

Water Justice Concerns in the Colorado River Basin

Bonnie Colby and Zoey Reed-Spitzer

JEL Classifications: Q25, Q28, Q54

Keywords: Climate change, Hispanic communities, Tribal nations, Water justice

The Colorado River Basin (CRB) and areas served by its waters, includes dozens of indigenous nations and numerous communities and water user organizations rooted in Hispanic culture. Tribal nations and Hispanic communities encounter challenges with access to clean and reliable water and have been marginalized in historic and ongoing water negotiations and policy dialogue. The CRB is experiencing devastating effects linked to a warming planet, including wildfires, extended drought, severe flooding, drying soil, and changing vegetation (Overpeck and Udall, 2020, Payton and Lukas, 2021). This article describes several key water justice issues in the CRB linked to indigenous and Hispanic communities. The concluding sections explore the contributions of tribal nations and Hispanic acequias in creating resilient responses to the basin's water challenges and suggest themes for further research.

The CRB (in this article, we include both the geographic basin and areas receiving imports of CRB water) supports a population of over 40 million, with over 5 million acres of irrigated cropland. The region is home to 30 indigenous tribal nations and to one-third of the entire U.S. Hispanic population (13 million Hispanics) (U.S. Environmental Protection Agency, 2022; U.S. Census Bureau, 2024). The indigenous population residing in CRB is about 2% of the total population. Hispanic nonwhite individuals account for 37% of the population (Reed-Spitzer and Colby, 2024).

Water justice is a term used worldwide to focus attention on the disproportionate effect of disruptions in regional water supplies on low-income and minority communities, communities already more vulnerable due to existing socio-political and economic inequities (Sultana, 2018). The U.S. federal government has committed to water justice through its environmental justice initiatives. In federal policies, environmental justice is characterized as "fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (U.S. Environmental Protection

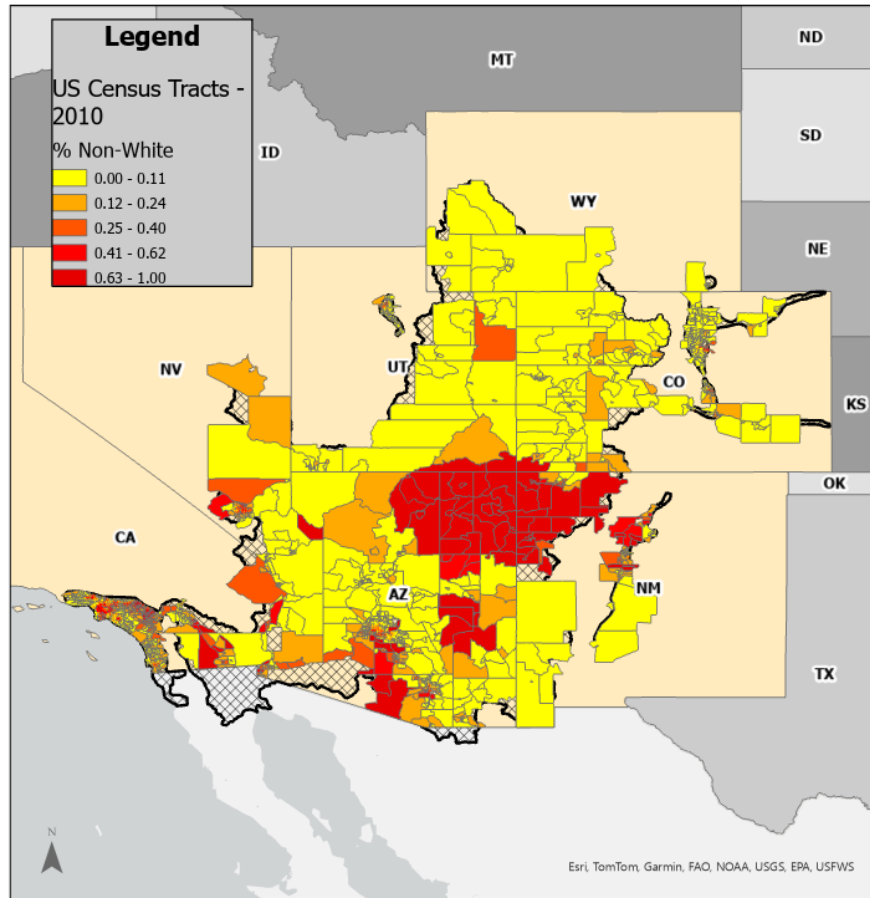
Agency, 2023). Many empirical studies demonstrate that in the United States, low-income households and people of color have greater exposure to environmental hazards (Banzhaf, Ma, and Timmins, 2019; Chakraborty et al., 2022; Balazs, Morello, and Ray, 2012; Cory and Rahman, 2009; Morata et al., 2022). The 2021 U.S. Justice 40 Initiative establishes a federal policy objective of directing 40% of benefits from federal investments to marginalized or underserved communities, emphasizing water supply, water quality, and wastewater treatment as key components (The White House, n.d.). The Climate and Economic Justice Screening Tool was developed to assist in the implementation of the Justice 40 Initiative (U.S. Environmental Protection Agency, 2022).

This article discusses three aspects of water justice related to Indigenous and Hispanic populations in the CRB: (1) household access to affordable and reliable water, (2) participation and representation in water negotiations and policy processes, and (3) impacts of CRB water policies on low-income and minority communities (including economic, environmental, cultural and resilience impacts). This latter water justice factor encompasses access to resources that support resilience in a changing climate, including public investments in water infrastructure (DataKind, 2023, U.S. Water Alliance, 2023).

The shading in Figure 1 indicates the nonwhite proportion of population (Native American plus black plus nonwhite Hispanic populations, as self-identified in the U.S. Census) in overall population of census tracts in the CRB. (The census tracts in Figure 1 include the geographic CRB as well as areas served by Colorado River water exported from the CRB.)

Table 1 summarizes data on income and education level, stratified by percentage of nonwhites in the census tract population (using the same strata illustrated by shading Figure 1). Note that mean income in the tracts with the smallest percent nonwhite (0%–11%) is about double that of the census tracts with greater than 63% nonwhite. Compared to census tracts with the smallest

Figure 1. Percentage Nonwhite Population in 2019 by U.S. Census Tract



Source: Created by authors based on data from the U.S. Environmental Protection Agency (2022).

percentages of nonwhite residents, the proportion of households with adults having no high school degree is 10 times higher in census tracts with a nonwhite population of higher than 63%.

Table 2 uses the same stratification by percentage of nonwhite population illustrated in Figure 1 to highlight two examples of differential exposure to environmental hazards in the CRB, drawing upon data in the Climate and Economic Justice Screening Tool (U.S. Environmental Protection Agency, 2022). PM 2.5 are fine inhalable particulates posing a significant health threat. Leaking underground storage tanks pose a threat to water quality as toxic materials leak into nearby soils and pollute water. As Table 2 indicates, the prevalence of PM 2.5 and leaking underground storage tanks is notably higher in census tracts with higher proportions of nonwhite populations.

Tribal Nations and Hispanic Acequia Communities in CRB

This article focuses on several water justice issues pertaining to two distinct groups in the CRB: tribal nations and Hispanic acequia communities. While these

two minority groups face some challenges in common, they are distinct in many important ways. These groups represent only a subset of populations affected by water justice concerns, and the water justice issues raised are discussed only briefly given the overview nature of the article.

Many tribal reservations and acequia communities are located in rural areas of the CRB, and rural areas face water access issues that differ from major cities. Low-income rural areas in the CRB are characterized by limitations on water supply reliability. Accessing safe, reliable water is a challenge for many rural areas of the CRB. Many small, rural communities lack adequate economic base to support modern water and wastewater services for sparse populations spread out over large areas (U.S. Water Alliance, 2023). Rural areas of the CRB tend to have lower per capita income than urban areas, and many rural census tracts contain high proportions of Native American and Hispanic residents.

The effects of climate change on precipitation, temperature, and water supply reliability are being disproportionately experienced in low-income rural areas, as changing regional hydrology and climate exacerbate long-term disparities and water justice

Table 1. Income and Education by Percentage Nonwhite in Census Tract

% non-white in census tract	Income			no HS degree		
	mean	median	stnd dev.	mean	median	stnd dev.
0 - 0.11	\$135,236.68	\$125,034.00	\$71,349.76	3.1	2.0	3.6
0.12 - 0.24	\$114,066.39	\$107,999.50	\$44,453.31	5.3	4.0	4.3
0.25 - 0.40	\$91,588.22	\$89,223.50	\$29,981.90	9.1	8.0	5.9
0.41 - 0.62	\$77,806.73	\$75,515.00	\$24,468.28	15.8	15.0	7.7
0.63 - 1.00	\$62,997.70	\$60,988.00	\$18,593.21	32.1	31.0	12.5

Source: Data from the U.S. Environmental Protection Agency (2022)

concerns. Historic lack of investment in water-related infrastructure serving low-income and minority populations places these communities at a significant disadvantage. Generally, tribal nations located away from major cities have not benefited from public investment in water storage and delivery infrastructure. Substantial research documents inequitable access to safe drinking water in low-income rural Hispanic communities within the CRB (Balazs, Morello, and Ray, 2012; Pannu et al., 2018; London et al., 2021; Mueller and Gasteyer, 2021; Acquah and Allaire, 2023). Native American and Hispanic communities each experience disproportionate poverty and marginalization in water decision-making and negotiations. They also each face distinct challenges related to water rights. Tribal nations and some Hispanic communities possess senior water entitlements that make them the target of efforts to acquire access to their water through litigation,

political maneuvering and market transactions. There also are important distinctions between the two groups in terms of water entitlements and water justice challenges, noted below.

Tribal Nations

Tribal nations are sovereign governments, enacting their own regulations over reservation water use and water quality. Tribal nations' entitlements to water resources were recognized by the U.S. Supreme Court in 1908 (*Winters v. U.S.*), though the process of quantifying those rights and putting them to use for the benefit of tribal communities has been slow and costly. Many CRB native nations have quantified senior water rights, which are more reliable than junior rights held by non-Indian farms, industries, and cities. This superior reliability puts tribes in a unique position in a region struggling with the effects of climate change on water supply and demand.

Table 2. PM 2.5 and Leaking Underground Storage Tanks (UST) by Percentage Nonwhite in Census Tract

Percentage nonwhite in census tract	PM 2.5			Leaking UST		
	mean	median	stnd dev.	mean	median	stnd dev.
0–0.11	8.29	7.82	2.18	1.71	0.79	2.62
0.12–0.24	8.90	8.47	2.37	2.61	1.63	3.24
0.25–0.40	9.18	8.69	2.56	3.25	2.20	3.70
0.41–0.62	9.62	9.34	2.54	3.72	2.71	3.84
0.63–1.00	10.79	12.06	2.66	4.80	3.49	4.73

Source: Based on data from the U.S. Environmental Protection Agency (2022).

Since tribal water rights are senior in priority, recognition and development of tribal rights threatens the reliability of supplies for other water users. This threat provides the impetus for negotiating tribal water settlements, legally binding agreements negotiated among tribal nations, federal agencies, states, water districts, and other water users. These agreements aim to reduce conflict by specifying water allocations and providing assured water supplies and are now an important component of water institutions in the CRB (Deol and Colby, 2018). Over four dozen tribal water rights settlements have occurred in the western United States, with Arizona and New Mexico settlements accounting for a large share of these. Each of the other five CRB states has a few tribal water settlements and/or tribal water entitlements formalized through litigation and court decrees (U.S. Department of the Interior, 2023).

Settlements provide many potential benefits (Colby and Reed-Spitzer, 2024). They can address inadequate access to water for tribal communities and often fund water infrastructure to serve tribal farms and communities and to address broader regional water challenges. Some settlements include provisions that expedite environmental restoration, contributing to cultural and recreational values.

Water settlements are costly in both water and financial commitments. The U.S. government—along with states, cities and other water users—incur notable financial obligations. Commitments of water can be large. The quantities of water for tribes in settlements vary across the CRB. The Gila River Indian Community settlement affirmed a water supply of 650,000 acre-feet per year for the tribal nation, a mix of local surface water and Central Arizona Project water (Lewis, 2005). Some settlements involve only a few thousand acre-feet per year for tribes but provide key economic development components. Examples include agreements made with the Yavapai Prescott Tribe in Arizona and the Shivwits Band of Paiute Indian Tribe in Utah (Colby and Young, 2018). Some settlements and court rulings restrict nontribal water groundwater users located near a reservation to protect groundwater underneath tribal lands (Colby and Young, 2018).

The role of Native American tribal nations in the CRB continues to evolve. A number of tribes serve as negotiators and co-implementers of agreements that address regional water challenges while also quantifying tribal water rights (Deol and Colby, 2018, Young, Colby and Thompson, 2018, Ten Tribes Partnership, 2023). Four states and six tribal nations are engaging in their first formal talks to establish a process for jointly negotiating Colorado River water issues. Each of the six tribes hold established senior water rights in the CRB, formalized through negotiated settlements and/or court decrees (Smith, 2022)

Acequia Water Users

Spanish colonists arrived in the CRB in the 1500s, bringing the Acequia irrigation system governance to parts of New Mexico, Colorado, and Arizona. Acequias continues to manage and deliver water in portions of the CRB (Brown and Ingram, 1987; Wescoat, Headington, and Theobald, 2007). The term acequia refers both to the physical water delivery system and to the governance of that system. While Hispanic communities are prominent in the CRB in many ways beyond acequias, the acequia focus was selected as particularly relevant for Hispanic water justice challenges. Acequia associations are still active in some portions of the CRB. The acequia systems operating in parts of New Mexico and Colorado involve farms that are smaller in size and that rely more heavily on off-farm income, compared to other farms in the region (Tory, 2021, Hicks and Pena, 2003). Most are located in areas remote from cities.

The acequias trace their water use back many centuries; water rights within acequias typically are held by landowner members of the acequia and are integrated into state water rights systems (Raheem et al., 2015, Rosenberg et al., 2020). This differs notably from tribal nations, whose water entitlements were recognized by the U.S. Supreme Court early but have required protracted and costly litigation and negotiations to become formalized water rights available for use on reservations.

Water Justice and Senior Tribal and Acequia Water Rights

Tribal nations and members of acequia associations often hold senior water rights, superior in reliability during times of shortage. While senior entitlements are an important asset and source of bargaining power, the question has arisen: What constitutes a voluntary transaction when the parties have highly disparate access to capital, political power and legal, economic, hydrologic, and other expertise? The United Nations developed guidelines related to this question, scrutinizing the role of coercion in natural resource transactions (United Nations, 2007). United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) principles are applied later in this article to tribal nations and Hispanic community engagement in water transactions to lease or sell their water. One key advantage of water markets is voluntary participation by those offering water for sale or lease. A water justice perspective invites more nuanced consideration of what constitutes a “voluntary transaction.”

Water Justice, CRB Tribal Nations, and Hispanic Acequia Communities

This section discusses three components of water justice, as applied to two different minority population in the CRB: tribal nations and acequias communities. A disclaimer at the outset: This article refers to tribal

nations generically given the brief length of this piece. However, tribal nations in the CRB differ from one another in culture, language, ways of livelihood, current status of water entitlements, and perspectives on water justice. Some tribal nations have senior water entitlements quantified decades ago in key court decisions and reliable water supplies for on-reservation use and for leasing. Other tribal nations are still struggling for formalization and implementation of water rights.

Access to Affordable and Reliable Water

Tribal Nations. While affordable and reliable water is a foundational component of water justice, basic potable indoor water is absent for many Native American households in the CRB. Native American households in the United States are 19 times more likely to lack indoor plumbing than white households. In CRB census tracts that include Native American reservations, complete indoor plumbing is available to 96% of households. Contrast this with 99.5% of all CRB households having complete indoor plumbing. (U.S. Census Bureau, 2024). In some tribal reservation areas of the CRB, a significant proportion of tribal households lack potable water and must rely on hauled water (Conroy-Ben and Richard, 2018; Teodoro, Heider, and Spitzer, 2018, Deitz and Meehan, 2019).

Hispanic Communities. Safe drinking water access is a concern in many Hispanic communities. There exists a strong correlation between higher proportion of Hispanic residents and higher exposure to contaminants in drinking water and higher lack of access to indoor plumbing (Acquah and Allaire, 2023; Balazs, Morello, and Ray, 2012; London et al., 2021; Mueller and Gasteyer, 2021; Pannu et al., 2018). Regarding reliability, water rights of acequia members generally are senior in their region and integrated into their state's water right management. Consequently, these rights tend to provide a reliable water entitlement even during drought.

Representation in Water Negotiations and Policy Processes

Tribal Nations. There has been progress in recent decades in tribal representation in CRB water decision-making, stimulated by severe drought and recognition that senior tribal water entitlements can help ameliorate losses in supply reliability for cities and commercial agriculture. Twenty CRB tribes formulated a joint statement of tribal consensus articulating what the Basin Tribes expect from the United States in ongoing federal-state-tribal negotiations to identify new operating guidelines for the CRB (Water and Tribes Initiative, 2024). Among other provisions, these include ensuring that tribes can use their water rights in CRB conservation programs, leasing water off reservations for multiple purposes and creating compensated forbearance agreements. The document also calls for a

permanent, formalized structure for tribal participation all Colorado River policy and governance and federal consultation with tribal governments on a basis comparable to state governments (Water and Tribes Initiative, 2024).

Specific CRB tribal nations that hold formalized senior entitlements have been playing a prominent role in CRB water negotiations (Colby and Young, 2018; Young, Colby and Thompson, 2018). For the nearly two dozen completed and ongoing tribal water settlement negotiations in the CRB, tribal signatories are central not only in crafting settlement provisions but in the multiyear settlement implementation process. In 2024, tribes with senior rights in the Upper CRB are meeting with states and other water users to craft Upper Basin responses to ongoing basin-wide negotiations (Smith, 2022).

Tribal nations are lead participants in negotiations involving sales or leases of tribal water. There are many long-term leases (up to 99 years) of tribal water in the basin, often negotiated in the course of a water settlement (Colby and Young, 2018). UNDRIP issues related to coercion continue to be relevant to water transactions involving tribes, given poverty and limited access to other revenue sources beyond water leasing. However, tribes with quantified senior rights now have strong bargaining power in this water-scarce era (Water and Tribes Initiative, 2019).

Hispanic Acequia Communities. While acequias are communally managed ditch systems, the water rights are held by individual acequia members as state water rights and their seniority typically predates statehood. Acequia associations represent groups of acequias in policy dialogue in New Mexico and southern Colorado (HECHO, 2023, Hicks and Pena, 2003). The individual ownership of rights leads to concern over the erosion of acequia associations when valuable senior rights are acquired by outside interests and water is transferred away for use elsewhere (Raheem et al., 2015, Hicks and Pena, 2003). The challenge with acequia associations and individual members selling off water rights differs markedly from the challenge that Indigenous nations face in barriers to leasing or selling water entitlements held by the tribal nation. The UNDRIP guidelines to address potential coercion in natural resource transactions are relevant to both tribal water and acequia water, due to financial, technical, and political power imbalances among the negotiating parties.

Impacts on Community Resilience

The third component of water justice discussed in this article is resilience in the face of climate change effects on water, a key concern for tribal nations and for acequia water users. These groups historically have not been primary beneficiaries of public infrastructure projects that can boost resilience in the face of shifting supplies. Today, however, some USDA programs allocate funds specifically for Native American and Hispanic farmers,

and other federal programs provide funding targeted for Native American and Hispanic communities (U.S. Environmental Protection Agency, 2023). Newly strengthened federal environmental justice initiatives may provide another source of funding (USDA Office of Tribal Relations, 2022, U.S. Environmental Protection Agency, 2023).

Tribal Nations. Tribal nations are negatively impacted by slow recognition of their water rights and lack of inclusion in basin decision processes (Sanchez, Leonard, and Edwards, 2023). The 2023 U.S. Supreme Court decision involving federal trust obligations for Navajo Nation water is another in decades of examples of failure to consider the impacts on tribal communities of key water policy decisions (Fletcher, 2023).

Tribal nations have historically experienced much lower access to resources for resilience in a changing climate. The benefits of decades of investments in water infrastructure largely have been directed to major cities and largescale commercial agriculture, with little emphasis on tribal nations. This lack of modern infrastructure results in tribal communities being disproportionately exposed to variability in water supplies (DataKind, 2023). The CRB tribal nations that have negotiated water settlements typically have received resources that improve their water supply reliability, along with funding for other tribal water needs and economic development (U.S. Department of the Interior, 2023).

Hispanic Acequia Communities. CRB water policies affect rural Hispanic communities through economic, environmental, and cultural impacts. The ability of acequias to demand mitigation of negative impacts rests upon legal tools they can draw upon (such as the Endangered Species Act or Clean Water Act), media attention, and cultivation of more powerful allies (Raheem et al., 2015, Hicks and Pena, 2003). Over time, recent U.S. social justice policies and commitments to expend federal monies to address water needs of disadvantaged populations may prove to be useful to rural Hispanic communities (U.S. Environmental Protection Agency, 2023).

Tribal and Acequia Contributions to Regional Resilience in CRB

This section of the article highlights ways in which tribal and acequia water management practices and policies contribute to resilience in the CRB. These contributions bolster the case for addressing water justice concerns to support diverse approaches to meeting the challenges of a changing climate and regional hydrology. Minority water user communities with different approaches to addressing shortages can provide an institutional diversity valuable for informing ongoing evolution in larger CRB policy processes and responses to the challenges facing the region.

Recent research highlights New Mexico acequia contribution to improved seasonal water flow, even though acequia farms account for a small portion of the state's irrigated cropland. Acequia ditch systems, often unlined, divert water from rivers and spread it across irrigated lands. This provides broad spatial distribution of groundwater recharge and alters the seasonality of return flows to streams in ways favorable to downstream cities, farms, and riparian ecosystems (Rosenberg et al., 2020, Gunda, Turner, and Tidwell, 2018). These hydrologic functions provided by acequias are important to regional water resilience during long-term drought. (Rosenberg et al., 2020, Gunda, Turner, and Tidwell, 2018).

Acequias differ from Western state approaches to cutting back water users during times of shortage. All acequia members are cut back proportionally relative to their individual baseline entitlements. This differs from the "first in time, first in right" approach common among the seven CRB states, in which junior water users are completely curtailed before senior right holders are cut back (Raheem et al., 2015). Equal proportional sharing of shortage is thought by some observers to facilitate a more co-operative approach to addressing shortages and may provide an informative contrast in creating new paradigms for the CRB (Gunda, Turner, and Tidwell, 2018, Kummu et al., 2016).

Tribal water settlements in the CRB contain resilience features valuable to both tribal and non-Indian water users and communities (Young, Colby and Thompson, 2018). Many settlements provide for trading of public project water, surface water, groundwater, and treated effluent between tribal nations and non-Indian water users. Several Phoenix-area cities lease tribal Central Arizona Project water for 99 years. Some Arizona settlements restrict pumping water from wells located near the tribal reservation by nontribal farms and towns to protect groundwater underlying tribal lands. These buffer zones benefit not only groundwater users but also streams and wetlands that rely on maintaining the groundwater table.

Tribal nations have provided innovations later adopted more widely in the CRB. The Navajo Indian Irrigation Project agreements, negotiated in the 1960s, provided a new approach for sharing shortages affecting New Mexico's San Juan-Chama Project and the Navajo Indian Irrigation Project. The 2004 Arizona Water Settlements Act created an innovative water banking system to store millions of acre-feet in aquifers underlying the Gila River Indian Community and contributed to broader regional acceptance and use of groundwater banking (Gila River Water Storage, 2013, Woods, 2017),

In settling litigation, the Quechan Tribe and Metropolitan Water District (MWD) of Southern California agreed in

2005 to a Forbearance Agreement under which the tribe limits the use of its water entitlement in return for MWD payments (Morisset, 2015). This allows the tribe to earn lease revenues without the expense of building storage and conveyance facilities to withhold their water. Tribes face obstacles to leasing their water given lack of incentive for other water users to pay tribes for tribal water already being used without payment. The Quechan Tribe-MWD agreement indicates that motivated parties can find a way, although forbearance agreements are still rare.

Tribes play an ongoing role in the Colorado River Basin System Conservation Program, initiated in 2014 by the Bureau of Reclamation and major municipal water interests to address shortage. Funding for “system conservation” supply reliability projects comes from multiple federal, municipal, and foundation sources. “System water” is stored in Lake Mead to avert shortage declarations and their cascading negative consequences. Several tribes with reservation lands located in Arizona contribute “system water” in return for payment (American Indian Policy Institute, 2019).

To summarize, acequias’ water management practices and innovations in tribal water settlements add to the resilience of the CRB in diverse ways. These include various forms of water leasing, shortage sharing, aquifer banking, dispute resolution approaches, and new types of groundwater pumping restrictions to protect both the environment and other water users. Focusing on water justice for minority water user communities enhances overall CRB resilience by supporting the diverse communities that contribute innovative approaches to shortage sharing and other forms of resilience.

Summary and Avenues for Future Research

This article has focused upon several water justice issues related to CRB tribal nations and acequias. Tribal nations have distinct legal status as sovereign governments, with a legacy of court rulings supporting senior water entitlements that bolster tribal bargaining power in regional negotiations. However, for many CRB tribes, impediments remain for tribal participation in water transactions and shortage sharing arrangements. Members of acequias possess senior rights predating statehood, rights that typically are integrated into state water right systems and can readily be sold or leased. However, sales of water by individual members can weaken the collective strength of the acequia.

Important differences exist between tribal nations and acequias in terms of water entitlements, access to reliable water, representation in policy-making, and consideration of community resilience. Both groups have historically been marginalized, but some improvements have been noted in recent decades, with many water justice issues remaining to be fully addressed.

Water justice is a promising arena for future research. The Climate and Economic Justice Screening Tool used in this article is an example of the types of data becoming available at finer spatial scales to identify disproportionate exposure to hazards (flooding, water contamination) and disproportionate access to amenities (parks and natural green space). The tool was developed to assist in the implementation of the U.S. Justice 40 Initiative (U.S. Environmental Protection Agency, 2022).

Over the next few years, further data will become available to analyze spatial specificity in water justice concerns and impacts on rural indigenous and Hispanic communities. Researchers also will be able to analyze whether 40% of federal resources indeed have been directed to reduce disparities faced by marginalized communities in the CRB since the adoption of the U.S. Justice 40 Initiative in 2021.

For More Information

- Acquah, S., and M. Allaire. 2023. "Disparities in Drinking Water Quality: Evidence from California." *Water Policy* 25(2): 69.
- Allaire, M., H. Wu, and U. Lall. 2018. "National Trends in Drinking Water Quality Violations." *Proc Natl Acad Sci PNAS* 115(9): 2078–2083.
- American Indian Policy Institute and Kyl Center for Water Policy. 2019. "Arizona's Drought Contingency Plan: A Tribal Perspective", Arizona State University.
- Balazs, C., R. Morello, and A.H. Ray. 2012. "Environmental Justice Implications of Arsenic Contamination in California's San Joaquin Valley: A Cross-Sectional, Cluster-Design Examining Exposure and Compliance in Community Drinking Water Systems." *Environmental Health* 11: 84.
- Balazs, C., R. Morello-Frosch, A. Hubbard, and I. Ray. 2011. "Social Disparities in Nitrate-Contaminated Drinking Water in California's San Joaquin Valley." *Environmental Health Perspectives* 119: 1272–1278.
- Banzhaf, S., L. Ma, and C. Timmins. 2019. "Environmental Justice: The Economics of Race, Place and Pollution." *Journal of Economic Perspectives* 33(1): 185–208.
- . 2019. "Environmental Justice: Establishing Causal Relationships." *Annual Review of Resource Economics* 11(1): 377–398.
- Brown, L., and H. Ingram. 1987. *Water and Poverty in the Southwest*. University of Arizona Press.
- Cahill, N. 2023, November 16. "Tribes Gain Clout as Colorado River Shrinks." *Western Water In-Depth* [blog]. Available online: <https://www.watereducation.org/western-water/tribes-gain-clout-colorado-river-shrinks>
- Chakraborty, J., T. Collins, S. Grineski, and J. Aun. 2022. "Air pollution exposure disparities in US public housing developments." *Scientific Reports* 12(1): 9887.
- Climate Science Alliance. 2021. *Building Authentic Collaborations with Tribal Communities: A Living Reference for Climate Practitioners*. Available online: <https://web.archive.org/web/20221002165813/https://www.climatesciencealliance.org/info/meaningful-engagement> [accessed September 28, 2022].
- Colby, B., and Z. Reed-Spitzer. 2024. "Evaluating Institutional Success: Regional Water Agreements with Tribal Nations." *Journal of Natural Resources Policy Research* (in press).
- Colby, B., and R. Young. 2018. "Case Study: Tribal Water Settlements: Economic Innovations for Addressing Water Conflicts." *Western Economics Forum* 16(1): 38–46.
- Commission on Accelerating Climate Action. *Water Rights in the Colorado River Basin: Honoring Treaty Water Rights under a Changing Climate*. Available online: <https://www.amacad.org/climate/case-study/water-rights-colorado-river-basin> .
- Conroy-Ben, O., and R. Richard. 2018. "Disparities in Water Quality in Indian Country." *Journal of Contemporary Water Research & Education* 163: 31–44.
- Cory, D. and T. Rahman. 2009. "Environmental justice and enforcement of the safe drinking water act: The Arizona arsenic experience." *Ecological Economics* 68(6): 1825-1837.
- Council on Environmental Quality. n.d. *Climate and Economic Justice Screening Tool*. Available online <https://screeningtool.geoplatform.gov>
- Crespo, D., M. Nemati, A. Dinar, Z. Frankel, and N. Halberg. 2023. *Hydro-Economic Analysis of the Colorado River Basin: A Comprehensive Framework for Water Management*. Working Paper 23-02. University of California, Riverside, School of Public Policy.

- DataKind. 2023. *Data Science for Water Justice: Climate Change and Drought in the Colorado River Basin*. Available online: <https://www.datakind.org/wp-content/uploads/2023/09/Water-Justice-Landscape-FINAL-KB-revised.pdf>
- Deitz, S. and K. Meehan. 2019. "Plumbing Poverty: Mapping Hot Spots of Racial and Geographic Inequality in U.S. Household Water Insecurity." *Annals of the American Association of Geographers* 109(4): 1092-1109.
- Deol, S. and Colby, B.G. 2018. *Economies of Tribal Nations: Water Rights, Agriculture and Gaming*. *Journal of Contemporary Water Research and Education* 163 (1): 45-63
- Fletcher, M.L.M. 2023, June 22. "Supreme Court Rules 5-4 against Navajo Nation in Water Rights Dispute." *SCOTUSblog*. Available online: <https://www.scotusblog.com/2023/06/supreme-court-rules-5-4-against-navajo-nation-in-water-rights-dispute/>
- Gunda, T., B.L. Turner and V.C. Tidwell. 2018. "The Influential Role of Sociocultural Feedbacks on Community-Managed Irrigation System Behaviors During Times of Water Stress." *Water Resources Research* 54(4): 2697-2714.
- HECHO (Hispanics Enjoying Camping, Hunting, and the Outdoors). 2023, November 9. "Recommendations for Increasing Hispanic Leadership and Participation in Shaping the Future of Colorado River Basin Resiliency." *Hecho Blog*. Available online: <https://www.hechoonline.org/blog/recommendations-for-increasing-hispanic-leadership-and-participation-in-shaping-the-future-of-colorado-river-basin-resiliency>
- Hicks, G., and D. Peña. 2023. "Community *Acequias* in Colorado's Rio Culebra Watershed: A Customary Commons in the Domain of Prior Appropriation." *University of Colorado Law Review* 74(2): 387–486.
- Kummu, M., J.H.A. Guillaume, H. de Moel, S. Eisner, M. Florke, M. Porkka, S. Siebert, T.I.E. Veldkamp, and P.J. Ward. 2016. "The World's Road to Water Scarcity: Shortage and Stress in the 20th Century and Pathways Towards Sustainability." *Nature Scientific Reports* 6: 38495.
- Lewis, R. 2005. "Gila River Indian Community Water Settlement." Slides presented at Hard Times on the Colorado River: Drought Growth and the Future of the Compact summer conference, June 8–10. Available online: <https://scholar.law.colorado.edu/hard-times-on-colorado-river/6/>.
- Lewis, S. 2013. Gila River Water Storage, LLC, Water Resources Research Center Seminar, University of Arizona, 2013
- London, J.K., A.L. Fencl, S. Watterson, Y. Choueiri, P. Seaton, J. Jarin, M. Dawson, A. Aranda, A. King, P. Nguyen, C. Pannu, L. Firestone, and C. Bailey. 2021. "Disadvantaged Unincorporated Communities and the Struggle for Water Justice in California." *Water Alternatives* 14: 520–545.
- Martinez-Morata, I., B. Bostick, O. Conroy-Ben, D. Duncan, M. Jones, M. Spaur, K. Patterson, S. Prins, A. Navas-Acien, and A. Nigra. 2022. "Nationwide geospatial analysis of county racial and ethnic composition and public drinking water arsenic and uranium." *Nature Communications* 13(1): 7461.
- Morisset, Mason. Legal Colloquium: Tribal Water Transfers Forbearance Agreements. CRWUA CONFERENCE Las Vegas, NV December 16, 2015
- Mueller, J.T., and S. Gasteyer. 2021. "The Widespread and Unjust Drinking Water and Clean Water Crisis in the United States." *Nature Communications* 12: 3544.
- Overpeck, J. and B. Udall, Climate change and the aridification of North America, *Proceedings of the National Academy of Sciences* (PNAS) 117 (22) 11856-11858
- Pannu, C., P. Seaton, L. Firestone, M. Dawson, and P. Nguyen. 2018. *The Struggle for Water Justice in California's San Joaquin Valley: A Focus on Disadvantaged Unincorporated Communities*. UC Davis Center for Regional Change.
- Payton, E., and J. Lukas 2021. "Colorado River Basin Climate and Hydrology State of the Science: A Synthesis Report to Support Water Planning and Management." *Colorado Water* 38: 1.
- Raheem, N., S. Archambault, E. Arellano, M. Gonzales, D. Kopp, J. Rivera, S. Guldan, K. Boykin, C. Oldham, A. Valdez, S. Colt, E. Lamadrid, J. Wang, J. Price, J. Goldstein, P. Arnold, S. Martin, and E. Dingwell. 2015. "A Framework

for Assessing Ecosystem Services in Acequia Irrigation Communities of the Upper Río Grande Watershed.” *WIRES Water* 2(5): 559–575.

Reed-Spitzer, Z., and B. Colby. 2024. “Environmental Justice in the Colorado River Basin.” Working paper.

Robison, J. 2023, July 12. “Arizona V. Navajo Nation: What SCOTUS Didn’t Do along the Colorado River.” *Inkstain* [blog]. Available online: <https://www.inkstain.net/2023/07/arizona-v-navajo-nation-what-scotus-didnt-do-along-the-colorado-river/>

Rosenberg, A., S. Guldán, A.G. Fernald, and J. Rivera, eds. 2020. *Acequias of the Southwestern United States: Elements of Resilience in a Coupled Natural and Human System*. Research Report 796. New Mexico State University, College of Agricultural, Consumer and Environmental Sciences.

Sanchez, L., B. Leonard, and E.C. Edwards. 2023. “Paper Water, Wet Water, and the Recognition of Indigenous Property Rights.” *Journal of the Association of Environmental and Resource Economists* 10(6): 1545–1579.

Smith, J. 2022, September 21. “Tribal Breakthrough? Four States, Six Tribes Announce First Formal Talks on Colorado River Negotiating Authority.” *Water Education Colorado*. Available online: <https://www.watereducationcolorado.org/fresh-water-news/tribal-breakthrough-four-states-six-tribes-announce-first-formal-talks-on-colorado-river-negotiating-authority/>

Sultana, F. 2018. “Water Justice: Why It Matters and How to Achieve It.” *Water International* 43(4): 483–493.

Ten Tribes Partnership. 2023. “Latest News.” Available online: <https://tentribespartnership.org/latest-news/>

Teodoro, M.P., M. Haider, and D. Switzer. 2018. “US Environmental Policy Implementation on Tribal Lands: Trust, Neglect, and Justice.” *Policy Studies Journal* 46(1): 37–59.

The White House. n.d. “Justice40.” Available online: <https://www.whitehouse.gov/environmentaljustice/justice40/>

Tory, S. 2021, November 23. “The Threat to Colorado’s Acequias and the Communities That Depend on Them.” *High Country News*. Available online: <https://www.hcn.org/articles/water-the-threat-to-colorados-acequias-and-the-communities-that-rely-on-them/>

Tucker, J. 2000, April 12. “A Conversation with Judy Lopez on the Long History of Water Sharing in the San Luis Valley.” *Water Education Colorado*. Available online: <https://www.watereducationcolorado.org/publications-and-radio/blog/a-conversation-with-judy-lopez-on-the-long-history-of-water-sharing-in-the-san-luis-valley/#/>

Woods, A. (2017, April 21). *AZ Central*. Retrieved from *The Republic*: <https://www.azcentral.com/story/news/local/arizona-water/2017/03/21/gila-river-indian-community-agrees-water-storage-deal-phoenix-restore-flow-gi-la-river/99274136/>

United Nations. 2007. “United Nations Declaration on the Rights of Indigenous Peoples.” Available online: <https://documents.un.org/doc/undoc/gen/n06/512/07/pdf/n0651207.pdf>

U.S. Census Bureau. 2024. *2010–2020 American Community Survey 5-year Estimates Detailed Tables*. Available online: [https://data.census.gov/table/ACS5Y2022.B25048?q=United States&t=Water, Sewage, and Plumbing Facilities&g=040XX00US04\\$1400000.06\\$1400000.35\\$1400000](https://data.census.gov/table/ACS5Y2022.B25048?q=United%20States&t=Water,%20Sewage,%20and%20Plumbing%20Facilities&g=040XX00US04$1400000.06$1400000.35$1400000)

U.S. Department of Agriculture Office of Tribal Relations. 2022. *USDA Resource Guide for American Indians and Alaska Natives 2022*. Available online: <https://www.usda.gov/sites/default/files/documents/usda-resource-guide-american-indians-alaska-natives.pdf>

U.S. Department of the Interior. 2023. “Enacted Indian Water Rights Settlements.” *Secretary’s Indian Water Rights Office*. Available online: <https://www.doi.gov/siwro/enacted-indian-water-rights-settlements>

U.S. Environmental Protection Agency. 2022 version [2024]. *Climate and Economic Justice Screening Tool*. Available online: <https://screeningtool.geoplatform.gov/en/downloads#5.78/31.554/-110.665> [Accessed April 9, 2024]

- U.S. Environmental Protection Agency. 2023. "Environmental Justice in Enforcement and Compliance Assurance." Available online: <https://www.epa.gov/enforcement/environmental-justice-enforcement-and-compliance-assurance>
- U.S. Water Alliance. 2023. *Advancing Water Equity: The Role of Digital Solutions in Small Rural Communities*. Available online: <https://uswateralliance.org/wp-content/uploads/2023/09/Advancing-Water-Equity-in-Small-and-Rural-Communities—The-Role-of-Digital-Solutions.pdf>
- Water & Tribes Initiative. 2019. "The Enduring Role of Tribes in the Colorado River Basin." Policy Brief 1. Available online: <https://www.naturalresourcespolicy.org/docs/water-tribes/policy-brief-1-final.pdf>
- . 2024. "Proposed Alternatives for Post-2026 Operating Guidelines." Available online: <https://www.waterandtribes.org>
- Wescoat, J., L. Headington, and R. Theobald. 2007. "Water and Poverty in the United States." *Geoforum* 38(5): 801–814.
- Young, R., B. Colby, and G. Thompson. 2019. "Tribal Water Rights, Community Economies, and Adaptive Water Institutions in the Western United States" *Journal of Natural Resources Policy Research* 9(1):74-102.

About the Authors: Bonnie Colby (bcolby@arizona.edu) is a Professor with the Department of Agricultural and Resource Economics at the University of Arizona. Zoey Reed-Spitzer (Zreedsp@ncsu.edu) is a Research Assistant with the Department of Agricultural and Resource Economics at North Carolina State University.

Acknowledgments: Funding for this research was provided by the Climate Assessment for the Southwest (Collaboratively Assessing Critical Social-Ecological System Buffers to Help Build Regional Climate Resilience grant) as well as joint funding from the National Science Foundation and U.S. Department of Agriculture (Innovations at the Nexus of Food, Energy, Water Systems NSF grant number: 1855912). We appreciate valuable suggestions provided by Jeff Michler, Anna Josephson, George Frisvold, and Gary Thompson, University of Arizona. Any errors of analysis or interpretation are the responsibility of the authors.