whose low-cost sustainable energy and flood protection supported the economic development of the Pacific Northwest is also the primary factor in the decline of salmon populations and resultant deleterious effects on Native American populations (see https://bit.ly/2OdVMmr); and
George Bernard Shaw once famously said, “The single biggest problem in communication is the illusion that it has taken place.”

Those in the water sector well understand the consequences of poor communication. Still, many find the tools and methods for improvement lacking. At the same time, the body of knowledge about communication and decision-making continues to grow. Advances in brain imaging and neuroscience as well as behavioral research provide insight to how humans process their environments, share information with one another and form decisions.

In terms of the brain, you’ve likely heard references to right-left brain thinking or have experienced your own reptilian brain (fight, flight or freeze). A colleague recently shared the story of a mediation training where a key takeaway was (paraphrased): “With every interaction our mammalian brain asks itself two questions: (1) Will it eat me? and (2) Can I mate with it?”

The mediation training story illustrates two principles of communication science, the role of the brain in communication and the importance of transmitting important information. Chances are, you or at least one of your colleagues have encountered a professional situation where they pondered, “Will it eat me?”

Humans have complex brains responsible for a range of process functions from reflexes and muscle control to logic, reasoning, analysis and problem solving, willpower, speech and verbal understanding, and a capacity for wisdom. We also know from behavioral research, and often our own experience, that humans are not always rational, predictable, or wise.

Much brain research has focused on the response to trauma and dysfunction. By design, various brain functions were segmented. Researchers analyzed parts of the brain and the behavior associated with it. Cognitive neuroscience research now evaluates brain activity during a range of information processing activities. This has allowed researchers to better understand how the full brain functions as one organ.

Some neuroscientists now debate the practice of associating function with specific brain structures. Research suggests that the function a brain region serves can be dynamic and change over time. Researchers Julian Kiverstein and Mark Miller in a 2015 article [https://bit.ly/2wZRNSQ] argue that cognitive neuroscience should look to an ecological dynamic psychology. They point out it is difficult to make predictions about human behavior without knowing in what situation, context or environment the behavior occurred. In their view, cognitive and emotional processing in the brain should be viewed as inseparable.

The University of Pennsylvania Communication Neuroscience Lab provides one of many examples of how the integration of brain and communication sciences is evolving. Housed in the Annenberg School for Communication, this lab takes an interdisciplinary communication neuroscience approach to link neural activity to behaviors at the individual, group and population levels. Their work includes predicting behavior change following exposure to persuasive messages and understanding what makes successful ideas spread (e.g. through social networks, through cultures).
generally speaking, regarding governmental roles and leadership for water quality protection, United States policies grew from the bottom up: locally to nationally. As urban centers grew and untreated wastewaters were discharged across the landscapes, local governments invested in sewer systems to collect, transport and discharge the wastes at “safe distances” from the population centers. Governments relied on local norms to determine the degree of protection afforded from waterborne threats to public health and water quality for swimming, fishing and drinking. Often the old axiom “the solution to pollution is dilution” held sway. In some locales, this worked well; usually where the discharged water was carried downstream and away from the generating communities. In other places, not so well.

Chicago famously went with the “solution” of discharging their wastes into the Chicago and Calumet Rivers and then on into Lake Michigan. Instead of dispersing the wastes, tidal and wave action concentrated the wastes close to the shore, creating imminent threats to public health, safety and general water quality. Well-founded fears of typhoid fever, cholera and dysentery encouraged local governments to come together to create a large scale, long term solution. In 1887, planning and construction of the Chicago Ship and Sanitary Canal and the interconnected Cal-Sag Channel...
Cold Water Refuges: Rethinking “Fishable” for Large Pacific Northwest Rivers

Paul J. Pickett

CLEAN WATER ACT water temperature protections have traditionally looked at the daily maximum temperature midstream. But in grappling with protection of salmon in the Pacific Northwest, a new focus of protection and enhancement is emerging for large rivers—cold water refuges. This will become particularly important in future years as rivers warm up from predicted climate change impacts.

Yet integrating cold water refuges into the structure of Clean Water Act regulations, such as water quality standards and total maximum daily Loads (TMDLs), is proving very challenging. The path forward remains far from clear.

The Pend Oreille River pours out of Lake Pend Oreille in Idaho and then flows through Washington into the Columbia River in Canada. The issue of cold water refuges (CWRs) first emerged for me as I developed a temperature TMDL for the Pend Oreille River. Despite the presence of three dams on the river, our modeling found that the river had always been quite warm, due to surface waters leaving the lake and flowing through a wide, open valley. Radio tag studies showed that bull trout were hiding in the mouths of cool tributaries and holding up near springs. The fish that stayed in the river died. However, because our water quality standards (WQS) regulate the temperature in the middle of the river, we have always focused on the question of what drives midstream temperatures. Now I was wondering: were we asking the wrong question?

The question arose again in even greater focus with EPA’s climate change pilot TMDL in the South Fork Nooksack. A “quantitative assessment” (EPA/600/R-14/233) included modeling of water temperatures under future climate scenarios. Results showed that the river would be too hot for salmon. But could this be the end of the story? The Nooksack Tribe worked with EPA to develop a “qualitative assessment” as an implementation plan (EPA/600/R-16/153). They designed river restoration along the lines proposed by the seminal research of National Oceanic and Atmospheric Administration (NOAA) Fisheries biologist Tim Beechie. The key part of the plan was to restore riparian and flood plain processes that create cool microclimates where salmon can hunker down to make it through the hottest days of summer.

The message is clear—cold water refuges are key to salmon survival in large rivers today, and even more so under future climate change. But how to integrate CWRs into water quality regulations that have historically paid them scant attention?

In exploring this question, I discovered that fish biologists had researched CWRs extensively. Study after study in Oregon and Washington and in the Columbia River had documented the pockets of cool water where salmon congregate. Papers talked about cold water “patchiness” creating “stepping stones” that allowed salmon to “hopscotch” up the river.
CONFUCIUS OBSERVED
“CHOOSE a job you love and you will never have to work a day in your life.” In 1981 I was profoundly blessed to have been chosen as AWRA’s chief staff officer. I have enjoyed my job since my first day at the association’s headquarters at the Saint Anthony Falls Hydraulic Laboratory on the campus of the University of Minnesota. Very few people can say that they enjoy getting up and going to work each day, but I can. What better job could a person wish for than to work for men and women who care about the world’s most precious resource? Couple that with having the most amazing set of co-workers one could ask for, and you have a perfect job. I’m blessed to have traveled this journey with an amazing professional staff. Mike Kowalski, Jacque Towner, Christine McCrehin, Patricia Reid, Michael Campana, Richard Engberg, Charlene Young, Gary Whitton and Susan Scalia have been my teammates for most of my tenure at AWRA and they are the backbone of your association. They are the ones responsible for all the successes we have achieved. From the depth of my heart and soul I thank each one of them and I want them all to know how much I appreciate their dedicated efforts on behalf of AWRA.

When I reflect upon my career I think about the amazing people I have had the privilege of knowing. We all stand on the shoulders of giants who have come before us and AWRA is no different. I periodically go into our conference room and look at the pictures of our past presidents. I stand in awe when I realize that every one of them was a trail blazer. Not only were they leaders of AWRA but they were leaders in our profession. They were at the forefront of promoting the multidisciplinary approach to finding solutions to our water resources challenges way before the term multidisciplinary became fashionable. I’ve always said that our AWRA members and leaders are the smartest kids in the class because they understand the concept of collaborative management of the resource. They came from all backgrounds and disciplines to create an organization that is on the cutting edge of water resources management.

The following piece entitled A Centering Thought, by the Rev. Peter Raible captures the essence of our association:

We build on foundations we did not lay.
We warm ourselves by fires we did not light.
We sit in the shade of trees we did not plant.
We drink from wells we did not dig.
This is as it should be.
Together we are more than any one person could be.
Together we can build across the generations.
Together we can renew our hope and faith in the life that is yet to unfold.
We are ever bound in community.
May it always be so.

As I go off into the sunset I am reminded of these words sung by Wilson Phillips in the song:

Turn! Turn! Turn! (To Everything There Is a Season)
To everything
Turn, turn, turn
There is a season
Turn, turn, turn
And a time for every purpose under Heaven
A time to be born, a time to die
A time to plant, a time to reap
To everything
Turn, turn, turn
There is a season
And a time for every purpose under Heaven

My purpose at AWRA has now been completed and as Pat and I turn to our next chapter in life we will always be ever grateful and filled with fond memories to all of you who have accompanied us on this magnificent journey.

Thank you!
AWRA Colorado Section Update

AWRA-CO hosted its annual field tour on September 13. We traveled from Denver to Glenwood Springs along the Colorado River, making stops at Xcel Energy’s Shoshone Hydroelectric Facility and the Colorado River District’s office, topping it off with a raft trip down Colorado River in Glenwood Canyon. This summer was busy, with two lunch talks in June and July. In June, we learned about the recent filamentous algae blooms occurring on the White River near Meeker, Colorado. In July, we heard a presentation from the South Platte Regional Opportunities Working Group on a new water supply concept for the Colorado Front Range. AWRA-CO will be hosting several upcoming events, including brownbag lunch talks, student networking events and our annual symposium in April 2019. Find more information about our chapter’s activities at www.awracolorado.org.

Submitted by Jonathan George, 2018-2019 Section President

AWRA Wisconsin Seeks Submissions for Annual Meeting

AWRA Wisconsin is looking forward to our 43rd Annual Meeting on February 28 and March 1, 2019 at the Lake Lawn Resort in Delevan, WI.

This year’s theme, “Clearing the Waters: Effective Science and Communication,” seeks to highlight the successes and challenges of conducting and communicating science in an age of skepticism. We encourage submissions on topics related to this year’s theme as well as for general sessions on research related to hydrogeology, watershed management, hydrology, limnology, aquatic toxicology, water chemistry, aquatic ecology, climate change and water use.

Highlights from our 2018 Annual Meeting: www.tinyurl.com/AWRA-WI-2018
We hope you will join us in Wisconsin for our 2019 Annual Meeting!
Albert Rango, 1942-2018

AWRA President 1986, AWRA Fellow Member 1988, AWRA William R. Boggess Award 1994

ALBERT RANGO’S CAREER

spanned nearly 50 years, during which he published more than 300 papers, led research pioneering the use of remote sensing for watershed modeling, co-wrote a key textbook on snow hydrology, was the United Nations Rapporteur on Remote Sensing in Hydrology for the World Meteorological Organization, and served as president of AWRA, the Western Snow Conference and the International Commission on Remote Sensing.

Al completed his Ph.D. in Watershed Management at Colorado State University in 1969. After a brief academic appointment, he moved to the federal sector, beginning with NASA in 1972 at the Goddard Space Flight Center. This coincided with the launching of the first remote-sensing satellites and Al began to employ the first images in his hydrologic research. After many firsts such as mapping and analyzing a flood monitored via satellite, using satellite images to measure snow cover depletion, inputting remotely-sensed data into models and using data and models to evaluate climate change and its effects, he was awarded NASA’s Exceptional Service Medal in 1974.

In 1983, Al transferred to the USDA-Agricultural Research Service and the Hydrology and Remote Sensing Laboratory in Beltsville, MD. He began incorporating remotely-sensed data into ARS hydrologic models, vastly improving them. During this period he continued to develop and refine the Snowmelt Runoff Model (SRM). He also began to work internationally to expand applications of the SRM. His model was applied to well over 125 basins in 20 countries.

In the mid-1990s, Al worked in the southwestern United States by collaboration with the ARS group at the Jornada Experimental Range. Called the Jornada Experiment, Al led a first-ever large-scale, long-term remote sensing project to explore temporal and spatial variability of remotely-sensed hydrologic data, using satellite platforms, aircraft and ground-based data. Participating scientists represented federal agencies and universities across the country, along with institutions in Japan, Holland, France and England. In 1999, Al was named the ARS Senior Scientist of the Year.

In 2000, Al transferred to the Jornada ARS group where he developed the SRM for the entire Rio Grande River basin. The SRM now provides > 90% reliability of daily forecasts to farmers, ranchers, and irrigation districts for the Rio Grande. In 2005, Al was recognized for the extreme productivity and impact of his first 32 years of research with the Presidential Rank Award of Meritorious Senior Professional from the White House.

Al worked to utilize new and improved methodologies for monitoring the ecological status of rangelands. He led efforts to employ newly available drones to capture high-resolution imagery for land surface analysis. In the last few years of his career, Al helped build and lead the USDA Southwest Climate Hub to assist the agricultural sector and rural communities to adapt to climate change. The development of region-scale climate projections for key agricultural production systems in the Southwest region was a major early success of the Hub.

Throughout the five decades of Al’s career he devoted much time to mentoring graduate students and postdoctoral research associates as the next generation of researchers. At universities, federal agencies and foreign research institutions around the world, many of his former students and associates are now pursuing and expanding the research themes he developed.

Al met his wife dancing and they loved to travel to Hawaii together and play with their terriers. Al had a real passion for sports beginning at an early age when his father introduced him to golf. He coached his daughter’s soccer team and was voted Coach of the Year by the Maryland State Youth Soccer Association in 1987. Al was the ultimate sports spectator, supporting local sports and watching his favorite professional teams on TV, especially the Cleveland Indians. Al also had a fondness for wearing Hawaiian shirts, reading books of many genres, listening to eclectic music and adopting small dogs.

Al was an award-winning scientist with global impacts who leaves behind many family, friends and colleagues who will miss his smile, wit and zest for life.
Delaware River Watershed Initiative Wins National Integrated Water Resources Management Award from AWRA

“It is so exciting to win the prestigious AWRA IWRM Award,” commented Carol Collier, senior advisor for Watershed Management and Policy at Drexel University, who submitted the nomination packet on behalf of the DRWI Coordinating Committee. “The Delaware River Watershed Initiative (DRWI) is a bottom-up, non-regulatory approach, engaging more than 50 NGOs working with landowners and local government officials to improve the water quality and biological communities of local streams. The more local streams that are improved or protected, the better the whole Delaware River Basin will be. We thank AWRA for recognizing this example of IWRM.”

Launched in January 2014, the Delaware River Watershed Initiative (DRWI) involves more than 50 non-government organizations (NGOs) focused on restoration of areas impacted by agricultural runoff, suburban stormwater and aquifer depletion and protection of forested areas in watersheds with high water quality. New water quality models, mapping and GIS tools were developed specifically for the Delaware Basin, along with specific social and collaborative skills. The Initiative brought together non-government organizations that were used to competing for funds and resources. Over the past four years, one can see that the NGOs are collaborating better and realizing that there is benefit to being part of something bigger.

On-the-ground results thus far:
- Lands restored: 8,818 acres with BMPs, 52 miles of riparian restoration, 744,108 pounds of nitrogen avoided, $7,964,952 invested, with a $15,207,032 match leverage.
- Lands protected: 46 projects, 19,605 acres, 87 miles of forested stream banks, $8,168,204 invested, with a $55,629,702 match leverage.

AWRA IS PLEASED to announce that the Delaware River Watershed Initiative (DRWI) is the 2018 winner of the association’s prestigious Integrated Water Resources Management (IWRM) Award.

The award will be presented during the Annual Awards Luncheon at the Association’s Annual Water Resources Conference, November 7, 2018, Marriott Inner Harbor, Camden Yards, Baltimore, MD.

Eight areas (clusters of subwatersheds) were selected by the DRWI for intense work, looking at changes on the land to improve and protect water quality and quantity.

AWRA will also present several other awards during the November conference, including:

W. R. Boggess Award
Lead Author: Ikechukwu C. Ahams
Co-Authors: Willa Paterson, Susana Garcia, Richard Rushforth, Benjamin L. Ruddell and Alfonso Mejia
Paper Title: “Water Footprint of 65 Mid- to Large-Sized U.S. Cities and Their Metropolitan Areas” Published in the Journal of the American Water Resources Association (JAWRA), October 2017

Icko Iben Award
Norman Starler

William C. Ackermann Medal
Robert J. Moresi

A. Ivan Johnson Outstanding Young Professional Award
Patrick Ray

Outstanding AWRA State Section
National Capital Region

Outstanding AWRA Student Chapter
University of Delaware Student Chapter
TRUE TO THE multidisciplinary spirit of the Journal of the American Water Resources Association, this issue contains papers covering a broad range of water topics.

Doyle presents a commentary on declining appropriations for Bureau of Reclamation infrastructure projects. He presents some suggestions on how policies can be changed to infuse private capital to rehabilitate aging western irrigation infrastructure.

Keim et al. analyze an extreme rainfall event during May 1 – 3 2010 that affected the south-central United States. Storm totals exceeding 330 mm occurred within a large elongated area extending from Memphis to Nashville and maximum rainfall totals for some durations exceeded 1000 year rainfall.

Moriaisi et al. study the loss in sediment and flood storage capacity over time in 12 reservoirs in the Little Washita River Experimental Watershed in Oklahoma. Their results indicate sediment and flood storage capacity losses can be related to climate, soils, and topographic characteristics. They provide a tool to prioritize remediation efforts in aging reservoirs.

Huggins et al. study groundwater pumping and its effects on streamflow depletion. They develop a new methodology for quantifying pumping-induced streamflow depletions. Their methodology significantly improves current practices and is demonstrated at a watershed in British Columbia, Canada.

Williams et al. provide a framework to incorporate temporal inequality into the conservation planning process. The study highlights the need for multiple best management practices to achieve pollutant load reduction goals in the Lake Erie Basin.

Ghimire et al. use data from 214 USGS gaging stations in Iowa to show river flow velocity can be estimated using power law relationships with discharge and drainage area.

Avila-Carrasco et al. validate the results from Tropical Rainfall Measurement Mission (TRMM) at different time frames in two hydrologic subregions of the Santiago River in Mexico. The results indicate the monthly TRMM v7 rainfall product can provide useful information in data poor regions.

Detenbeck evaluates summer baseflows and total flows in New England streams and rivers. She concludes both summer baseflows and total flows exhibit increasing trends in recent times.

Jasperson et al. use stable isotopes and reach-scale monitoring to study groundwater upwelling in Amity Creek, Minnesota along Lake Superior’s north shore. The results highlight the importance of surficial geology in maintaining baseflows necessary for cold species survival in a warming climate.

Hunt et al. study the effects of meadow restoration on baseflows and groundwater storage in the Sierra Nevada Mountains of California in the midst of a record-setting drought and demonstrate restoration efforts improved baseflows and groundwater storage despite increased drought conditions.

Hale et al. study the social dimensions of urban flooding. They focus on social vulnerability which looks at peoples’ experiences and concerns about floods and exposure to floods. Managing flood risks requires this social dimension is also given full consideration.

Nustad et al. study the differences in longitudinal patterns of sediment mobility and its implications on channel complexity using quasi-3D hydrodynamic models of the Missouri River 2011 flood data. Their results depict the complexity of deposition and erosion during flooding and have practical implications on river management.
Interested in submitting an article to Water Resources IMPACT? Contact Managing Editor Christine McCrehin (Christine@awra.org). Advertising queries should be sent to christine@awra.org.

2019 Editorial Calendar

JANUARY
State Water Plans
Guest Editors: Jon Jones, Brenda Bateman, Scott Kudlas

MARCH
Citizen Science
Guest Editor: Alan Kolok

MAY
Integrated Water Resources Management
Guest Editors: Mike Antos, Amy Zoller
Spring Conference Recap Issue

JULY
Texas Water
Guest Editor: Todd Votteler

SEPTEMBER
AWRA Annual Conference Preview
Guest Editors: Candice Hasenyager, Marissa Egbert
Annual Conference Issue

NOVEMBER
Conservation Finance
Guest Editor: Kelly Mott LaCroix
2019 AWRA Spring Conference
Integrated Water Resources Management: From Policy to Practice

Embassy Suites by Hilton - Downtown
Old Market, Omaha, NE
March 23 - 27, 2019

Abstract Submittal Deadline:
November 16, 2018

www.awra.org

Whether your organization has been practicing IWRM for years or is just starting to explore how it can support your mission, the conference will expand your knowledge and understanding and connect you to practitioners and policy-makers who are also seeking to improve and share. In Omaha, we will confer about what policy conditions are needed for IWRM to succeed, what has or hasn’t worked in IWRM, and what innovative data and tools are being developed and used to support IWRM.

AWRA 2019 Conferences

2019 AWRA Summer Specialty Conference - Improving Water Infrastructure Through Resilient Adaptation

June 16-19, 2019
Nugget Casino Resort
Sparks, NV

2019 AWRA Annual Water Resources Conference

November 3 - 7, 2019
Sheraton Salt Lake City Hotel
Salt Lake City, UT