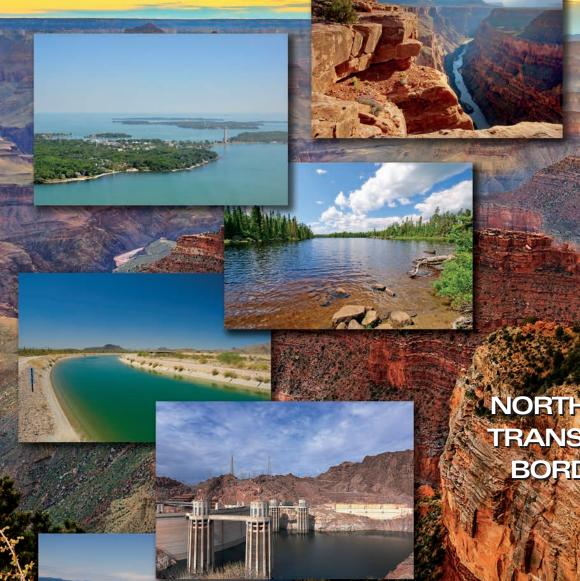


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NORTH AMERICAN TRANSBOUNDARY/ BORDER ISSUES

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NORTH AMERICAN TRANSBOUNDARY/ BORDER ISSUES

ERIC J. FITCH Editor-in-Chief ~ fitche@marietta.edu

This issue of *Water Resources IMPACT* focuses on some of the issues encountered when a river, lake, or aquifer crosses the invisible line that we call a political/legal jurisdiction and the complications that can arise from the management of these resources. These waters are shared between towns, townships, cities, counties, parishes, states, provinces, and countries. The articles touch upon a few places where consensus and conflict have chances of arising but also on what is being done to share these resources for the benefit of all.

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THE INTERNATIONAL JOINT COMMISSION AND MANAGEMENT OF THE GREAT LAKES AND BOUNDARY WATERS

DAVE DEMPSEY

One of the world's longest-running and most effective institutions for addressing critical transboundary water issues is the International Joint Commission (IJC). In the upcoming century of unprecedented challenges to water resource protection and management, the IJC has an ever more important role in helping to assure the conservation and prudent use of Canada-United States (U.S.) transboundary waters.

The IJC is a creation of the Boundary Waters Treaty (Treaty) of 1909, which sets forth the principles and mechanisms for preventing and resolving disputes over the use of boundary waters. Under the treaty, the governments gave the IJC important responsibilities in managing levels and flows in transboundary waters along the border from the Atlantic to the Pacific, and along the Alaska-Yukon boundary. These boundary waters encompass over 300 lakes and rivers across, along, and over the nations' common 5,525-mile border, from the St. Croix River to the Straits of Juan de Fuca, to the Beaufort Sea in the north.

The Treaty was deemed necessary because settlers in Montana and Alberta were building competing canals to divert the waters of the St. Mary and Milk Rivers, which cross the international boundary, for their own use and because of disputes at Niagara Falls about the amount of water that should be diverted from the falls for hydropower purposes - which could have left the falls dry. The St. Mary and Milk River dispute escalated to the point where many thought it would lead to violence. But the Treaty signaled the determination of the two nations to resolve disputes over boundary waters peacefully and amicably. One of the keys to the Treaty's success is its nonprescriptive nature, which offers general principles on how the two countries and the IJC will address issues. Although over a century old, the Treaty is modern in its approach to these problems and is often cited as a global model. Traditionally, the Commission - which, despite the differing population sizes of the two nations, is made up of three Americans and three Canadians - has made decisions and recommendations on a consensus basis. When the Commission consults or advises, it consults or advises both the Government of the U.S. and the Government of Canada. The IJC is a truly binational organization and is equally funded by and engaged with both federal governments.

To guide the two countries in matters, such as approving dams that would affect natural water levels or flows across the boundary, the Treaty sets an order of precedence for water uses, while considering no use as absolute. The order of precedence is protecting access to drinking water, navigation, hydropower, and irrigation. The Treaty also compels the IJC to consider all other interests, which include Tribes, First Nations, and Métis.

watershed residents, industry, recreation, and ecosystem health. Additionally, the Treaty requires the Commission to provide all interested parties a convenient opportunity to be heard.

The Commission has also undertaken an innovative approach to assist the governments to anticipate, prevent, and resolve transboundary water issues. The International Watersheds Initiative (IWI) seeks to address these issues locally before they escalate into international disputes.

The IWI is a science-based approach to address local concerns such as fish habitat, pollution, and low and high water flows. Historically, IJC boards have focused on regulating water levels or flows or on monitoring water quality. IWI boards are different. They work closely with local citizenry to recognize and understand the complex interrelationships of water quantity, water quality, and land use issues within a watershed. IWI Boards are in a partnership with governments. The IJC has seen how the IWI can catalyze effective local efforts to solve water related issues and achieve the desired outcomes for communities on both sides of the border.

Pollution was also a concern of the Treaty authors. In light of the cholera and typhoid outbreaks of the early 1900s, the countries made the far-sighted commitment not to pollute the waters to an extent that would cause injury to health or property in the other country.

The U.S. and Canada share one of the longest peacefully-tended borders in the world ... the policy of consensus-based resolution of conflict over shared waters set forth in the Boundary Waters Treaty is an indispensable part of this binational relationship; its existence has successfully mitigated the number and intensity of disputes over water between the signatories.

Today, much of IJC's work on water quality falls under the Great Lakes Water Quality Agreement (Agreement), first signed in 1972 and most recently revised in 2012. Under the Agreement, the IJC does not have authority to regulate issues related to water quality, but the Commission does have substantial influence. The IJC exercises this influence through direct communication with the public as well as providing science-based advice to governments.

Done right, the IJC's advice can make a big difference as the two federal governments decide where to make their science investments as they create policies and programs for waters on both sides of the border. In the late 1960s, the IJC's advice to the governments on the eutrophication of Lake Erie led to binational action to control phosphorus pollution and led to the Water Qual-

The IJC and Management of the Great Lakes and Boundary Waters . . . cont'd.

ity Agreement itself, contributing to the remarkable recovery of the lake. Unfortunately, it is a recovery that ceased in the mid-1990s, and the Commission is again involved in investigating and recommending remedies.

Under the Agreement, the governments directed the Commission to establish the Great Lakes Regional Office, which is located in Windsor, Ontario, and the Great Lakes Water Quality Board and the Great Lakes Science Advisory Board, which advise the Commission. Recently the Commission restructured the Water Quality Board to include a broad array of stakeholders, instead of being limited solely to government officials as it was from 1972 to 2011. The 2012 Agreement opened the door to this more diverse membership. The Commission believes the Water Quality Board should reflect the diversity of the Great Lakes community. Under the Agreement, the Water Quality Board is the principal advisor to the Commission on Great Lakes water quality matters, and plays a critical role in the Commission's assessment of the progress being made toward restoring and preserving the Great Lakes. The inclusion of many perspectives on the Board will assist the Commission substantially in its Great Lakes work.

The Commission's Science Advisory Board now consists of two committees. One is the Science Priorities Committee, whose membership also comes from outside government. The other is the Research Coordination Committee, made up of managers of research from government agencies and universities.

The Science Advisory Board is responsible for developing recommendations on all matters related to research and the development of scientific knowledge pertinent to Great Lakes water quality.

The use of science in the Commission's work is illustrated by the February 2014 report on Lake Erie's renewed eutrophication crisis, A Balanced Diet for Lake Erie: Reducing Phosphorus Loadings and Harmful Algal Blooms. Lake Erie drew international attention in August 2014 when a bloom of microsystin-laden algae forced the City of Toledo to urge the 400,000 people who depend on its drinking water not to consume that water. This was symbolic of the worsening water quality of Lake Erie, overenriched by nutrients.

The Commission paid close attention to Lake Erie for several years before the Toledo crisis. In 2012, the Commission formed a science working group and commissioned papers from scientists and technical experts summarizing the state of research and knowledge about the problem and potential solutions. Staff and commissioners took it from there, formulating 16 recommendations to governments at all levels.

Members of the science work group pointed to dissolved reactive phosphorus (DRP) as a primary concern and focused on the Maumee River watershed as the highest priority for remedial action, recommending a 37 percent reduction in DRP loadings for the spring compared to the 2007-2012 average. To help achieve loading targets, the Commission recommended that Ohio and Michigan work with the U.S. Environmental Protection Agency to develop a cleanup plan. The Commission also recommended that a plan using both regulatory and non-

regulatory measures be used to reduce DRP loadings from Ontario watersheds.

Perhaps the Commission's most important contribution to the dialogue involves agriculture. Given that the major phosphorus loadings to Lake Erie are from nonpoint sources, especially agricultural operations, the Commission recommended not just voluntary measures to curb farm pollution, but also mandated protections. These included a ban on the application of manure, biosolids, and commercial fertilizer containing phosphorus on frozen ground or ground covered by snow and the linkage of eligibility for taxpayer-supported crop insurance with farm conservation practices.

These may seem like elementary measures, but they are far from it. Going beyond strictly voluntary, incentive-based environmental measures for agriculture and other nonpoint sources is largely taboo in the public policy discourse. With its reliance on science and its reputation as an impartial advisor to the governments, the Commission is able to provide fearless advice.

It's important to stress that the Lake Erie report and indeed all of the Commission's work rests on the foundation that the Canadian and U.S. Sections agree on a problem and work together to find solutions. Neither Section, nor the Great Lakes Regional Office, acts alone.

That applies as well to emerging issues – and there are many that affect Canada-U.S. shared waters. Two such issues are climate change and water regulation.

CLIMATE CHANGE

The proliferation of intense storm events, a long-term decline in ice cover, and the expansion of algae blooms are symptoms of a profound challenge to management of Canada-U.S. boundary waters. The U.S.-Canada boundary area may experience significant climatic changes in the coming decades, with scientific predictions of the following:

- Warmer temperatures year-round, but particularly in winter.
- Increased precipitation overall, with wetter win ters and springs and drier summers.
- In general, increased runoff and increasing drought.
- Changes in groundwater.
- Lengthened growing season and freeze-free season.
- More rainy and fewer snowy days.
- Shifts in ecosystem boundaries.

The IJC is reviewing its regulation plans, which govern projects affecting the levels and flows of boundary waters, to take into account potential predicted changes in climate.

Traditional water management agencies often assume the past predicts the future. With mounting evidence of change occurring and the dramatic potential for future change, many prominent hydrologists are questioning this assumption.

The IJC's work on water levels and flows relies heavily on the expertise of volunteer boards and task forces,

The IJC and Management of the Great Lakes and Boundary Waters . . . cont'd.

an effective communications strategy, and recognizing the connection between water quality and quantity. These will be key elements of the Commission's consideration of climate change impacts. The Commission is working to assure that it and the control boards that manage transboundary projects adapt to changing circumstances and new knowledge.

WATER MANAGEMENT

In 1998, the proposed transport of Lake Superior water to Asian markets by vessel touched off a furor. Although the proposal was cancelled, the controversy revealed the perceived vulnerability of the Great Lakes to diversions and exports of water in an increasingly thirsty

The Canadian and U.S. governments turned to the IJC for impartial fact-finding and analysis. In 2000, the IJC issued the report Protection of the Waters of the Great Lakes (http://www.ijc.org/files/publications/C129.pdf) that analyzed the issue of Great Lakes water uses, with a focus on withdrawals and diversions.

The Commission made 12 recommendations in the report. Most notably, the report called for the development of a common, legally defensible decision-making standard for proposed new water uses and diversions to be implemented across the Great Lakes states and Ontario. After major effort by governments of the Great Lakes states and nongovernmental organizations, the U.S. Congress in 2008 ratified an interstate compact with such a standard and water conservation provisions. The states also entered into a parallel agreement with Ontario and Ohio that contained similar features.

The Commission issued a progress report reviewing the recommendations in 2004 and will soon commence another review. As some declare water the oil of the 21st Century, it will be vital for the governments and other

stewards of the Great Lakes to practice environmentally responsible water management.

The U.S. and Canada share one of the longest peacefully-tended borders in the world. The policy of consensus-based resolution of conflict over shared waters set forth in the Boundary Waters Treaty is an indispensable part of this binational relationship; its existence has successfully mitigated the number and intensity of disputes over water between the signatories. The Treaty is more than a century old, but its framework and the work of the IJC enable adaptation to changing times and evolving issues.

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AWRA SCHEDULED MEETINGS IN 2015

March 30-April 1, 2015 ~ Los Angeles Airport Hilton ~ Los Angeles, California AWRA'S 2015 SPRING SPECIALTY CONFERENCE "WATER FOR URBAN AREAS: MANAGING RISKS AND BUILDING RESILIENCY" GRACE CHAN ~ CONFERENCE CHAIR (SEE PG. 31 FOR MORE INFORMATION)

June 15-17, 2015 ~ Hyatt Regency French Quarter ~ New Orleans, Louisiana **AWRA'S 2015 SUMMER SPECIALTY CONFERENCE** "CLIMATE CHANGE ADAPTATION"

C. MARK DUNNING AND CAROL R. COLLIER, CONFERENCE CO-CHAIRS (SEE PG. 31 FOR MORE INFORMATION)

NOVEMBER 16-19, 2015 ~ GRAND HYATT DENVER ~ DENVER, COLORADO AWRA'S 2015 ANNUAL WATER RESOURCES CONFERENCE LAUREL STADJUHAR ~ CONFERENCE CHAIR

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TRANSBOUNDARY GOVERNANCE OF GROUNDWATER AND AQUIFERS: YOU CAN'T SEPARATE ONE FROM THE OTHER

W. TODD JARVIS

We often hear the expression ".... Is the glass half-full or half-empty" sometime in our daily lives interacting with colleagues, friends, and family. It is one of those clichés used to express positive versus negative thinking or philosophical differences in addressing everyday problems. Professional entertainers and websites regularly use the cliché in their routines or to compile funny quotes; one resonated well with the issue of transboundary waters (www.businessballs.com):

The optimist says the glass is half full.

The pessimist says the glass is half empty.

The project manager says the glass is twice as big as it needs to be.

The realist says the glass contains half the required amount of liquid for it to overflow.

And the cynic wonders who drank the other half.

When one carefully examines the contents of the quote, we see the issue is about both the fluid in the glass and the glass that stores the fluid. The same analogy can be applied to groundwater versus aquifers that cross jurisdictional boundaries, regardless if the transboundary situation separates countries, states, counties, the urban/rural divide, or the unseen boundaries between the rational and spiritual domains. While the differentiation between the two resources may sound like the philosophical debate over whether groundwater is one word or two (currently resolved) or whether an aguifer includes both the saturated and unsaturated portions of a stratum (not resolved), one comes to the dilemma facing the "hydroschizophrenic" when it comes to the half-full or half-empty debate. Is it crazy to govern a glass of surface water and groundwater separately despite in many cases being the "same" water? And why is the glass not part of the discourse over transboundary groundwaters? Transboundary water governance must include the aquifer that stores groundwater, especially when one considers the permanent loss of about 80% of storage space in three of the large artesian basins in the United States (U.S.) (Narasimhan, 2009). This assertion, however, will require new instruments for multilevel governance.

CONVENTIONAL THOUGHTS ON TRANSBOUNDARY WATERS

The big news in transboundary waters is that on May 19, 2014, Vietnam became the 35th party to the 1997 United Nations (U.N.) Convention on the Non-Navigational Uses of International Watercourses (Convention). The Convention came into force on August 17, 2014.

What does it all mean for the approximately 290 international river basins identified by the Transboundary Freshwater Dispute Database at Oregon State University? One can secure the geopolitical reality by visiting Gabriel Eckstein's excellent *International Water Law Project Blog* (http://www.internationalwaterlaw.org/blog/), a wonderful primer for those water wonks not intimately familiar with the Convention. Gabriel has tapped the international experts for their say on the matter in a series of invited editorials. Gabriel cautions that the Convention is not intended to be the final word on transboundary waters, but rather serves as a framework that contains general legal norms and principles that can be used to develop more formal legal instruments worldwide.

Despite the Convention's obvious emphasis on international watercourses, where do groundwater and aquifers fit? Stephen McCaffery, international water lawyer and the architect of the Convention, contributes to the International Water Law Project Blog and opines that one of the underappreciated aspects of the Convention is the discussion of both surface water and related groundwater (emphasis added). He offers that the definition of "watercourse" means "a system of surface waters and groundwaters constituting by virtue of their physical relationship a unitary whole" His commentary indicates that the Convention's provisions would apply to shared aquifers that have some connection with surface water as well as aquifers that are not themselves shared but which have a hydraulic connection with shared surface water (emphasis added).

Local control over groundwater management and aquifer uses is best accomplished through aquifer communities composed of local landowners, municipalities, or counties through either formal or informal agreement.

LAW OF TRANSBOUNDARY AQUIFERS

But are aquifers and groundwater one and the same resource as suggested by the Convention? The International Groundwater Assessment Centre (IGRAC) inventoried 608 transboundary aquifers as part of a 10-year global effort of developing and adopting the Draft Articles of the Law of Transboundary Aquifers that is now annexed to a U.N. General Assembly Resolution (Eckstein and Sindico, 2014). Since the adoption of the Law of Transboundary Aquifers, the ways of moving forward on governing the hidden resources are manifold, but only a few formal initiatives exist today. One transboundary aquifer treaty exists, and it covers the geographically limited Genevese Aquifer shared between France and Switzerland. Less formal instruments exist to cooperate

Transboundary Goverenance of Groundwater and Aquifers: You Can't Separate One cont'd.

on future development and information sharing between the countries that share the geographically large Guarani Aquifer shared between Uruguay, Paraguay, Argentina, and Brazil, as well as Nubian Sandstone and North Western Sahara aquifer systems in northern Africa. Yet when one carefully reads the Law of Transboundary Aquifers detailing the use of terms within the instrument, the use of aquifers extends beyond groundwater - "utilization of transboundary aquifers or aquifer system includes extraction of water, heat and minerals, and storage and disposal of any substance" (emphasis added). This is an important acknowledgment that the available aquifer storage is also an important transboundary resource that must be collectively managed beyond just considering the aquifer as just a container for storing recoverable groundwater.

INFORMAL INTERNATIONAL AGREEMENTS

The U.S. shares 17 aguifers with Canada and Mexico. While joint fact finding is an important part of managing shared aquifers, the outcomes of such efforts have been more informal than formal in terms of legal instruments. One such effort is the U.S.-Mexico Transboundary Aquifer Assessment Program (TAAP) that was signed into law in 2006 as part of the Transboundary Aquifer Assessment Act that applies to the states of Texas, New Mexico, and Arizona. While the TAAP was authorized with \$50 million authorized for appropriation over a 10year period, the program has not been provided the anticipated funding. Eckstein and Sindico (2014) report that despite the lack of formal agreements between the U.S., Mexico, and Canada regarding shared aquifers, cooperation does exist at the local level between the aquifer communities sharing transboundary aquifers in the form of Memoranda of Agreements/Understanding between individual U.S. states and Canadian provinces, or between U.S. and Mexican cities.

THE GREAT AMERICAN DRAINING

Closer to home, there are several geographically large shared aquifers in the U.S. But unlike the shared large surface water systems, such as the Colorado River or Great Lakes that are covered by legal compacts, the groundwater and aquifers are not managed by any formal agreements. Complicating matters even more is the fact that the neighboring states often have groundwater allocation laws that differ in terms of use and private versus public ownership of the captured groundwater.

The Ogallala or High Plains Aquifer System is shared between eight midwestern states, all of which have different water laws governing how groundwater is allocated, and in some cases owned, within the individual states. The fractured-rock Carbonate Aquifer System underlies four western states and is under consideration for a large wellfield and long pipeline project by the Southern Nevada Water Authority that may cost upwards of \$15 billion; a groundwater sharing agreement for the aquifer developed over a period of four years between Utah and Nevada was close to signing by both governors in 2013 until the Utah governor had second thoughts. The Columbia River Basalt Aquifer in the Pacific North-

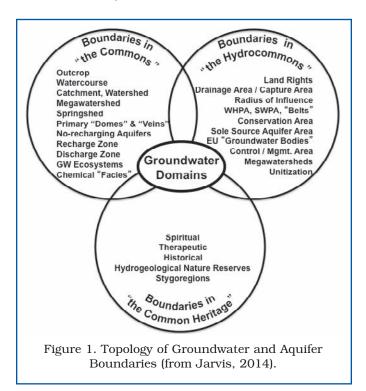
west is shared by three states with no agreements on allocations despite rapid depletion, especially in the vicinity of the Columbia River. And the Memphis Sand Aquifer underlies four eastern states. Here the State of Mississippi continues to explore legal approaches to suing the City of Memphis, apparently the largest city in the world that relies solely on groundwater, for damages associated with capturing water underlying Mississippi.

Recognition of other uses of aquifers beyond extracting groundwater as promoted by the Law of Transboundary Aquifers, include geothermal energy development, carbon sequestration, and managed aquifer recharge, is acknowledged by very few states. Some states incorporate, or are testing collective action of aquifer governance using "pooling" of interests, a concept of unitization employed by the oil and gas industry over the past 100 years (Jarvis, 2011). The main challenges to successful collaboration in assessing and managing transboundary aquifer systems in North America was explored by one of my past graduate students. His research revealed that the challenges are the usual culprits of water conflict: conflicting goals, lack of incentive to cooperate, and fear of compromise. However, the joint development of collaborative conceptual models of the aquifer systems is an important step towards transforming disputes over transboundary groundwater and aquifers (Delgado, 2013).

THE DILEMMA OF BOUNDARIES

The problem of how boundaries are placed around groundwater and aquifers are commonly referred to as "fuzzy" and impossible to undertake with a reasonable degree of certainty because of the vagaries in where recharge areas are located, the hydrologic connection to surface water resources and flow and discharge characteristics that are typically only known at only a reconnaissance level. Yet the literature is replete with boundaries for groundwater domains. In my book Contesting Hidden Waters: Conflict Resolution for Groundwater and Aguifers (Jarvis, 2014), I argue that consideration of a transdisciplinary approach to exploring the geopolitics of groundwater yields a typology for groundwater and aguifer boundaries (Figure 1). My findings indicate (1) traditional approaches to defining groundwater domains focus on predevelopment conditions; (2) groundwater development creates new boundaries, where hydrology, hydraulics, property rights, and economics are meshed; and (3) groundwater and aquifer users regularly define boundaries that acknowledges social and cultural values the resources. Yellowstone National Park is a good example of a "common heritage" boundary that serves as a global hydrogeological nature reserve that considers the influence of the private and public lands and associated geothermal resources, as well as their management, that surround the legally defined park boundary. The significance of this groundwater and aquifer topology is that it focuses more on the notions of "problemsheds" and "policysheds" - the boundaries of a particular problem or policy defined by the groundwater and aquifer users.

Transboundary Goverenance of Groundwater and Aquifers: You Can't Separate One cont'd.



The new world order of transboundary groundwater and aquifers will focus on the delineation of resource and user-domain boundaries because boundaries are needed for governance. But the selection of boundaries are not strictly limited to the geological boundaries as technological options to manage groundwater quantity and quality problems must employ water transfers, managed recharge, or conjunctive use. Resource governance solutions must also include collective or community action, developing instrumental approaches such as treaties, agreements, rights, rules, and prices or other incentives, such as preserving the structural and ecological integrity of groundwater systems, as summarized by Giordano (2009). As a consequence, politics dictates both a glass half-empty and a glass half-full approach to achieve the desired outcomes. These desired outcomes must be spelled out in the new legal instruments for groundwater and aguifers, as the boundaries are an important part of governance, regardless of whether one considers groundwater and aquifers as common pool resources or as individual commodities.

RETHINKING SCALE AND JURISDICTIONAL BOUNDARY SPANNING

Concurrency laws are one of the most effective instruments for linking water availability and land use at local jurisdictional scales. Since the 1970s, concurrency laws in the U.S. typically focused on the availability of public facilities such as schools, roads, sewers, and water supplies to accommodate rapid growth. The fragmented nature of water and land use at the State or Provincial level, due in part to the lack of integration between land use and water laws, is leading to a new paradigm in water planning that focuses on a "bottom-up"

approach instead of the traditional "top-down" approach. Funding shortfalls, the uncertainty associated with the quantitative characteristics of groundwater systems, and the growing frustration with the dueling expert situation is leading to increased reliance on a "prove-it" approach to assertions of adequate water supplies by developers and their consultants alike.

Different "scales" of groundwater governance and management have evolved since 2000. For example, concurrency laws for proposed land use have evolved to address groundwater recoverability and aquifer mechanics. The change in this instrument came about due to highly variable well yields unrelated to groundwater recharge or depletion, but instead due to damaged and lost aquifer storage.

Several jurisdictions across North America and beyond, usually at the county level rather than at the state level, have crafted policies that specifically require a link between proving water availability for housing developments (California, Colorado, Utah), new agriculture (California), and to minimize interference with senior surface water rights through uncontrolled pumping of groundwater through domestic wells (Washington). The Qinxu Groundwater Management System regulates all groundwater usage in the Qinxu, one of the counties in Shanxi Province in China. Some counties require periodic retesting of wells for redetermination of water availability, acknowledging that change is the by-product of aquifer exploitation and needs to be monitored. These policy experiments reflect changing political will, moving beyond "if we build it, the water will come," to "if we have it, you are welcome."

American comedian George Carlin once said "Some people think of the glass as half full. Some people think of the glass as half empty. I think of the glass as too big." One interpretation of Carlin's joke is that the glass is just as important as the fluid contributing to the debate over "half-full or half-empty." In the current era of groundwater depletion with simultaneous irreversible damage to aquifer storage, new instruments of transboundary groundwater governance must focus not only on process equity and outcome equity, but also on transboundary aquifer governance - what to do to preserve and reuse the storage characteristics of the container holding the water. Local control over groundwater management and aquifer uses is best accomplished through aquifer communities composed of local landowners, municipalities, or counties through either formal or informal agreements. The new and emerging use of international conventions and legal instruments provide frameworks for collective action at all jurisdictional scales.

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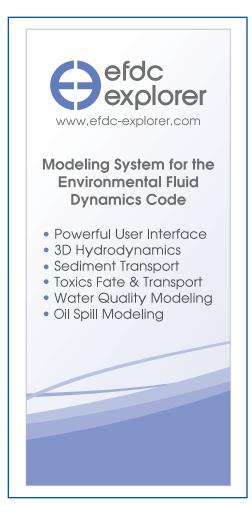


AWRA Welcomes
New JAWRA Editor-in-Chief

Jim Wigington

Jim will assume the duties of JAWRA EIC on January 1, 2015.

To read more about his plans for the journal and a press release announcement, visit the AWRA Blog at www.awra.org.





CANADA-UNITED STATES WATER RELATIONS: ONE CANADIAN'S PERSPECTIVE

RALPH PENTLAND

Interestingly, the world's longest lasting and arguably most successful cooperative water management arrangement grew out of a very local water sharing dispute in the St. Marys and Milk River Basins. The consequent Boundary Waters Treaty of 1909 established binational rules regarding water quantity and quality, and created the International Joint Commission (IJC), one of the earliest, most enduring, and most widely admired international dispute resolving organizations.

One measure of the IJC's success over more than a century is the fact that out of some 120 cases referred to the Commission for advice and resolution, only two have resulted in the commissioners failing to reach consensus. Notwithstanding the fact that these binational arrangements have achieved considerable success in the past, those successes are now showing signs of unraveling. To understand the root causes of that unraveling and possible solutions, one must look not only at the evolution of water issues, but also at broader societal trends beyond the water sector (Pentland, 2010).

WATER RESOURCES DEVELOPMERNT (1940–1965)

In the quarter century before about 1965, conventional wisdom about resources and governance was very well summed up in the following quote by Canada's Resource Minister of the day at the 1962 Resources for Tomorrow Conference: "...our concern is not just with resources alone but with resources in relation to capital and labour, and our complex of institutions as they all, in turn, relate to the objective of growth.... we must be able to turn resources into income and employment opportunities" (Pentland, 2010).

Economic growth was the theme, and multiple use and coordination were the means most often alluded to. South of the border, the U.S. Corps of Engineers and Bureau of Reclamation spent billions on dams, flood control and diversion projects. In the more remote northern regions of Canada, many of the world's largest diversions captured and directed water through large-scale hydroelectric facilities.

Consumptive use of water grew exponentially during that period and shortly thereafter as massive irrigation projects were completed in both countries. The two countries were already well on their way towards fully allocating several major water sources, including the Colorado River, the Ogallala Aquifer, and the South Saskatchewan River.

In the context of Canada–United States (U.S.) water relations, that period featured large-scale projects of mutual advantage. One such project was the St. Lawrence Seaway, a 3,700 kilometer marine highway flowing into

and out of the industrial heartland of North America. Another was the Columbia River Treaty, an Agreement between the two countries to cost-share, develop and operate dams in the Upper Columbia River Basin to provide hydropower and flood control benefits in both countries. Towards the end of that period, Canada adopted a more general "pre-build" policy, under which hydroelectric and other major energy projects would be approved for construction in Canada well before a domestic demand developed, as long as there was a demand from outside the country that would assist in their financing. Since that time, the two countries have operated under something close to a continental energy policy – a policy that has had enormous implications for subsequent trade agreements, and for Canada's environment and water resources.

Basically, what will eventually be needed is a more holistic approach – not in the systems analysis sense of the 1970s and 1980s, but in the sense of more systemic thinking about the relationship between natural security, health, and wealth.

Interestingly, at about the same time Canada chose not to pursue a continental water policy. The reasons for that were many and varied, including: overwhelming hostility to the notion of bulk water export among the Canadian public; the impracticality of mostly Canadian private-sector water export proposals; misconceptions about potential markets in the U.S.; and the ecological and economic implications in potential donor regions.

To this day, public opposition in Canada remains so strong on this issue that both the federal and most provincial governments have passed legislation prohibiting bulk removals of water from major river basins. Early in this century, that consensus even spread across the international border, when citizens throughout the Great Lakes Region demanded, and achieved a prohibition on bulk removals of water from the Great Lakes Basin, with minor and well-defined exceptions.

THE ENVIRONMENTAL ERA (1965 - 1990)

By the end of the 1960s, citizens in both countries began to realize that unbridled development came with an environmental price, and were demanding action. One of the most visible manifestations of a degrading environment was extensive algae growth in Lakes Erie and Ontario. Algae growth, the IJC observed, "curtail commercial fishing and recreational activities, impart noxious odors, impair filtering operations of industrial and municipal water treatment plants, lower water front

Canada-United States Water Relations: One Canadian's Perspective . . . cont'd.

property values, interfere with the manufacture of certain industrial products, and generally threaten destruction of the lake as a valuable water resource" (IJC, 1965). In 1972, President Nixon and Prime Minister Trudeau signed the historic Great Lakes Water Quality Agreement.

Other spectacular events like the Cuyahoga River fire further sparked political interest, and within three years, the U.S. would pass some of the most significant antipollution legislation the world had yet seen, including the Clean Air, Clean Water and Safe Drinking Water Acts. Later in the 1970s, health issues related to contaminated sites, such as the Love Canal, prompted President Carter to sign the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) into law a month before leaving office.

Meanwhile, north of the border, Canada's First Ministers received advice from their Canadian Council of Resource Ministers in 1970 to unify environmental responsibilities under single Ministries. Shortly thereafter, environmental agencies were created at the federal level and in all provinces, backed up by a substantial suite of new environmental and water laws. In 1970, the Canada Water Act also came into force, which led to dozens of comprehensive federal-provincial basin planning initiatives over the following two decades.

In both countries, including their shared watersheds, water and environmental management generally flourished during the environmental era. The high degree of interdependence created by advancing technologies suggested the need for a total "systems" approach in the search for optimal societal solutions. That search took many forms including greater interjurisdictional cooperation, an integrated approach to planning in a river basin context, and an emphasis on interdisciplinary science.

The Canadian Science Council, in its landmark 1968 report described the implications of a systems approach as follows: "The Science Council considers such an approach to involve the systematic and rational analysis and design of an object or policy, in which every possible effort is made to ensure consideration of all reasonable alternatives and in which attempts are made to provide objective quantitative measures of the consequences of alternative courses of action as a basis for decision. It is in effect an optimization technique."

The Canada-U.S. water relationship took its cue from conventional wisdom about governance and science. Some examples included sophisticated simulation and optimization models to bring about more systemic regulation of Great Lakes levels, and several complex mathematical models to better understand the transboundary implications of proposed developments like the Garrison Diversion Project in North Dakota. Even where mathematical modeling per se was not involved, a systems approach was always touted (for example the ecosystems approach under the Great Lakes Water Quality Agreement).

By the end of this era, several impressive accomplishments were evident in shared watersheds and shared airsheds. The Great Lakes had at least temporarily regained some of their sparkle as the algae problem subsided, the concentration of several of the nastiest

chemicals had declined, and intense efforts were underway to clean up several local areas of concern. And acid rain had effectively been brought under control mainly through a binational cap and trade approach. While local irritants continued to arise from time to time, they were well under control due to relatively effective institutional arrangements in most boundary and transboundary basins, and strong scientific capacities in both countries.

THE AGE OF MARKET TRIUMPHALISM (1990-PRESENT)

As the period after about 1990 began, optimism was running high around the concept of sustainable development. In 1987, the Brundtland Commission had published its landmark document "Our Common Future" (The World Commission on Environment and Development, 1987). The entire report was based on the assumption that "humanity has the ability to make development sustainable – to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs."

That clearly implies limits. But what made the Brundland concept different from previous theories about limits to growth was the added assumption that the limits themselves could be expanded through improved technology and social organization. In other words, the biosphere could absorb increased volumes of human activity through technological and institutional advances.

We can, and have in fact, expanded limits to some degree. For example, with respect to water we have traditionally expanded limits by building dams and drilling wells. As that potential diminished, we began to raise water productivity by improving the efficiency of water use and the management of wastes. There is also potential to expand limits by taking advantage of synergies between sectors. For example, saving water also saves energy and vice versa.

Unfortunately, sustainable development concepts were overtaken by a more powerful governance theory. Environmental progress began to slow in the early to mid-1980s when Ronald Reagan and Margret Thatcher proclaimed that markets, not governments, held the key to prosperity and freedom. That's not a political statement. The same philosophy continued to hold sway through the 1990s, with the market-friendly liberalism of Bill Clinton and Tony Blair. And of course other western industrialized nations, including Canada followed suit.

As a result, since the early 1990s, the globalism and competitiveness agendas have clearly been dominating conventional wisdom on governance. Even though we claimed to be operating under the banner of sustainable development, the underlying agenda had become the so-called virtuous cycle – the assumption that global economic growth, the promotion of democratic systems and the encouragement of international trade and investment would produce a virtuous cycle of wealth generation, so-cial advances, and eventually ecological protection.

Market triumphalism has clearly had some benefits on a global scale, as many of the world's less fortunate

Canada-United States Water Relations: One Canadian's Perspective . . . cont'd.

have at least temporarily climbed out of abject poverty. But the assumption that it will eventually lead to ecological protection is faltering. It is true, a World Bank report (Hallegatte *et al.*, 2011) conceded in 2011 that most developed countries have contained the worst excesses of water and air pollution from their past. But this is not true of local pollutants with invisible or long-term impacts (e.g., the build up of endocrine disrupting chemicals), global pollutants (e.g., greenhouse gas-induced climate change), or the destruction of biodiversity.

One casualty of the blind pursuit of the so-called virtuous cycle and short-term profit has been evidence-based decision making. As inferred in the 1996 Canadian government report *Science and Technology for the New Century*, the dominant R&D priority became innovation in service of profit. Science and regulation in support of the broader public good – the environment and public safety has taken a back seat, and has been very significantly hollowed out. For example, in Canada environmental science in government at all levels has been reduced by at least a third since 1990. And the environmental science that was left behind has been put on a very short leash, becoming both less transparent and less independent.

Another casualty of market triumphalism has been a loss of appreciation that there are moral limits to markets (Sandell, 2012). This fundamental lack of appreciation became obvious with the virtual collapse of mostly unconstrained financial markets in 2008. It has yet to become apparent with respect to what have become mostly unconstrained risks to our natural security, even though those risks are potentially even more serious. The drift away from evidence-based decision making, declines in capacity and transparency, and the intensification of issues that are beyond the direct control of water managers have all contributed to an unraveling of previous boundary waters successes.

The most glaring example is Great Lakes water quality. New toxic substances are showing up in fish and sediments. These include fire retardants, plasticizers, pharmaceuticals, and personal care products. Many of these pose a risk to fish, wildlife, and people. Although the exact cause has not been definitively established, various species of Great Lakes fish now suffer from tumors and lesions, and their reproductive capacities are decreasing. Of the ten most valuable species in Lake Ontario, seven have almost totally vanished.

Nonnative species are threatening the balance in biological systems and water chemistry, and climate change is contributing new challenges to the sustainability and health of the basin. In recent years, we have been witnessing biological deserts developing in some areas, a series of botulism outbreaks in fish and birds, and extensive algae blooms. An increasing proportion of these algae blooms are blue-green cyanobacteria, which when they break down release a variety of liver, skin, and neurological toxins.

Other examples include Great Plains region water projects such as the Red River Valley Water Supply and Devils Lake projects that have the potential of harming transboundary waters without reference to the Boundary Waters Treaty or the IJC. Lake Winnipeg, whose basin encompasses four provinces and four states, is experiencing rapidly deteriorating water quality due to increasing nutrient inflows, more than half of which originate outside of Manitoba. In the past, issues of this type would have been dealt with expeditiously by way of binational fact finding through the IJC, with a high probability of arriving at mutually beneficial solutions.

LOOKING AHEAD

By 1965, North Americans had concluded that the pendulum had swung too far in the direction of unfettered development. By 1990 they had concluded it had swung too far in the direction of environmental protection, and began a search for a better balance under the label of sustainable development. That balance has proven to be very elusive. Instead of finding the balance, the pendulum has swung to yet another extreme – market triumphalism, with a failure to appreciate that there are moral limits to markets.

Looking ahead, conventional wisdom on governance will no doubt shift again, simply because changing circumstances will force it to change. And when conventional wisdom about governance changes both conventional wisdom about science and the nature of Canada-U.S. water relations will inevitably follow.

Market-driven exponential economic growth and poverty reduction require enormous flows of natural capital; and global ecological decline is already beginning to constrain those flows of natural capital. The most pervasive manifestation of that decline is the instability of weather patterns as they accommodate the extra energy pent up on the planet by human carbon emissions that exceed the capacity of oceans and the biosphere to assimilate them. A changing climate has already reduced renewable water supplies in boundary and transboundary waters by close to 10%, and increased the magnitude and frequency of floods and droughts, with significant negative impacts on both the economy and the environment.

Another manifestation of the decline is the addition of toxic, persistent and bioaccumulative chemicals to the environment at a much faster rate than nature can break them down. There is now overwhelming evidence that this build up of chemicals, especially those of the endocrine disrupting kind, is harming the health of fish, wildlife, and humans. While the short-term economic benefits of pure market triumphalism have been clear, at some point the costs to our health, wealth, and natural security will inevitably exceed those benefits (Pentland and Wood, 2013). We may have already crossed that threshold.

We cannot survive without biodiversity, clean air and freshwater, and healthy oceans – so the laws of nature will eventually have to be re-elevated relative to the unnatural laws of economics. Assuming we still operate under a market economy a quarter century from now, that means the efficiencies of the free market will have to be redirected to the goals of preserving and repairing lifesustaining natural capital. For example, we will only get

Canada-United States Water Relations: One Canadian's Perspective . . . cont'd.

to a sustainable energy future when we are able to internalize environmental costs through some form of carbon tax, and we will not deal effectively with environmental contaminants until we are able to internalize related health costs.

Basically, what will eventually be needed is a more holistic approach – not in the systems analysis sense of the 1970s and 1980s, but in the sense of more systemic thinking about the relationships between natural security, health, and wealth. Unfortunately, that will not happen overnight, because governments never change fundamental direction without a groundswell of public support – support that does not yet exist. In the meantime, Canada-U.S. water relations are likely to involve a combination of traditional activities, plus a lot of coping and adapting to things that are beyond the direct control of water managers.

What can water managers at the level of shared Canada-U.S. river basins do when faced with unpredictable and largely uncontrollable things like climate change, exponentially accelerating shale gas fracking and other nonrenewable resource extraction, and a growing array of health-threatening pollutants, all of which are largely beyond their control, and at best uncertain top-down governance? I would suggest they should hope for the best but plan for the worst. What they can do is focus on maximizing the resilience of local ecosystems to cope with the unknown and uncontrollable – by dealing as effectively as they can with what is known and what is within their control.

One very positive trend in that regard is a proliferation of nongovernmental and government-nongovernment partnership watershed organizations. There are now numerous large-scale and small-scale examples across the continent. What these organizations still lack is connectivity – an institutional home. In that regard, the IJC's new Watershed Board approach would appear to hold out considerable promise. That approach is expected to advance local solutions through an integrated ecosystem approach, enhanced local participation, and strengthened local capacity.

There are promising signs from the bottom up. From the top down, it is less clear that senior governments are willing to confront the major issues that extend beyond watershed boundaries, to capitalize fully on the potential of the IJC and the timeless principles in the Boundary Waters Treaty, or to ensure that local entities have the science, policy, and financial support that they need to cope with rapidly evolving social, economic, and environmental situations in shared watersheds.

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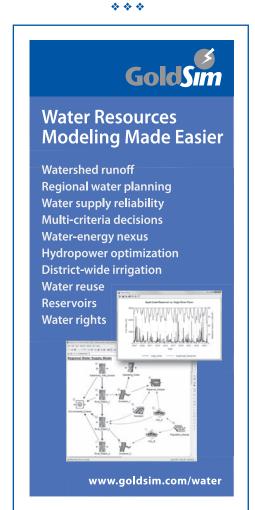
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MULTI-JURISDICTIONAL CHALLENGES OF TRANSBOUNDARY WATER MANAGEMENT: LESSONS FROM THE COLUMBIA RIVER TREATY REVIEWS

KIM OGREN

INTRODUCTION

The mighty Columbia River Basin (CRB) recently garnered increased attention as the United States (U.S.) and Canada conducted reviews of the Columbia River Treaty (CRT or Treaty), an international model of transboundary cooperation between countries in water management. Through case studies and experience, water professionals and academics identified several challenges in transboundary water management, including sovereignty, authority, power, knowledge, funding/resource availability, scale, and complexity (Table 1). The rest of this article highlights examples of how the U.S. and Canada addressed these challenges in their reviews of the CRT through a series of questions: (1) Who leads? (2) Who gets a seat at the table? and (3) What falls within the scope of the effort? Before launching into answering those questions a background on the basin and Treaty is provided for context.

THE COLUMBIA RIVER BASIN

The CRB is an international basin shared between the U.S. and Canada (Figure 1). Seven states and one Canadian province have land within the basin, which covers an area of 259,500 mi² or 668,000 km². The basin is home to over six million people and over 609 fish and wildlife species. The 1,214-mile main-stem originates in British Columbia, Canada, and flows through the U.S. to the Pacific Ocean. The main stem of the Columbia River is the fourth largest river in North America as measured

by average annual flow, which at its mouth is 198 million acre-feet (MAF).



Figure 1. The Columbia River Basin.

Table 1. Common Challenges in Multijurisdictional Basins.

Sovereignty and Authority: A government or group's independent authority and right to govern itself. Sovereigns can include federal governments, states, provinces, territories, and indigenous peoples. Multi-jurisdictional basins have multiple sovereigns with overlapping, conflicting, or fragmented authorities related to water.

Power: The ability to successfully exert one's will, which impacts interactions between interests and the ability of the government, individual, or group to meaningfully participate in a project.

Resource Availability: Different sovereigns and interests have different access to resources in terms of time, funding, and personnel to devote to a particular issue. This impacts the ability to participate in an effort.

Knowledge: A potential area of conflict or barrier to meaningful engagement if the parties in different jurisdictions (1) disagree on the science and information to be used in the project or when making decisions, and/or (2) one group lacks the ability needed to understand the technical information presented.

Scale: Both the geographic extent of the transboundary water management problem being addressed and the goal of matching the specific water management issue with the appropriate scale of governance.

Complexity: A factor in both in terms of the issue at hand and interests in the basin. Transboundary management is often much more complex since it has to work within multiple legal structures to work within, involves a greater number of interests and/or agencies involved, and often deals with larger scale problems.

THE COLUMBIA RIVER TREATY AND ITS UPCOMING CHANGES

The U.S. and Canada ratified the CRT in 1964. The goal was to maximize flood control and hydropower benefits received on both sides of the border. This meant constructing dams to utilize the storage sites in Canada and managing flows across the border through coordinated dam and reservoir operations. The CRT authorized construction of four dams: Mica Dam, Hugh Keenleyside Dam, and Duncan Dam in British Columbia, Canada, as well as Libby Dam in the U.S. (Montana). To ensure equal sharing of Treaty benefits the U.S. paid Canada \$64.4 million for dam construction and half the projected flood damages to be avoided through 2024. Each year the U.S. also returns to Canada half of the calculated additional downstream power benefits in the form of energy and capacity. This is known as the Canadian Entitlement, which ranges in value from \$100 to \$350 million per

The terms of the Treaty will change in 2024. Specifically, 60 years of prepurchased (known as "assured") storage for flood control will expire and shift Treaty flood control provisions to what is referred to as "Called Upon" flood control. Under certain conditions, the U.S. can "call upon" and pay Canada for storage in the northern portion of the basin in order to help protect downstream portions of the basin from flooding. "Called Upon" flood control has always been an option under the Treaty, but has never been utilized. Thus the exact procedures have never been defined. The date of September 16, 2024, is also significant as it marks the earliest date that either country can unilaterally terminate the Treaty - after giving 10 years notice. Meaning, if either country wants to terminate the Treaty in 2024 they must notify the other country in 2014. To explore their options both nations conducted reviews to decide: "Is it in the nations' best interest to continue with, modify, or terminate the CRT?"

MULTIJURISDICTIONAL CHALLENGES IN THE REVIEWS OF THE CRT

The question seems simple enough until you recall that, in addition to federal agencies within the basin there are seven states and at least 16 tribal nations within the U.S. portion of the basin as well as one province and four First Nations in the Canadian portion of the basin. While a treaty between two countries, the CRT impacts water management in multiple other jurisdictions within the basin. Therefore, each review encountered a number of challenges typical of multijurisdictional efforts. The following are examples of how they addressed those issues.

Who Leads?

Who is in charge of a multijurisdictional effort depends on who has the authority, resources, and knowledge to take on the task. It depends highly on context. In the U.S., the U.S. Department of State has the authority to handle international relations and treaties. For the U.S. Treaty review it kept its authority to make a deci-

sion, but requested the U.S. Army Corps of Engineers (Corps) and Bonneville Power Administration (BPA) lead a process to develop a regional recommendation. BPA and the Corps serve as the management authority for the Treaty, working with BC Hydro in Canada to implement the Treaty as the U.S. and Canadian Entities, respectively. Thus, they have the technical knowledge about the basin and are also familiar with regional issues, interests, and players. In Canada, the Canadian Department of Foreign Affairs, Trade, and Development is in charge of international relations. However, the 1963 Canada-British Columbia (BC) Agreement transferred most Treaty benefits, rights, and obligations to the Province. Canada also learned from, and did not want to repeat, the difficulties it faced in ratifying the Treaty due to its lack of consultation of the Province during Treaty negotiations. Therefore, the Province led the Canadian review and tasked its Ministry of Energy, Mines, and Natural Gas with coordinating the effort.

Regardless of the U.S. and Canada's decision on the Treaty, the two countries will need to work together in order to define "Called Upon," a provision of the Treaty that will continue to exist regardless of whether the Treaty does.

Who Gets a Seat at the Table?

Both reviews pursued a two-pronged approach of sovereign and stakeholder participation. In BC, the Provincial government formed the Local Governments Committee as a way to consult with local elected officials. Engagement of First Nations was coordinated through the federal agency, Natural Resources Canada. Federal and provincial agencies as well as First Nations contributed to technical studies. Stakeholder participation took place through a series of community meetings, a technical conference, and a committee of basin residents called the Sounding Board. The Sounding Board was comprised of residents from different geographic regions within the Canadian portion of the basin. In the U.S., the U.S. Entity formed the Sovereign Review Team (SRT) and accompanying Sovereign Technical Team (STT) as a means to engage other federal agencies, state governments, and tribal nations within the basin on policy and technical issues. The U.S. Entity also consulted with the Pacific Northwest congressional delegation and Inter-Agency Policy Committee. Stakeholder engagement took the form of various types of public meetings and individual meetings and presentations for interest groups. Example challenges in sovereign engagement and resource access are listed in Tables 2 and 3, respectively.

What Falls Within the Scope of the Effort?

Task definition is important for any project, but it can be particularly challenging for large multijurisdictional collaborative efforts. For the Treaty reviews, the U.S. and BC needed to decide what fell within the scope of their review efforts. This included what technical analyses to conduct and which transboundary water

Multi-Jurisdictional Challenges of Transboundary Water Management: Lessons cont'd.

Table 2. Challenges Related to Sovereignty.									
Challenge	Remedy	Result							
How do you achieve adequate representation of indigenous peoples? (U.S.)	The U.S. Entity requested that the tribal nations designate three representatives to serve on the SRT. The tribes responsed by forming a coalition known as the "Columbia River Treaty Tribes" and designating five representatives, which were accepted into the SRT.	The tribal coalition is regarded as a major success. However, not having elected tribal leadership on the SRT created some difficulties. One tribe needed to be consulted separately as it was not part of the tribal coalition.							
What do you do when the scale of governments do not match? (Canada)	The Province of BC reached out to First Nations, who in turn, asserted their right to be engaged by the federal government of Canada as sovereigns.	The First Nations request was met with the involvement of Natural Resources Canada, though some BC residents wanted to hear more First Nations perspectives.							
What qualifies as a sovereign? (U.S.)	The U.S. needed to decide who were basin sovereign and qualified for a seat on the SRT. The U.S. Entity decided to not include public utilities, state legislators, or local (county) officials on the SRT because: (1) their interests were represented through the other federal and state government SRT members and (2) they had other opportunities for input.	Some select legislators and local officials were upset, but it did not have major implications. The U.S. Entity received a lot of push back from the power utilities and it was challenging to gain their support for the regional recommendation. However, some felt this decision increased equity and equialized power among different interests.							

Table 3. Challenges Related to Resource Access.										
Challenge	Remedy	Result								
How do you reach everyone in the basin? (Both)	While the two reviews hosted public meetings around the basin, they could not go to every town. Therefore, both reviews hosted live meetings via the web and maintained active websites to share information.	This use of technology worked well for reaching a broader audience. It also allowed continued U.S. federal participation despite travel restrictions.								
What if a sovereign lacks the funding to conduct a study (U.S.)	The U.S. review wanted to study tribal cultural resources in order to better understand what existed in the basin and might be at risk depending on river operations under the Treaty. BPA had funding available if tribal nations wanted to use it for their own aseessments of their cultural resources.	A number of tribes utilized the funding. Other tribes felt the funding or time available for the studies was insufficient.								

management concerns were international topics (that fell within the purview of deciding whether the Treaty should be continued, modified, or terminated) and which were domestic matters (that each country could address within its own borders) (Table 4).

FUTURE CHALLENGES

Looking forward the CRB faces numerous multijurisdictional conversations and decision. First, is the actual formal decision on the Treaty by Canada and the U.S.:

will they choose to continue, modify, or terminate the Treaty? The U.S. and Canada identified the 50-year anniversary of the Treaty, September 16, 2024, as a target date for a decision, but there is no official deadline. Both BC and the U.S. Pacific Northwest region recommended modification. If the countries go that or some other route, they will then need to determine what future river operations will look like.

Regardless of the U.S. and Canada's decision on the Treaty, the two countries will need to work together in

Multi-Jurisdictional Challenges of Transboundary Water Management: Lessons cont'd.

Table 4. Challenges Related to Complexity and Knowledge.									
Challenge	Remedy	Result							
What basin wide problems do you consider? (Both)	Various interests in both countries believe that fish passage, for species such as salmon, past Chief Joseph and Grand Coulee dams in Washington across the border into Canada (and past Canadian dams) is a Treaty issue. In their recommendations both nations decided that it was a domestic issue.	While some are unhappy with the treaty issue versus domestic matter delineation most are happy that the domestic issue are acknowledged in the recommendations.							
What technical studies should be conducted? (Both)	The two reviews conducted studies to understand river management under different scenarios. Sovereigns, stakeholders, and the public were given the opportunity to provide input on what the scenarios should include.	Technical analyses took longer than expected, but had greater legitimacy amongst sovereigns, stakeholders, and the public.							
What information should be shared? (U.S.)	Initially all technical study results were shared with the SRT, STT, stakeholder groups, and the public. However, as this information might be used in future negotiations, the Department of State requested that only it and the U.S. Entity see the final study results and reports.	At first, the sudden change of course perceived as a betrayal. While still unhappy, groups later expressed that they understood the reasons for the decision.							

order to define "Called Upon," a provision of the Treaty that will continue to exist regardless of whether the Treaty does. At its core, "Called Upon" is the ability of the U.S. to call upon Canada for additional storage in the BC reservoirs under certain conditions. These conditions include meeting a minimum flow threshold at the Dalles Dam between Oregon and Washington on the Columbia River as well as making "effective use" of U.S. reservoirs for flood control. Neither "Called Upon" or "effective use" are defined in the Treaty. "Called Upon" has always been an available option, but it has never been needed. Therefore the two countries have not negotiated the specific terms of the provision. The U.S. and Canada reviewed the notes from the original Treaty negotiations as well as their own laws and stated differing opinions of how those Treaty provisions should be interpreted. One area of disagreement is the minimum flow level required before the U.S. can make a call to Canada. The U.S. states the flow is 450 kcfs, while Canada states that level is 600 kcfs. Another is what it means to make "effective use" of U.S. reservoirs for flood control. Canada believes that this means that the U.S. must utilize all reservoirs that can contribute to flood control. The U.S. believes that "effective use" pertains only to the eight reservoirs authorized to operate for system flood control (as opposed to local flood control, hydropower, conservation, recreation, irrigation and other reservoir purposes). In addition to these issues, the two nations must also decide how to calculate the payment for any calls to Canada. Despite these differences and challenges, both countries and almost all parties agree climate change a critical challenge facing the Columbia River and its residents. If they choose to use the Treaty as a venue for addressing climate change it may serve as a potential unifying force or problem to bring together various parties as they try to identify how

the basin should adapt to and mitigate the effects of climate change.

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THE COLORADO RIVER BASIN: A BASIN UNDER PERPETUAL DISTRESS

MARK SVOBODA

Much has changed since the Colorado River Compact of 1922, or has it? It seems that the old adage of "whiskey is for drinking; water is for fighting over" still applies all these years later. Signed coming off a historically wet period, the 1922 Compact and anticipated life line to development of the western United States (U.S.) was already behind the eight ball from the very beginning given the fact that allocations were divided up based on average river flow numbers that were overestimated. The constant in this equation is the fact that the river, and deliveries from it, were already destined to fall short of its promises independent of drought, climate change, increasing demands given a booming population (and the desert urban centers that followed), tribal rights, economic development, hydropower (energy) needs, agricultural and municipal use along with environmental concerns dealing with habitat, water quality, and endangered species to name just a few.

Drought is just one of many stressors that exacerbate the supply-demand balance within the Colorado River Basin (CRB) states and between the U.S. and Mexico. But of all the hazards and threats to our country's water security, perhaps none represent a bigger threat to more people and sectors than drought. Drought also serves as a pretty good analog to the longer term issue of climate change in that it is typically slow to evolve, doesn't recognize geopolitical borders, can potentially last several years (decades in fact), can cover millions of square miles, and impact millions of people. At the same time, drought risk management offers a glimpse at how we may be able to learn and benefit from dealing with an extreme event such as drought and applying it to a longer and more gradual trend toward a more arid climate as a result of global warming.

The 15-year drought currently affecting the CRB has been a rally cry to focus on impacts and management issues and toward potential solutions moving forward. Adaptation measures are already underway, denoted by several management changes between the Upper and Lower Basins of the Colorado River and between the U.S. and Mexico as well (more on this later). Due to the ongoing drought (and droughts before it), decisions have been forced on decision and policy makers within the Bureau of Reclamation (BOR), the states falling within the CRB and Mexico. These negotiations and proactive actions may serve the community well in the future under a more permanent shift of climate. Indeed, changes are already underway on many fronts given alterations to the melt-out season and substantial reductions in the basin's largest reservoirs (Lake Mead and Lake Powell).

MONITORING AND EARLY WARNING

Early on during the current drought in the CRB, around the first apex in 2002 to be more exact, the BOR noted that demand on the Colorado River had finally surpassed total flow in the river. The drought only served to heighten this issue and deepen the deficit. A recent study by the BOR in 2012 predicts that CRB river deliveries could be short by three billion cubic meters come 2035. Without the ability to see drought coming on radar or satellite imagery, diligent monitoring is necessary in order to better detect when a drought begins such that actions can be triggered by decision makers through a variety of planning and management efforts.

To that end, collaborative efforts to develop better drought early warning capacity are underway both domestically and internationally. Closer to home, the National Integrated Drought Information System (NIDIS) (drought.gov) was signed into law in 2006 and then reauthorized in 2014. Charged with increasing our country's drought early warning capacity (meaning both drought monitoring and forecasting efforts), NIDIS has focused efforts on coordinating and facilitating regional/basin level systems tied and customized to the needs of the stakeholders within these basins. NIDIS has also been supporting monitoring and planning efforts between the U.S., Canada, and Mexico. Activities are underway in both the CRB and the Rio Grande/Bravo basins and they will be spinning up soon in the Pacific Northwest as well.

At the global scale, several international groups (including NIDIS and the National Drought Mitigation Center) are being coordinated through the World Climate Research Programme. Efforts are underway to better monitor, predict, and disseminate information about drought and its impacts using a regionally driven approach around the globe as a means of addressing water, food, and national security issues pertaining to drought through a Global Drought Information System (GDIS).

In the case of the Colorado River Basin, most of the conflict will likely be between the Upper and Lower Colorado River instead of with Mexico in finding ways to continue serving 30 million acres of irrigated agricultural land while also allowing for continued growth and development.

THE PAST AND THE FUTURE

The past can still give us a glimpse into how droughts will generally behave under a warmer climate. Elevated temperatures have ramifications on soil moisture, evapotranspiration rates, sea surface temperatures, atmos-

The Colorado River Basin: A Basin Under Perpetual Distress . . . cont'd.

pheric circulation patterns, and the timing and length of the wet season in the West. More importantly, the question is how does this increased temperature signal affect precipitation during the wet season? More precipitation falling as rain at higher elevations, coupled with earlier melting of the snow pack are all factors that water managers need to deal with in how water moves in and through the system between states and between countries.

The key take away point from the future warming, aridity, drought nexus is that when they occur together, and they have done so many times in the past, they have the capacity to last much longer than any drought we have seen in modern history, including the current ongoing drought in the West/Southwest. Studies by Cook *et al.* (2004) and Woodhouse *et al.* (2010) both show that the drought currently causing such strain in the West today pales in comparison to megadroughts that occurred in AD 900 and 1300, which lasted several decades.

A look at projected climate scenarios shows the West, in general (and the Southwest in particular), to very likely see increased temperatures and less precipitation (Seager *et al.*, 2007, Garfin *et al.*, 2014; IPCC, 2013) with more days inbetween rain events, thus, more droughts are expected. The shift to a more arid climate doesn't mean droughts won't occur in the future. They will simply be a departure from this new climate norm. Aridity is a permanent feature of a region's climate whereas drought is a temporary departure from normal. In addition, this likely warming scenario means there is a moving target that water managers, planners, and policy makers need to take into account when dealing with the management of the resource, both today and decades from now.

TAKING ACTION

Given the existing treaty language and agreements in place, the onus is certainly on the U.S. side moving forward given the headwaters and majority of the water are on the U.S. side. Most of the infrastructure in place is set up to handle arrangements between the Upper and Lower CRB, but recent droughts and subsequent, marked declines in storage, has led to an increasing amount of strain on the system and serves as a real threat for the first shortage call on the river should Lake Mead fall below 1,075 feet above sea level. There is the potential to offset some of the projected shortfall through increases in conservation and technology/efficiency advances in irrigation and desalination applications.

The Law of the River is a collection of guidelines, laws and contracts aimed at managing the Colorado River. Drought has played a significant role in spurring action through several of these management vehicles, which have been put in place over the years as conditions warranted. The following are some of the key decrees that can be traced back to drought as a stimulus for cooperative and innovative risk management planning (BOR, 2014).

- 1. The Mexican Water Treaty of 1944 was necessary because no allocation amount was defined in the 1922 Compact. The Treaty of 1944 defined that annual delivery amount to be 1.5 million acre-feet (maf) during normal years and more or less if there is a surplus or deficit. The amount can be less during "extraordinary drought," which was left undefined. Serious drought in Mexico in the 1990s, followed by exceptional drought on both sides of the border on-and-off during the current 15-year drought (1999-2014) has led to "extraordinary drought" claims by Mexico on the Rio Grande, which led to reductions in water delivery from Mexico to the U.S. These instances of "extraordinary drought" declarations can only be expected to become more frequent not only on the Rio Grande, but also on the Colorado River between the U.S. and Mexico.
- 2. The Colorado River Interim Guidelines (CRIG) for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead of 2007 was a historic event. The drought (still ongoing) and decline of Lake Mead served as a window of opportunity for changes that allowed for better management between the Upper and Lower Basin during times of drought and/or low storage. Surprisingly, there had been no guidance for the U.S. Secretary of the Interior in times of shortage even though the Secretary is obligated to annually declare the Colorado River water supply availability conditions for the Lower Basin States in terms of Normal, Surplus, or Shortage. The CRIG also provides guidance as how to manage and transfer water between Lake Powell to Lake Mead during times of drought or shortages (BOR, 2014) and through an option called Intentionally Created Surplus. These temporary guidelines are set to expire in 2026.
- 3. Per Minute No. 318, a short-term agreement signed between officials in Mexico and the U.S. in 2010 that serves as an example of innovative and flexible joint management of the resource allowed Mexico to store a deferred portion (260,000 acre-feet) of its annual allocation of 1.5 maf in Lake Mead up through the end of 2013 while they repaired some damaged infrastructure.
- 4. Minute No. 319 is yet another example of recent compromises and management changes within the CRB. Signed by the U.S. and Mexico offices of the International Boundary Water Commission in 2012, the idea is to deliver enough water to Mexico annually in order to ensure flow into the delta region of the Colorado River into the Gulf of California in the Baja Norte province, which will hopefully allow for more agricultural and environmental habitat restoration on Mexico's side of the border. This "pulse flow" was set to begin in spring 2014 followed by nominal base flows to ensure that the delta doesn't completely dry up again.

The Colorado River Basin: A Basin Under Perpetual Distress . . . cont'd.

MOVING FORWARD

The amount of water carried by the Colorado River in any given year is still quite variable, but recent studies and reports (Seager et al., 2007; Garfin et al., 2014) tell us these average annual flows will likely continue to decline in the coming decades as the region moves into an even more arid regime. This change, coupled with changes in the characteristics of the runoff season in the future means it will take more than just conservation to remedy the over-allocation issue now that demand is outpacing supply. As a result of both the ongoing drought and increased demand over the past decade or more, Lake Mead (our country's largest reservoir) is already at a record low elevation, the lowest it has been since it was first filled in the 1930s (BOR, 2014).

A combination of efforts will be needed to help offset and/or make up the projected challenges that less water will demand under a more arid climate regime. Examples include more efficient desalination, above-ground and below-ground water banking, joint management and transfer agreements, irrigation efficiency or changes in crops grown and where they are grown will all play a role as well as continued conservation efforts. There is no silver bullet that will take care of all of these issues ... and perhaps all of the above will not be enough to keep up with growth and demand that is projected to play out in the not so far off future.

The full impact of all of these factors on water security in the CRB has yet to play out, but it is certainly not an issue unique to the Colorado River as future droughts and transboundary water issues will certainly cause conflicts to arise in other theaters of the world, including Asia and Africa in particular, but in many other places as well. A combination of proactive policy and management will need to be jointly carried out by countries working together in order to ensure that enough water is available for essential needs along with economic growth. A changing climate and growing world will only serve to put more strain on an already over-spoken for, and under-valued, commodity. In the case of the CRB, most of the conflict will likely be between the Upper and Lower Colorado River instead of with Mexico in finding ways to continue serving 30 million people and over 3 million acres of irrigated agricultural land while also allowing for continued growth and development. We can at least take something positive away from the droughts of today or tomorrow as they will continue to serve as learning opportunities while also keeping the spotlight on the CRB as a vital resource moving forward given the essential role it plays in our nation's water and food security.

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Mark Svoboda has been with the NDMC since it was formed in 1995. As the NDMC's Monitoring Program Area Leader, his duties include overseeing the center's operational drought monitoring activities and in providing expertise on climate and water management issues. Mark co-founded (and still authors) the development of the U.S. Drought Monitor in 1999 and currently sits on the American Meteorological Society's Applied Climate Committee as well as the National Integrated Drought Information System Implementation Team. In addition, he has extensive experience working with the international drought, water, and climate community via project collaboration and consultation with over 50 countries and international organizations to date. Mark earned both his Bachelor's Degree in Geography specializing in Climatology and a Masters Degree in Geography with a specialization in Remote Sensing, Climatology, and GIS from the University of Nebraska-Lincoln. He is currently working on his dissertation for a Ph.D. in Natural Resources specializing in Human Dimensions.

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THE ROCK CRIED OUT NO HIDING PLACE ERIC J. FITCH

In the future days, which we seek to make secure, we look forward to a world founded upon four essential human freedoms. The first is freedom of speech and expression – everywhere in the world.

The second is freedom of every person to worship God in his own way - everywhere in the world.

The third is freedom from want—which, translated into world terms, means economic understandings which will secure to every nation a healthy peacetime life for its inhabitants – everywhere in the world. The fourth is freedom from fear – ...

Franklin D. Roosevelt, excerpted from the State of the Union Address to the Congress, January 6, 1941

Certain events in recent days have inspired this column. I was able to view parts of the excellent Ken Burns documentary on The Roosevelts and was reminded of how government could work for the betterment of its people. Both T.R. and FDR fought for government that helped all citizens and not just the wealthy. They fought against the trusts and the plutocrats who seemed to live by the motto that "I've got mine and the rest of the world can pound sand."

Teddy fought for conservation of parks, forests, soil and water resources and against the pillage and spoil mentality of the robber barons. Franklin fought to put people to work building up the essential infrastructure of the nation and by furthering Teddy's conservation legacy. As best she could as an unelected volunteer, Eleanor Roosevelt pushed to continue FDRs legacy in terms of human rights and human dignity. Much of the momentum of New Deal policies continued through the Truman, Eisenhower, Kennedy, Johnson, and yes, Nixon administrations.

Carter failed to rally Congress to continue domestic progress with the same vigor of prior administrations but there was progress. President Ronald Reagan embraced a different path for government, but some environmental progress continued despite some questionable leadership appointments at the department and agency level. Since then, leadership from the White House, the Congress, and the Courts on improving environmental stewardship through public policy and works seems to have waned

This inertia has been a fault under both Parties' leadership, in the White House and in Congress. Efforts to create a true cabinet level Department of the Environment, though endorsed and submitted to Congress under administrations from Carter to Clinton never gained sufficient momentum to be realized. Revisions to TSCA (the Toxic Substances Control Act) and CERCLA (the Comprehensive Environmental Response, Compensation and Liability Act *aka* Superfund) have languished in Congress after Congress. Responsible responses to climate change have been left by the wayside as well. It is as if we have lost our collective will to act to protect our home and our health ... our planet has dwindled.

I've been following the ongoing crisis in Detroit as it works its way out from beneath bankruptcy under the leadership of appointed, not elected, officials. The water and sewer departments are in such dire straits that they have suggested becoming a regional authority just to

have enough of a tax base to fund replacement and expansion of antiquated and broken down infrastructure. To demonstrate their fiscal responsibility, they engaged in massive cutoffs to delinquent clients that meant at minimum thousands of poor households would be without water. A large portion of these cutoffs would be in poor, largely minority neighborhoods. Appeals to city, county, and state authorities seemed to fall on deaf ears, so the courts became the route of last resort. This relates back to the Roosevelts in that after FDR's death. Eleanor pushed for Franklin's concept of the Four Freedoms to be a part of global law via the Universal Declaration of Human Rights. Ratified by the United Nations with the United States as a signatory, it represents a set of goals for all governments and nations to pursue. Public interest attorneys in a fairly novel approach argued that the cutoff of water by agents of the government violated the Human Rights of the poor. "How can there be freedom from want if the basic need for potable water is not being addressed?" is how the argument has been presented and it makes some valid points.

In Washington during some of the limited sessions that have actually taken place in Congress, efforts at creating or revitalizing infrastructure and research programs are falling on deaf ears. Instead politicians pursue conspiracy theories about science and scientists. Recently, in a hearing on climate change, NASA's top climate scientist was bombarded with charges that "Climate Change" is a vast conspiracy aimed at making scientists rich and dragging down the economy. If one works even a short period of time with real scientists one would know how absurd the idea of scientists in conspiracy is, especially to promulgate a false idea for profit.

By ignoring the fruits of science, starving public funding for education and science, and instead taking every tactic necessary to concentrate wealth in the hands of the few, we are moving away from the true vision of America as epitomized by the thoughts, words, and actions of the Roosevelts, and back to the Gilded Age America that led to the Great Depression. Over 230+ plus years of progress as a society that presents opportunities for all while protecting the environment and conserving critical resources will be lost to adherence to economic ideas that no nation in the history of the world have used as operating concepts.

(continued on pg. 22)



STUDY FINDS ALARMING GROUNDWATER LOSSES IN THE COLORADO RIVER BASIN

TANNER KETELLAPPER AND CLAY J. LANDRY

Due to ongoing drought and growing demand, water levels in Lake Mead are currently at their lowest levels since the lake was first filled in 1937. Falling water levels have led to concerns over future water supplies in the Colorado River Basin (CRB), and legislation has been passed to manage future shortages of Colorado River water. So far, the focus has been on the supply of surface water within the basin. However, a recent study suggests depletion to groundwater resources has far exceeded surface water losses since 2004.

Researchers from University of California Irvine and NASA analyzed data from the NASA Gravity Recovery and Climate Experiment (GRACE) satellite to estimate groundwater levels from 2004 to 2013. Findings estimated that groundwater supplies within the basin were depleted by 50.3 km³, or approximately 40 million acre feet. By comparison, the volume of Lake Mead when completely full is approximately 26 million acre feet. Groundwater accounted for 78% of the total freshwater losses in the basin over the period of the study (Castle *et al.*, 2014). These numbers indicate that groundwater may account for a larger percentage of water use in the Colorado River Basin than previously thought. Figure 1 shows estimated change to the volume of groundwater and reservoir storage within the CRB.

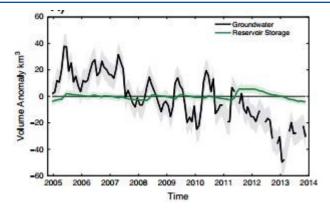


Figure 1. Monthly Anomalies of Groundwater and Surface Water Storage.

The apparent groundwater depletion of the CRB draws comparison to the large depletions in the Ogallala aquifer. The Ogallala aquifer stretches across portions of eight western states and has been heavily relied upon as a water source since large-scale pumping began in the 1950s. Reliance on the aquifer has led to pumping that far exceeds natural recharge and has led to significant groundwater depletion. As a result, the future availability of the resource has come into question, and the aquifer is not considered a reliable long-term water supply.

Groundwater depletion in the Ogallala aquifer has brought with it significant economic impacts. A 2012 study from the Harvard Environmental Economics Program estimated the market value of Ogallala aquifer water supplies over time using land price differential analysis. The analysis compared prices of land with access to Ogallala water with land prices without access to estimate the value of the water. Ogallala water values peaked in the 1970s at an estimate \$26 billion, but by 2002 had fallen 65% to an estimated \$9 billion (Hornbeck and Keskin, 2012). The drop in market value was attributed to expectations that many areas will lose access to Ogallala groundwater due to overpumping. Similar to the Ogallala aquifer, the CRB supports a large amount of agriculture - nearly four million irrigated acres. Continued declines in the supply of CRB groundwater may lead to a similar economic loss resulting from reduced water supplies. Implementation of improved groundwater management would help limit overpumping of groundwater, and potentially prevent groundwater depletions from getting to the extent of the Ogallala aquifer.

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The Rock Cried Out No Hiding Place cont'd.

On the other hand, one can hope that the robustness of the truth and the strengths of Democracy can bring us back to the Roosevelt's shining examples. As for those who are against the change, against responding to the warnings on climate change, against debuting an American "Marshall" plan to rebuild America's infrastructure and, amongst other goals, secure healthy sustainable water supply and quality systems and otherwise do what is right and necessary. May it come to be that we have no fear of taking the steps that are needed to secure a sustainable water future and may it come soon.

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AWRA'S VALUE TO YOU ... DID YOU KNOW? C. MARK DUNNING

Most of my President's columns in *IMPACT* this year have focused on the substantial value that AWRA provides to members through its services. In January, I noted that AWRA's longevity – we're celebrating our 50th anniversary this year – comes from offering services that help members be more successful in their water resources professions, in combination with a friendly and supportive culture that encourages dialogue and productive information exchange.

I elaborated on this theme in the May issue, noting that AWRA is "The" resource for Integrated Water Resources Management (IWRM) through its information webinars, case studies, IWRM technical committee, and specialty conferences on this important water resources philosophy and methodology. In July, I focused on AWRA's newly re-engineered and energized technical committees – open to all members – that provide the opportunity for professionals and aspiring professionals to remain up-to-date on technical areas, as well as work with their fellow members on important projects that support AWRA's mission of advancing multidisciplinary water resources education, management, and research.

In this current President's message, I want to again return to this theme and touch on three other services that AWRA provides to members that can help us be more successful in our water resources professions.

PUBLICATIONS

The Journal of the American Water Resources Association (JAWRA), available as either a printed publication or electronically, is highly regarded as one of the pre-eminent peer-reviewed journals on water resources topics. Besides receiving bi-monthly issues of JAWRA, members have access to extensive search and retrieval capabilities enabling them to identify and download past articles on a wide variety of water resources topics.

Water Resources IMPACT is our popular consumption magazine where members can obtain shorter, less technical overviews on many critical water resources topics and issues. Once again, members have easy access to search and retrieve past issues of IMPACT.

Another publication that you should know about is our "Connections" E-newsletter. This monthly newsletter provides information on what's happening at AWRA as well as events, publications, webinars, conferences, and many other newsworthy items. Current and past issues can be found on the AWRA website (awra.org) under Publications – Newsletter, and also as a monthly download to members (and nonmembers) by signing up for the newsletter on the website.

CONFERENCES

AWRA conferences provide a great opportunity to network with fellow water resources professionals and hear presentations on the latest in water resources practice, methods, and issues. AWRA presents three conferences per year – one annual conference spanning a broad array of water resources topics, and two specialty conferences targeted to a more focused audience. For example, in 2014 our specialty conferences focused on GIS in water resources, and on advances in the application of IWRM

For 2015 the specialty conferences will target water supply issues in urban areas, and applications in climate change action planning and implementation. While our conferences are open to everyone, members receive a substantial discount in conference attendance fees, and have access to past conference proceedings as a member benefit.

WEBINARS

In 2014, AWRA has presented eight webinars on topics ranging from ecosystem services to hydrophilanthropy. Webinars are provided as a member benefit, but nonmembers may attend for a \$25.00 fee. In addition to timely access to the latest thinking and developments presented in our webinars, another member benefit is the ability to access to the archive of past webinars. If you are unable to see it live, you can always access the archive by logging in to the AWRA website and following the links to the webinar archive. The Webinar Task Force is currently planning the schedule for a robust 2015 webinar series.

It is worth noting that the services mentioned above – when purchased separately by a nonmember – costs much more than an annual AWRA membership. That is, AWRA's "Value Proposition" – the value that members receive for their dues – is positive. Your Board of Directors and AWRA's excellent and dedicated staff are committed to making sure that AWRA products and services are providing value to members commensurate with membership dues.

We are always open to ideas and comments for ways that our value to members can be improved. Please let me know at president@awra.org of any ideas or comments you may have about how we can continue to serve you better!

E-Mail Connection

C. Mark Dunning ~ president@awra.org

WATER RESOURCES PUZZLER (answers on pg. 32)

ACROSS

- 1 robbery or murder
- 6 mix
- 10 late
- 14 anagram of steer
- 15 city in Italy
- 17 wrath
- 18 shortly
- 19 an admirable person
- 20 mental conception
- 21 an allotment of money
- 22 come afterward
- 23 weather report
- 24 a useful thing
- 26 Ireland, formerly
- 28 not sq.
- 29 fill one's stomach
- 31 sweet vermouth (Brit.)
- 32 noisily and quietly
- 35 an NBA team
- 37 always
- 38 last year's jr.
- 39 CA National Park
- 40 bit
- 42 usher's beat
- 44 sales pitch
- 45 a full supply
- 47 Mars or Pluto
- 48 frat party purchase
- 50 a form of a chemical element
- 52 no. 40 of 44
- 53 a source of spam
- 55 followed by control or sensing
- 56 cousins of aves.
- 58 a violent oceanic disturbance
- 60 those elected
- 61 follows web or stinky
- 62 loc. of Congaree R.
- 63 Swiss R.
- 64 water state
- 65 pack animal
- 66 fuses alloys
- 69 can be short or long
- 71 basic training instr.
- 72 famous for its arch
- 75 followed by iron or Latin
- 77 erects
- 78 dear

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77							78								
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DOWN

- 1 ____ to grave
- 2 gambling center
- 3 sets apart
- 4 first king of Egypt
- 5 movie alien
- 6 homonym of sent
- 7 anagram of sent
- 8 synonym of sent
- 9 antonym of sent
- 10 prof's aide
- 11 "____ in the sky"
- 12 fear
- 13 fiscal or leap _____
- loc. of the Connecticut R.
- 19 conferences
- 20 loc. of the Rock R.
- 23 morning repast
- 25 locate
- 27 ____ up (the engine)
- 30 deans and professors
- 32 of deep discernment
- 33 a thorny plant
- 34 to feel discontent
- 36 60's drug

- 38 thin
- 39 Kobe's team
- 41 followed by clock or weight
- 43 sleep disturber
- 46 traditional knowledge
- 47 cats and dogs
- 49 a mountain pass
- 50 an epic poem
- 51 type of bread
- 54 style of printing type
- 57 slapstick's Moe
- 59 A-line
- 61 ____ and games
- 64 ____ of Man
- 65 boatswain
- 67 a lyric poem
- 68 turn dir.
- 69 bind
- 70 h.s. class
- 73 a draft animal
- 74 elevator direction
- 75 3.14159
- 76 hosp. practice

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AWRA 2015-2016 RICHARD A. HERBERT MEMORIAL SCHOLARSHIP OPPORTUNITIES

Background – In 1980, AWRA established the Endowment-Memorial Fund to be used for the enhancement of education in water resources. The fund has since been renamed the Richard A. Herbert Memorial Educational Fund to honor Richard A. Herbert — a champion for water resources education — who passed away in 1994. In order to carry out his vision, AWRA is proud to announce the availability of scholarships derived from the proceeds of this fund.

Eligibility and Awards Available – **Each applicant must be a national AWRA member.** At least one \$2,000 scholarship will be awarded to a **full-time undergraduate student** working toward his/her first undergraduate degree and who is enrolled in a program related to water resources for the 2015-2016 academic year. At least one \$2,000 scholarship will also be awarded to a **full-time graduate student** enrolled in a program relating to water resources for the 2015-2016 academic year. (The AWRA Board of Directors may, at its sole discretion, approve additional scholarship awards, based upon the performance of the Memorial Fund.)

Selection Criteria – The undergraduate scholarship will be awarded to the student most qualified by academic performance. Measures of academic performance include the cumulative grade point average, relevance of the student's curriculum to water resources, and leadership in extracurricular activities related to water resources. The graduate scholarship will be awarded to the student most qualified by academic and/or research performance. The measures of academic performance are identical to those of the undergraduate scholarship with the addition of the quality of the student's research and its relevance to water resources. Recipients will be selected by the AWRA Student Activities Committee and announced during summer 2015.

Application Process – A complete application packet contains:

- Title page that includes the applicant's full name, permanent mailing address, email address, phone number where he or she may be easily reached, and the type of scholarship (undergraduate or graduate).
- Two-page summary (approx. 500 words) of his/her academic interests and achievements, extracurricular interests, and career goals as they relate to the above selection criteria.
- Resume or curriculum vitae.
- Three signed letters of reference from professors and/or advisors. Letters of reference MUST include the signatures of the referee PDFs of the signed letters work best.
- Transcripts of all college courses (undergraduate and graduate). <u>Legible</u> copies of "Issued to Student" transcripts
 are acceptable to save on fees but unofficial grade reports (such as those students can access from their online
 student accounts at the university) are unacceptable. *Application packets that include unofficial grade reports will not be considered.*

Application packets should be submitted electronically to info@awra.org and limited to 5mb in size to ensure delivery. <u>All applications must be submitted in their entirety.</u> AWRA <u>will</u> provide an acknowledgement of receipt of your application but will not provide updates to your application status or request missing information. Please make sure your application is complete when it is submitted. We look forward to hearing from you.

Deadline

All applications and supporting materials must be received electronically by

APRIL 22, 2015



Questions? Call AWRA at (540) 687-8390 or send an e-mail to info@awra.org

American Water Resources Association PO Box 1626 Middleburg, VA 20118-1626 Phone (540) 687-8390 Fax: (540) 687-8395 info@awra.org www.awra.org

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AWRA'S 2014 ELECTION RESULTS (TAKE OFFICE EFFECTIVE JANUARY 1, 2015)

AWRA is pleased to announce the Association's recent election results. Martha Corrozi Narvaezl, incoming President-Elect and incoming Directors Lisa Beutler and Wayne S. Wright will assume their new offices on January 1, 2015. At that time, John C. Tracy will become AWRA President and current President C. Mark Dunning will become immediate Past President.

PRESIDENT-ELECT ~ MARTHA CORROZI NARVAEZ - Martha is an Associate Policy Scientist at the University of Delaware's Water Resources Agency (WRA), a unit of the Institute for Public Administration. Martha is responsible for providing regional watershed technical, policy, and research support to state and local governments; University staff and faculty; and nonprofit organizations in Delaware and the Delaware Valley. These responsibilities include research in water resources issues and policy, development and coordination of public education and outreach initiatives, advisement on State and local water resource issues, assistance with graduate courses at the University of Delaware, and advisement of graduate and undergraduate students. Prior to becoming a University of Delaware staff member, Martha was employed by the Chesapeake Research Consortium at the USEPA's Chesapeake Bay Program Office in Annapolis, Maryland; the Public Works Department in the City of Wilmington, Delaware; the Conservancy of Southwest Florida in Naples, Florida; and Environmental Consulting



Services Inc. (ECSI) in Middletown, Delaware. Martha received her Bachelor of Science (BS) in Biology from Lehigh University and her Master of Public Administration (MPA) degree from the University of Delaware where she specialized in watershed management.

Martha has been a member of AWRA for almost 15 years, both as a student and professional, and served on the Board of Directors from 2008-2013. She was the charter president of DEAWRA and is currently a DEAWRA board member. She has served on numerous local and national AWRA conference committees, including Co-Chair for both the 2010 Annual Conference and the 2007 Mid-Atlantic Sections Conference. Martha received AWRA's A. Ivan Johnson Award for Young Professionals in 2007.

DIRECTOR/2015-2017 ~ LISA BEUTLER – It has been an honor to serve on the AWRA Board this year. Our focus has been on promoting integrated water resources management and there is far more to do. In particular, I have been part of the effort to expand AWRA's use of Webinars and other methods to leverage technology and share information. The Webinar series is a tremendous benefit of membership. It has been particularly gratifying to have been both a presenter and sponsor of the series.

The last 14 years, four of them as a Principal and Executive Facilitator at MWH (Montgomery, Watson, Harza) and before that at the California State University Center for Collaborative Policy, I have served on multidisciplinary leadership teams for four California Water Plan updates, a federal-state-regional-local planning team to integrate land use and water quality goals at Lake Tahoe, and as senior consultant for the Central Valley Flood Protection Plan. I have helped develop Integrated Regional Water Management Plans, enjoyed working with executive teams from irrigation districts, regional



sanitation and water supply agencies and assisted state and regional water boards in creating a better regulatory alignment and strategic plans and approaches for water quality goals. My projects typically tackle wicked, complex problems at massive scales.

In all, the goal has been for sustainable water management and policy. We focus on good science, solid decision making processes, technology, and collaboration. Another passion is making technical information accessible to decision makers and those impacted by their decisions as well as working with citizen science. As an AWRA Board member, I've been able to leverage my career in the public sector, the university and private industry along with experience working across disciplines to support the AWRA goals for a National Water Vision and to promote IWRM.

DIRECTOR/2015-2017 ~ **WAYNE S. WRIGHT** – Over the course of a career, many professional organizations become part of your network of information, interest and colleagues. Water is the driving force of nature – Leonardo da Vinci made this observation so many years ago. Jacques Cousteau astutely noted in a similar quote that "We forget that the water cycle and life cycle are one." These quotes resonate to me the importance of water and how our future depends on how we respond to the issues facing us. Society sits at a 5-way intersection of supply, demand, climate change, pollution, and sustainability. At no greater time in history does America - and the world - need comprehensive leadership to guide the changes that are necessary to secure future generations with adequate water resources. In 2014, it was very rewarding to help prepare the 2013 Proactive Flood and Drought Management Report with the AWRA Policy Committee. The recent mudslide that wiped out the town of Oso here in Washington demonstrates the HUGE importance of water resource management and disaster preparedness. I have driven by and stopped at that town many, many times over the years.



For me, AWRA is the ONE organization that matches my personal and professional interests best. Since joining AWRA in 1994 I have been involved with the Fish Ecology (now Flowing Waters Committee), Policy Committee, worked with students as a resource and mentor, and have assisted with several conferences – servicing on the planning committees, presenting papers, or coordinating panel discussions. It is my sincere desire to assist the AWRA Board and AWRA organization with making a positive difference regarding water resource issues.

* * *

RECIPIENTS OF AWRA'S ANNUAL AWARDS FOR 2014

The American Water Resources Association presented the following awards at their Annual Water Resources Conference in Tysons Corner, Virginia, in November 2014. Additional information on these awards can be found on AWRA's website: info@ awra.org.

FELLOW MEMBER

AMVROSSIOS BAGTZOGLOU

PROFESSOR AND DEPARTMENT HEAD OF CIVIL AND ENVIRONMENTAL ENGINEERING UNIVERSITY OF CONNECTICUT ~ CHESHIRE, CONNECTICUT

Ross Bagtzoglou teaches Water Resources and Environmental Engineering courses and specializes in numerical modeling of environmental and hydrologic processes. He holds a Diploma in Civil Engineering from the Aristotle University of Thessaloniki-Greece (1985), a MS in Hydrology and Water Resources Engineering from the Florida Institute of Technology (1987), and a PhD in Water Resources and Environmental Engineering from the University of California at Irvine (1990). He is a licensed civil engineer in Greece. As a graduate student he has been the recipient of Fulbright and NATO scholarships. Before joining academia he has held research and development positions first as a post-doctoral associate (1990-1991) at the University of California under funding from the U.S. Department of Energy (US DOE), and then as a research engineer (1991-1993) and senior research engineer (1993-1996) at the Southwest Research Institute under funding from the U.S. Nuclear Regulatory Commission (US NRC). Prior to joining UConn in 2002, he has also served as Assistant Professor of Water Resources and Geo-Environmental Engineering at Columbia University (1997-2002).

Professor Bagtzoglou has served or currently serves as Editor for the following journals: Water, Air and Soil Pollution: Advances in Remediation Technology (2004-2006), Innovative Remediation Technologies for Pollution Abatement (2007-2008), and Environmental Engineering Topical Editor for the Encyclopedia of Earth (2006-2011). In addition, he has served or currently serves as Associate Editor for the following journals: Groundwater (1994-1997), Water Resources Research (1999-2004), Inverse Problems in Science and Engineering (2007-2009), Stochastic Environmental Research and Risk Assessment (2006–), and Journal of the American Water Resources Association (2003-2007). He is also a member of the editorial board for the Journal of Environmental Forensics (2003-). He reviews technical papers for more than 40 journals and is or has been a member of several national and international professional organizations, the AGU Hydrology Section Groundwater Technical Committee, the ASCE Groundwater Hydrology Committee, the Water Environment Federation Groundwater Committee, the IAEG Commission 14 (Underground Disposal of Waste), the DOE Subject Expert Panel, and the Long Island Sound Study Science and Technical Advisory Commit-

Professor Bagtzoglou has a record of more than 160 technical publications including 75 papers in archival journals, book chapters, and monographs. He has delivered more than 100 presentations all over the world and has taught as visiting professor in Ethiopia, France, and Greece. He is an elected Member of the Connecticut Academy of Science and Engineering (2009–) and New York Academy of Sciences (1999–). He is an elected Fellow of the American Society of Civil Engineers (2012–) and the Institution of Civil Engineers (2012–).

Fellow Members of AWRA are elected in recognition of membership in the Association for at least 10 consecutive years, service as an Officer or Director or on a Committee for one year, and an eminent record in a branch of water resources science or technology.

WILLIAM R. BOGGESS AWARD

Using Multiple Watershed Models to Predict Water, Nitrogen, and Phosphorus Discharges to the Patuxent Estuary

JAWRA ~ February 2013 ~ Vol. 49 ~ No. 1 ~ pp. 15-39

KATHLEEN M.B. BOOMER

WATERSHED SCIENTIST ~ THE NATURE CONSERVANCY BETHESDA, MARYLAND

THOMAS E. JORDAN

SENIOR SCIENTIST AND CHEMICAL ECOLOGIST SMITHSONIAN ENVIRONMENTAL RESEARCH CENTER EDGEWATER, MARYLAND

LEWIS C. LINKER

CHESAPEAKE BAY PROGRAM MODELING COORINATOR
U.S. EPA CHESAPEAKE BAY PROGRAM
ANNAPOLIS, MARYLAND

ZHI-JUN LIU

Professor ~ Department of Geography University of North Carolina at Greensboro Greensboro, North Carolina

JAMES REILLY

REILLY CONSULTING ~ LAFAYETTE HILL, PENNSYLVANIA

GARY SHENK

INTEGRATED ANALYSIS COORDINATOR ~ USEPA CHESAPEAKE BAY PROGRAM ~ ANNAPOLIS, MARYLAND

ALEXEY A. VOINOV

ASSOCIATE PROFESSOR ~ INTERNATIONAL INSTITUTE FOR GEO-INFORMATION SCIENCE AND EARTH OBSERVATION THE NETHERLANDS

DONALD E. WELLER

SENIOR SCIENTIST AND QUANTITATIVE ECOLOGIST SMITHSONIAN ENVIRONMENTAL RESEARCH CENTER EDGEWATER, MARYLAND

Dr. Kathy Boomer has almost 20 years of experience working on water resource issues. She currently is the Watershed Scientist for The Nature Conservancy's Chesapeake Bay Whole System Restoration project. With a background in wetland hydrology, plant nutrient dynamics, and watershed modeling, she focuses much of her efforts on developing decision support tools to best place management practices for achieving water quality and habitat goals. She earned her Master's and Doctoral degrees from Cornell University, New York.

Thomas Jordan is a Senior Scientist and Chemical Ecologist at the Smithsonian Environmental Research Center in Edgewater, Maryland. He earned a B.S. in Biology from Bucknell University and a Ph.D. in Biology from Boston University. He has 34 years of postgraduate research experience. His research focuses on processes controlling the flows of nitrogen and phosphorus through ecosystems, especially flows from watersheds to estuaries and the role of wetlands in modulating these flows.

Recipients of AWRA's Annual Awards for 2014 . . . cont'd.

Lewis Linker is the Chesapeake Bay Program Modeling Coordinator, and works with colleagues throughout the Chesapeake Bay Program to develop linked models of the airshed, watershed, estuary, and living resources of the Chesapeake. He received his Masters from the Johns Hopkins Whiting School of Engineering. His professional interest is in the expansion and refinement of current watershed, airshed, and estuarine models of the Chesapeake, and in expanding the capabilities and analysis of linked water quality and living resource models generally.

Zhi-Jun Liu is a physical geographer and a statistician who received his Ph.D. from the University of Iowa. Two papers from his dissertation research have been published in the JAWRA. He is now a professor at the University of North Carolina-Greensboro, teaching hydrology, spatial statistics, and GIS programming. His primary research interest lies in the study of stream hydrology and ecology as related to human activities in the watershed.

Jim Reilly began his career as a City and Regional Planner with Wallace, McHarg, Roberts and Todd. After 16 years he switched to the public sector and worked as a senior planner and regional scientist for the State of New Jersey Office of State Planning and for the State of Maryland Department of Planning. While at these state agencies, Jim conducted statistical research about land use change and its various impacts. He is the author of numerous articles in various refereed journals as well as the author of GAMe, a computer model to predict future small area forecasts of land consumption, population, and jobs.

Gary Shenk is the integrated analysis coordinator for the Environmental Protection Agency at the Chesapeake Bay Program (CBP) Office. He focuses on the development of environmental models and monitoring analysis and their application to management questions. He leads a multidisciplinary team responsible for the development and operations for the CBP Partnership's watershed modeling effort. Gary holds a B.A. in economics and an M.S. in Civil Engineering, both from the University of Virginia

Alexey Voinov is Associate Professor at the University of Twente (Netherlands) Faculty for Geo-information Science and Earth Observation (ITC). His academic and teaching interests evolve around simulation modeling of ecosystems and sustainability science in application to decision support and policy making. Previously he coordinated the Chesapeake Research Consortium Community Modeling Program, and was also Principal Research Scientist at John's Hopkins University. Before that he was with the Institute for Ecological Economics, first at the Univ. of Maryland, and, later, the Univ. of Vermont, working on integrated studies of the ecological and human dynamics and sustainability sciences. He is a keen advocate of stakeholder involvement in modeling and decision making. He earned his MSc and Ph.D. from Moscow State University, Russia.

Don Weller is a Senior Scientist and Quantitative Ecologist at the Smithsonian Environmental Research Center (SERC). He earned a B.A. in Biology from Wabash College and a Ph.D. in Ecology from the University of Tennessee. He leads a research program that applies spatial analysis and mathematical, statistical, and computer models to ecological problems. His work considers the linkages among ecosystems and the role of human activities in complex landscapes. His recent research has focused on the linkages of watersheds to wetland condition, to stream chemistry and biology, and to estuarine health.

This Award is given to the author or authors of the paper, published in *JAWRA* during the preceding year, that best describes, delineates, or analyzes a major problem or aspect of water resources from either a theoretical, applied, or philosophical standpoint. Established in 1973, the Award honors William R. "Randy" Boggess, a member of AWRA, one of the first Directors, and a for-

mer President of the Association, who also made significant contributions to AWRA as an Editor of the Water Resources Bulletin (now Journal of the American Water Resources Association, JAWRA).

WILLIAM C. ACKERMANN MEDAL

CHRISTOPHER BADER

Manager of Information Systems North Dakota State Water Commission Bismark, North Dakota

Christopher Bader is currently the Manager of Information Systems for the North Dakota State Water Commission. I started my career at the Water Commission shortly after receiving my Bachelor of Science degree in Geology in 1985. My initial focus at the Water Commission included responsibilities for the state's water use data program. Over time, my responsibilities included more field activity related to wellhead protection studies and general hydrologic studies. Because there was not a great deal of software to address the types of management issues that the agency faced, I began to gravitate toward the information management and related software development. In 1991, I took a leave of absence from the Water Commission to pursue a Masters degree at the University of Kansas where my focus was on GIS and related technology. After returning to the Water Commission in 1993, I began working to build and design many of the management systems that are currently the foundation of the agency's data management program. This foundation represents more than 20 years of continuous evolution and development, and the result is one of the most comprehensive water resource data management initiatives anywhere in the

This Award was established in 1988 to honor the late William C. Ackermann, an individual who achieved eminence and compiled a distinguished record in the design and implementation of exemplary water management practices at the state, regional, and local government levels. The first Ackermann Medal was presented posthumously to Mrs. Margaret Ackermann and family at AWRA's Annual Conference in Milwaukee in 1988. The Medal is awarded each year to an individual who has achieved eminence in exemplary water management practices at the state, regional, or local levels.

SANDOR C. CSALLANY INSTITUTIONAL AWARD

DEPARTMENT OF HYDRAULIC AND WATER RESOURCES, BUDAPEST UNIVERSITY OF TECHNOLOGY AND ECONOMICS

BUDAPEST, HUNGARY

The Department of Hydraulic and Water Resources Engineering is one of the ten departments forming the Faculty (College) of Civil Engineering of the Budapest University of Technology and Economics. The Department carries out research and education in hydraulics, hydrology and water resources engineering.

The selected research interests and expertise of the Department cover hydrodynamics and interface processes in shallow surface waters; wind-induced shallow lake flows; mixing in compound channels; fractality and chaos in mixing; fluvial morphological; flood hydrology and forecasting; satellite data-based evapotranspiration estimation, flood hazard and risk assessment; and disaster prevention and management.

The Department has scientific links to water-related departments of a number of recognized universities in Europe. In the United States the Department maintains cooperation with IIHR-University of Iowa,

Recipients of AWRA's Annual Awards for 2014 . . . cont'd.

College of Engineering and with the School of Natural Resources, University of Nebraska-Lincoln.

The department offers B.S., M.S. and Ph.D. degrees. The number of students graduating with B.S. and M.S. degrees each year is approximately 60. The number of Ph.D. students is approximately five on a continuous basis. The teaching staff includes two professors, five associate professors, two lecturers and one assistant lecturer.

This Award was established in 1991 and is awarded (at such time as there are qualified nominees) to a water resources institution that has achieved a status of eminence in some aspect of managing the nation's waters.

MARY H. MARSH MEDAL

RONALD W. SULLIVAN

Commissioner ~ Santa Ana Watershed Project Authority RIVERSIDE, CALIFORNIA

Ron Sullivan has been a board member since January 2003, and brings a wide variety of service with city and county organizations, including chair of the Riverside County Planning Commission, City of Hemet Planning Commission, and Riverside County Aviation Commission. He served as a representative to former State Senator Marian Bergeson. A licensed general contractor, he is experienced in real estate planning, design, development, and construction. He is an owner in Sullivan & Sullivan R.E. Group Inc.

Mr. Sullivan serves on EMWD's Operations and Engineering Committee and Planning Committee. He is also liasion with Elsinore Valley Municipal Water District, Western Municipal Water District, and Western Riverside Water, Wastewater Financing Authority, and the Pechanga Tribal Committee as well as EMWD's commissioner of the five-member Santa Ana Watershed Project Authority. His EMWD board term expires in January 2017.

This Award was established in 1991 and is awarded annually (or at such time as there are qualified nominees) to an individual who has achieved a status of eminence in some aspect of public service related to water resources education and/or management.

INTEGRATED WATER RESOURCES **MANAGEMENT (IWRM) PROJECT AWARD**

SANTA ANA RIVER WATERSHED ONE WATER ONE WATERSHED 2.0 PLAN

SANTA ANA WATERSHED PROJECT AUTHORITY RIVERSIDE, CALIFORNIA

With the development of the One Water One Watershed (OWOW) 2.0 Plan, there have been physical accomplishments with more water saved and environmental habitat created, and there have been accomplishments in building a more resilient Santa Ana River Watershed. The transformation seen in how people wish to landscape has been powerful. With each garden transformed into a beautiful California water friendly design from the monolithic water guzzling turf, a tremendous amount of water is saved.

Many multi-beneficial projects and programs have been proposed and funded under OWOW for the improvement of communities and water agencies alike within the Santa Ana River Watershed. These projects have been financed by California's Proposition 84 Integrated Regional Water Management Grant Program and a local match, and implementation of these developments has begun to provide both regional and inter-regional benefits. The focus of the programs and projects is to get it right, as the resiliency of water projects or programs depends not only on their design, but on how they integrate within the watershed.

These benefits of these programs and projects include:

- Reducing landscape irrigation demand by 9,000 acre feet per year (AFY).
- Capturing 42,000 AFY of stormwater for recharge.
- Producing 18,000 AFY of desalted groundwater.
- Removing 25,000 tons of salt from groundwater each year.
- Creating 9,000 AFY of additional recycled water.
- Restoring 3,000 acres of environmental habitat.
- Creating about 6,700 construction related jobs.
- In total, the reduced demand of water imported from the Sacramento Bay Delta is 78,000 AFY. The equivalent of water used by about 156,000 households.

OWOW has also created relationships and synergies between the water purveyors, conservationists, remediators, the energy community, etc., within the watershed. The OWOW "bottom-up" approach of vetting solutions and implementation actions by Pillar groups, workgroups of experts and volunteers organized generally based on water resource management strategies, has allowed for an effective method for identifying an acceptable path forward for the watershed.

Managing the Santa Ana River Watershed has required these actors at multiple scales of management and with vastly different authorities and responsibilities to provide their judgment and expertise. It is a dynamic process, especially in light of the long-term challenges the watershed faces with climate change, population growth, the Colorado River drought and instability in the Bay Delta, but the OWOW Plan ensures a resilient watershed for people and the environment.

An IWRM approach to water resources has been a hallmark of AWRA since its establishment. Therefore, in 2012 AWRA established an award that recognizes outstanding IWRM work on a water resources project in consulting, government, nonprofit, or academia. This award is presented annually, or at such time as there are qualified nominees to an interdisciplinary team.

PRESIDENT'S AWARD FOR OUTSTANDING SERVICE JACQUE TOWNER

OFFICE MANAGER ~ AMERICAN WATER RESOURCES ASSOCIATION MIDDLEBURG, VIRGINIA

This Award recognizes those who have made significant contributions to the American Water Resources Association.

OUTSTANDING STUDENT CHAPTER AWARD TEXAS A&M UNIVERSITY STUDENT CHAPTER

This Award is presented to the AWRA Student Chapter that has been most active in advancing water resources knowledge to their respective Chapter, State, and Section.

OUTSTANDING STATE SECTION AWARD

FLORIDA STATE SECTION

This Award is given in recognition of a State Section's activities in advancing water resources knowledge in the Section; number, type, and scope of Section activity; special activities of unusual note; and number of National members in the Section.

FOUNDER'S AWARD

SANDER C. CSALLANY

GENERAL ENVIRONMENTAL AND ENGINEERING COMPANY

St. Paul, Minnesota

This Award was presented to the Founder of the American Water Resources Association on the occasion of its 50th Anniversary Conference.

SCHEDULED FUTURE TOPICS FOR 2015 ISSUES OF WATER RESOURCES IMPACT

JANUARY 2015

MEGACITIES AND WATER RESOURCES

Eric Fitch ~ Editor-in-Chief ~ fitche@marietta.edu

MARCH 2015

WATER AND ENERGY RESOURCE DEVELOPMENT

Jonathan E. Jones ~ Associate Editor ~ jonjones@wrightwater.com

MAY 2015

APPLIED INTEGRATED WATER RESOURCES MANAGEMENT (IWRM)

Richard A. Engberg ~ Guest Editor ~ dick@awra.org Carol R. Collier ~ Guest Editor ~ crc92@drexel.edu

JULY 2015

FIRST PEOPLES AND WATER: WATER RESOURCE ISSUES FOR NATIVE AMERICANS

Lisa Beutler ~ Associate Editor ~ lisa-beutler@comcast.net

SEPTEMBER 2015

URBAN WATERSHEDS AND WATERFRONTS

Joe Berg ~ Associate Editor ~ jberg@biohabitats.com

NOVEMBER 2015 HYDROPHILANTHROPY

Mae Davenport ~ Associate Editor ~ mdaven@umn.edu

The topics listed above are subject to change. For information concerning submitting an article to be included in these issues, contact the Editor(s) listed above or the Editor-in-Chief Eric J. Fitch at fitche@marietta.edu.

AWRA 2014 EXECUTIVE COMMITTEE

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ISSUE OF IMPACT? SEND US YOUR FEEDBACK

Water Resources IMPACT is in its 16th year of publication and we have explored a lot of ideas. We hope we have raised some questions for you to contemplate. "Feedback" is your opportunity to reflect and respond. We want to give you an opportunity to let your colleagues know your opinions ... we want to moderate a debate ... we want to know how we are doing.

For this issue send your comments by e-mail to IMPACT Editor-in-Chief Eric Fitch at **fitche@marietta.edu**.

Please share your opinions and ideas. Limit your comments to approximately 350 to 400 words. If published, your comments may be edited for length or space requirements.



AWRA SPRING SPECIALTY CONFERENCE ... LOS ANGELES, CALIFORNIA

WATER FOR URBAN AREAS: MANAGING RISKS AND BUILDING RESILIENCY March 30-April 1, 2015 ~ Hilton Los Angeles Airport Hotel ~ Los Angeles, California

This Conference provides an opportunity for water resource professionals to gather for discussions on the unique challenges associated with water resources for large urban areas – recognizing the need to effectively manage the increasing risks to their supplies and facilities and to prudently incorporate long-term resiliency within their systems, allowing for future flexibility to adapt to the impacts of these risks as they unfold.

The AWRA Spring Specialty Conference will meet in Los Angeles, California, at the Hilton Los Angeles Airport Hotel, just a quarter of a mile away from the Los Angeles International Airport (LAX) and featuring a complimentary shuttle service to and from the airport. Los Angeles, the entertainment capital of the world, is the second largest city in the United States (U.S.) with a population approaching four million. Take some time out in the California sun to visit the local beaches, including Manhattan Beach, which is just a mile away, where restaurants, shopping, and unique art galleries are located. Hollywood and the region's numerous cultural, entertainment, and historic venues are within reach during your visit.

A highlight of the conference will be a pre-conference field trip on Sunday, March 29, to the nearby Edward C. Little Water Recycling Facility, owned and operated by the West Basin Municipal Water District and the largest water recycling facility of its kind in the U.S. It is the only treatment facility in the country that produces five different qualities of "designer" or custom-made recycled water that meet the unique needs of West Basin's municipal, commercial, and industrial customers. The facility produces 40 million gallons of water every day, conserving enough drinking water to meet the needs of 80,000 households for a year. West Basin's Water Recycling Facility also houses a 60,000 square foot solar power generating system that has reduced emissions of carbon dioxide by over 356 tons in one year's time. So join us in Los Angeles for Water for Urban Areas! We look forward to creating a terrific conference experience for everyone

Grace Chan, Conference Chair

Metropolitan Water District of Southern California Los Angeles, CA **Don Bentley, Conference Technical Chair** Metropolitan Water District of Southern California Los Angeles, CA



AWRA SUMMER SPECIALTY CONFERENCE ... NEW ORLEANS, LOUISIANA

CLIMATE CHANGE ADAPTATION June 15-17, 2015 ~ Hyatt Regency French Quarter Hotel ~ New Orleans, Louisiana

This conference is about ACTION – how we respond, build resilient systems, and influence decision makers. Much activity during the past year has addressed the scope of climate change nationally and internationally. U.S. federal agencies are developing programs to address the problems on a national scale and provide tools and assistance to states, tribes, and local communities in response to the President's Climate Action Plan issued in June 2013 and the November 2013 Executive Order 13653. States, water, and wastewater authorities, and local and regional governments are evaluating alternatives and implementing action plans. The private sector is developing tools and programs to aid in the analysis and products to build resiliency.

If you are involved in developing a climate action plan for water resources by

- building models and developing future scenarios;
- evaluating precipitation, temperature, and sea level rise impacts on water supply, wastewater treatment, ecological systems, land use changes, and/or forest cover;
- enhancing public understanding;
- developing tools and interactive websites for planners, emergency responders, and local officials; or
- facilitating discussions with decision makers we want to hear from you!

The value of an AWRA specialty conference is that engineers, planners, hydrologists, ecologists, social scientists, economists, and meteorologists come together to discuss complex issues that cannot be solved by any one professional sector. Please visit this website frequently to see updates and plan to join us in New Orleans in June 2015.

C. Mark Dunning, Conference Co-Chair

CDM Smith Fairfax, VA

Carol R. Collier, Conference Co-Chair

The Academy of Natural Sciences of Drexel University Philadelphia, PA

EDITOR'S NOTE ... **Eric J. Fitch** ... With this issue my first year as Editor-in-Chief comes to an end. I hope you, our readers, have gotten value and enjoyment from our efforts and we look forward to a new and, hopefully, enlightening and entertaining set of issues. I would like to take a moment to thank all our contributors this year, for without their efforts there would not be a *Water Resources IMPACT*. I would also like to thank Charlene Young and Dick Engberg whose efforts get us to print each and every issue. Thanks, also to Ken Reid and all of our staff at AWRA for all the great work they do. finally dear readers and fellow AWRA members, I would like to thank you for your loyalty and for giving us incentive to bring to you the best publication we can. Happy Holidays!

HIGHLIGHTS OF JAWRA TECHNICAL PAPERS • OCTOBER 2014 • VOL. 50 • NO. 5

TECHNICAL PAPERS

- **Caruso** analyzes stream characteristics in a mountain watershed in southwestern Colorado and develops a three-level hierarchical classification scheme using national datasets to demonstrate jurisdictional evaluation as "waters of the United States" under U.S. Clean Water Act Section 404 at the watershed scale.
- **Daraio** *et al.*, in two companion papers, use available downscaled climate projections and land use change simulations to estimate the potential effects on average daily stream temperature. They then develop a stochastic hourly stream temperature model to estimate probability of exceeding given threshold temperature to assess potential impacts on freshwater mussels in the upper Tar River, North Carolina.
- **Zegre** *et al.*, present a multiscale evaluation to establish the nature of hydrologic impacts associated with mountain top removal mining.
- **Wolaver** *et al.*, estimate potential economic impacts of environmental flows for five freshwater unionid mussels in three Central Texas basins (Brazos, Colorado, and Guadalupe-San Antonio Rivers) that encompass 36% of Texas.
- Sarlak presents nonparametric approaches to reconstruct streamflow ensembles from tree-ring data in Filyos River region, Turkey.
- **Sood and Smakhtin** show how, globally, desalination with renewable energy can become a viable option to replace domestic and industrial water demand in the 100-km coastal belt by 2050.
- **Kenner** *et al.*, present data showing the atmosphere is a potential consistent source of acetone, benzene, and MTBE to urban streams.
- **Li** et al., develop a recourse-based interval fuzzy programming (RIFP) model for tackling uncertainties in an effluent trading program.
- **Salman** *et al.*, address an ongoing challenge in water governance by examining how profitability at both the farm and basin levels is affected by various water appropriation systems in the Tigris-Euphrates Basin.
- **Dile and Srinivasan** assess the applicability of the National Centers for Environmental Prediction's Climate Forecast System Reanalysis (CFSR) climate data in modeling the hydrology of the Upper Blue Nile basin.

A full Table of Contents may be viewed at http://www.onlinelibrary.wiley.com/doi/10.1111/jawr.2014.50.issue-5/issuetoc

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Solution to Puzzle (pg. 24)





Earn \$5 for each new member you bring to AWRA!

As a member, you know that the strength of AWRA is its diversity. Our multidisciplinary nature is our hallmark.

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What They Get:

- Educational Resources: Conferences and JAWRA and IMPACT, oh my!
- Tools to Do Their Job Better: Webinars, Reports, and Technical Committees.
- The Chance to Make a Difference: Network with the top people in government, academia and the private sector. Those who understand the value of bringing all disciplines to the water resources management table belong to AWRA.

For more information and resources to help you get started, go to the AWRA website and click on the M2M logo!

www.awra.org



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From Our Members:

AWRA is still the best multidisciplinary organization in the world and if your interests in water resources are broad like mine, then AWRA is home. Anything you want to do in a water professional organization, you can do in AWRA.

- Michael Campana, member since 1996

Through AWRA I am able to network with a broad cross section of professionals working to improve water management. Attending the meetings was a great way to keep up with water management and policy issues and multidisciplinary science. Also, the meetings provided a terrific forum for presenting new directions, policies and programs to an audience of managers from all over the country.

- Nancy Lopez, member since 1979



We're all in this together... and joining AWRA is a great way to meet and get to know others in the water resources community.



Participating in AWRA allows you to follow your passion while engaging in the vital conversations surrounding water resources management.



The work you do and the things you accomplish as a member of AWRA will have a huge impact on your career and our profession.

AWRA Information

Founded in 1964, the American Water Resources Association is a nonprofit professional association dedicated to the advancement of men and women in water resources management, research, and education. AWRA's membership is multidisciplinary; its diversity is its hallmark. It is the professional home of a wide variety of water resources experts including engineers, educators, foresters, biologists, ecologists, geographers, managers, regulators, hydrologists and attorneys.

Find us online at: www.awra.org Email us at: info@awra.org





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