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URBAN WATER CONSERVATION IN THE COLORADO RIVER BASIN

by Tamee Albrecht (Colorado State University) and Gina Gilson, Andrea K. Gerlak, and Adriana Zuniga-Teran (University of Arizona)

Introduction

For the past two decades, the Colorado River Basin in the western United States and northern Mexico has faced pervasive drought and increased aridification due to climate change (Overpeck and Udall, 2020). In the same period, the region's population has grown, with four of the ten fastest-growing states in the US using Colorado River water: Nevada, Arizona, Utah, and Colorado (US Census Bureau, 2021). Water from the Colorado River Basin contributes to municipal supply for approximately 40 million people, 70% of whom live outside its boundaries (Cohen et al., 2011). Municipal water use, which accounts for 15% of the basin's overall water use, is the fastest-growing water-use sector (Cohen et al., 2011). Despite rapid population growth in many cities in the Colorado River Basin, increasing attention to water conservation strategies has led to declines in per-capita water use (Richter et al., 2020). In some cases, such as Salt Lake City and Phoenix, total water use has declined (Colby and Hansen, 2022).

Municipalities of the basin have become key actors in adaptation and resilience efforts through innovative water conservation strategies. Cities are often first in line for cuts during water shortages on the Colorado River, as they typically have lower-priority water rights than agricultural users. Because of this, cities in the western US have been forced to explore adaptive strategies to build resilience to drought and ongoing aridification and maintain economic and population growth in the face of climate change (Loomis, 2022). Cities often have greater financial resources than other water-use sectors that allow them to advance the development of innovative technologies and pursue experimentation to advance long-term, sustainable adaptation (Hondula et al., 2019). Thus, examining trends in urban water conservation in the Colorado River Basin can inform strategies in other urban areas, both within and outside the Colorado River Basin.

While urban water conservation alone cannot solve the basin's water scarcity challenges, it plays a role in advancing water conservation across sectors (Cohen et al., 2013). For example, urban water conservation may help to reduce the impacts of constrained water supplies on farming communities and possibly encourage participation by the agricultural sector in basin-wide conservation efforts. If we are to better understand the role of urban water conservation in addressing basin-wide water scarcity and water governance more broadly, we need to examine the impacts of current strategies and how they can be improved.

In this article, we review the contributions and limitations of urban water conservation practices in the Colorado River Basin, drawing on academic and practitioner studies to better understand which conservation strategies are employed by municipal utilities and water providers in the basin. We also investigate the effectiveness of these strategies to better understand their impacts. Finally, we tackle the political dimensions of urban water conservation and question the larger role of urban water conservation in basin-wide water

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The Growing and Evolving Role of Urban Water Conservation Practices

A DIVERSITY OF URBAN WATER CONSERVATION APPROACHES

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To meet the challenges of climate change, overallocation, and urban growth in the Colorado River Basin, municipal utilities and water providers are turning to demand-side management, including water conservation and efficiency improvements, which are often implemented at the household level (Obringer and White, 2023). In arid regions of the western US—where outdoor water use accounts for up to 70% of residential water use (Hayden et al., 2015)—attention on outdoor water conservation is growing (Western Resource Advocates, 2017). Other efforts target improvements in **c**ommercial, **i**ndustrial, and **i**nstitutional (CII) water use. Here, we provide insights into how municipal utilities and water providers in the Colorado River Basin employ a mix of educational, market-based, regulatory, and emergency measures to promote indoor and outdoor water conservation.

Educational measures refer to information, outreach, and awareness campaigns targeting behavioral changes in water users. Denver Water, for example, launched a broad educational campaign in the 2000s using the slogan "Use Only What You Need" (Denver Water, 2024). A new campaign that began in 2023 features clever phrases on billboards, buses, and social media (Proctor, 2023). The City of Phoenix Water Services Department has encouraged cultural change around water use through ongoing educational efforts such as the "Water – Use It Wisely" campaign, which promotes efficient indoor plumbing fixtures and low–water use landscaping (City of Phoenix, 2021). The Los Angeles Department of Water and Power (LADWP) provides low–water use landscaping education that is targeted at single-family residential customers, and it also provides businesses with guidance for reducing water use (LADWP, 2013). In Las Vegas, the Southern Nevada Water Authority (SNWA)—the water wholesaler for the region's municipal utilities—provides outreach tailored to individual customer needs through site appraisals for high–water use customers, and it also reaches out to homeowners associations (SNWA, 2019).

Incentives

Market-based approaches such as rebates are commonly offered for residential and commercial indoor fixture replacement, and incentive programs are used to promote improvements in the efficiency of outdoor irrigation. In Los Angeles, the LADWP sponsors rebates for high-efficiency indoor plumbing fixtures (LADWP, 2013). Utilities and water providers may also use pricing to encourage conservation. For example, LADWP employs a four-tiered volumetric water rate system and individualized calculations using customer lot size and temperature zone to discourage overuse (LADWP, 2021). Member agencies of SNWA follow shared principles that include employing increasing block rates and a usage-based commodity charge that supports system enhancements (SNWA, 2019). Similarly, the Albuquerque Bernalillo County Water Utility Authority (ABCWUA) employs surcharges to encourage the conservation of irrigation water and offers numerous rebate programs to promote efficient indoor and outdoor water use (ABCWUA, 2018).

Market-based approaches are also used to incentivize changes in outdoor water use. In southern Nevada, as part of its Water Smart Landscapes program, SNWA offers a rebate (up to $5 per square foot in 2024) for the permanent replacement of turfed areas with desert-appropriate vegetation. SNWA also offers rebates for smart irrigation controllers, pool covers, and leak detection units (SNWA, 2024). Since 1999, the program has helped to convert nearly 190 million square feet (1760 hectares) of turf (SNWA, 2019). Denver Water provides tailored recommendations and technical assistance to customers to help them become more efficient, including through outdoor water-use audits (Denver Water, 2017). In Albuquerque, the ABCWUA is shifting its conservation strategy from rebates for indoor use (i.e., toilets and showerheads) to rebate programs focused on irrigation efficiency (ABCWUA, 2018). In southern California, a turf replacement program encourages homeowners to remove existing grass and replace it with drought-tolerant landscaping.

Ordinances & Codes

Regulatory measures may also be used by municipal utilities and water providers to increase conservation. In Los Angeles, for example, city ordinances integrate water efficiency into building codes and mandate the installation of high-efficiency plumbing fixtures in new constructions, renovations, and newly purchased existing buildings (LADWP, 2013). Denver Water's regulatory measures similarly require the retrofitting of indoor fixtures when residential properties are sold. New single-family residences and new commercial developments are also required to have efficient indoor fixtures and metered irrigation systems (Denver Water, 2007). Similarly, San Diego has had permanent, mandatory water-use restrictions in place since 2016 (City of San Diego, 2023).

Regulatory measures also apply to outdoor use. Since the 1990s, city ordinances in Phoenix have controlled water use on golf courses, parks, and other facilities with large turf areas, limiting them to an annual water allotment; they also require low–water use vegetation in public rights-of-way (City of

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Phoenix, 2021). Similarly, Tucson passed an ordinance in 1991 requiring the use of desert vegetation in multifamily, commercial, and industrial developments, which reduced turf area and considerably decreased the demand for potable water. Golf courses and parks in Tucson are required to use reclaimed water for turf irrigation. A Nevada state bill prohibits the use of river water for irrigation of nonfunctional turf in government, commercial, and multifamily properties in southern Nevada, starting in 2027 (SNWA, 2021a). Urban water suppliers in California are required to follow the state's Model Water Efficient Landscape Ordinance, which limits outdoor water use for new developments and retrofitted landscapes (California DNR, 2023). The current implementation of California's statewide 2018 conservation legislation includes the development of water efficiency standards for outdoor residential and CII water use (California Water Boards, 2023).

Mandatory Restrictions

Emergency measures have also been taken to conserve water during drought conditions. Most recently, the Metropolitan Water District of Southern California, the nation's largest water supplier, declared a drought emergency for Southern California, clearing the way for mandatory water restrictions (AP News, 2022). At the state level, California passed emergency measures in 2022 that, among other restrictions, banned the irrigation of decorative turf at CII facilities (California Water Boards, 2022). In 2023, California made these emergency measures permanent, including prohibiting the use of potable water to irrigate nonfunctional turf on CII properties (Government of California, 2023). Colorado recently followed suit, banning the installation of new nonfunctional turf in CII properties (Government of Colorado, 2024). Commitments to reduce nonfunctional turf have also been made by individual water suppliers across Arizona, California, Nevada, New Mexico, Utah, and Colorado (SNWA, 2022).

EVALUATING THE IMPACT OF WATER CONSERVATION EFFORTS

Per-Capita Use

The evidence suggests that, collectively, conservation efforts have contributed to declines in municipal per-capita water use over the past two decades in many cities that utilize Colorado River water (Colby and Hansen, 2022; Richter et al., 2020; Richter, 2023). Relying on data obtained from 28 water utilities in the Colorado River Basin, Richter (2023) found that total and residential median per-capita water use declined by approximately 30% between 2000 and 2020 despite increases in the service populations of urban water utilities in cities such as Los Angeles, Phoenix, San Diego, Denver, Albuquerque, and Las Vegas. However, there are other places, such as in Arizona, where rapid growth has led to increased overall water use despite the improved water efficiency offered by new developments. Both Gilbert and Avondale saw increases in total water use, although there was a decrease in total per-capita use (Richter, 2023: 4).

Additional Research & Results

Author(s)	Location(s)	Conservation Strategy	Summary	Results
Baerenklau et al., 2014	Moreno Valley, Perris, Hemet, Murrieta and Temecula, CA	Pricing	The authors explore the household-level effects of an increasing block rate water budget.	Results show a gradual demand reduction of 17% over more than three years compared to water use under a uniform rate price structure.
Baker, 2021	Las Vegas, NV	Rebates and/or incentives for turf removal	The author uses event studies and panel models to evaluate the water savings attributable to Las Vegas' Cash-for-Grass rebate program that incentivizes turf removal.	The average reduction in water use for a participating property is 19–21%, and savings persist over time.
Brelsford and Abbott, 2021	Las Vegas, NV	Rebates and/or incentives for turf removal	The authors evaluate SNWA's Water Smart Landscapes rebate program for residential turf removal.	Using monthly water-use data for 300,000 residences over a 16-year period, they find that the program led to a 20% reduction in average residential water use.
Campbell et al., 2004	Phoenix, AZ	Pricing, ordinances, indoor fixture efficiency, low–water use vegetation, education	Using a multivariate regression model, the authors analyze monthly observations to compare the marginal effectiveness of various water conservation programs.	Water pricing and mandatory programs were more effective and cost less than educational programs.

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Additional Research & Results

Author(s)	Location(s)	Conservation Strategy	Summary	Results
Coleman, 2009	Salt Lake City, UT	Pricing, education	The author develops a water demand model using observations of water use from 1999 to 2002.	Findings suggest that water demand is price inelastic (a 1% change in the price results in less than 1% change in demand), except for in the summer. A public information campaign is found to have had only a small impact.
Kenney et al., 2004	Aurora, Boulder, Fort Collins, Lafayette, Louisville, Thornton, Westminster, CO	Voluntary versus mandatory water-use restrictions	The authors compare the effectiveness of voluntary and mandatory water-use restrictions as drought response strategies in eight cities in Colorado.	Mandatory outdoor water-use restrictions were more effective than voluntary restrictions, leading to water savings of between 18 to 56% of the total **g**allons **p**er **c**apita **p**er **d**ay (GPCD).
Kenney et al., 2008	Aurora, CO	Education, pricing, mandatory water-use restrictions	The authors examine factors influencing residential water demand during and following drought.	Real-time information helped customers reduce water use, and water pricing and mandatory restrictions had different levels of effectiveness for customers at different water-use levels.
Mini et al., 2014	Los Angeles, CA	Voluntary and mandatory water-use restrictions and pricing	The authors compare the impact of voluntary restrictions, mandatory restrictions and pricing signals on outdoor residential water use between 2008 and 2010.	Mandatory water use restrictions combined with pricing signals were the most effective, resulting in a 23% decrease in average single-family residential water use.
Neale et al., 2020	Denver, CO, and Tucson, AZ	Irrigation efficiency, indoor fixture efficiency, low– water use vegetation, alternative water sources	The authors compare different urban water conservation strategies using monthly water-use data.	Efficient irrigation systems and the use of stormwater for irrigation were the most effective strategies. They note that conservation effectiveness varies based on local conditions.
Sovocool et al., 2006	Las Vegas, NV	Incentives for conversion to low–water use vegetation	The authors examine the conservation and economic effects of converting turf landscapes to xeriscape landscapes.	Results show a decrease in annual water use by 30%, or 96,000 gallons per year, and savings of $206 per year on maintenance.
Wang and Chermak, 2021	Albuquerque, NM	Education	The authors analyze the WaterSmart education program, which focuses on outdoor water use.	The program resulted in an initial decrease in water use, but impacts declined after two months and during mild drought conditions. Results also varied by customer water-use level.
Yoo et al., 2014	Phoenix, AZ	Pricing	The authors analyze observed price data to evaluate the price elasticity of residential water demand.	Lower water users and lower income households were most sensitive to pricing signals under the existing rate structure.

Table 1. Academic studies evaluating urban water conservation programs throughout the Colorado River Basin

Note: Studies are limited to those that use empirical observations to quantify the impact of specific conservation strategies on water use for cities in the Colorado River Basin. The list is not intended to be exhaustive.

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Despite declines observed in urban water use, much is still uncertain about the effectiveness of any particular strategy, program, or policy. Table 1 summarizes a range of studies from over the past two decades evaluating conservation strategies used in cities in the Colorado River Basin.

Variation

In looking broadly across this research, we see that the effects of conservation programs depend on multiple social, economic, political, and environmental factors that often interact, leading to site-specific results (Neale et al., 2020). For example, mandatory water-use restrictions in Colorado and Arizona conserved higher volumes of water per capita than voluntary measures (Kenney et al., 2004; Campbell et al., 2004). In Los Angeles, mandatory measures combined with pricing mechanisms were found to be most effective, resulting in a 23% decrease in single-family residential water use (Mini et al., 2015). While the effectiveness of pricing-based methods is debated (Wichman et al., 2016), pricing may be more effective at reducing outdoor water use, which, in some locations, such as Salt Lake City, was found to be more sensitive to price changes than indoor use (Coleman, 2009). The impact of price signals can also vary by user class (e.g., low versus high water users) (Kenney et al., 2008; Yoo et al., 2014). But with pricing mechanisms, reductions can take a long time to be realized (Baerenklau et al., 2014). The results of education campaigns have been found to vary depending on weather conditions, customer type, and time since implementation (Wang and Chermak, 2021). In Utah and Colorado, public education was found to be moderately effective (Coleman, 2009; Kenney et al., 2008), while a study in Arizona showed no clear effects resulting from educational strategies (Campbell et al., 2004).

Outdoor Conservation

Context is especially important when assessing outdoor water conservation. Despite recent momentum, there has been limited research on these strategies, and uncertainty persists regarding their effectiveness (Mayer et al., 2015; Brelsford and Abbott, 2021). Outdoor strategies are integral to urban conservation programs in multiple locations, including Denver, Las Vegas, and Tucson; however, the effectiveness of conservation strategies varies according to local climate conditions, land development, and population (Neale et al., 2020). In Las Vegas, the conversion of turf to lower–water use xeriscaping decreased annual residential water use by 20 to 30% (Sovocool et al., 2006; Brelsford and Abbott, 2021; Baker, 2021). Assessing actual water savings that result from particular outdoor water conservation measures can be difficult due to the challenges of measurement, the variability of local conditions, the influence of climate, and the complicating effects of human behavior (Mayer et al., 2015; Gober et al., 2016).

Challenges Measuring Impact

It can also be difficult to evaluate the impact of various conservation programs when multiple strategies have been implemented concurrently (Kenney et al., 2008; Inman and Jeffrey, 2006). For example, in California, Stokes and Hunnicutt (2018) found that conservation messaging positively impacted water savings, but the addition of pricing mechanisms did not substantially improve these results. Another study found that while combining mandatory restrictions to outdoor water use with price signals increased water savings, the two programs interacted to reduce the overall effects (Kenney et al., 2008).

In large cities such as Las Vegas, San Diego, and Denver, municipal utilities and water providers have invested in detailed program evaluations to assess the performances of conservation strategies. These studies, however, may use varying amounts of data and rely on assumptions. Water utilities use estimates of conservation program performance to help them decide which measures to continue implementing and which programs have outlived their usefulness. Many cities, however, especially those with smaller utilities, may not have the resources or capacity to conduct such detailed studies and may, instead, rely on more general guidance on best practices provided by organizations such as the American Water Works Association and the US Environmental Protection Agency.

The Political Dimensions of Urban Water Conservation

The numbers associated with urban water conservation—from shower fixtures installed to acres of lawns removed—can hide or distort the more political dimensions of urban water conservation. Researchers and practitioners are calling attention to the unknowns around the effects of water conservation, the trade-offs associated with different strategies, the winners and losers of different policies, and how framing can privilege particular actions.

Demand Hardening

First, research highlights some significant unknowns associated with the effects of urban water conservation. Although water conservation can help reduce demand for water supplies, some proponents of economic growth contend that water conservation may act as a disincentive to growth (Brown and Hess, 2017). While studies have suggested that growth control may be necessary to secure long-term water supplies in arid cities, few have implemented limits on growth (Hirt et al., 2017). Indeed, some decision-makers may be amenable only to conservation measures that do not inhibit economic growth (Boyer et al., 2021a). This creates the risk of demand hardening, which is "the concern that policies that encourage consumers to use less water can effectively reduce the 'slack' in the system and thereby undermine the ability of those consumers to further reduce consumption during droughts or other supply emergencies" (Kenney, 2014: 37).

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Trades-Offs

Second, researchers are uncovering trade-offs related to the fiscal realities for urban water providers that may serve as disincentives to water conservation. Water providers rely on revenue from the sale of water to help finance their operations; reduced water use can, therefore, cause revenue loss. This can lead to "budgetary shortfalls that necessitate rate increases unpopular with customers, utilities, and political leaders" (Kenney, 2014: 37). Household water bill debt has already been rising in many communities across the US in the wake of the coronavirus pandemic; in California, for example, a recent survey by the state's water regulator estimates that about 1.6 million households have a combined water debt of US$1 billion (CSWRCB, 2020). This suggests that there are dual, contradictory pressures to both ensure that water utilities are financially sound and recognize the growing water debt and consumer financial burden that exist in many communities.

Inequities

Third, there is a growing body of research that reports inequities in access to urban water conservation programs and their benefits. In Tucson, rainwater harvesting incentive programs have largely benefited well-organized middle-class communities at the expense of poorer and more vulnerable communities (Gerlak et al., 2021). Water conservation programs directed at outdoor water use may target green infrastructure projects, but the unequal distribution of green infrastructure represents an environmental justice issue, with underlying factors that are rooted in legacies of redlining and disinvestment in neighborhoods where minority populations prevail (Zuniga-Teran et al., 2021).

Despite efforts to expand water conservation in cities, water justice issues related to water access and quality persist and are especially pronounced for Native American Tribes and low-income minority communities. For example, about 40% of Navajo Tribal members do not have access to running water in their homes and must haul water from distant sources (Wilson et al., 2023). Other injustices include less oversight of contaminants in rural areas served by small water systems—which have less financial capacity to address these issues—and the selective annexation of communities living on the fringes of municipal jurisdictions that serves to exclude certain populations from water service, such as colonias on the US–Mexico border (Balaz and Ray, 2014). Basin-level justice issues thus emerge when examining water conservation in cities: for what purpose are cities conserving water and for whom?

Framing

Finally, there is a growing number of critiques suggesting that framing the crisis in the basin as a problem of urban areas and urban consumption is incomplete and misleading. Framing of water challenges is important because it strongly influences the strategies pursued. A crisis framing may inspire all sorts of new expensive infrastructure projects in the urban water domain that are loosely vetted and economically infeasible. One such example is a desalination plant in Mexico which was approved by the Water Infrastructure Finance Authority of Arizona, though its implementation has faced challenges. Criticized as an energy-intensive, environmentally harmful, and expensive proposal by environmental groups and characterized as a backroom deal by some legislators, the plant was approved quickly and without much process or oversight in the final days of an outgoing state administration (Partlow, 2022).

Augmentation & Infrastructure

Others argue that conservation messaging has framed water conservation as being necessary to support economic growth in desert cities of the US Southwest (Boyer et al., 2021a) and can be used to justify new infrastructure projects (Welsh and Endter-Wada, 2017). Supply augmentation—which often involves new or expanded infrastructure—remains a critical component of many cities' long-term water supply plans. Projects that are either underway or under consideration include the expansion of potable water reuse infrastructure in San Diego (City of San Diego, 2021), the implementation of direct potable reuse in Phoenix (Paredez, 2023), binational desalination water exchanges between Las Vegas and Mexico (SNWA, 2021b), the expansion of storage capacity for Phoenix and Denver (City of Phoenix, 2021; Denver Water, 2023), and groundwater remediation and replenishment in Los Angeles (LADWP, 2021). Path dependencies promoting such infrastructure-based solutions often overlook the political and financial challenges associated with them and fail to acknowledge how such "solutions" can impede future adaptation (O'Neill and Boyer, 2023).

The Role of Urban Water Conservation in a Constrained Colorado River

Benefits

Going forward, there is no question that urban water conservation can play an important role in the Colorado River Basin. There are clear financial benefits of water conservation, as it is often less expensive than acquiring new supplies or reallocating water from rural uses to urban ones (Rupprecht et al., 2020). There are also notable savings associated with urban water conservation, including lower energy costs (Chini et al., 2016) and reduced carbon emissions (Sowby and Capener, 2022). Additional savings through conservation and efficiency are possible through full market saturation of high-efficiency indoor water fixtures and appliances (Mayer, 2016), implementation of water-efficient technologies across

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sectors (Cooley et al., 2022), and the expansion of low–water use landscaping and water rates designed to reduce outdoor water use (Mayer et al., 2015). The capture of these additional savings is challenged by data gaps, difficulties in monitoring, and the site-specific performance of conservation programs.

Basin Challenges

At the same time, however, we caution against the overreliance on urban water conservation to solve basin-wide water supply and demand imbalances. Urban water conservation will likely not be enough to balance the current water deficit in the Colorado River Basin. We need to move the conversation beyond urban water conservation, such that it also examines the relationship between the basin's cities and agriculture. Water conservation in agriculture is essential, as agriculture represents about 80% of water withdrawals in the Colorado River Basin (Hung et al., 2022). A central tension in the basin today—and a matter that is at the heart of current negotiations—is how to balance water cuts between urban and agricultural regions, as farmers hold the most senior water rights, but cities contain the majority of the population (Partlow, 2023). Some municipal utilities and water providers in the basin have shifted water allocations from agricultural to municipal uses as one of their first strategies for addressing water scarcity; for example, Tucson acquired water rights by purchasing farmland on the outskirts of the city (Zuniga-Teran and Staddon, 2019). However, conserving water by reducing agricultural use comes with its own challenges and potentially unjust impacts. Reallocating water from agriculture to other water uses can impact crop productivity and farm incomes, and payments for voluntary reductions do not always include compensation for local farmworkers and other third parties who may be affected (Frisvold and Duval, 2023). Agriculture-to-urban transfers may also reduce flexibility in the system since municipal water use is fairly constant, whereas agricultural users have the option of fallowing fields if necessary (Hirt et al., 2017).

Recommendations

To help guide future urban water conservation in the basin, we outline three key steps forward for research and practice. Based on our review of urban water conservation trends in Colorado River Basin cities, we call for greater attention to the design of new urban water strategies, improved assessment and monitoring of conservation efforts, and the addressing of key political and equity dimensions. All of these recommendations are meant to help fully realize the potential of urban water conservation while acknowledging its limitations for long-term water sustainability.

First, more can be done to improve existing programs and inform the design of new urban conservation strategies. Some studies have argued that Phoenix's passive approach, which emphasized creating a "culture of conservation," was undermined by weakened regulations and a continued focus on the expansion of supply (Larson et al., 2009: 108). Even with the reductions in per-capita water use, the city acknowledges that it "should proactively develop strategies to reduce per-capita demand to levels lower than those that would be achieved passively over time" (City of Phoenix, 2021: 113). In Las Vegas, the SNWA recognizes that many of its current programs may have already reached their maximum feasible impact and that future gains are likely to come more slowly (SNWA, 2019). Potential additional conservation savings will likely require new approaches and more holistic programs. This may involve thinking beyond traditional conservation approaches and considering new models such as "Net Zero Urban Water," which aims to meet the water needs of a city using local water supplies such as surface water, groundwater, stormwater, rainwater, and reclaimed water (Crosson et al., 2020).

Improving Data

Second, there is a need for improved monitoring and metering to better track the benefits of conservation strategies in their local contexts. Because many conservation measures are directed at outdoor water use, dual (indoor/outdoor) meters have been recommended (Mini et al., 2014). Not all municipal utilities and water providers, however, have the capacity to carry out detailed evaluation studies or improve monitoring. Therefore, state and federal governments can offer funding to help municipal utilities and water providers collect and analyze data. This can especially benefit smaller utilities or communities that are burdened with a level of water debt that limits their ability to implement effective conservation programs (Maggioni, 2014; Richter, 2023). The 2022 Inflation Reduction Act could provide some support, as it allows for spending on water conservation and efficiency projects for both urban and agricultural water uses (Alliance for Water Efficiency, 2022). Researchers can partner with municipal utilities and water providers on these efforts to provide valuable accountability checks in interrogating the data. At the same time, it is important to reveal how both the benefits and the burdens of conservation efforts are shared, uncovering the political dimensions: who benefits, what investments are made, and how water allocations and reductions are distributed across basin water users.

Funding

Big Picture

Finally, we need to work harder to think more holistically about the basin and consider all Colorado River water users as part of the same system. The historic "oasis in the desert" model of developing cities in the western US is insufficient in today's context of increasing basin-wide aridification. While cities seem able to create a sense of water security amid basin-wide scarcity, they still influence, and are influenced by, the broader socio-ecological system. In addition to honing urban water conservation

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programs, we need to seriously consider the role of water conservation across all sectors in the basin and critically evaluate the cross-sectoral impacts and trade-offs of these strategies. Ultimately, accurately perceiving who wins and who loses and understanding the more political dimensions of urban water conservation are key to more sustainable, fair, and just water governance across the broader Colorado River Basin.

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