Universities Council on Water Resources
Journal of Contemporary Water Research & Education
Issue 163, Pages 1-5, April 2018

Emerging Voices of Tribal Perspectives in Water Resources

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Tribal perspectives in water resources and education are often overlooked. Only recently, the field of hydrologic sciences began to include people in conducting science (Sivapalan et al. 2012) and to value indigenous perspectives with western science (Huntington 2002; Redsteer et al. 2012). The April 2018 issue of *Journal of Contemporary Water Research & Education* (JCWRE) explores emerging voices in tribal communities related to water resources quality and quantity and impacts to tribal water resources such as climate change and water use. This special issue begins with three foundational papers, providing a baseline understanding on water quality regulation, water quality disparities, and tribal economies as they relate to water settlements. The special issue features articles focusing on various water challenges facing tribes and the role of tribal colleges in addressing these challenges. There are less than 0.3% of Native American graduate students and post-doctorates in Science and Engineering and only a handful in hydrologic sciences and related sciences (NCSES 2016). While tribal lands are rich in natural resources and have significant water challenges (Cozetto et al. 2007; Smith and Frehner 2010), it is very unique that 67% of the lead authors are Native American including three Native American faculty, three Native American graduate students, and one Tribal College and University (TCU) Faculty. A deep discussion on water challenges facing tribes and Native American scientists working on these challenges are emerging voices of tribal perspectives in water resources.

This special April 2018 issue rose out of my initial discussions with conference organizers at the 2015 Universities Council on Water Resources Annual Conference in Henderson, NV, increasing the voice and presence of tribal perspectives in water resources. This led to an invitation to me to organize a special session at the 2017 conference in Fort Collins, CO, which I titled "Tribal Perspectives on Water Management Topics and Collaborative Engagement Approaches" (Chief et al. 2017). Two of the speakers from this session, O. Conroy-Ben and R.E. Emanuel, wrote papers based on their presentations that are published in this April 2018 issue. Through these collaborations, I partnered with an all Native American geoscience principal investigator team including O. Conroy-Ben (Arizona State University), R.E. Emanuel (North Carolina State University), R. Torres (University of South Carolina), and S. Pete (Salish Kootenai College). In the fall of 2017, we were awarded a National Science Foundation (NSF) Integrative and Collaborative Education and Research (ICER) Grant entitled "Water in the Native World; A Symposium on Indigenous Water Knowledge and Hydrologic Science" to be held at a tribal college, Salish Kootenai College, in Pablo, MT in August 2018. The purpose of this symposium is to: 1) define research and education priorities in the hydrologic sciences that are relevant to indigenous peoples in a rapidly changing world; 2) create a network of indigenous hydrologists and traditional knowledge holders of water; and 3) identify educational needs and tools to support indigenous perspectives in hydrology. This JCWRE April 2018 issue on "Emerging Voices of Tribal Perspectives in Water Resources" is a building block towards these NSF ICER objectives.

There are 567 federally recognized tribes in the United States and 62 tribes who are state recognized; additionally, there are many tribes who are not state or federally recognized, but may be seeking federal recognition (Koenig 2007; Department of the Interior 2018). Tribes are diverse in their culture, language, land base, and government. Tribes are situated in urban and rural areas, in various geographic and ecological regions, and range from small to large in population (Cozetto et al. 2013). In stark contrast to the 99% of Americans who have access to clean water, 12% of Native Americans in the U.S. do not have access to clean water (Cozetto et al. 2013). On the Navajo Nation, 25-40% of households haul water. Hauling water creates increased susceptibility to waterborne diseases. In addition, tribes have 10% of the U.S. energy reserves and contribute billions of dollars to the national energy economy, but are only 1% of the U.S. population, making them vulnerable to impacts of mining on their people and environment (Smith and Frehner 2010). Furthermore, federally recognized tribes have a nation-to-nation relationship with the U.S. federal government and their sovereign status means tribes have federal reserved water rights, which are often not quantified due to legal and political challenges in defining water rights. Federally recognized tribes are also eligible to determine tribal water quality standards through the Clean Water Act (CWA) under Treatment as a State (TAS) provisions. Their uniqueness guides the way in which water and natural resources are managed and how they view the environment. Their similarities as sovereign nations provide similar legal rights, protections, and challenges.

The first article by Diver provides a foundation for understanding water quality regulation on tribal lands and explains the history and challenges facing tribes in environmental self-determination. Diver examines the way tribes exercise their tribal sovereignty and self-determination to develop their own tribal water quality standards and TAS programs under the CWA Amendments of 1987. Diver delves in deeper to examine the political and legal impacts of tribal water quality standards and begins to examine the environmental and social impacts. This article provides insight as to why so few tribes have tribal water quality standards – only 16% (54) of tribes, out of about 330 eligible tribes, have established TAS status to administer a Section 303 water quality standards program. Recent TAS revisions enable greater tribal water regulation authority over the entire tribal reservation despite landowner status. Working through the federal permitting process, tribes can use their own water quality standards to influence off-reservation water use. Diver asks if tribes can leverage the federal environmental regulatory framework while creating their own regulatory frameworks under tribal law.

A complementary article to Diver is written by Conroy-Ben and Richard who investigate the evident disparities in drinking water quality for tribal communities. These include maximum level contaminant level violations, reporting and monitoring, and public notice. Using public data from the Environmental Protection Agency's Enforcement and Compliance History Online (ECHO) for 2014-2017, violations were compared between tribal and non-tribal areas of the same state. Conroy-Ben and Richard found that tribal facilities had violation points six times the national average, and in certain states, these violations affected a larger percentage of tribal population than non-tribal populations. This article highlights the need to improve infrastructure and water quality regulation in tribal communities.

The third article by Deol and Colby focuses on tribal economies in the western United States and explores patterns in water rights, agriculture, gaming, and economies. The paper summarizes and compares critical information for selected tribal nations which have and have not quantified tribal water rights. Nine variables were examined to investigate patterns across tribal nations, including: 1) Value of Agricultural Products Sold, 2) Unemployment, 3) Income, 4) Education, 5) Population, 6) Proximity to Major City, 7) Casino, 8) Water Rights, and 9) Year. Southwestern tribes have the lowest revenue from agricultural products. Northwestern tribes have higher rates of water quantification followed by Southwestern tribes. Midwestern tribes have the highest casino operations. Deol and Colby find a significant difference between tribes with quantified water rights and tribes without water rights in terms of having higher agriculture revenue, higher

population, a closer proximity to larger cities, lower education, and lower income. Tribal nations in this study that operate casinos had lower rates of water quantification. Development of tribal economies involves diverse types of enterprises, understanding regional differences, and building upon the strengths of each sovereign nation. While settling tribal water rights can contribute to tribal economies, a deeper look at causal relationships between gaming, agriculture, water rights, and tribal economic indicators is warranted. This will require in-depth location-specific research.

Climate change will impact tribal communities and tribal waters in unique ways due to the deep connections between indigenous people and the environment, as well as the strong land-based values and subsistence activities practiced by many indigenous peoples (Cozetto et al. 2013). Tribal College and Universities (TCUs) are centers of higher learning in tribal communities and offer a platform on which climate change adaptation in tribal communities can be addressed through education, research, and outreach. The fourth article, Fillmore et al., surveyed TCUs in 2016 to assess the priorities of TCUs in climate adaptation teaching, research, and outreach. Survey results represent 68% of the TCUs including administrators, outreach educators, staff, faculty instructors, and students. The interviews were grouped according to United States Geological Survey (USGS) Hydrology Unit Code (HUC) and were also grouped based on similar climate and ecological units and aridity units based on precipitation. Top concerns include food-sovereignty programs and climate change impacts on tribal water resources. Although TCUs have great potential to promote and implement climate adaptation, lack of funding limits TCUs from fully exploring these opportunities. Literature gaps exist on topics of climate change impacts and adaptation on tribal lands, particularly when focusing on specific ways in which to enhance tribal capacity for adaptation. Fillmore et al. fill a literature gap, particularly with regards to climate change and TCUs, and provide direction on where TCUs can be supported to improve teaching, research, outreach, and professional development to forward climate adaptation on tribal lands.

Another major contribution to the knowledge base of tribal climate adaptation is the fifth paper by Emanuel. This article outlines climate change issues and impacts on the Lumbee Tribe of North Carolina. Currently, there is a significant literature gap on climate change impacts on tribes along the Atlantic Coastal Plain who are often considered to be in water rich environments. Like many Native American communities, climate change impacts extend into the traditional and cultural livelihoods of the Lumbee Tribe. Emanuel highlights the challenges experienced by a state recognized tribe, as opposed to the experiences of federally recognized tribes that are covered by preceding papers. For the Lumbee Tribe, climate change impacts to wetland and aquatic ecosystems also pose risks to cultural loss. As a state recognized tribe, many of the statutory protections, which Diver, and Deol and Colby discuss in this journal issue, are not applicable to the Lumbee Tribe. However, like many federally recognized tribes, cultural and traditional impacts are real risks for the Lumbee Tribe.

The sixth article by Kozich et al. complements Emanuel and focuses on Anishinaabe perspectives on water resources and conservation in the water-rich region of the Great Lakes. Interviews revealed multiple insights: water was important, water quality was of higher concern than water quality, and Native American perspectives were unique from non-Native perspectives. Similar to the importance of the cultural values of water that Diver and Emanuel discuss, Kozich et al. finds a reoccurring theme of cultural and spiritual values of Anishinaabe interviewees with water. The overall importance of water quality to the Anishinaabe people complements the papers by Diver, and Conroy-Ben and Richard.

The final two papers of this special issue by Tulley-Cordova et al. and Tsinnajinnie et al. focus on quantifying precipitation and snowpack variability on the Navajo Nation. These papers are unique because both papers involved close partnership with the Navajo Nation Department of Water Resources to leverage existing hydrologic data and collect additional samples to answer important research questions. Both papers involved large and comprehensive hydrologic data sets on the Navajo Nation where data had not be scientifically analyzed or interpreted. Tulley-Cordova et al. characterized hydroclimatic changes on the Navajo

Nation using data from 90 sites from 2002 to 2015 to identify regional precipitation patterns using quantitative cluster analysis. They correlated the cluster groups with climatic modes and variables to identify how regional precipitation relates to larger climatic patterns. Tsinnajinnie et al. characterized snowpack data for the period 1985-2014 using nine Navajo Nation snow survey stations and identified snowpack patterns, variability, and trends. This characterization provided a basis to evaluate the efficacy of snowpack data collection efforts to focus on important data points and reduce redundancy to save tribal managers' time and money. Given climate change impacts on water resources on tribal lands, the importance of monitoring and characterizing water resources is critical for the Navajo Nation. These two papers are excellent examples of partnerships with tribal water resources managers who are working to collect data, conduct research, and manage water resources for a tribe where 25-40% of households haul water (NDWR 2003; ITFAS 2008), but where tribal members are deeply connected to water and rely heavily on water for spiritual, cultural, and livelihood purposes.

In conclusion, this JCWRE April 2018 issue on emerging tribal voices in water resources brings together foundational papers with tribal college priorities and tribal case examples from the Great Lakes Region to the Atlantic Coast to the Southwest. The breadth and depth of this issue provides a foundational understanding of water quality governance, water quality disparities, and tribal economies with examples of socio-hydrological, climatic, and hydrologic research. Successful hydrologic research in tribal communities requires respectful engagement that involves an equal partnership with the tribe; oversight by the tribe; research plans that respect indigenous cultural contexts, histories of interactions with settler governments and researchers; and considers socio-economic and political context (Chief et al. 2016). Furthermore, when researchers are from the tribal communities, there is greater understanding of cultural context, a foundation where trust can be built, and commitment to give back to their communities. With a very small percentage of Native Americans in the sciences, much less in the hydrologic sciences, I am pleased that 67% of the lead authors are Native American, three are Native American professors, and three are Native American graduate students working in their tribal communities. This April 2018 issue is also pleased to highlight research priorities for Tribal Colleges and Universities, and to have one author who is a TCU professor, which demonstrates a move toward TCUs engaging in research activities that can be incorporated back into the education of tribal college students. There is still a lot of work needed to fill the literature gap of tribal voices in the hydrologic sciences; with more respectful partnerships with tribes and tribal researchers leading these efforts, this gap will begin to fill.

Acknowledgments

This work was supported by the National Science Foundation Award Number ICER 1747709 "Water in the Native World; A Symposium on Indigenous Water Knowledge and Hydrologic Science"; and USDA National Institute of Food and Agriculture, Water for Agriculture Challenge Area Award Number 2015-69007-23190 "Enhancing climate resiliency and agriculture on American Indian Land."

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