tx H$_2$O

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THE RIO GRANDE

Inside: Putting the pieces together on this important binational water source

Texas A&M AgriLife Research | Texas A&M AgriLife Extension Service | Texas A&M University College of Agriculture and Life Sciences

Working to make every drop count

When you think about the Rio Grande, what comes to mind? The songs written about it? The cultures surrounding it? That it's a physical border between two countries? The growing populations on both sides of the border that rely on that water? The fact that in recent history it hasn't reached the Gulf of Mexico? Or maybe it seems like some mystical landmark you only hear about on the news?

Whatever your thoughts, the Rio Grande is an extremely important landmark, resource and cultural icon in our history. Wars have been fought over using it as a border. There have been battles in courtrooms over allocation of its water. There is a strong sense of culture and pride among those who live within close proximity of it. All viewpoints on the importance of the Rio Grande are valid, but they also present some unique challenges and have caused the river to be classified as one of the top most endangered American and world rivers according to the World Wildlife Fund.

If you think about challenges in managing a water resource, the Rio Grande Basin cannot go unmentioned. It is fed by snowpack in the upper basin and monsoons in the lower basin. Some of the fastest population growth in Texas is occurring there. It has some of the most diverse and unique crop mixes in the country that rely on the Rio Grande for irrigation. In addition, climate change threatens what was once a reliable source of water. Those are only some of the topics that have been and will be debated for many years to come. As a result, the Rio Grande Basin also presents many opportunities for research, extension and education.

In this issue of txH2O, we only scratch the surface of the many challenges that the Rio Grande faces, but we provide a more in-depth look at some of the efforts aimed at addressing these challenges. Collaborators from across Texas were willing to share their thoughts, passion and work as it relates to our shared resource and we thank them for what they do.

As always, please join us in "making every drop count."

Allen Berthold, Ph.D.
Assistant Director

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Santa Elena Canyon in Big Bend National Park. Photo by Chantal Cough-Schulze.

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Story by Kerry Halladay

GETTING TO KNOW THE RIO GRANDE

More than the sum of its pieces

Puzzle piece photos by Kerry Halladay, using map graphic provided by Rosario Sanchez and Laura Rodriguez. Manipulated by Audrey Guidry.

You may think you know the Rio Grande — or perhaps you know it as the Rio Bravo as it is commonly called in Mexico. But you probably only know a small piece of the overall picture. It is one river but, in many ways, it is so much more.

The Rio Grande/Rio Bravo is one of the longest rivers in North America, running about 1,900 miles from its headwaters in the San Juan Mountains in southern Colorado to where it meets the sea in the Gulf of Mexico. Its total watershed covers about 336,000 square miles across two countries, three U.S. states and four Mexican states.

But more than the tangible details, the river is the stuff of legends and the backbone of life in an arid region. It is the lifeblood to agriculture and the wider economy of booming metropolitan areas. It is the force that literally shaped the U.S. and Mexico and helps define those countries as they are known today.

However, the river is not what it once was.

"The Rio Grande is not grand. It was, but it's not anymore," said Rosario Sanchez, Ph.D., Texas A&M AgriLife Research senior research scientist at the Texas Water Resources Institute (TWRI) and director of the Permanent Forum of Binational Waters (PFBW).

Samuel Sandoval Solis, Ph.D., associate professor in the Department of Land, Air and Water Resources at the University of California, Davis, spoke of the river in familiar terms as an old friend who has fallen on hard times lately.

"If you would have known him in his good years, he was a very strong, resourceful person, but as time has passed, he has gotten very sick," said Sandoval, who is also a Cooperative Extension specialist in water management and part of the executive committee for PFBW.

Sandoval is not alone in describing the river as unwell. Several U.S. and international nonprofit groups including American Rivers, the World Wildlife Fund and the World Resources Institute place the Rio Grande on "endangered river" lists due in large part to high levels of water stress in the region. The river's water is overallocated, with its flow frequently low to nonexistent in places. For example, 2001 was the first time in a half century that the river stopped flowing to the Gulf of Mexico. Additionally, the river's water quality is hampered by excessive bacteria and high salinity.

The Rio Grande/Rio Bravo is so many things to so many people: the border between countries, the economic lifeblood of a desert and an old friend. But it is more than the sum of its parts, and we risk our future by trying to look at individual pieces rather than the whole picture.

The river's ailments have been attributed to its extensively controlled nature, ever-increasing demands on its water, and climate change. However, experts also said the problems lie in how we think about the river, as parts rather than a whole picture.

"We don't see and we don't think of the river as a whole natural, socio-economic system, and we haven't managed it as one," said Luzma Fabiola Nava, Ph.D., researcher for Mexico's National Council for Science and Technology (Consejo Nacional de Ciencia y Tecnología) and member of the PFBW advisory committee.

"We have managed water for different users and for different purposes, and then, more recently, as the border that we need to control and secure," Nava said. "When we think about the river, it's a set of different pieces of different sizes or different characteristics."

Sanchez said this approach is understandable given how big and complex the river, its basin and the issues surrounding it are.

"But the river doesn't understand that," she said. "Whatever we do will impact the entire river up and down stream and people both north and south of the border."

A river in pieces: A force to be tamed

The segmented way people think about the river can be seen in the very fact it has two names, said Jude Benavides, Ph.D., associate professor in the School of Earth, Environmental, and Marine Sciences at the University of Texas Rio Grande Valley.

"When you're getting to the point where you even have different names for the system, you can see how easy it is to have disconnects when thinking about it and approaching it."

He also said both the names and the river itself can surprise people — for good or bad — depending on what they expected.

"People misconstrue the name Rio Grande, meaning big, or Rio Bravo, meaning brave or fierce. And when you say 'river,' people envision a flowing waterway with a lot of water in it," he explained.

"Yes, it's a long river, but it is not a big river in the sense of overall annual flow. We had to break the back of this once brave river and tame it for our benefit," Benavides said. "When they tamed it, it changed."

The river has been called one of the most engineered rivers in the world. According to the U.S. Bureau of Reclamation, there are dozens of dams; hundreds if not thousands of miles of canals, laterals and drains; two major international reservoirs; and several hydroelectric powerplants constructed along the river's length. Construction of existing structures on the river began in 1906 with the modest Leasburg Diversion Dam in New Mexico, but this was quickly followed by the massive Elephant Butte Reservoir in 1916. Such infrastructure allowed the area to become a veritable garden of agricultural bounty through irrigation and allowed people — by the millions — to settle in the region without the threat of regular cataclysmic floods.

Still, Benavides says he prefers the Mexican nomenclature because it conjures up images of a river that can wake up and be a destructive, powerful force again under the right conditions. It is not just sentiment that draws him and others to this element of the river.

"I think that name 'Rio Bravo' better sums up the hydrology of the river than the name 'Rio Grande.' You've got a river that is primarily what we call ephemeral or flashy," Benavides said.

Jaime Flores, Texas A&M AgriLife Extension program coordinator at TWRI and watershed coordinator for the Arroyo Colorado Watershed Partnership, shared this perspective.

"Here in Texas, the Rio Grande has always been mythical, like folklore. Before it was dammed, it was a very powerful river, and it would flood every year. When the river wakes up — when it becomes the Rio Bravo again — it's still a sight to see. It will still destroy anything it wants to."

Flores explained that the last time the river "woke up" in a big way was during Hurricane Alex in July 2010, which saw the worst flooding in decades. Hundreds of homeless families and over $100 million in damages to crops, property, and infrastructure were left in the floodwaters' wake.

A view of the U.S. from Mexico, across the Rio Grande. Photo by Herman Ramsden.

"It was kind of a reminder of the way the river used to flow. It also showed how, through modern technology, we've been able to tame it in a sense," Flores said. "We can at least guide it without it destroying everything. But if one of those levies had failed up in Mission, it would have wiped out the entire Rio Grande Valley."

A river in pieces: A resource to be used

The river is an intimate part of an ever-growing number of lives. Currently, an estimated 12-13 million people on both sides of the border depend upon the Rio Grande/Rio Bravo for their water, according to the International Boundary and Water Commission (IBWC).

Agriculture also needs the river. An estimated 1.8 million acres of crop and pastureland was irrigated with the river's waters in 2006, according to the IBWC. According to the U.S. Census of Agriculture's 2018 Irrigation and Water Management Survey, roughly 710,000 acres in the U.S. were irrigated in the Rio Grande Water Resources Region, supplying billions of dollars worth of agricultural goods to the Texas and U.S. economies. Those agricultural goods — including pecans, citrus, beef, sugar and cotton from Texas alone — go on to feed and clothe untold numbers of people in the U.S., Mexico and around the world. Though exact numbers are harder to come by for Mexico, the cultivation of cash crops in Mexico has grown in recent years, creating yet more demands on the water.

"I think population honestly trumps all the other issues simply because there are so many more straws in the bucket now than there were back in the day," said Lucas Gregory, Ph.D., AgriLife Research assistant director of TWRI, referencing the history of water disbursement along the river. Though management of water distribution from the river started far earlier, what is now often called the 1944 Treaty governs water allocations between the U.S. and Mexico along several rivers, including the Rio Grande/Rio Bravo.

Allen Berthold, Ph.D., AgriLife Research assistant director of TWRI, agreed.

"A lot of people would tell you climate change is the biggest threat, but there's a reason that you need the water; there's a growing demand for it. The climate has varied year after year after year, at least in modern history, and it's been managed for, but with population growth we're getting into demand levels that we've not had to meet in the past."

The number of people living along the border has grown significantly over the years, and more are expected. The major sister cities along the river have added over a half million people in the last 10 years, for example. According to IBWC, municipal use of water from the Rio Grande/Rio Bravo is expected to double in the next 50 years.

A river in pieces: A border to be controlled

The Rio Grande/Rio Bravo has marked the edges of the U.S. and Mexico along what is now Texas and the Mexican states of Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas since the signing of the Treaty of Guadalupe-Hidalgo in 1848. But living and working along the river-as-a-border has changed in recent years, particularly as drug cartel activity and contentions related to immigration and the border wall have increased along the river.

"The river was used a whole lot for fishing in the past, which was nice," said Victor Gutierrez, AgriLife Extension associate at TWRI. "But under current circumstances, you can't get near it anymore, and it's a shame because it's a really pretty river."

Gutierrez' family has lived and farmed in the Rio Grande Valley for generations. He explained that riverside farmers have had to alter the way they do business — literally — because of the suspected drug cartel activities on the opposite side of the river, particularly at night.

"My family who farms in the Valley can only be out there irrigating when there's sunlight now," Gutierrez said. "Before you could irrigate day and night. There wasn't anything wrong. The only thing you'd see was ocelots, bobcats or feral hogs, and that's it. But now, you can't do that."

Flores said that while the activities of drug cartels represent safety problems, they aren't the only ones. The expanded border wall — not to mention the recent increase in anti-immigrant sentiments and anti-Latino racism that helped fuel its creation — poses literal safety risks too.

"We know where there are immigration problems, and we know where the drug routes are, but the walls are not effective," Flores said. "If you do put a wall in there, and the river decides to wake up, now you've endangered people by creating a flood risk if that segment of wall goes tumbling down the river. The river can undo any man-made thing if it wants to."

Hurricane Hanna of July 2020 seemed like it might wake the river up to do just that. Floodwaters further eroded an already shaky foundation to a segment of wall according to joint reporting by the Texas Tribune and ProPublica.

Flores, who grew up in the Rio Grande Valley and whose grandparents came to the U.S. from Mexico as farmworkers, described the river as an integral part of life along the border, making efforts to deepen the separation between communities hard to watch.

"People get very excited when you start messing with the river. The levees they understand. The walls they do not. And it's seen as a very bad symbol," Flores said.

"A lot of people down here have family on both sides. Sometimes the river is the only thing that separates these families. Anybody along the river would tell you the same thing. It's just part of the fabric of life. It's part of everything they do."

Putting the pieces together for a whole picture of a river

Though there are issues that make it difficult to see the river as a whole, looking at the river holistically could be the key to its future.

"We have a whole natural system that is being managed in very different ways. That's an issue that we need to address to cope with the consequences of the different management approaches," said Luzma.

For many experts, a more comprehensive approach to the river and its management is to again see it as a river. That is, a flowing river.

There have been many suggestions for getting the river flowing more regularly again. Improving agricultural water use via changes in irrigation techniques and switching to more drought- and saline-tolerant crops and slowing the growth of municipal water demands through improved efficiency could reduce demands on the water.

The Rio Grande extends from Southern Colorado through New Mexico and Texas to the Gulf of Mexico. Map graphic provided by Rosario Sanchez and Laura Rodriguez.

More regular releases of water by Mexico in accordance with its 1944 Treaty obligations and keeping some of that water flowing through the existing dam system could help give back water to the river and its ecological needs. But none of those possibilities are simple, and one effort will not be enough.

"I think we can get to a point where the river can be, at minimum, sustained," Sanchez said. "The problem is I don't know if the river will be able to hold on that much until we all, everybody, agree that we need to do A, B and C in order to protect it."

Shifting focus to the larger picture can threaten everyone's own little pieces of the river according to Sanchez.

"When you make policies over water, you're always going to get somebody mad and somebody really happy. Or everybody mad and then only the river happy," she said.

"You don't want to increase the price of water or reduce consumption because access to food and water is a human right. But we need people who are willing to take the time and the effort to sit down together to put together a decent, meaningful minimum plan to protect the river for the future."

Sanchez and others voiced skepticism that the river will ever be allowed to reach its full potential as a river because human priorities will always drive the discussion. But more people are starting to realize the need for the discussion and consider the whole picture of the river.

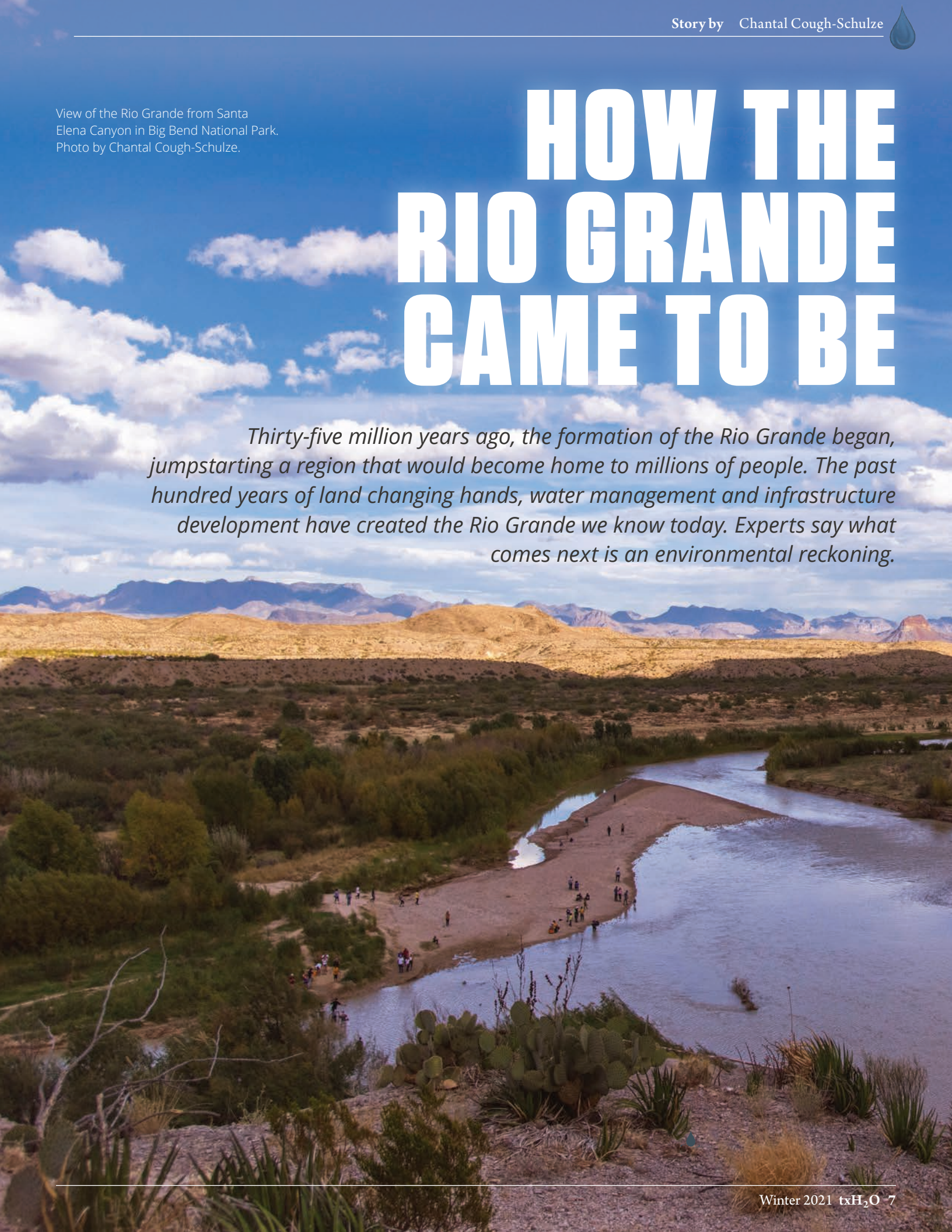
"The river is a source of conflict," Sanchez acknowledged. "But it is also a potential resource for cooperation."

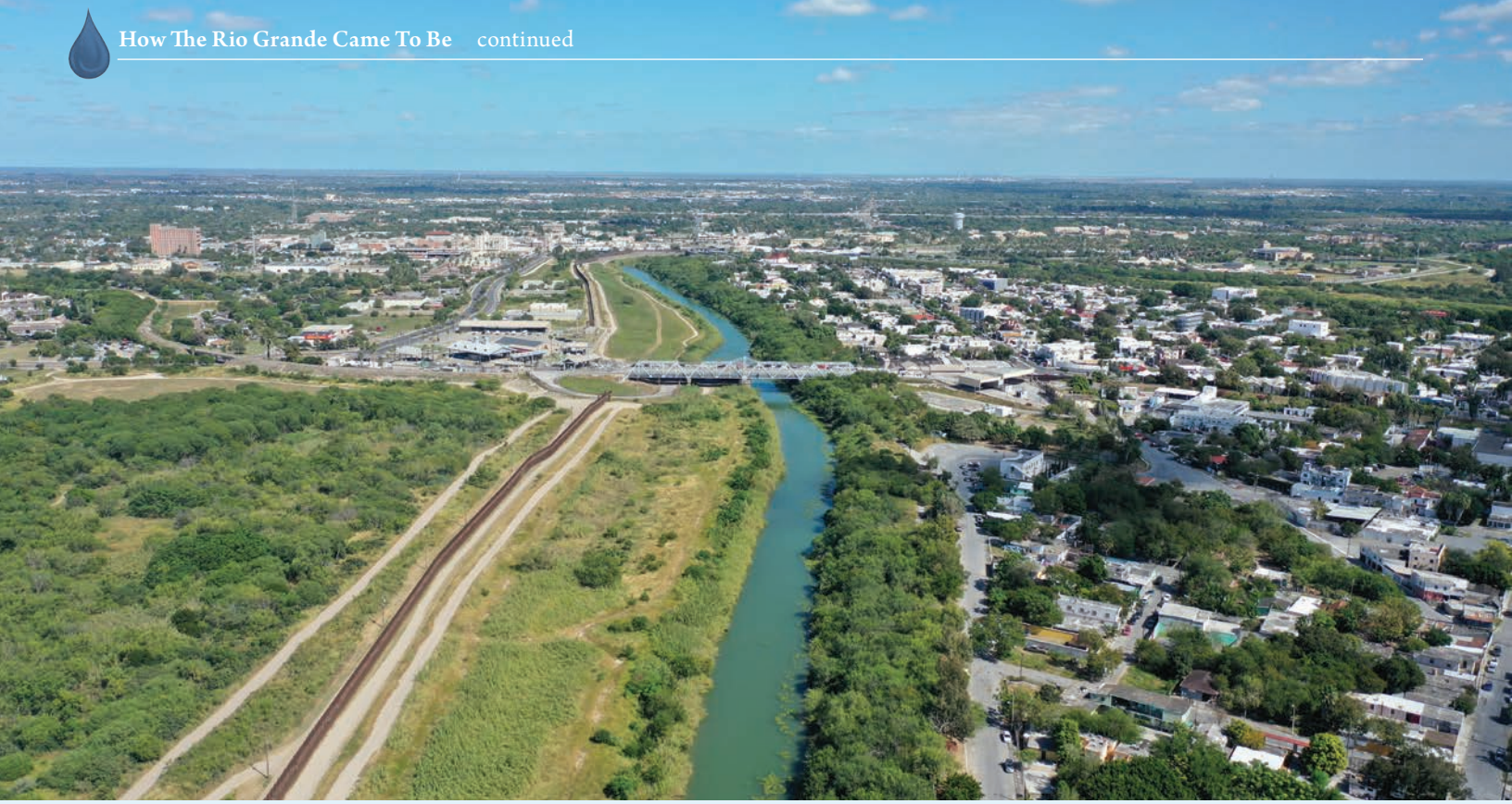
Story by Chantal Cough-Schulze

HOW THE RIO GRANDE CAME TO BE

View of the Rio Grande from Santa Elena Canyon in Big Bend National Park. Photo by Chantal Cough-Schulze.

Thirty-five million years ago, the formation of the Rio Grande began, jumpstarting a region that would become home to millions of people. The past hundred years of land changing hands, water management and infrastructure development have created the Rio Grande we know today. Experts say what comes next is an environmental reckoning.





The Rio Grande separates the Texas city of Brownsville and the Mexican city of Matamoros. Photo by Herman Ramsden.

From where the Rio Grande springs forth in Colorado's San Juan Mountains to where it empties into the Gulf of Mexico, the river supports an ever-growing population, vital agriculture and vast ecosystems today. But the present is rooted in the past, and the history of the river and the laws surrounding it shaped today the same way the river literally shaped the countries that border it.

Roughly two-thirds of the Rio Grande's length and 50,000 square miles of its watershed can be found in what today is known as Texas. In the often-dry landscape of South and West Texas, the use, management and value of the Rio Grande's water has long been a hot topic in Texas, said Carlos Rubinstein, former chairman of the Texas Water Development Board and former commissioner and Rio Grande Watermaster for the Texas Commission on Environmental Quality.

"You can't talk about Texas water history without starting with the Rio Grande. You just can't," Rubinstein said.

From the ground up

The Rio Grande Valley isn't really a valley.

The history of the Rio Grande starts with what's under your feet, said Jude Benavides, Ph.D., associate professor in the University of Texas Rio Grande Valley's School of Earth, Environmental and Marine Sciences. What's underfoot in the Rio Grande Valley — the area along the southernmost part of the river — is misnamed. The Rio Grande Valley is actually a delta.

Being called the wrong name is significant, Benavides said. It means people know less about where they are, how to identify with the land and how history has shaped that land.

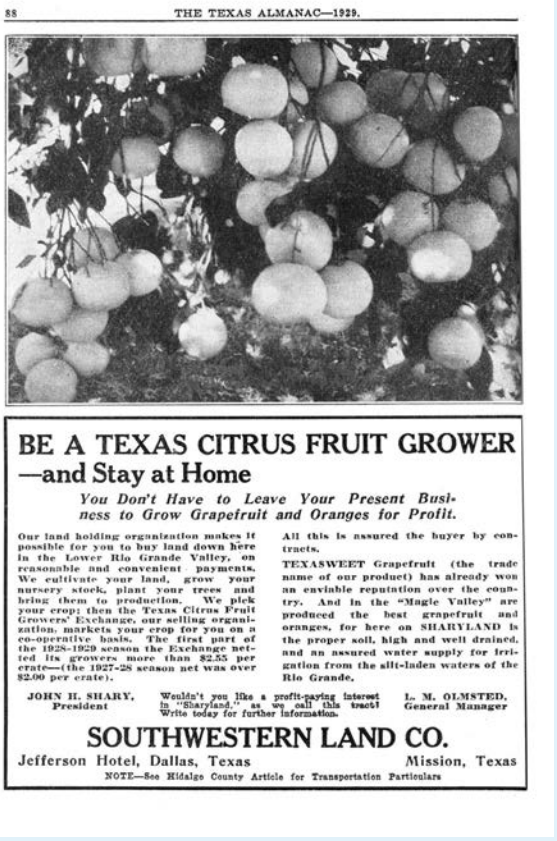
"It sounds like playing semantics, but it's a big deal if you don't know exactly what the land is, how your region was created, how the very soil that farmers rely on was created," he said.

Understanding the Rio Grande, as well as the people, ecosystems and economies along it, requires looking back — way back.

"All history starts with geologic history," said Jaime Flores, Texas A&M AgriLife Extension program coordinator at the Texas Water Resources Institute. "You have to start there to get to the point where it was the 1900s and they were going to start developing this area."

About 140 million years ago, much of what would become Texas was under a vast shallow sea. The remains of marine organisms formed limestone rocks that are still visible around Texas. Dinosaurs roamed the region; just over 65 million years ago, the world's largest known flying creature, Quetzalcoatlus, soared over Big Bend.

The Earth's crust began to stretch and thin in southern Colorado and New Mexico some 36 million years ago, triggering volcanoes and eventually creating a rift. Over the next 35 million years or so, streams followed the rift and coalesced into the ancestral Rio Grande, gradually pushing toward the Gulf of Mexico. The river finally reached the Gulf less than 2 million years ago, depositing fertile soils and creating the delta now known as the Rio Grande Valley.



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NOTE—See Hidalgo County Article for Transportation Particulars

Peopling the Rio Grande

By 11,500 years ago, hunter-gatherers were living in the Rio Grande region. Over the next thousands of years, inhabitants would leave behind shell ornaments and spear points, as well as beads possibly traded from Mesoamerican people.

A number of Native American tribes, including the Coahuiltecans, Jumanos, Apache and Pueblo peoples, lived near the Rio Grande when Spanish conquistadors first arrived in Texas in 1519. By the 1750s, the Spanish had colonized the Rio Grande and begun dividing the land into tracts for cattle ranching.

Mexico, including what is now known as Texas, won independence from Spain in 1821. In quick succession over the next 50 years, Texas went from being part of Mexico to being an independent nation, a U.S. state, a Confederate state and a U.S. state again.

After the Mexican-American War — during Texas' first round of being a U.S. state — the 1848 Treaty of Guadalupe-Hidalgo established the Rio Grande as the border between the United States and Mexico. People living along some parts of the river woke up as part of a different country. Though many people on the river's northern bank stayed and became U.S. citizens, the region remained predominantly culturally Mexican, and on the 1887 Texas state census, most people living in the area identified as "Mexican."

Taking and creating the Magic Valley

In the late 1800s and early 1900s, the landscape of the Rio Grande began to change. Intense droughts resulted in the deaths of thousands of cattle. To survive, many Tejanos — Texans of Mexican descent — had to sell their remaining livestock and the land that had been in their family for generations.

Land developers descended on the area in the early 1900s, seeing an opportunity to expand agriculture by capitalizing on irrigation and the region's mild winters, said Wayne Halbert, former general manager for the Harlingen Irrigation District.

"The river is the highest place in the delta, so the land developers determined that if they could just get the water out of the river, that it would flow for miles north and east," he said. "So they brought the steam engines in and set them up on the river and began to build waterways to develop that land."

Some land was purchased, often for far below market value. Thanks to readily available water, land prices had shot up from $0.25 per acre to $300 per acre between 1903 and 1910, roughly equivalent to increasing from $7.60 per acre to $8,200 per acre in today's dollars. Property taxes went up as well. The land of cash-poor, land-rich Tejano landowners was often foreclosed on, and the valuable land was sold for nothing but the tax arrears.

Other times, incoming land developers and ranchers resorted "to the simple expedient of occupying a desired tract and violently expelling previous occupants," wrote Benjamin Heber ⇨

(Left) A citrus ad from the 1929 Texas Almanac. (Right) Elephant Butte in 2006 showing the signs of low water levels. Photo by Zhuping Sheng, Ph.D.

Johnson, Ph.D., in his book, "Revolution in Texas: How a Forgotten Rebellion and Its Bloody Suppression Turned Mexicans Into Americans."

All the while, the land developers began marketing the lower Rio Grande region as the "Magic Valley."

"I guess the 'Magic Valley' sounded more appealing in advertisements than a delta," Halbert said.

Railroad advertisements described an abundant tropical farming paradise where irrigation water was plentiful and citrus groves popped up with little help. Labor — mostly from the same Tejanos who the land developers had bought, swindled or stolen the land from — was said to be readily available.

C.H. Swallow, a land developer, made a song book to encourage the "Magic Valley" mythos. Despite the region's periodic droughts, one song's lyrics included: "This valley cares not for the rain / No [drought] can ever mar its name / By telephone the water comes / To grow our crops and build our home."

Whether or not the advertisements were all true, the allure of good land drew hopeful farmers from all over to the "Magic Valley," said Halbert.

"The land developers had land drives; they went up north and brought thousands of people down who were interested in moving to the 'tropical Rio Grande Valley' and start farming," he said.

"Lots of folks came from as far as Ohio, Illinois, Nebraska and all of that farm country up there. Many of those places were going through drought issues, and of course, they were limited because they couldn't farm during the wintertime. So there was a huge incentive for those people to come down."

Setting ground rules

In 1910 and 1917, more droughts devastated parts of Texas.

"Texas always responds to droughts. Each drought resulted in a different set of legislation," Rubinstein said.

Those droughts led to a landmark Texas constitutional amendment stating that conservation of the state's natural resources, including water, were "public rights and duties."

"Without the amendment, we couldn't have river authorities, the Texas Water Development Board or the Texas Commission on Environmental Quality. If you're going to make a list of laws that have had the greatest impact statewide for water management, you have to start with that amendment," Rubinstein said.

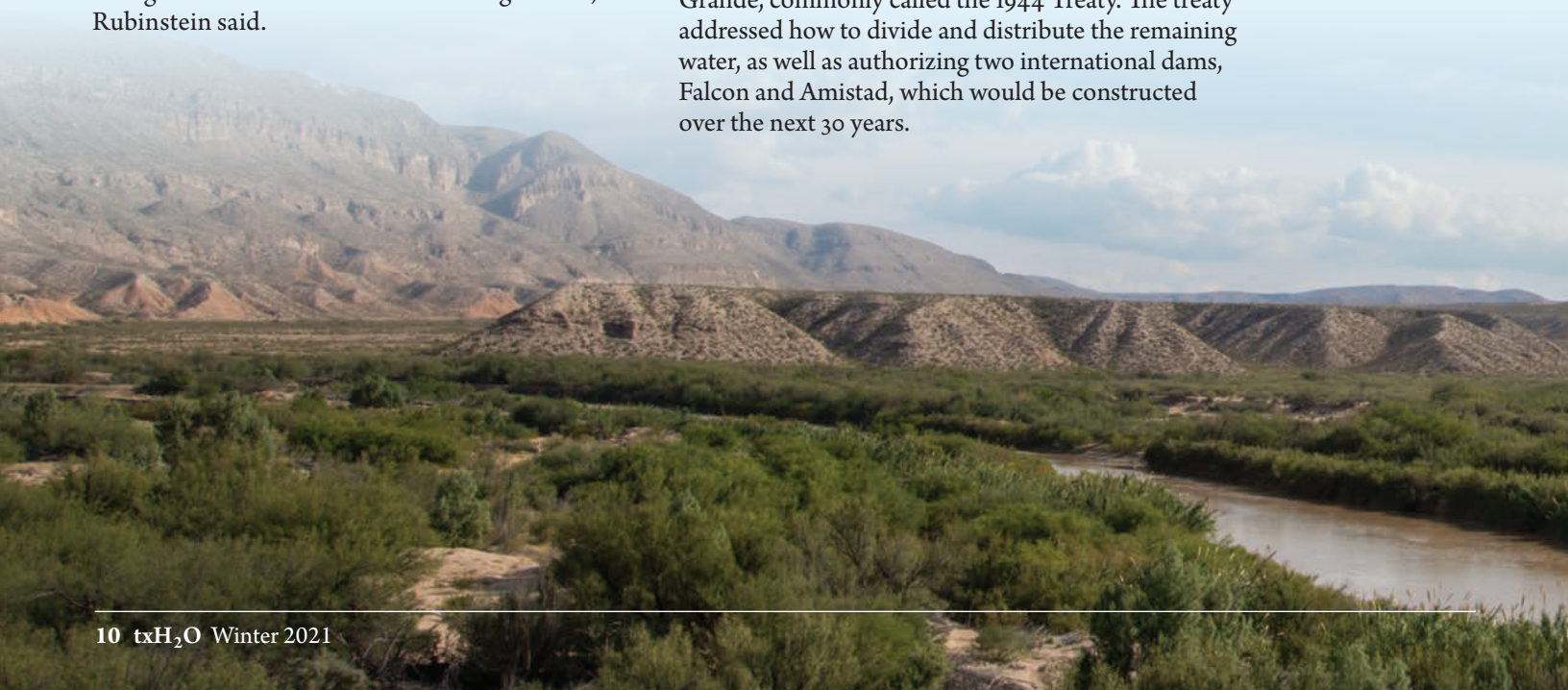
The amendment also helped strengthen irrigation districts, which had begun forming several years earlier when land developers had gone bankrupt from trying to provide farmers with enough water. The irrigation districts are governed by an elected board of directors made up of district landowners, who in turn select a general manager to manage the district. Unlike the land developers, the irrigation districts could tax themselves to be able to continue providing water.

The creation of irrigation districts was one step in a stream of changes to the Rio Grande's management. In 1906, the U.S. and Mexico held a convention leading to the creation of Elephant Butte Dam, which allowed for capturing and delivering set amounts of water to Mexico, New Mexico and Texas. But the convention only governed water use as far as Fort Quitman, hundreds of miles upstream from the Gulf of Mexico.

"The rest said, 'What about us? What's going to govern our use?' The folks in the Rio Grande Valley were promised another treaty, and they waited," Rubinstein said.

After the wait

Nearly 40 years later, Mexico and the U.S. created the 1944 Treaty for the Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande, commonly called the 1944 Treaty. The treaty addressed how to divide and distribute the remaining water, as well as authorizing two international dams, Falcon and Amistad, which would be constructed over the next 30 years.



When Falcon Dam was finished in 1954, water management swiftly got more complicated. Thanks to a tropical storm, Falcon Reservoir filled to the brim in a month, rather than the expected seven years.

"Everybody thought that's it; our problems are over. And they weren't, of course. Two years later the lake was largely empty," Rubinstein said.

"But there was still some water left. The city of Brownsville ordered water out of Falcon Reservoir. The water was released, and a small irrigation district in Hidalgo County saw it flow by and picked up the water instead. The river went dry, and there was a court case."

That case is commonly called the 1969 Valley Water Case and, together with the subsequent Water Rights Adjudication Act, changed everything about how water rights were handled in Texas.

Halbert explained that the case took on the arduous task of sorting through historical use claims from water rights holders. It took seven years to fully adjudicate. The case also established the Texas Watermaster Program, which allowed water to be released according to different irrigation districts' water allocations.

"It's just like a bank account; you're only allowed however much your percentage is of the water that's behind Amistad and Falcon dams," Halbert said. "Just like you can only write a check for how much money you've got in your bank account, you can only order that much more water."

The watermaster manages everyone's water bank account, ensuring everyone gets the amount they need from their total amount when they need it.

"There's a schedule of how long it takes for water to leave Falcon Reservoir and arrive at a certain locality on the river," Halbert said. "For the Harlingen Irrigation District, for instance, it's four days. So the irrigation district calls the watermaster and says four days from now, and for five days, we're going to be pumping 300 cubic feet per second out of the Rio Grande."

The watermaster then combines every irrigation district's water requests and releases the water, which is depleted in each district as it moves downstream.

An environmental reckoning

The Rio Grande region's population has continued to grow in the years since the Valley Water Case. Despite all the regulations, Rubinstein said it has become obvious that one vital element had been left out of the equation.

"We allocated all the water, but we never reserved water for the environment," he said.

Over the past 25 years, there have been a few Texas Senate bills that address the lack of water left for the environment, but in Rubinstein's perspective, none of them have been enough. Without leaving water for the environment, the Rio Grande — and the resources and services it provides — is dwindling.

The fallout of that is that during drought conditions, the environment is the first to be impacted," he said. "The ecosystems of our rivers and streams bring great economic value to Texas, and not recognizing those impacts will have long-term implications on fish production, healthy ecosystems, biodiversity, water quality and on and on.

According to Rubinstein, the next steps in the history of the Rio Grande's water — and all of Texas' water — will be to set aside water for the environment, support farmers and ensure that existing treaties are adhered to.

"It's all of that, and no one of them come first," he said. "It all comes back to — how are we going to properly value water?"

"If you don't know what your water is worth other than what it's worth from the crops you're going to grow, then it's a use-it-or-lose-it proposition. If you know what your water is really worth, then you can put it up to the market at its proper value to see if somebody else can put it to a higher and better use. That could mean meeting somebody's municipal demands or a forbearance agreement to meet environmental flows."

With the population along the Rio Grande continuing to grow and more droughts on the horizon, Rubinstein said that talking about the history of water won't be enough. More policy and action will be necessary.

"It's easy to talk about but very hard to do," Rubinstein said. "But if you don't value water, then you're not protecting water."

The Rio Grande serves as a geographical and political boundary between Mexico and the U.S. Photo by Adobe Stock

Story by Kerry Halladay

JUST ONE SHARED RIVER

The future of water deliveries on the Rio Grande

The U.S. and Mexico are divided by the Rio Grande, but the two countries must come together to solve their water delivery problems because it is just one river.

Every five years a water clock ticks down to a due date between the U.S. and Mexico. According to a 77-year-old agreement, Mexico must deliver water from the Rio Grande to the U.S. But with ever greater demands on the river and increased uncertainty of its flow due to climate change, those deliveries have faced increasingly tense problems that require ever more collaborative, flexible, human answers to solve.

The year 2020 was one where the water came due and Mexico had to delivery on its five-year water quota from the Rio Grande to the U.S. under the 1944 Treaty for the Utilization of Waters of the Colorado and Tijuana Rivers (1944 Treaty). Though this delivery obligation was often called Mexico's "water debt" in the mainstream news media in the U.S., according to the treaty, actual "debt" does not occur until the deadline passes without full deliveries being made.

Prior to the Oct. 24 delivery deadline, tensions strained to the breaking point in Mexico. Farmers from the Mexican state of Chihuahua protested the government delivering water to the U.S. aggressively throughout the year. They were angry that what they felt was their water — the means to their livelihood — was being given away.

Tensions were exacerbated by demands from north of the border as well where many Texas farmers were angry because they felt their water was being withheld. In a Sept. 15, 2020 letter to U.S. Secretary of State Mike Pompeo, Texas Gov. Greg Abbott called the waters of the Rio Grande vital to Texas agriculture as well as municipal and industrial needs.

Carlos Rubinstein — past chairman of the Texas Water Development Board and past commissioner and Rio Grande Watermaster for the Texas Commission on Environmental Quality — spoke at the first "Coffee Break" event held by the Permanent Forum for Binational Waters on Aug. 26 to discuss the delivery situation. He told attendees that the situation should not surprise anyone who has paid attention to the history of the Rio Grande.

"We've seen it before. It's not a surprise," he said.

Samuel Sandoval Solis, Ph.D., associate professor in the Department of Land, Air and Water Resources at the University of California, Davis and Cooperative Extension Specialist in Water Management, had much the same to say at the Coffee Break event. He called the tensions leading up to the deadline "a story repeating."

The beginning of the troubled water sharing story

Today's tensions over the water debt are rooted in a long history of disputes that go back to the U.S.-Mexican War and the shaping of the two countries as they exist today. The war ended with the signing of Treaty of Guadalupe-Hidalgo in 1848 and with the U.S. annexing over half of what had been Mexico. That ceded territory today represents the U.S. states of California, Nevada, Utah, Arizona, New Mexico, part of Colorado, and Texas west of the Nueces River. This territory included the headwaters of the Rio Grande in the mountains of what is now Colorado.

Beyond using the Rio Grande and other rivers including the Colorado and the Gila as boundary markers between the two countries, the Treaty of Guadalupe-Hidalgo said nothing about water sharing. That topic was first addressed in the Convention of 1906 for the "Equitable Distribution of the Waters of the Rio Grande." The agreement stipulated that the U.S. would deliver 60,000 acre feet (about 19.5 billion gallons) of water annually to Mexico from the upper portion of the Rio Grande ending at what is now El Paso/Ciudad Juarez.

The Convention of 1906 laid the groundwork for the 1944 Treaty, which outlines water delivery requirements between the two countries and created the International Boundary and Water Commission (IBWC, or Comisión Internacional de Límites y Aguas in Mexico) to implement the treaty.

Under the 1944 Treaty, the U.S. is required to deliver 1.5 million-acre feet (about 489 billion gallons) to Mexico annually from the Colorado River. Meanwhile, according to the treaty's Article 4, Mexico is required to deliver 1.75 million-acre feet (about 570 billion gallons) of water to the U.S. from the Rio Grande every five-year cycle. If U.S. storage at the Amistad and Falcon reservoirs reach full capacity within the five-year period, however, the cycle ends and a new one begins. The treaty additionally "forgives" all debts if at any time during a cycle the U.S. storage at both reservoirs reach 100% capacity.

The 1944 Treaty also outlines that if Mexico is unable to make this minimum delivery every five years, such as in the case of extraordinary drought, the deficiencies "shall be made up in the following five-year cycle with water" from some Rio Grande tributaries. This allows for what some have begun calling Mexico's water debt to build over the years.

In the recent past, when Mexico either built up a water debt to the U.S. or otherwise struggled to make deliveries from the Rio Grande, other strategies were used. Specifically, Article 9 of the treaty allows the commission to be flexible in making water deliveries from other tributaries to pay or augment the water deliveries. For example, in 2015, water from the San Juan River was delivered to reduce the amount of shortfall that would exist at the end of that cycle.

Speaking of that agreement, Mario López Pérez said both Mexican and U.S. negotiators had focused on the main goal of getting water to the U.S. in 2014-2015. López was a past coordinator of hydrology at the Mexican Institute of Water Technology (Instituto Mexicano de Tecnología del Agua) as well as the former engineering and binational water affairs issues manager at the National Water Commission (Comisión Nacional del Agua) of Mexico.

"Treating the United States as the first obligation in the allocation of the water, that was our main goal. As an example of that kind of agreement to honor our words, we agreed with Texas. We went directly to the stakeholders," he explained.

"The United States received the San Juan water in order to reduce the deliveries from Falcon dam. The Mexican water came from excess water from excess runoff from severe storms that occurred in the upper San Juan Basin."

Change along the Rio Grande

Change is a reoccurring theme in the list of potential problems that led to this point. In some ways, the 1944 Treaty is uniquely set up for change because of its Minute system. A "Minute" is a small implementation agreement to solve an emerging issue not otherwise addressed by the treaty. There are currently 325 Minutes that have been made to the treaty, the most recent having ended the most recent water delivery issue on Oct. 21, 2020.

According to Sally Spener, IBWC U.S. foreign affairs officer, the strength of the Minute system is that it allows IBWC to develop agreements to implement various aspects of the treaty and adapt over time. It additionally does not require going through the congresses of either country, meaning it can more rapidly and nimbly adapt than most international agreements.

"That is pretty unique. You hardly find this in any other water sharing treaty in the world and definitely not between the two countries," said Rosario Sanchez, Ph.D., Texas A&M AgriLife Research senior research scientist at the Texas Water Resources Institute and director of the Permanent Forum for Binational Waters. "But the drafters of the treaty never expected a couple of things: population growth and climate change."

"The number of people living in that area has greatly increased from the 1900s to 2020," said ⇨

Luzma Fabiola Nava, Ph.D., researcher for Mexico's National Council for Science and Technology (Consejo Nacional de Ciencia y Tecnología). Indeed, the populations of El Paso and Cameron counties are more than four times larger today than what they were in 1940, for example. According to U.S. Census data compiled by the Texas County Information Program, El Paso County had about 131,000 and Cameron County had about 83,000 residents in 1940 compared to 839,000 and 423,000 today, respectively.

"So, the demands have increased automatically as more people are living in the area," Nava said.

More people mean more demands on the water, but there is also the impact of climate change, or "increased hydrologic variability" as López called it.

"Some say it is climate change; others say it is not climate change. We don't care if it is or not. The fact is there is huge variability in the system. That was not the case when the treaty was signed."

"At the core, the problem is an overallocation," he added.

Sandoval said much the same, describing the situation as there being more water on paper than is in the river. He said the treaty allocates as much as 50% more water than regularly flows in the river. Nava agreed, adding that the on-paper water is currently "locked" with the treaty as is.

"That means that taking into consideration all these changes is not possible unless something else happens to modify those quantities that have to be shared among the parties," Nava said.

Not an easy question; not an easy answer

If there is a problem with water allocation from the Rio Grande, and the 1944 Treaty is uniquely changeable through its Minute system, why not change it?

There are many disagreements about what needs be done to prevent issues like the current situation from developing again. Primary among them is whether the 1944 Treaty should be changed, replaced, or if it is part of the problem at all.

On the one hand, those involved with Texas agriculture have noted that the treaty has no teeth as is; there is no enforcement tool for the U.S. if Mexico continues to repeatedly fail to make its water deliveries. Also, the treaty's drafters focused on agricultural needs and uses only. They did not know that one day cities would rely on agricultural infrastructure to get their water too. Today those oversights are increasingly palpable as urban populations grow along the Rio Grande and the ecological importance of the river and its systems become better known.

Both oversights could argue for a substantial change to the treaty, possibly even a new treaty entirely.

On the other hand, some involved with the treaty and the Rio Grande have noted that there are more human problems underlying issues that must be addressed first.

"The treaty is not the problem. If we can't comply with this one, what makes you think we can comply with a different one?" asked Rubinstein.

"There is a real problem that the population and the uses of the water have dramatically increased along the border, but they also have on the Colorado, and there's cooperation there. So, something is missing here," he said.

"On the Mexican side, they are not setting aside water as a priority for delivery first just like the United States does out of the Colorado. On the American side, we think we have a right to dictate to Mexico on the exact steps it needs to comply. We would not accept that from another country, and we need to show the exact same respect for Mexico. Both sides have taken positions that are counter to finding solutions."

He additionally opined that selectively reading the treaty is a problem on both sides of the border.

"Read the whole darn thing and empower the people who are sitting across the table to apply the entire treaty," he urged. "The commissioner of IBWC absolutely has the authority to look at the San Juan, and we have used that in the past. But when you only want to read Article 4 and you want to ignore Article 9, it isn't a problem with the treaty anymore, is it?"

Nava agreed that the treaty is not the problem.

"The 1944 Treaty, from my perspective, is a very good treaty. It could be better, but as of today, it is very good. It has the institutional capacity to solve our current problems through the Minute process," she said, adding that the current situation is an issue that needs to be addressed by diplomatic means.

"The current situation between Mexico and the United States regarding water deliveries under the 1944 Treaty reflects how these countries have been managing an issue related to complex changes, including climate, hydrology, demographics, agriculture, pollution and politics," she said.

"An enormous generation of political will is needed as well as sustained dialog on those socioenvironmental issues."

Elephant Butte Reservoir is governed by The Rio Grande Compact, an agreement between Texas, New Mexico and Colorado that equitably apportions the waters of the Rio Grande Basin. TWRI file photo.

The path forward on the Rio Grande

While there are many problems facing the Rio Grande, U.S./Mexico relations over its water and working within the 1944 Treaty, there are also areas of agreement; specifically that there are non-water issues that affect the discussion of water. Many participants in the Coffee Break stressed the need to rebuild trust and foster cooperation between stakeholders.

"The non-water issues become important because they are a big part of the discussion process. You want to feel respected, and you want to feel secure. And this goes in both directions," said Sandoval. "We need to have improved diplomacy. We need to start thinking how to avoid some of these issues, and how they can be prevented."

Part of the proactive effort at fostering respect is acknowledging the different needs, interests and concerns of water users on both sides of the border according to Rubinstein and López.

"Part of the issue we have to recognize is that the social, economic and political implications state by state in Mexico are different, and that gets in the way of the ability to comply," said Rubinstein.

López echoed this, noting that sometimes the water basin councils in Mexico don't take this into account either.

"The people from Chihuahua do not have the same vision as the people from Tamaulipas. They have different visions. They have different interests," he said. "And the opinions of the representatives of stakeholders at the basin council level, most of the time it is not the opinion of the people they are representing."

"But let's not forget that this is a social issue, a human issue, that we are dealing with and it will take time. It is all is about trust," he added.

"We need to rebuild trust with the Mexican water users because we have disrespected them. We must rebuild trust in the Mexican basin councils. And we must rebuild trust with the United States and the Texas governments regarding the treaty. We need to learn from the Colorado process."

Both he and Rubinstein spoke at length about their efforts in the late 1990s through the middle of the last decade. According to López, they sat down and hashed out a practical approach that could work for all stakeholders rather than adopting a top-down, demanding position that puts Mexican farmers on the defensive.

"We agreed with the stakeholders. We explained. We gave them reasons and justifications, explanations that this was going to be different for everybody, not only for the Mexican farmers, but also for the U.S. farmers in Texas," López said.

Rubinstein also warned that excluding stakeholders from either or both sides is "a great recipe for failure."

"Harsh positions taken by both sides actually get in the way of what should be an amicable resolution," he added. "What we did to resolve the issue before was find solutions to not only the problem that was facing us, but to proactively prevent it going forward. That's what we need to get back to."

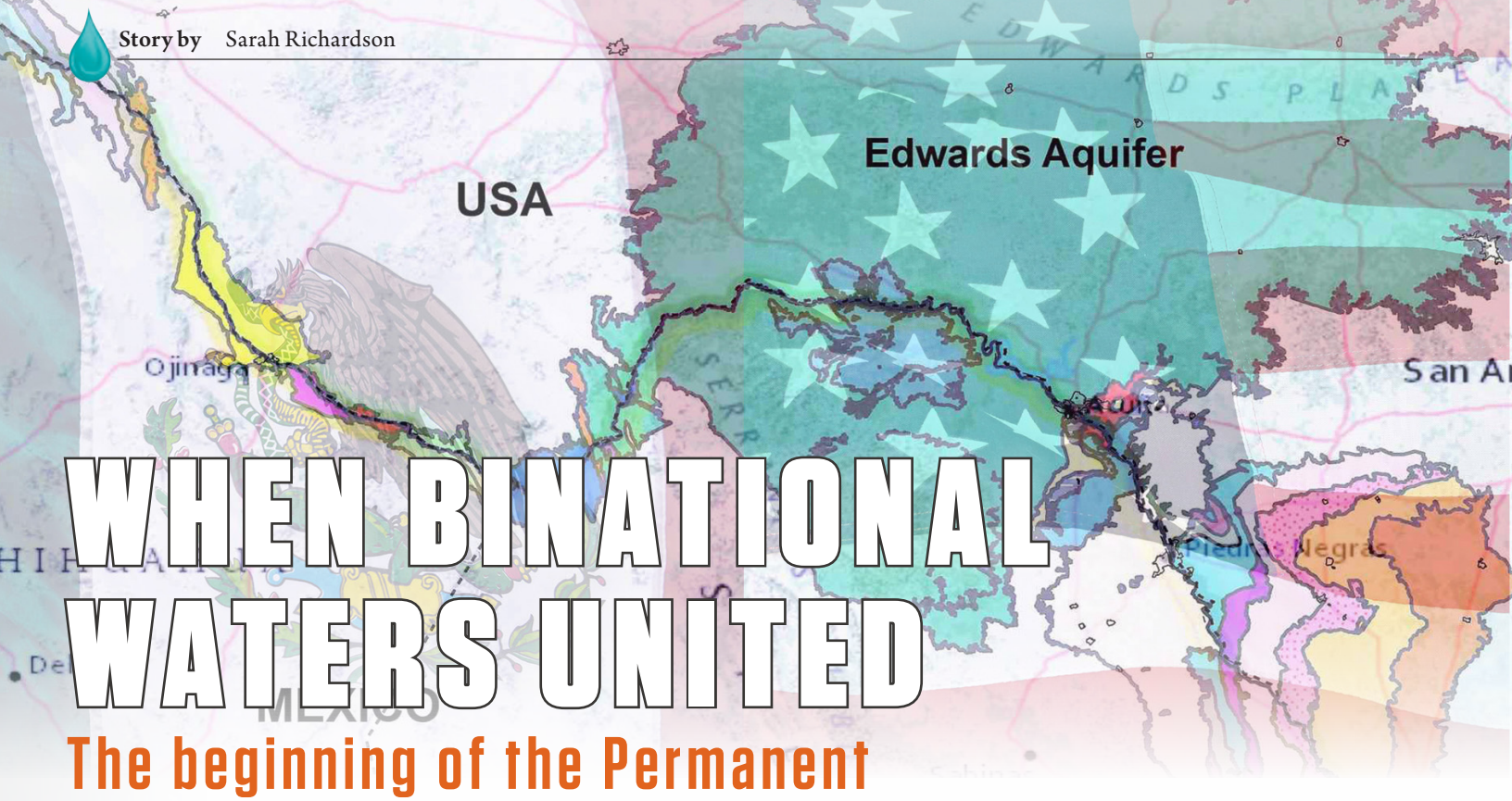
Several of the participants in the Coffee Break said that there must be a shift in mindset related to the river itself and those who depend on it.

"I think all stakeholders need to make a distinction between ownership and a sense of community. It's not the same thing," Nava said. "If I own the water, I do what I want because it is my water. But if I belong to the basin community, I care what is happening upstream, downstream and within my area."

Sandoval echoed this, stressing that it is not and cannot be a U.S. versus Mexico situation.

"The fate of Mexico is tied to the fate of the United States, and the fate of the United States is tied to the operations in Mexico," said Sandoval. "It isn't one side of the border or another; the reality is the fate of the farmers is tied together. We need to see this as a shared resource. We just need to realize it's just one river."

Story by Sarah Richardson



WHEN BINATIONAL WATERS UNITED

The beginning of the Permanent Forum of Binational Waters

Strengthening relationships and connections among experts and stakeholders throughout the U.S.-Mexico border region

When two countries are established, water does not stop flowing at the boundary between them. Its continuous stream circulates through the natural landscapes and ecosystems formed long before any countries were named.

As communities have developed along the border of the U.S. and Mexico over the years, treaties were created to apply boundary demarcation, national ownership of waters, sanitation efforts, water quality and flood control in the border region, according to the U.S. Section of the International Boundary and Water Commission.

With increasing populations, less frequent precipitation, intensifying droughts and extreme hurricane events in the border region, challenges such as water quality and water scarcity continue to grow.

In response to these and other challenges, a group of problem solvers created the Permanent Forum of Binational Waters to foster communication and collaboration efforts for the sustainability of binational waters. The group is a network of scientists, government officials, nongovernment organization members and citizens cooperating to understand all the parts of the binational water system.

How it all began

"As every other great idea, it started with a drink and a napkin," said Rosario Sanchez, Ph.D., director of the Permanent Forum of Binational Waters and Texas A&M AgriLife Research senior research scientist at the Texas Water Resources Institute.

While talking with colleague Chris Scott, Ph.D. at the University of Arizona, about their different events and related water projects along the border, Sanchez said they began to realize how disconnected their work was.

"We noticed that sometimes our binational cooperation efforts end up being isolated."

She said binational communication about water-related challenges is one of the biggest struggles to overcome to make progress at a border-wide level.

"It was very rare that we communicated what we were doing, and then we said, 'Well, why don't we create a permanent forum?' We should integrate our efforts to make bigger impacts," Sanchez said.

Sanchez emphasized the need for a permanent forum to serve as an ongoing communication platform and not just one event a year where people tend to meet and then go back home without a plan

to reconnect. She expressed a need for continuous communication between academics, public agencies, nongovernmental organizations and private institutions. A forum would allow collaborators to share what they are working on with each other, such as research updates, events, proposals and anything else that has to do with binational waters.

Sanchez invited Samuel Sandoval Solis, Ph.D., associate professor in the Department of Land, Air and Water Resources at the University of California, Davis and Cooperative Extension specialist in Water Management, to brainstorm about the project's possibilities.

"He loved the idea," Sanchez said. "He and his team gracefully joined the effort, and we started planning what to do."

Building the network

To help connect the people working on water-related projects along nearly 2,000 miles of border lands, Sanchez, Sandoval and the growing team began developing a communication method to integrate border-wide collaboration.

"It's really a big, huge problem to communicate successfully, to transmit a message and be able to move that message toward something bigger," Sanchez said. "There are three big things that we aim to happen successfully under the umbrella of the forum. One is communication; two is a consequence of the first one, sharing information. The third is building trust."

Without effective communication and information sharing, Sanchez said it is often not possible to move forward with any kind of project. "Those two elements give us the key for successful cooperation, which has to be based on trust. But to have trust, you have to engage and communicate. You have to know each other first. As basic as this sounds, it is where everything starts."

Agreeing with Sanchez, Sandoval said, "We needed to have a place where information is not lost."

Sanchez started sending emails to more colleagues she worked with along the border explaining the forum. The response was amazing.

"It started having this snowball effect of 'Yes, please do it! We need this, we will support it,' and the word started spreading all over the border with different academics and nongovernmental organizations. Anyone you could think of working on binational waters was totally into the idea," Sanchez said.

"We needed a place where a researcher or academic could come in and say 'Hey I'm looking for a person who is knowledgeable in A, B and C,'" Sandoval said.

People often need expertise and Sandoval said the problem is that they do not know where and who to look for. "This network is that thing where they can actually go to look."

With their collaborators, Sanchez and Sandoval named the project the Permanent Forum of Binational Waters and began creating a website.

One year later, Sanchez said there are now about 150 network members on the forum.

"We are communicating constantly and receiving a very good response. We have created a database with a network of people to find who you are interested in working with, to see what they are doing and their areas of expertise or their location.

"The network is an integration of experts, not just academics," Sanchez said. "They became very interested and passionate in participating in the network." She said their enthusiasm was a testament to the demand for this kind of network. "There was a gap in the binational waters narrative we weren't addressing, and it was very much needed." Sandoval agreed. "We have the people in the room, but just being in the room doesn't mean things are going to change."

The next step, he said, is to get the network members to work together and start generating synergy.

"We are trying to cooperate and build good relationships," Sandoval said. "Right now, we have the room and the people and we're trying to make the people work together."

The socialization of science

The forum's website includes a listing of the network members based on their expertise. The categories include the general fields of groundwater, surface water, wildlife, agriculture, social and economic systems and institutions and administrative systems. Experts can also be sorted by specialty categories, such as water quality, managed aquifer recharge, public policy, climate change and infrastructure development.

To encourage networking and more efficient communication, the network uses a Slack channel to share information and resources. And because of their growing roster of purpose-driven conversation events, the forum members have developed a blog for their discussions.

The forum has also hosted virtual events via Zoom with great success. It hosted its first conference, the "U.S.-Mexico Transboundary Groundwater Conference: Where We Are and the Way Forward," in October 2020. The theme of the conference was "Innovation and Creativity: Strategies for Unprecedented Challenges." It was well attended with 140-150 participants the first day and 120 the second day. ⇨

Themed discussion Coffee Breaks are held monthly and are another example of how the forum is connecting. The theme of the August event was "Water Deliveries from Mexico to the U.S.: The 1944 Treaty and Conciliation Points," and the September event's theme was "U.S.-Mexico Transboundary Groundwater: Withdrawals and Binational Implications."

The forum has planned another event series named Science Talks. The first Science Talk was in November 2020, titled "Women, Science and Water in the U.S.-Mexico Border."

"In the water sector, we have made strides to increase gender equality among our scientific peers and we do not, by any means, having adequate representation in this case," Sandoval said. "So how can you do that? Well, you start showing that it is possible. It is not that there are not good female scientists. It's just that sometimes we don't give them the microphone."

Sanchez said the Science Talks present an opportunity to communicate new information, research and scientific developments in lay terms to the people who live in communities along the border.

"So the border communities will understand what we are doing. What are the new developments in science around the border and what does that mean for them? How that science can actually be useful and applicable to the border. Why it's important."

In addition to communicating the science, Sandoval said the forum intends to have events that are as inclusive as possible with English and Spanish translations available to make the events truly binational. Inclusion also means giving everyone a voice at the table.

Sanchez said the participant turnout to the first conference was more evenly split between the U.S. and Mexico with the addition of professional translation services and the online format reducing usual participation barriers. "When you have an in-person conference, you usually get a lot of people from the host country, but with this conference, it was almost 50-50 in attendance."

With such positive feedback from attendees, Sanchez said the Science Talks will also be available in English and Spanish.

Additionally, Sanchez said the Science Talks will be run by young people, "who have passion and strength and are very creative and hardworking people. They think about things that you usually hadn't thought about and that can only come from a fresh mind.

"I think that's part of the success of the forum," Sanchez said. "It's really a mix of old people, me included, with really young people. We all have the same say, the same vote. That really has made a difference."

Moving forward

For Sandoval, the next step for the forum is making the network a two-way street.

"We have a solid one-way street, and we're building the infrastructure to have a two-way or a multiple-way street. That is in the mission: people communicating, fostering these groups and communicating with society, decision-makers, stakeholders and so on," he said.

Sandoval said the two-way street must include stakeholder involvement. "We need people. We need to include the social component, the stakeholder engagement, the coproduction of science, having people from the beginning."

An important part of communicating binational water sustainability includes reconnecting society, scientists and decision-makers back to the river, Sandoval said.

"Unfortunately, society has been disconnected from the food that we eat and the water that we drink. We do that every day when we turn on the faucet. Where is the water coming from? All of it comes from Mother Nature. It rains; it gets into the aquifers and the rivers and reservoirs, canals, pipes, treatment plants and back into the river."

Communicating, collaborating and implementing solutions cannot happen overnight.

"We're going to need a lot of time," Sandoval said. "That's why the forum is important because we're thinking of this as a long-lasting place."

Sanchez agreed, likening the Permanent Forum of Binational Waters to building necessary infrastructure. "It's building a network, a community, and you're always going to need that, especially at the border, especially when it comes with water issues," she said.

Building something permanent doesn't happen on its own; it requires a community, and it takes community-focused work.

"This is a platform for everyone," Sandoval said. "This is service. It's all of us, and it is inclusive. So the last word or the key message here is that we're building long-lasting bridges. This is good news. This is cooperation. This is a mutual understanding."

"This is something that is only going to get bigger as long as we support it and as long as we lead the integrated effort with passionate people working behind the scenes," Sanchez said. "That's why our slogan is, 'water unites us,' because it really does."

Story by Chantal Cough-Schulze

SALINITY ALONG THE RIO GRANDE

Changing the agricultural landscape

In South and West Texas, agriculture is made possible by irrigation from the Rio Grande. In recent years, the river and soil have been getting dryer and saltier. For agriculture to keep up, researchers say that something needs to change.

The land along the Rio Grande is one of the agricultural homes of many of Texas' state symbols. Pecans are the state tree and nut, cotton is the state fabric and fiber, red grapefruit is the state fruit and 1015 onions — a Texas-developed sweet onion variety — is the state vegetable. Other crops, such as sorghum, sugarcane and alfalfa, might not be state symbols, but they have the distinction of contributing hundreds of millions of dollars to the state and national economy.

The Rio Grande is what has made agriculture possible in South and West Texas for hundreds of years or more. Today, the Rio Grande irrigates 2 million acres of land, roughly twice the size of Rhode Island.

To understand agriculture along the Rio Grande, one must first understand "where the water comes from, what volume and how the water drains," said Juan Enciso, Ph.D. Enciso is an associate professor in Texas A&M University's Department of Biological and Agricultural Engineering, administered by the College of Agriculture and Life Sciences. Enciso also has a research appointment at the Texas A&M AgriLife Research and Extension Center at Weslaco.

As the Rio Grande makes its way from its snowmelt-fed headwaters in Colorado to its outlet in the Gulf of Mexico, 80% of the water is diverted for agriculture.

"We are a very dry state; we don't have enough water," Enciso said. "We have to be very careful about not overusing the water."

Many of the crops, like pecans and alfalfa, require a lot of water, said Girisha Ganjegunte, Ph.D. Ganjegunte is a professor in the Texas A&M College of Agriculture and Life Sciences' Department of Soil and Crop Sciences and has a research appointment at the Texas A&M AgriLife Research Center at El Paso.

"Because of high evaporation and high agricultural operation, you need a lot of water to grow the crops," he said. "The irrigation water depth is measured in feet here, not in inches."

As global temperatures rise, drought is becoming more common and snowpack at the headwaters of the Rio Grande is decreasing. With water getting scarcer, producers have to choose which crops to prioritize. ⇨

Furrow irrigation is a common strategy in Texas as seen here in this sugarcane field. Irrigation is necessary in Texas, but it also exacerbates existing salinity issues. TWRI file photo.

"During periods of drought, people divert all that water to salvage pecan crops because it's a tree crop, and it takes years to produce," Ganjegunte said. "So, if you kill it, then you have to wait for 10 years again. But in the meantime, payments to the banks won't stop."

Ganjegunte said the water producers use to irrigate and the soil the crops grow in are saltier than many crops prefer, and it's getting saltier still.

Salty and getting saltier

The agricultural soil along the Rio Grande is naturally somewhat salty.

"Soil is nothing but weathered rock. It's formed by the action of vegetation, living beings like humans, climatic variables — but the major thing is water," Ganjegunte said.

He used El Paso County as an example.

"All these rocks are some kind of salts, an amalgamation of different minerals. So, when they get fragmented, when they become soil, all those salts that were present in the parent material are still there."

Because of the geological formations, groundwater along the Rio Grande tends toward saltiness. This presents a problem for both municipal and agricultural water users in the region. El Paso pulls 50% of its drinking water from groundwater, and pecan producers who can afford it drill wells hundreds of feet deep, but the aquifers get saltier as they get deeper.

Surface water, meanwhile, comes from the Rio Grande. At the river's headwaters, the water is "pristine," Ganjegunte said. By the time the river reaches El Paso, the salinity of the water is above 1,000 parts per million. Water above 1,000 parts per million is no longer considered freshwater and, while still safe to drink, is above secondary drinking water standards.

As the Rio Grande's water journeys toward the Gulf of Mexico, it passes through both urban and agricultural land. Booming populations on both sides of the border means more people are using water softeners — also salts — which are discharged with wastewater. Because wastewater treatment doesn't remove salts, they all end up in the river.

Meanwhile, on agricultural land, salt-containing fertilizers can enter the river through drainage. As that water is used for irrigation, more salt is put into the soil.

"It's a combination of different things: population growth, more wastewater, more softeners, fertilizers," Ganjagunte said. "So, over time, the salinity is going only up and up and up."

If enough freshwater comes into the soil regularly, such as from rain, salt is leached out of the soil, said Genhua Niu, Ph.D., professor of urban agriculture at the Texas A&M AgriLife Center at Dallas. But along the Rio Grande, rain can be hard to come by.

El Paso County, for example, has an annual precipitation of nearly 9 inches, mostly of rain. Potential evapotranspiration — how much

Niu demonstrates indoor farming methods that use LED lights to grow leafy greens. Photo by Genhua Niu.

Enisco stands beside some sensing equipment. AgriLife Today photo by Rod Santa Ana.

evaporation there would be if enough water was available — is determined by temperature, wind and sun exposure. In El Paso County, the annual potential evapotranspiration is around 78 inches, Ganjegunte said. That means that on average, the local climate is capable of evaporating nearly nine times more water than actually rains down.

Decreasing water levels in the Rio Grande further concentrate the salt in the soil with little rain to leach it away. Even if there was more rain, the local soil — fine soil deposited by the river and clay-heavy agricultural soil — isn't very permeable, so it's hard for water to get in to leach salt out.

Irrigating with salty water — the only water available — therefore creates a self-perpetuating problem, Niu said.

"The rainfall is so little, so water is constantly evaporating. If you are irrigating, like a pecan orchard or a field of cotton, the salinity gets worse with more irrigation, because there's no pure water," she said. "Then water will evaporate. As soon as the water is lost in the atmosphere, you have no control. But the salt stays there forever."

Every crop has a threshold for the amount of salt it can handle before the quality and yield suffers: cotton is somewhat tolerant to salinity, while pecans are not. Too much salt can burn crops' leaves and roots, reduce their ability to take up water and nutrients and stunt plants.

"So we have to manage it, because we don't have any other type of water available in the region," she said. "Anything that is going to save water and grow plants, I would be willing to try."

Solutions and other problems

Finding solutions to the salinity and water issues starts with knowing the extent of the problem. Enciso uses sensors to understand fluctuations in groundwater and soil moisture, while Ganjegunte identifies salt hotspots in agricultural fields, making field-scale salinity maps for producers and district-level salinity maps for policymakers.

"We need to see where the problem is and rectify it," Ganjegunte said. "We are trying to develop solutions to make life sustainable, to ensure the long-term viability of irrigated agriculture."

Some solutions focus on removing the salt, such as growing salt-absorbing crops like barley and sorghum. When the plants are harvested, less salt remains in the soil. If producers are trying to leach the salts out of the soil, deep tilling and applying water-soluble forms of calcium can help.

With some creative design, Niu said producers can also lop off the saltiest part of the soil.

"They build a ridge and a furrow. When you irrigate the field before seeds are sown, the water is evaporated to the air gradually, and the salt follows the movement to the top of the ridge," she said. "So the salt accumulates on the edge of the ridge, and producers just top off that ridge, removing the top, and then they sow the seeds. This way, the new soil layer is not so saline." ⇨

Alternatively, producers can use irrigation strategies that reduce salt application, Ganjegunte said.

Salinity depends on the volume of water, so using low-water irrigation methods like drip irrigation adds less salt to the soil and makes less preexisting salt become soluble. By using less water, drip irrigation also leaves more water for the river and the overall stability of the ecosystem. Desalination of agricultural water may also be an option someday, he said, but it isn't affordable yet.

Other solutions address the crops being grown in the salty soil. Some crops can be made hardier, such as with the salt-tolerant pecan rootstocks that Niu has worked on.

"You cannot find a cultivar that is good on everything. But how about we find something that is salt tolerant?" she said. "Then we can always do grafting — you know, find a good rootstock and graft on something that has the quality of the nuts or high yield."

There's also the possibility of changing or adding crops, she said, giving the example of indoor hydroponic farming of leafy greens. Hydroponics requires greenhouses but not soil, so it sidesteps the soil salinity issue while using a fraction of the water.

Growing less-common crops such as pomegranates and quinoa is also an option, because they are salt tolerant enough to handle the region's soil.

"Quinoa is a salt tolerant, short duration and low water intensive crop. It can produce revenues at the same level as pecans," Ganjegunte said. "It can give serious competition to the existing cash crops."

Still, no one solution to the salt and water problems will be enough, Enciso said.

"This is a complex area where simplistic approaches and solutions don't work," Enciso said. "We have to carefully study each situation."

Keeping agriculture along the Rio Grande resilient will take a little bit of a lot of solutions, Niu said.

"I think diversifying is good. The traditional crops such as pecans and cotton can stay, but we probably need to add more crops," she said. "Diversification is needed to keep the vitality. This way you keep busy and you keep the flow of cash coming in."

The future for producers

That flow of money to producers is important. Growing new crops like pomegranates requires new machinery, skills and distribution chains, while the market for bioenergy crops fluctuates with the price of crude oil. Changing crops and methods involves a lot of risk.

"Producers' livelihood depends on agriculture. They have invested so much on equipment and labor force, and they're used to growing crops in certain ways. They have bank payments to make," Ganjegunte said. "If they make a mistake, if they don't irrigate at crucial stages, it can reduce the yield and the money that they are getting."

As new crops and methods come into the picture, Enciso said it is vital to support producers.

"It's not about efficiency, it's about inclusiveness. We can't leave aside the needs of the people," he said.

"Producers are smart. They figure things out fast. I think we need to have a good support system for producers, and we need to continue supporting our research and extension network for producers so this region continues to be successful."

Enciso, Niu and Ganjegunte all said that meeting producers' needs starts with demonstration.

"Most of my research is in the producers' fields," Ganjegunte said. "There are producers who are eager to embrace new technologies, and they themselves are using sensors, and they download the data and send it to me. I think the best thing is to demonstrate it there, and then others will start adapting."

Demonstrating the variety of solutions — from hydroponics to pomegranates to drip irrigation — will also help attract the next generation of producers, Niu said.

"A new way of growing things will be challenging to start, so we need a training of the workforce," she said.

With droughts, salinity and population all increasing along the Rio Grande, change to agriculture is inevitable, Enciso said. The goal is "to be sustainable socially, economically and environmentally," he said.

"The thing is, everything changes. That's why we have different crops, and we have to look for new opportunities. We have to think long term, because sometimes we want fast results, and sometimes things don't work like that, you know?" he said. "We never stop learning, because the situation changes all the time."

Story by Sarah Richardson

The Community Keeping a Little River Working

The Arroyo Colorado is often called "the little river with a big job." That job is to be a major drainage and flood control system to the Rio Grande, as well as feeding one of the most unique ecosystems in the world. A dedicated community group, the Arroyo Colorado Watershed Partnership, has been helping this little river do its work.

Even rivers like the Rio Grande need help sometimes. The Arroyo Colorado is often called "the little river with a big job," and that job is as a drainage to the Rio Grande and the people and ecosystems that depend on it.

But the Arroyo Colorado also needs some help too, and a partnership of dedicated local, state and federal stakeholders have worked together since 2002 to develop and implement a community-based watershed plan to improve the health and function of this small, but important, tributary of the Rio Grande.

Originally a stream channel of the Rio Grande that provided quality habitat for fish and wildlife, the modern Arroyo Colorado has been modified to carry both commercial barges and, when necessary, flood waters to the sea. It additionally serves as the main drainage stream for the Lower Rio Grande Valley (LRGV) with its flow sustained by wastewater discharges, agricultural irrigation return flows, urban runoff and base flows from shallow groundwater.

The Arroyo Colorado empties into the Lower Laguna Madre, one of only six hyper-saline lagoons in the world. The river is still a productive nursery for fish and other aquatic species and provides bird habitat, as well as premier recreational spaces for fishing, hiking and bird-watching. However, for decades, water quality data in the Arroyo have shown high levels of bacteria that exceed the state's standards for recreational contact. This is where the Arroyo Colorado Watershed Partnership (ACWP) came in.

Initially organized by two smaller groups of local stakeholders formed in 1998 as part of the State of Texas total maximum daily load (TMDL) process, the ACWP has since grown into an innovative group of local stakeholders and leaders. It collaboratively works with federal, state and private organizations to improve the health and function of the Arroyo Colorado watershed through various projects including working with cities to build coastal wetland habitats, educating farmers on agricultural best management practices and producing public service announcements on urban stormwater. ⇨

From beginning to drain

The Arroyo Colorado watershed, part of the Nueces Rio Grande Coastal Basin, covers 420,000 acres of land in the LRGV, located in southern tip of Texas.

According to Jaime Flores, Texas A&M AgriLife Extension program coordinator at the Texas Water Resources Institute (TWRI) and ACWP watershed coordinator, the Arroyo Colorado is a yazoo river to the Rio Grande. "Yazoo" rivers or streams form over extended periods of time alongside rivers that regularly flood. Strong seasonal flows coupled with flooding events can cause natural levees to form along the banks of a river. When a river with these natural levees flood, they effectively trap water alongside the river once it recedes. This results in parallel tributaries that are only refreshed with flow when the main river floods.

What natural forces first created, human activity expanded, Flores said.

"Because settlers to the area in the early 1900s had the Rio Grande, they were able to access water," said Flores. "After clearing the native thornscrub and brush to access the rich soil of the Rio Grande Delta, they started creating a huge irrigation system. They started building the canal systems and drainage systems, directing water from the Rio Grande to the irrigation districts where they could easily use it."

Flores explained that the Rio Grande and the Arroyo played a big role in the development of farms that became the towns and cities that now make up the LRGV as the agricultural hub it is today.

"Each town developed from one farm, or several farms in that one area," Flores said. "If you look at the Valley, it's really unique in the sense that it's got all these little towns and cities that once were farms. Over time, these small towns and cities have grown so much and so rapidly that they have expanded into each other and are now one of the fastest growing metroplexes in the state."

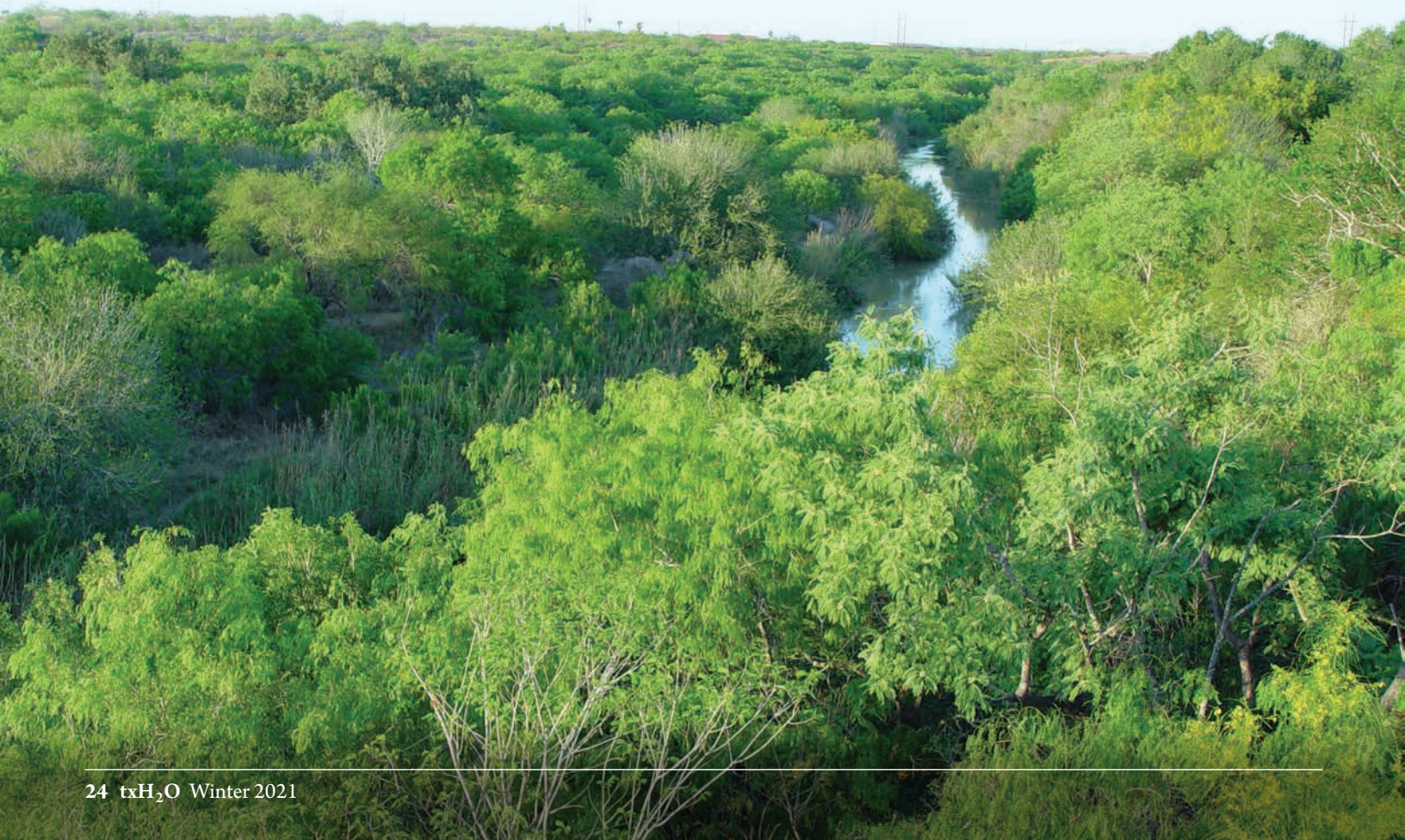
As the farms grew, so did the discharge demands on the Arroyo Colorado.

"It became a way to get rid of all the excesses used for everyday life. It became a way to drain everything," he said. "That became the norm. And as we got more wastewater treatment facilities, their discharge went into the Arroyo Colorado."

While the area started off as a series of farming communities, urbanization of the LRGV began to pick up in the 1980s according to Flores. This has been especially noticeable in recent years.

"Now we're about 50-50 farm-to-urbanization, whereas 10-15 years ago, it was like 75-80% was still ag use compared to urbanization," he said.

The Arroyo Colorado stretches approximately 90 miles through the heart of the Lower Rio Grande and empties into Lower Laguna Madre. Photo below and on pg. 23 by Christina Mild.



Even as the LRGV has shifted away from being a predominantly agricultural area, the demands on the Arroyo Colorado for drainage have continued. The impact has been water quality problems in the Arroyo Colorado.

Coming together to solve the problem

"It's not that water users in the area were deliberately trying to pollute the river, but after 100 years of it, it starts to accumulate," Flores said of the problem.

He explained that excessive nitrites, nitrates and phosphates from both agricultural and urban land, as well as 24 permitted wastewater treatment facilities that discharge approximately 60 million gallons a day in the Arroyo Colorado Watershed, can cause algae blooms and other water problems. The polluted condition of the river additionally endangers the fragile ecosystem of the Lower Laguna Madre estuary and lagoon.

"The estuary is a nursery for all the shrimp and the crab and fish and the birds," Flores said.

Because of the invaluable nature of recreation in the Arroyo Colorado, as well as the economic and ecological benefits that come from those species, businesses leaders, farmers and cities were motivated to form and join the ACWP.

Flores said the original partnership developed in 2002 from several groups working to reduce pollutants to the Arroyo Colorado. This started out as a TMDL study by the Texas Commission on Environmental Quality (TCEQ) before watershed protection plans (WPPs) existed in Texas.

"The TMDL work group, the monitoring work group, the outreach and education work group all merged to form the partnership," Flores said.

With support from Texas Sea Grant, TCEQ, the U.S. Environmental Protection Agency (EPA) and TWRI, the group published the "Arroyo Colorado Watershed Protection Plan" in 2007.

"It was the first WPP written in Texas. It was a template," Flores said. "Because it was the first WPP, it was very important for the state."

Since then, the ACWP published the "Update for the Arroyo Colorado WPP" in 2017, which outlined accomplishments to date, including significant technical and regulatory upgrades to eight wastewater treatment facilities (WWTFs), significant decreases in nutrient loading from those facilities and facilitating the increased and/or improved wastewater services to thousands of residents across 42 colonias along the border.

Today there are four different work groups related to the river and each one focuses on a different area of need. The Arroyo Colorado Agricultural Issues Work Group identifies and addresses agricultural nonpoint source pollution in the watershed. The Habitat Restoration Work Group was established to protect the remaining natural habitats in the watershed. The Education and Outreach Work Group was formed to address the low dissolved oxygen and high fecal bacteria in the Arroyo Colorado by increasing public awareness and fostering local stewardship in the watershed. The Wastewater Infrastructure Work Group was established to document the permitted point source WWTFs being discharged into the Arroyo Colorado and work to establish more stringent discharge permits for existing WWTFs.

"Everybody depends on the Arroyo Colorado for discharge," said Victor Gutierrez, AgriLife Extension associate with TWRI who works on the Arroyo Colorado WPP implementation. He says the ACWP is a huge undertaking, but people are getting the job done.

"Everybody comes together. There are a lot of people on these groups. We all get together and when a project comes up, we are all in agreement," Gutierrez said. "Everybody has their specific job duties within a group, and we just try to do the best we can with stakeholders. It is a big job."

There are over 700 collaborators involved with ACWP projects. Flores said there has been a lot more cooperation over the years. "It's very different now compared to how it started. It has kept evolving and growing."

To date, the ACWP has completed 19 projects made possible with funding from the EPA TCEQ, the General Land Office and the Texas State Soil and Water Conservation Board.

The ACWP currently has four community projects: Implementing Agriculture and Rural Management Measures, "Los Fresnos Best Management Practices Implementation", Tracking and Inventory of On-Site Sewage Facilities, Llano Grande Lake Restoration Project, and San Benito Wetlands Phase IV. These projects have all helped to implement the WPP and restore the Arroyo Colorado in some way.

Flores said it is a lot of work meeting with everyone and tackling the complex issues facing the river, but the protection of the Arroyo Colorado relies on everyone doing their part.

"Through these projects, our goal is to protect the Arroyo Colorado, the Lower Laguna Madre and the remaining natural habitat."

Story by Ava English

IRRIGATION CHANGES CAN HELP SAVE WATER AND A RIVER

Water availability and delivery logistics dictate irrigation practices along the Rio Grande. In a situation where unprecedented urban growth in the area is putting larger demands on a dwindling resource, irrigators must find ways to use less water.

Water delivered from blue polypipe evenly flows down furrow rows during a 2019 farm demonstration trip in the Lower Rio Grande Valley. Photo by Victor Gutierrez.

One of the wonders of Texas is its agricultural abundance. However, because rainfall cannot meet the needs for dryland farming, farmers along the border rely on surface water from the Rio Grande to make up the difference. But this supply of water is dwindling.

Rio Grande water demand for municipal use is on track to increase as the population grows and climate change threatens the net availability of the water in the river. As the water continues to be spread thin, the districts have less water to allocate for agricultural use. This puts pressure on agricultural water users to reduce water waste in their irrigation practices.

In addition to water availability, the water delivery system is part what makes irrigation in the valley a "strange creature" said Ray Prewett, an agricultural issues consultant. Unlike most irrigation systems in Texas, very few farmers along the Rio Grande own individual water rights. Most of the water is owned by irrigation districts that manage and distribute the water for urban and agricultural use.

Tom McLemore, general manager of the Harlingen Irrigation District, explained that to irrigate, farmers must contact the irrigation districts and request a water ticket.

"So normally a farmer walks in on a Monday and says, 'I need to buy 40 acres worth of water, and I want to irrigate it next Friday,' then we can order the water that Monday to be delivered for us to pick it up out of the river on Friday."

This system requires careful planning for the growers and districts.

"We try to anticipate what they're going to need as much as possible, but sometimes we get it wrong, and it's hard on the farmer whose crop is burning up and he forgot to order water," McLemore said.

"It's not an immediate turn of the switch like if you had a groundwater well, and that makes a big difference in what the folks down there can do," Prewett said.

Despite these unique obstacles, improvements in both water delivery and on-farm irrigation techniques have increased water sustainability practices in the Rio Grande Valley.

One effort that significantly boosted water-saving practices in the valley was the Rio Grande Basin Initiative (RGBI), a federally funded, collaborative outreach project by Texas A&M AgriLife Research, Texas A&M AgriLife Extension Service and the New Mexico State University College of Agriculture and Home Economics from 2001-2013. The goal of this program was to address present and future water demands in the Rio Grande Basin.

One example of this project was the canal lining evaluation project. Canal lining is a technique used to prevent water loss from seeping into the soil by lining the base of the canals with synthetic fabrics, concrete or both.

In 2005, RGBI engineers began evaluating the durability, efficiency and long-term viability of several of these liners. They determined that the best lining system incorporated both synthetic fabrics and overlaid concrete. In the 2010 Joint RGBI Annual Conference, RGBI researchers reported that using this lining reduced water losses by 94%. The engineers who worked on this evaluation also helped irrigation district managers in the valley select, install and maintain these canal liners.

Some farmers have adopted a similar approach and are even doing away with on-farm head ditches entirely by using polypipe to get water directly to the furrows.

"Just like we are piping in the canal, farmers are putting their water in a polypipe because they too can have and have had breaks in their own ditches to their irrigation," said Sonia Lambert, general manager for Cameron County Irrigation District No. 2.

Polypipe is a flexible plastic pipe that wraps around the farm like a long garden hose and the farmers can "poke holes" where they want the water to come out. Using this technique, farmers can direct the distribution of water flow in their fields.

The alternative to using polypipe is holding water in earthen ditches carved around farms. To irrigate, farmers transfer this water onto crop rows using siphon tubes. This practice is vulnerable to water loss from percolation and overflow if canal levels fluctuate.

The Texas Water Development Board (TWDB) recommended on-farm canal lining in their "Best Management Practices for Agricultural Water Users" report. This report was included as an educational resource to the Diversifying the Water Portfolio for Agriculture in the Rio Grande Basin, a Coordinated Agriculture Project (CAP). This program is funded by the U.S. Department of Agriculture's National Institute of Food and Agriculture and tries to increase water sustainability in the valley through water-saving educational resources for farmers to improve irrigation techniques.

Using polypipe complements other sustainable irrigation practices, like narrow border flooding. Compared to traditional pan flooding, which completely floods rows of crops, narrow border flooding in citrus farming targets the flow of water directly into the root zone.

"It's pretty simple, which is why it's caught on quite a bit. You just put up a dike and you run the water down where the trees are, so you don't waste a lot of water in the middle of your grove," Prewett said.

For citrus growers, narrow border flooding not only saves water and reduces costs, but also produces better fruit. The Texas Project for Ag Water Efficiency, a water conservation program funded by TWDB from 2005–2015, demonstrated that narrow border flooding uses one third of the amount of water and can double the economic value of citrus crops compared to pan flooding.

Polypipe and narrow border flooding can improve water sustainability for surface irrigation. Lucas Gregory, Ph.D., Texas A&M AgriLife Research assistant director at the Texas Water Resources Institute (TWRI), explained that although drip irrigation is often considered the "holy grail of water conservation," flood irrigation remains the most common irrigation system in the Rio Grande Valley. The high cost of drip usually outweighs its water-saving benefits for growers in the valley and is just not feasible for each farmer.

"It's a challenge because our districts were designed to deliver a large amount of water over a short period of time, but a drip irrigation system requires small volumes of water over an extended period of time," McLemore said.

Despite this, a few growers, especially citrus and vegetable farmers, in the valley have shifted to drip because it gives farmers more control over their water supply.

"It's not as much for water saving as it is for timing application," said Sonny Hinojosa, general manager of Hidalgo County Irrigation District No. 2. "This district is not low on water, but we are still seeing more and more drip coming in because the farmers appreciate the precise application of water to that individual plant."

The Texas A&M Kingsville Citrus Center has started to apply drip irrigation to several of its citrus groves. The researchers found that using drip irrigation has saved them up to 25-35% of water use and also gave the farmers more control of the nutrient supply to individual plants and reduced weed-related labor costs.

The best citrus outcomes, however, occurred when they used drip irrigation in combination with other irrigation techniques, including raised beds and plastic permeable tarp. The combination of these irrigation techniques yielded fuller citrus trees compared to those without raised beds or tarp.

The raised beds and tarp field design demonstrated in the Citrus Center study can also be adapted to surface irrigated farms to improve water efficiency. In surface irrigation, soil and potential diseases can be picked up by water as it moves down the field. Raised beds covered with tarp can help protect the trees by preventing water from touching the tree trunk. Using tarps also helps reduce evaporation, which is triggered by particularly high winds and temperatures in South Texas.

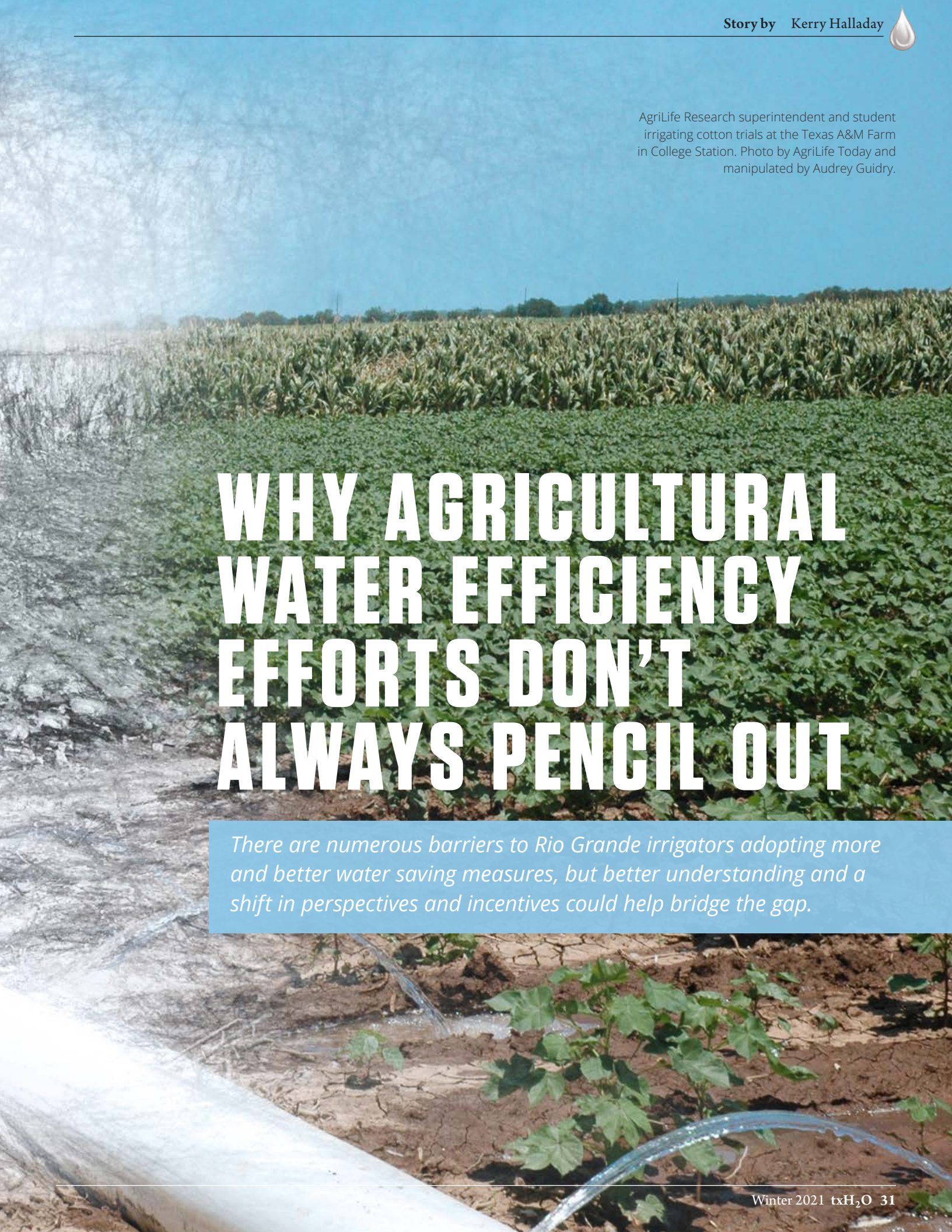
When it comes to choosing an irrigation system, "it really comes down to how good you are at managing the crop you have, with the water you have, and the information you have," said Dana Porter, AgriLife Extension agricultural engineering specialist at the Texas A&M AgriLife Research and Extension Center at Lubbock.

Lambert says the next steps to improve water conservation in the valley should be that everyone is on board with the current water saving efforts. "Still not everyone is using polypipe, and there is still some work to be done to get to that point," she said.

"We need to be better stewards of the water and it's one of the situations where it's hard to get people to shift gears if they've been accustomed to doing it this way for all the other years," Gregory said.

Citrus trees with drip lines running underneath them. TWRI file photo.

Story by Kerry Halladay



AgriLife Research superintendent and student irrigating cotton trials at the Texas A&M Farm in College Station. Photo by AgriLife Today and manipulated by Audrey Guidry.

WHY AGRICULTURAL WATER EFFICIENCY EFFORTS DON'T ALWAYS PENCIL OUT

There are numerous barriers to Rio Grande irrigators adopting more and better water saving measures, but better understanding and a shift in perspectives and incentives could help bridge the gap.

The water of the Rio Grande drew people to the area and it — via irrigation — made the desert bloom into a garden of agricultural abundance.

Without irrigation, agriculture along the Rio Grande would not look the same. According to the 2018 Census of Agriculture's Irrigation and Water Management Survey, the incomes of over half (52.6%) of U.S. farms in the Rio Grande water resource region are completely dependent on irrigation.

However, Rio Grande irrigators know the availability of the river's water is increasingly uncertain as urban populations in the region grow. Over the past decade, the major paired U.S. and Mexican cities along the border — El Paso and Ciudad Juárez, Del Rio and Ciudad Acuña, Eagle Pass and Piedras Negras, Laredo and Nuevo Laredo, McAllen and Reynosa, and Brownsville and Matamoros — have added over a half million more people to the banks of the Rio Bravo as it is called in Mexico.

With urban growth expected to continue, agriculture dependent on the Rio Grande must be ever more water efficient. Producers in the area know this; the Irrigation and Water Management Surveys show that three out of every four area farmers and ranchers listed water conservation as a priority in 2018. That number was only two out of three in 2008.

Luckily, numerous water efficiency strategies are already available, and research is ongoing to improve it even more. Examples include the Agriculture and Food Research Initiative-funded projects looking at salt-tolerant pecan rootstocks, the viability of switching usual Texas cash crops to quinoa or pomegranates and indoor vertical farming discussed elsewhere in this issue.

However, continued improvement of water efficiency in Rio Grande-area agriculture means the need for change, and change is always a challenge.

The high cost of change

Change means costs. That can be a problem in agriculture where margins are often razor thin even in a good year.

"I can tell you that for a producer to adopt a practice, it's got to be cost-effective first," said Allen Berthold, Ph.D., Texas A&M AgriLife Research assistant director of the Texas Water Resources Institute (TWRI). In addition to his role with TWRI, Berthold comes from a farming and ranching family and ranches himself. He has a strong connection to the concerns of Texas farmers and ranchers because he is one and shares their concerns.

A water meter used in irrigating onions. TWRI file photo.

"You can bet I'm not going to do something that's going to cost me a bunch of money," he said, speaking as a producer. "If it's going to cost me a lot of money to invest in something that I don't get a whole lot of return on, why would I do it?"

"Cost" usually refers to money, but it can also mean things like the time and frustration involved with learning new, unfamiliar technologies or practices. It can also mean the opportunity cost of doing something different; if the "old way" of irrigating a crop was producing a good yield, the potential for reduced yields if something is changed is a steep cost.

All of these costs were highlighted in a past effort by the Texas Project for Ag Water Efficiency (AWE) to encourage the adoption of automatic surge flow valves for furrow irrigation. AWE was a program of the Harlingen Irrigation District funded by a grant from the Texas Water Development Board from 2005-2015. Even though the group estimated the water savings associated with the technology at anywhere from 22-52% in the Lower Rio Grande Valley depending upon crop, adoption was low.

The monetary expense of the technology was high. One automatic surge flow valve can cost a couple thousand dollars in addition to the cost of the necessary piping. But the "costs" associated with the technology didn't stop there; the new and increased operation and management was a concern too.

"They were very hard to work with," said Victor Gutierrez, AgriLife Extension associate with TWRI. In addition to his role at TWRI, Gutierrez comes from a farming family in the Lower Rio Grande Valley and regularly helps them with on-farm needs.

"A lot of these ranch hands or farm hands don't know how to work with that technology," he said. "It wasn't very easy or friendly to operate."

Gutierrez added that some of the producers he worked with said the cost, time and effort related to the technology wasn't worth it for them and their operations; it just didn't pencil out.

"There are a lot of technologies out there, but the fact is they are expensive and I don't know if people would see the profits back if they invested in something like that," Gutierrez said.

Many share his skepticism. In the most recent Irrigation and Water Management Survey, a third of respondents from the Rio Grande water resources region said they could not finance water-saving improvements to their operations. Another 15.6% said they didn't think the cost of improvements would be covered by the savings those improvements might create. Opportunity costs were also of strong concern; almost a fifth of respondents were worried that water conserving measures would reduce yields and another 7.4% feared improvements would increase their management costs.

In addition to direct costs, structural barriers stand in the way of irrigators' adoption of water-saving technologies and methods. While most acknowledge that freshwater availability is uncertain and more people see water conservation as a priority, the structural incentive to save water just isn't there.

"Overall, the cost of water is so cheap that it's hard to encourage people to use less," Berthold said. "Plus, why would a producer risk a much lower yield and less income when putting a little more of something so inexpensive guarantees maximum yields?"

Though exact pricing for irrigation water varies by irrigation district, a common price is $20 per acre foot. With an acre foot of water being 325,851 gallons, this cost of irrigation water isn't even measured in pennies per gallons, but rather gallons — almost 163 of them to be exact — per penny.

There are other charges involved with irrigation costs — general tax, wasted water fees, delivery costs depending on location, maintenance fees and more — that can more than double the functional per-acre foot of water charge. However, even in that situation, irrigation water is still valued in gallons per penny.

When it comes to the effort to improve water efficiency, particularly in the face of the steep cost of change, the relatively low cost of water sends a mixed message.

"That's always been the struggle with water conservation down there," said Lucas Gregory, Ph.D., Texas A&M AgriLife Research assistant director of TWRI. In addition to his role at TWRI, Gregory grew up in a grass-farming family that raised forage for cattle.

"It just doesn't pay because water is a literal drop in the cost bucket in the Valley, so there is no economic incentive for irrigators to conserve water in many cases," he said.

Looking to the future of the Rio Grande and irrigation

Overcoming the costs associated with increased adoption of water-saving technologies and practices in agriculture along the Rio Grande is an ongoing effort and one that will require a multi-pronged approach. However, a producer- and economics-focused perspective must be part of any effort.

"I've had some discussions with growers down there about what they would be willing to do if money was not an option and many of them are interested and eager to try things, but it all ties back to economics," Gregory said.

He, Berthold and Gutierrez — being researchers as well as coming from agricultural backgrounds — ⇨

all stressed the importance of pragmatic, real-world approaches to addressing the costs associated with pursuing solutions to water issues in agriculture along the Rio Grande.

"If we can show them something saves money, whether it be a labor savings or something else, then they're in, but until you can do that, they're going to be hesitant," Gregory said.

A potential way to lower the costs of water efficiency improvements could come from the irrigation districts, Gregory said. He explained that most Rio Grande-area water districts charge by the irrigation, using rule-of-thumb estimates of water use per irrigation, rather than by the actual volume of water used. If producers who use less than the assumed volume could save money, "then I think you would have a lot more people buy into it," he said.

Unfortunately, such a possibility would require volumetric pricing, which comes with its own set of adoption challenges with the meters necessary to make it work. Water meters for agricultural use are expensive, are often stolen and can come with operational difficulties.

"Old-school propeller meters were tried down in the Valley, but they did not work well," Gregory said. "The main complaint I heard from growers was that they got plugged up with trash and fish, and increased labor needed to keep irrigation going."

Newer meter technology that uses doppler or ultrasonic technology is available that bypasses the issue of debris in the water, but they are still expensive.

"It gets back to the economics; producers won't be willing to invest in those unknowns," Gregory said. "That's really where AgriLife comes into play. If we can get the funding to do these demonstrations and really prove some of these things as practical, I think you're going to see a lot more buy in."

The need for change doesn't rest only on producers. Everyone along the Rio Grande, including the growing urban population, depends on the finite water resources the river offers.

"The fact that urban spaces and urban water demands have grown so quickly has been an unprecedented change to the region and its agriculture. There have always been water shortages during drought times, but the river never had this level of demand on it in the past," Berthold said.

"Under ideal conditions, urban people would adapt to a desert mindset," Berthold added. He acknowledged that such a shift would require expensive city infrastructure changes that present their own adoption challenges, but it would be ideal, nonetheless.

"If urban water consumption was static instead of rising, that would reduce that competing demand on water for agriculture."

Similarly, since the Rio Grande is a shared river between the U.S. and Mexico, the need for change does not fall only north of the border. Much of the flow of the Rio Grande in Texas is dependent on what happens upstream in Mexico. According to the 1944 Treaty for the Utilization of Waters of the Colorado and Tijuana Rivers, Mexico must deliver a five-year water quota of 1.75 million-acre feet (about 570 billion gallons) from the Rio Grande to the U.S. In recent decades, Mexico has often waited until the fifth year to deliver all the required volume rather than spreading the amount out over the five years. This makes the river's flow in Texas less than consistent or dependable.

Berthold, Gutierrez and Gregory said that Mexico should release water annually to keep the flow of the Rio Grande in Texas more consistent. Without a dependable, consistent supply of water from the river reduces Texas producers' abilities to irrigate strategically to the needs of their crops. According to recent Irrigation and Water Management Surveys, the number of Rio Grande producers scheduling their irrigations based on water supply more than doubled from 22.3% in 2008 to 46.4% in 2018.

"Pretty much all of us are dependent on the river, and we're dependent on that treaty that was signed between the U.S. and Mexico," Gutierrez said.

Ultimately, overcoming the barriers to increased water efficiency and conservation in irrigation along the Rio Grande will take change on a large scale, and it will take more than just area irrigators to make it happen.

"You have to see the picture in the whole," Gutierrez said. "You have to get everybody together, and that's a challenge."

Irrigators have done good work over the years to become ever more water efficient, but Gregory said the situation cannot stagnate; things must continue improve all along the Rio Grande to preserve water availability for all water users in the area going forward.

"The challenge is going to be getting people to look at things from a different perspective and be willing to change the way they currently operate," he said. "You are starting to see a change in the mentality, but it all hinges on the economics."

Story by Chantal Cough-Schulze

WATER COMPETITION AND COOPERATION AT THE CROSSROADS

With less water available and more water being used, competition on the Rio Grande is getting trickier. Experts are thinking about cooperative solutions.

The sun sets over Resaca del Rancho Viejo in Cameron County, Texas. Photo by Herman Ramsden.

The Rio Grande is a convergence point. Established as the U.S.–Mexico border in 1848, the river travels through two countries, three U.S. states, four Mexican states and numerous cities, irrigation districts and farms.

It's therefore fitting that the slogan of Brownsville, Texas' easternmost city on the Rio Grande, used to be "Crossroads of the Hemisphere," said Jude Benavides, Ph.D. Benavides is an associate professor in the University of Texas Rio Grande Valley's School of Earth, Environmental and Marine Sciences.

"I think the slogan was initially intended to be crossroads as far as economics, the coastline and the land and the border between the United States and Mexico," Benavides said. "But I think it also sufficiently describes our situation as far as our ecosystems, modified or not by humans."

As the region's population grows and the climate warms, working together to share the river's water is more important — and harder — than ever, said Bill Hargrove, Ph.D., former director of the University of Texas at El Paso's Center for Environmental Resource Management.

"We draw out of the same river, and we draw out of the same aquifers. So it really behooves us to try to cooperate and manage the water to the best of our ability, instead of just using it as fast as we can," Hargrove said.

Shrinking supply and growing demand

Working together along the Rio Grande wasn't always as necessary as it is now, Hargrove said.

"There was less need for cooperation in the past because there was more water and people were kind of content with what they had. It was a little less contentious, a little less competitive," Hargrove said.

The reason competition for water has increased comes down to a simple economics principle.

"The supply is going down and the demands are going up. That's it," Hargrove said.

The Rio Grande region already tends toward heat and dryness, and it's getting more extreme as the climate changes. In El Paso, where Hargrove works, the long-term average number of days with temperatures over 100 degrees is 15. In the summer of 2020, there were 57.

"The supply of water is going down mainly because of warmer temperatures, which are producing less snowpack in the headwaters, so there's less flow in the river for the most part, and the quality of the water is lower," Hargrove said.

Meanwhile, the demand for water is increasing: In Texas alone, the population along the Rio Grande has more than quadrupled since 1950. Benavides said that all those people mean that far more water is being used than was ever planned for.

"Our entire water distribution and drainage system in the Rio Grande Valley is built off the backs of an irrigation system for agriculture built 75 to 125 years ago," Benavides said. "I don't think any of those folks in the 1920s envisioned that on both sides of the border we would have over a million people."

The faces behind the numbers

Working together starts with having enough data to base your work on, said Alfredo Granados Olivas, Ph.D., professor at the Autonomous University of Ciudad Juárez's Institute of Engineering and Technology.

"Hydrology is a monster that changes every day, so it's not something that's really easy to manage. If you don't have a way to monitor, you're lost," Granados Olivas said. ⇨

Benavides agreed that the Rio Grande region is still somewhat data-poor.

"If you were to wipe all the other shared resource problems off the table, you would still have issues because you're data-limited," Benavides said.

But just expanding research and data gathering in the region isn't enough to foster collaboration, Granados Olivas said.

"It's not just about the numbers. There is a face behind the number, and there is an economic issue behind the face," Granados Olivas said.

The people behind those numbers often don't feel heard by each other, Hargrove said.

"It's really complicated. People in agriculture say, 'People in the cities don't appreciate that we produce food for people,' and the cities say, 'People don't appreciate that we try to provide cheap water or how difficult it is.' And then the people from the environmental groups say, 'People don't understand the benefits of different water management schemes for the environment.'"

Hargrove said all that competition — especially for a resource as vital as water — creates a lot of stress and fear, especially if people are already pressed for money and resources.

"People feel very threatened. They feel like 'blank' is trying to take our water. And 'blank' can be filled in with the federal government, the state government, the cities, the public, environmental groups or irrigators," Hargrove said.

When Hargrove was at a meeting in Chihuahua in 2019, a fellow participant summed up people's fears.

"He said the problem is that all the cheap water is gone. And that's a problem for us. Because the easy solutions, the cheap water — there isn't any," Hargrove said. "All of our alternatives that are left are hard and expensive."

Steps in the right direction

Solving the Rio Grande region's water struggles starts at home with more involvement from those who rely on the basin, said Rosario Sanchez, Ph.D.

"That's the only way that they would have a voice or a little bit of knowledge on the current conditions of water in the basin," said Sanchez, Texas A&M AgriLife Research senior scientist at the Texas Water Resources Institute and director of the Permanent Forum of Binational Waters.

Collaborative efforts have seen success in the region. For example, El Paso Water, the local utilities provider, is working with the local irrigation district to capture stormwater runoff that would otherwise be lost downstream because of the area's slope towards the river. Additionally, the partnership is reforming old wastewater holding ponds to store runoff for both agricultural and municipal use.

Far to the southeast, the Brownsville Public Utilities Board is collaborating with the city of Brownsville and the U.S. Army Corps of Engineers to restore resacas, former channels of the Rio Grande that are naturally cut off from the river. Many resacas have been filled in over the years, removing valuable habitat and natural floodwater storage.

"Fresh surface water of any kind here, even if it's mildly brackish, is precious to the environment, to the ecosystem," Benavides said.

Not far from Brownsville, the Arroyo Colorado Watershed Partnership has brought together the Texas Water Resources Institute, Texas Commission on Environmental Quality, Texas State Soil and Water Conservation Board and other organizations to improve issues such as flooding, drainage, habitat and water quality.

Thanks to the partnership's work, 10 wastewater treatment facilities have been created or upgraded, centralized wastewater service has been provided to over 17,000 residents in 42 colonias, and best management practices have been adopted on 130,000 acres of irrigated croplands.

"We had the right mix of experts — people who were from here or had a passion about this region. All of that coming together enabled the Arroyo Colorado Watershed Partnership to get started on a very strong footing," said Benavides, who chairs the Arroyo Colorado Watershed Partnership's steering committee.

Along the entire Rio Grande, the newly created Permanent Forum of Binational Waters is fostering conversation and collaboration across state and international borders through a network of specialists, academics, citizens and scientists. Sanchez wants the forum to help pave the way for bigger changes.

"We definitely need someone or a couple of someones to actually take the lead on this. That's what we're trying to do in the forum," Sanchez said. "But we need much more than that — bigger, stronger definitely, and willing to actually do something."

Holistic, long-term solutions

Existing collaborations are steps in the right direction. But to face the increasing population, temperature and drought, Benavides said more cooperation efforts are going to have to get a whole lot bigger.

"This region is fragmented by design, politically. In the Rio Grande Valley, our legislature and congressional districts split the valley. The same is true with counties in this region, states, upstream, downstream, left bank, right bank, north bank,

south bank," Benavides said. "And with all of those competing interests, not enough people are looking at this problem from a holistic standpoint."

If people don't look at the whole problem, they won't be able to hear each other, feel heard or create whole solutions, Benavides said.

"We have to be honest about what we as a region are, where we were, in order to know where we want to be," Benavides said.

"The better we understand the way this area functions naturally, the better we're going to be able to make the most out of how the future changes climatologically and anthropogenically. To look at the situation in a vacuum without that I think is folly anywhere, but particularly here."

Especially as drought becomes more frequent, solutions must also focus on the long term, Granados Olivas said. He added that creating holistic, long-term cooperative solutions will require teaching society about the scientific nuances of the Rio Grande region's water woes — and teaching scientists and decision makers more about society.

"If we don't frame society in teaching what the issue is, then we are going to have a big loophole in there in reaching decisions. You have to connect to what's really happening out there, bring it into real life," Granados Olivas said. "People who want to solve these problems have to understand economy; they have to understand technology; they have to understand society."

One size won't fit all

Even if future solutions are holistic and long-term, no one solution will solve all of the Rio Grande region's water supply and demand troubles, Hargrove said.

"The real solution for the future is some kind of combination of all these things. You have to have some kind of integrated strategy moving forward that includes both developing new supplies and reducing demand," Hargrove said.

Technological solutions such as desalination can help fortify existing water supplies and develop new supplies, while conservation measures such as shifting to drip irrigation over flood irrigation can help decrease water demand. Improved water allocation measures can help on both the supply and demand sides.

Benavides emphasized that everyone working on those different solutions will need to work in tandem.

"None of us are going to be able to solve the problem alone. It's not going to be the academic sector alone or the private sector alone. It's going to take all of us," Benavides said. "Unless we get to work fast, this is going to become a very, very big problem very soon."

At the crossroads

For Benavides, looking for water solutions comes back to Brownsville's old slogan, "Crossroads of the Hemisphere."

"I think this region needs to be a focus point, a meeting point for bringing folks from upstream, downstream, north of the border and south of the border truly together," Benavides said. "I think that's going to be our golden ticket really: to find out where we can overlap, where we can make a synergistic use and development of water and water resources in this area."

Meanwhile, Granados Olivas will soon be putting his ideas about collaborative solutions into action in his own backyard. His ranch will serve as a training center for producers, where they can learn about new technology, water conservation and other ways to reduce their costs and increase their yields.

"My philosophy here is really simple. My plot has 50 hectares. My biggest concern is that my neighbors are as successful as they can be in water conservation, and then they have to do that with their own neighbors, and so on and so forth. You have to take care of your neighbors," Granados Olivas said.

"Strong communities are the ones that are working on the base, on the people. If you solve the issues of food, water, energy and health, you have the potential for growth, art, music and literature, and that's a different society," he said.

Benavides hopes that finding cooperative solutions to the Rio Grande's water supply and demand issues can keep the region flourishing for years to come.

"Water has been here, remains here and makes it all possible. I'm a fifth generation northeastern Mexican, and now I'm a second generation American. I hope that one or both of my two kids decides to remain here. I'm intensely proud of this region having done what it's done well," Benavides said. "I hope to continue to make sure that we have enough water and the right quantity and quality to keep this place as beautiful as it is to us."

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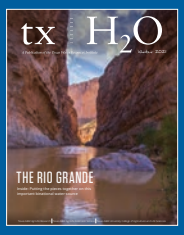

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