BABBITT CENTER FOR LAND AND WATER POLICY

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MOUNTAINS TO SEA

The History and Future of the Colorado River

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The Colorado River is one of the most extraordinary rivers on the planet. It is a lifeline in the desert that fuels a regional economy that would, by some accounts, be the fifth-largest in the world if the Colorado River Basin were a separate nation. Rising in the Rocky Mountains, the Colorado traverses 1,450 miles through some of the most dramatic and rugged territory on Earth. Along with its tributaries, it flows through Wyoming, Colorado, New Mexico, Utah, Arizona, Nevada, and California before entering the Mexican states of Sonora and Baja California and, at least historically, emptying into the Gulf of California.

Weaving through two countries and across a diverse range of cultures, the River is a source of both unity and controversy. It has served as an anvil on which debates over the value of free-flowing rivers and the broader modern environmental conscience have been formed. And in the 21st century, it has become ground zero in the West for addressing challenges such as urban growth, drought, food security, environmental justice, and climate change.

The effort to confront these challenges is breaking down barriers and giving rise to an unprecedented sense of collaboration. Sustaining the River through this century and beyond will demand an even stronger spirit of cooperation, compromise, and sacrifice.

The Law of the River

The Colorado River is governed by a patchwork of agreements and treaties, laws, court decisions, contracts, and operating agreements collectively known as the Law of the River. In the United States, the watershed is legally divided between the Upper Basin states, which include Colorado, Wyoming, New Mexico, and Utah, and the Lower Basin states, which include Arizona, Nevada, and California.

According to the Law of the River, the Lower Basin states receive annual allocations of 4.4 million acre-feet (maf) for California, 2.8 maf for Arizona, and 0.3 maf for Nevada (one acre-foot is 325,851 gallons of water, enough to supply two to three families for a year.) Allocations for the Upper Basin states, by contrast, are expressed as percentages of the water available, up to 7.5 maf: 51.75 percent for Colorado; 11.25 percent for New Mexico; 23 percent for Utah; and 14 percent for Wyoming. The U.S. also has a treaty obligation to deliver 1.5 maf that meets agreed upon water-quality standards to Mexico each year.

During the 20th century, the federal government created a massive system of dams and reservoirs on the Colorado and its tributaries that has the capacity to store about four times the River's annual average flow. That system is anchored by two primary reservoirs, Lake Mead and Lake Powell, and backed up by scores of smaller dams and reservoirs that balance overall system storage, provide flood control or power production, and hold water allocated for specific users. As the massive system grew, progressively bigger diversion projects carried more and more water outside the hydrologic basin, to growing urban areas like Denver, Los Angeles, and San Diego.

Even as demand for Colorado River water increased, it became clear that the basic hydrologic assumptions underlying the entire allocation structure are flawed. The 1922 Colorado River Compact, the foundation of the Law of the River, allocated 15.0 maf to the U.S. states—7.5 maf to the Lower Basin and 7.5 maf to the Upper Basin—and assumed sufficient supplies were available to provide a portion to Mexico via a future agreement. By 1944, with the execution of a treaty between the United States and Mexico, the promised allotments totaled 16.5 maf per year. But streamflow reconstructions based on tree-ring records extending almost 900 years into the past indicate that the long-term average natural flow of the River was only 14.3 maf per year—much less than the quantity originally apportioned in the Compact.

The challenge of managing an overallocated River has been compounded by an extended drought that began in 2000. Earlier this century, multi-year negotiations led to a set of "shortage guidelines" finalized in 2007, which essentially served as a triage protocol for how to spread water-supply cuts should the drought continue. Further negotiations led to the adoption of two additional agreements intended to extend the available supply: Minute 323 with Mexico (enacted in 2017) and a comprehensive set of Drought Contingency Plans (enacted in 2019).

The proactive steps outlined in these agreements and the increasing efficiency of water users throughout the Basin provide some security, but they may not be enough to stave off a grim reality: demand exceeds supply. In 2020, the first year governed by the Lower Basin Drought Contingency Plan, water users, particularly in Arizona, Nevada, and Mexico, implemented reductions and conservation measures to protect water levels in Lake Mead that have dropped to record lows in recent years. When those levels fall below agreed thresholds, water users in California will face similar reductions.

Scientists project more severe shortages looming. In 2017, climate researchers Brad Udall and Jonathan Overpeck found that increasing temperatures will cause significant losses in Colorado River streamflow—anywhere from 20 to 30 percent at mid-century, and a devastating 35 to 55 percent by the end of the 21st century. The United States and Mexico are beginning to face the reality that the Colorado cannot meet the demands placed on it, and that climate change is only exacerbating the problem.

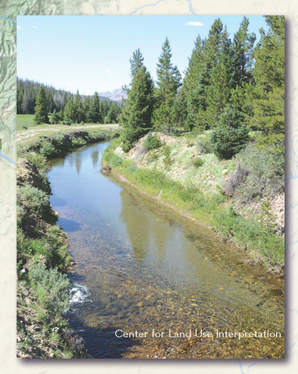
In response to this threat, relationships among Colorado Basin states, tribal nations, and major water users are evolving, as is the Law of the River itself. The 2007 shortage guidelines, the Drought Contingency Plans, and Minute 323 all expire in 2026. In late 2020, Basin states and Federal agencies charged with management of the River began preparing to negotiate a longer-term shortage sharing agreement. The next round of operating rules for sharing the Colorado River will need to address how water users adapt to a drier future with less Colorado River water. The discussions will also determine how to mitigate the risks a drier future poses to a wide array of Colorado River resources, including tribal water supplies, hydropower production, and the preservation of natural habitats.

The recent high-level negotiations in the Basin have demonstrated that the major stakeholders are much more willing to cooperate than in years past and are able to move beyond old antagonisms in response to the urgency of the current situation. More than 40 million people are inextricably connected to each other by the expansive water systems they rely upon for their daily existence. These connections mean that communities across the Colorado River Basin—and many outside of it—must find ways to forge a sustainable future for the entire Basin.

Waterkeepers – Powell and Mead
The two biggest reservoirs in the U.S., Lake Mead and Lake Powell, are the heart of the Colorado River Basin's federal water storage and distribution system. Together they can store about 50 million acre-feet of water, which is more than three times the historical average annual flow of the River and over 80 percent of the total reservoir storage capacity in the system. However, with increasing demands, persistent drought, and hotter temperatures, the amount of water actually stored in the two reservoirs has been shrinking since the early 1980s.

The Great Divide Basin in Wyoming is an unusual topographical feature in the Continental Divide about 2.4 million acres in size. It is considered a "closed" basin because surface runoff does not escape to either the east or west side of the Divide. Although it has been hydrologically cut off from the Colorado River for millennia, the Great Divide Basin is sometimes included in maps of the Upper Colorado River Basin for other reasons.

Many of the biggest users of Colorado River water are not actually within the Basin. Large metro areas like Albuquerque, Denver, Los Angeles, Salt Lake City, and San Diego tap into the River via interbasin transfers comprised of hundreds of miles of aqueducts and tunnels running up hills and through mountains. In contrast to the 20th century focus on supply-side approaches for meeting water demands through major infrastructure projects, large water users have increasingly turned to conservation and efficiency measures to avoid increasing their dependence on the overtaxed Colorado River.



Center for Land Use Interpretation

The Salton Basin and Laguna Salada Basin are usually excluded from contemporary Colorado River Basin maps because they do not currently contribute flow to the River. However, they were functionally part of the greater Colorado River Delta until 20th century upstream dams and diversions, and were included in some federal agency maps of the Basin prior to the completion of Hoover Dam. Even in the post-dam era, Colorado River floodwaters cause the typically dry Laguna Salada to occasionally reform during wet years.

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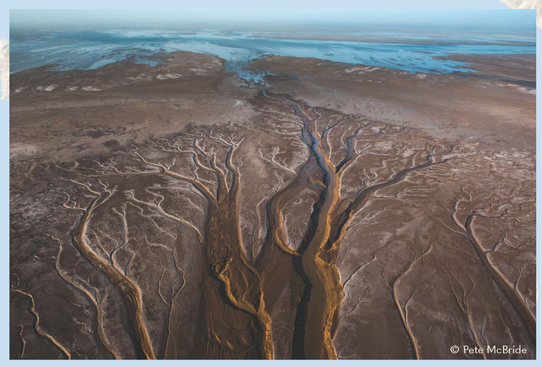
Neighborly Cooperation

The Colorado River is renowned for international transboundary cooperation. The U.S. and Mexican Sections of the International Boundary and Water Commission (IBWC) jointly govern the waters and land along the 1,954 miles of the U.S.–Mexico border, including the transboundary Rio Grande, Tijuana, and Colorado Rivers and their tributaries, and the Colorado River Delta. Since 1889, the IBWC Commissioners from the U.S. and Mexico have signed numerous treaties and agreements, called Minutes. Two of these agreements—Minutes 319 and 323, signed in 2012 and 2017, respectively—are exceptional examples of international cooperation for water sharing and environmental protection as the Colorado River Basin faces diminishing water supply and quality.



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Water and Tribes

Among the biggest issues in the Colorado River Basin are tribal water rights and the treatment of indigenous peoples. Thirty Native American tribes call the Basin home, with tribal land in the region totaling over 29 million acres, or about 13 percent of the total land mass. They are legally entitled to 15 percent or more of the water in the Basin. Yet, with a few exceptions, most tribes have historically been excluded from modern-day Colorado River negotiations and have been unable to use much of this water—depriving them of both the historic uses of this resource and the economic development potential it holds for the future.

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Humble Beginnings

Ninety percent of the water in the Colorado River system starts as small trickles in the modest headwaters areas in the mountains of the Upper Basin, yet the River serves one-twelfth of the land mass of the continental United States. However, consistent flow is not guaranteed. Climate change is shrinking the snowpack that feeds the River during snowmelt each spring, both by decreasing the amount of snowfall and by increasing temperatures. The flows of the system depend heavily on the snow that falls in this remote region—a place most people who rely on the Colorado River Basin will never know, let alone visit.

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Nature Abounds

The Colorado River harbors abundant biodiversity, including fourteen native fish species, four of which are endangered and found only within the Colorado River system. The River's dams have created adverse conditions for these species by trapping sediment and altering seasonal flow patterns and water temperatures. Partnerships such as the Lower Colorado River Multi-Species Conservation Program and the Upper Colorado River Endangered Fish Recovery Program are working to restore habitats and recover these species. Surprisingly, human modifications have supported "new" habitats in a few cases. La Ciénega de Santa Clara, a rich 40,000-acre wetland home to 280 bird species, was inadvertently created and then sustained by farm runoff diverted from Arizona into the Mexican desert east of the Delta.

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Where the River Met the Sea

One bright spot in the past several decades has been the coalescence of broad support to undo the damage caused to the Colorado River Delta in Mexico by nearly a century of aggressive upstream water development. The Delta was once a sweeping expanse that covered nearly two million acres with wetlands and thick cottonwood, willow, and mesquite forests, providing habitat for more than 350 species of birds and a key link in the Pacific Flyway. The rich Delta environment also sustained the Cucapá people for at least 1,000 years before Europeans arrived. But the construction of upstream dams and diversions during the mid-20th century choked the river flows that had kept the Delta alive. By the 1970s, the Colorado rarely reached the sea and the Delta shrank to a fraction of its original size. This deprived the Cucapá and other inhabitants, who had relied on fishing in the Delta, of their way of life.

Beginning in the late 1990s, scientists and environmental non-governmental organizations (NGOs) began a campaign to restore the Delta. They negotiated with the International Boundary and Water Commission (IBWC), a bilateral agency created by Mexico and the United States, to craft and sign an unprecedented agreement in 2012 known as Minute 319, which provided water for environmental or "pulse" flows for the Delta. The two countries released a pulse flow of more than 105,000 acre-feet in 2014 to help restart ecological regeneration in the Delta, an effort supported by the planting of tens of thousands of trees. In 2017, the IBWC signed Minute 323, which expands restoration efforts and tasks "Raise the River," a binational partnership of six NGOs, with raising money and carrying out restoration work. Reallocating enough water to revive and sustain the Delta ecology in the long term and reconnect the River to the sea continues to be a challenging task, and one of vital importance.

A New View - Relative Elevation Modeling (REM)
This map style is a different view of the Colorado River Delta. It shows how channel heights have evolved over time. Deltas are typically dynamic systems that change year to year with annual flooding that creates new paths and leaves behind fertile sediment. This REM map helps visualize the area that would have been a beautiful green oasis full of life if it hadn't been choked upstream. The historic pulse flow in 2014 demonstrated that even with a small amount of water for a short period of time, life in the Delta sprang back almost immediately.

An Increasingly Common Reality: Wildfires

A critical but frequently overlooked land and water connection in the Basin is the wildland - urban interface, or "WUI"—areas where the built environment mixes with forests and other natural, fire-prone landscapes. As people have flocked to the mountain West, drawn by the allure of abundant recreation opportunities out the back door, the extent of the WUI has dramatically increased.

Between 1990 and 2010, the WUI grew rapidly throughout the U.S., increasing from 224,325 to 297,298 square miles, a 33 percent increase. Homes in the WUI increased from 30.8 million to 43.4 million during the same period, a 41 percent increase. New WUI area during that period totaled 72,973 square miles, an area larger than Washington State.

Why is this such a problem? As ecologists have come to better understand the West's forests, they have learned that natural fire regimes, characterized by relatively frequent but smaller and less severe wildfires, perform important regenerative ecological functions. More than a century of aggressive fire suppression has resulted in less frequent fires and thus a temporary illusion of safety for humans and forest health, but has ultimately contributed to a buildup of fuel, resulting in bigger and more catastrophic fires when they do occur. On top of years of fire suppression, increased temperatures and lack of precipitation that stem from climate change have made forest lands much drier, more vulnerable to pests such as the pine beetle, and more flammable, causing hotter and longer-burning fires.

Wadsworth Ridge fire burns in the hills southwest of Denver.

Now, with a better understanding of the natural dynamics of fire, land managers have been trying to "unwind" the risk through prescribed, or controlled, burns. However, the growth of the WUI thwarts this effort, by putting more property and residents' lives at risk, dramatically increasing the risks to firefighters, and draining already limited water resources in areas where the Forest Service and other land management agencies might otherwise let fires burn. Because wildfires in the WUI pose a greater risk to lives and homes, fire managers are forced to fight such fires as aggressively as possible.

Severe wildfires cause catastrophic damage, and the damage continues even after the fires are finally put out. With little vegetation left to stand in the way, burned hillslopes are easily eroded by storms, which wash sediment and contaminants into downstream water bodies. These impacts are especially problematic because so much of the Colorado River Basin's water supplies come from forested mountain watersheds.

Agriculture and the Salton Sea

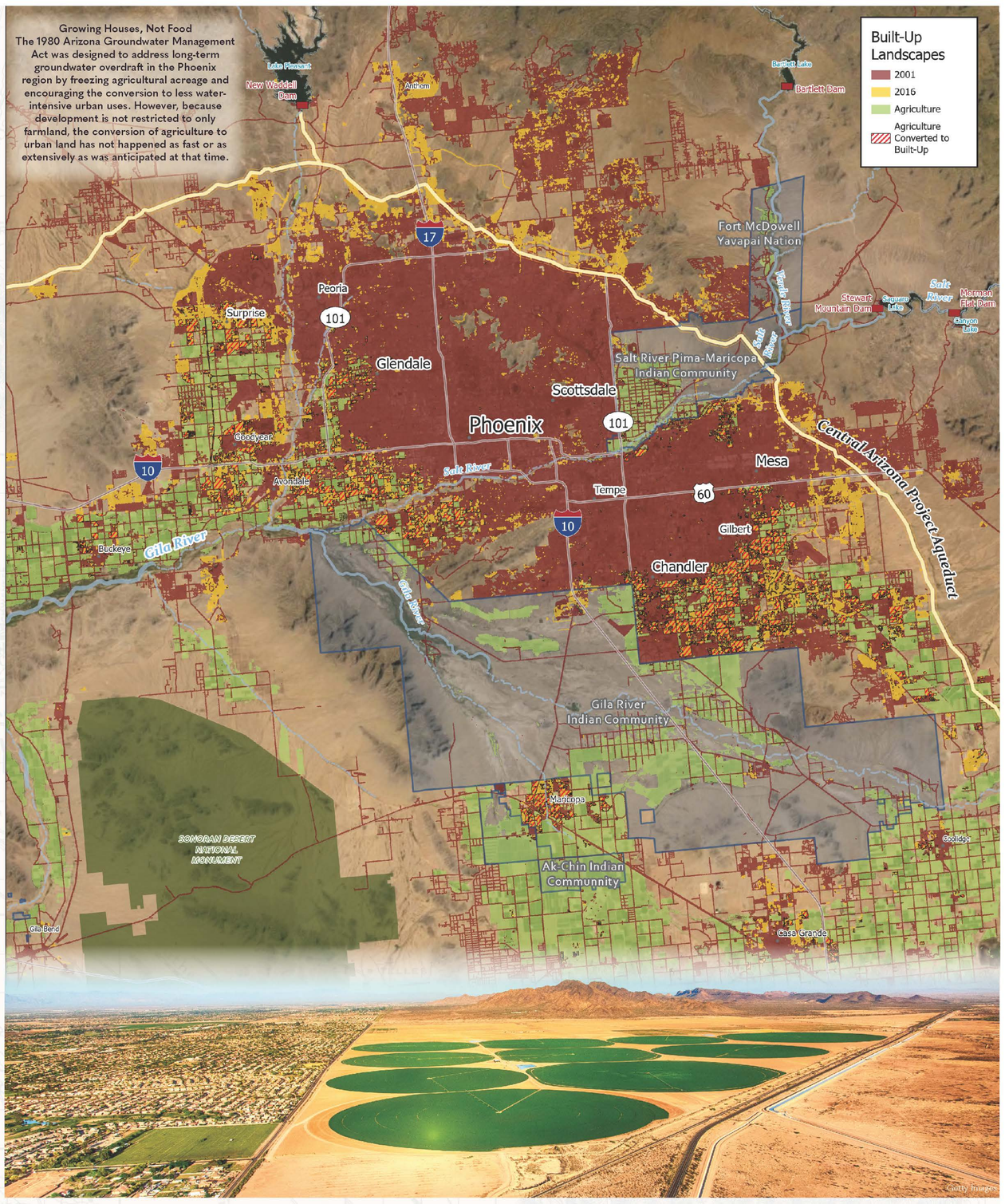
One of the most enduring conundrums in the Basin is the fate of California's Salton Sea, which lies west of the mainstem Colorado in the Salton Trough, about 280 feet below sea level. For millennia, lakes and wetlands of various sizes formed and receded in the Salton Trough, part of the historical Colorado River Delta. The lake called the Salton Sea formed when the River returned once again to the Salton Trough during intense flooding in 1905–1907, despite farmers' efforts to keep it out. In the subsequent decades, access to Colorado River water that flowed through a large canal system allowed flourishing agricultural operations to develop on the rich soils at the south end of the Sea, in the Imperial Valley, and at the north end, in the Coachella Valley. Runoff from two irrigation districts kept the lake alive, turning it into an important stop for migratory birds traversing the Pacific Flyway.

Yet the Salton Sea has hardly led a charmed life. Colorado River water has a high level of salinity by the time it is used for irrigation in this region. That level extends to the runoff that sustains the Salton Sea, where it becomes further concentrated due to evaporation. Fertilizer-laden runoff has created anoxic conditions and strong winds have periodically stirred up hydrogen sulfide gas from the bottom of the sea, suffocating fish. Additionally, toxic farm chemicals have accumulated in lakebed sediments. As the Sea has shrunk, more of these sediments have become exposed to the air and turned into hazardous windblown dust, worsening widespread respiratory problems among people who live near the Sea.

With increasing environmental awareness, the Salton Sea has become an issue of concern for those who live in the West. For years, California had been allowed to use more than its allocation of water from the Colorado. Under state and federal pressure to cut back, several major water agencies worked to rebalance supplies by orchestrating a large transfer of water from the Imperial Irrigation District to San Diego County, Coachella Valley, and the Metropolitan Water District of Southern California. In exchange, the water agencies funded conservation and efficiency improvements in the Imperial Valley. Greater efficiency for the Imperial Valley has resulted in less water destined for the Salton Sea, which has intensified the Sea's growing environmental problems. California's plans for habitat restoration and dust suppression have not kept pace with the Sea's decline.

As the level of the Salton Sea falls, more of the playa is exposed, increasing health risks in surrounding communities.

Growing Houses, Not Food
The 1980 Arizona Groundwater Management Act was designed to address long-term groundwater overdraft in the Phoenix region by freezing agricultural acreage and encouraging the conversion to less water-intensive urban uses. However, because development is not restricted to only farmland, the conversion of agriculture to urban land has not happened as fast or as extensively as was anticipated at that time.



Challenges of Managing Water in a Developing Landscape

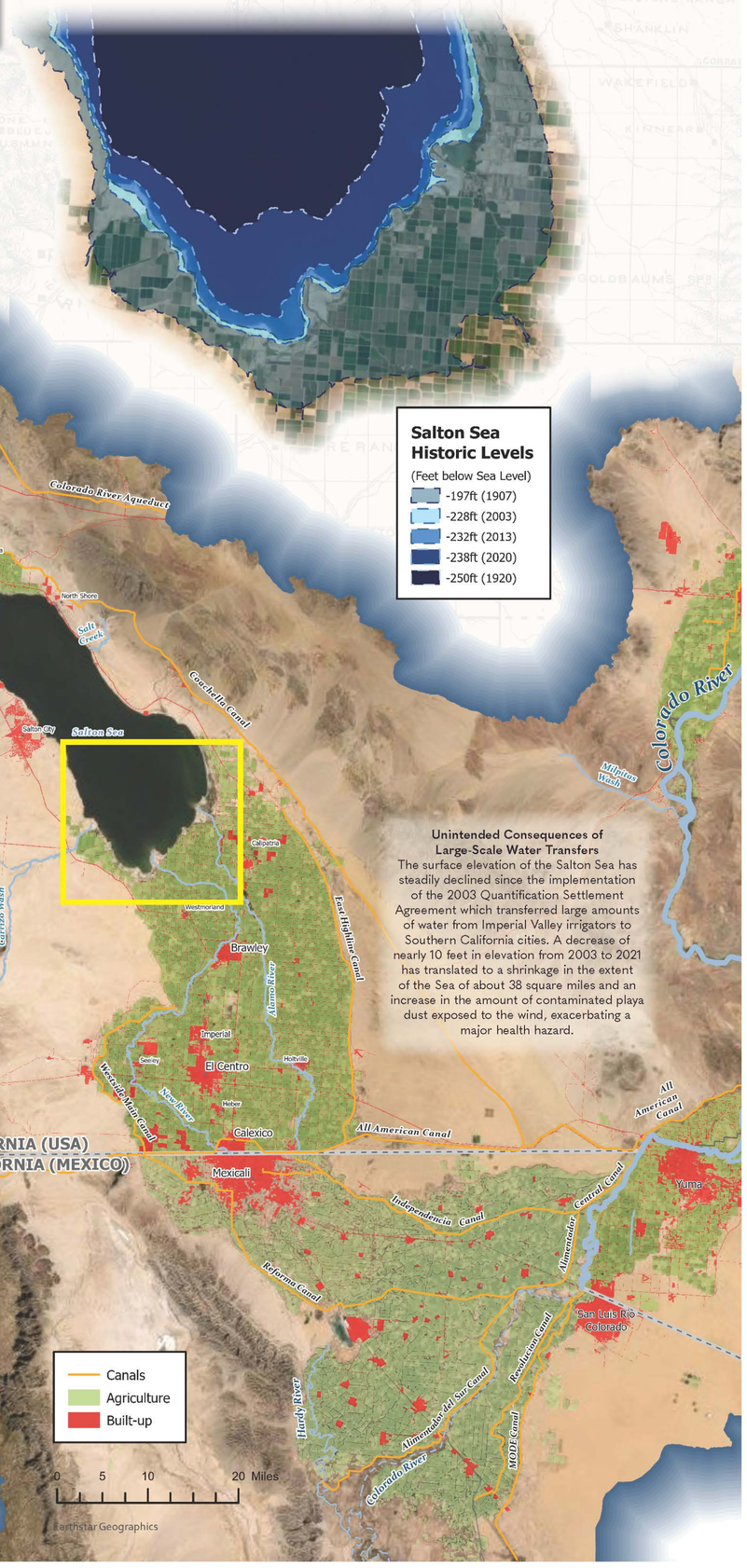
More than 70 percent of the water in the Colorado River is used to irrigate 4.5 million acres of farmland, both within and outside the Basin. In some cases, agricultural uses have steadily declined as urban areas that also depend on the River's water have replaced them. The transition of water and land use from agriculture to urban use in the greater Phoenix region highlights the need to confront and manage these changes from both land use and water availability perspectives.

Neighborhoods bordering agricultural fields, such as this example south of Phoenix, are an increasingly common sight.

A large amount of urban development has occurred on former farmland in and around Phoenix. Because urban development typically uses less water per acre than farms, overall water use remained relatively stable despite new growth, a trend bolstered by "demand management" requirements to ensure that new development is relatively water efficient.

The nature of agriculture and its water rights and water uses as well as the character of urban growth vary widely across the Basin, thus land and water use transitions will play out differently. Proposals for water transfers from agricultural and rural areas to larger distant cities are particularly controversial. These transfers can take the form of purchasing farms to transfer water to cities (commonly called buy and dry), or more creative water sharing arrangements between agriculture with senior water rights and cities for water in exchange for efficiency improvements or short-term land fallowing while also preserving prime farmland.

However, the loss of farmland comes with its own cost to society such as reduced food and feed production, loss of environmental benefits from agriculture, including loss of agricultural lands that provide a flexible temporary water source for urban areas when severe drought strikes. When agricultural water is transferred away from rural areas it can haves a negative impact on the entire region, causing job losses and socio-economic decline.



Unintended Consequences of Large-Scale Water Transfers
The surface elevation of the Salton Sea has steadily declined since the implementation of the 2003 Quantification Settlement Agreement which transferred large amounts of water from Imperial Valley irrigators to Southern California cities. A decrease of nearly 10 feet in elevation from 2003 to 2021 has translated to a shrinkage in the extent of the Sea of about 38 square miles and an increase in the amount of contaminated playa dust exposed to the wind, exacerbating a major health hazard.