The future of water in the Southwest

Scott Seckel

The West's precarious water supply will not return to previous levels.
This is the new normal, and we've got to figure out how to live here.
Solution will involve range of strategie in law, policy, science, technology.
October 4, 2016

First of 3-part series on how ASU scientists are putting expertise toward sustaining life in arid land

Editor's note: *This is the first of a three-part series examining the work that ASU is doing in the realm of water as a resource in the arid West. We'll explore solutions, but first we look at the current situation and how we got here.*

HOOVER DAM — Atop Hoover Dam on a 115-degree July afternoon, tourists line up to suck cold water from fountains and crowd into the air-conditioned cafe and visitors' center.

Transpose both those actions to the 30 million people who depend upon that blue-green water behind the dam. That's water for a jogger in Santa Monica. Water for an oleander hedge in Phoenix. Water for a shower to wash away a night in Vegas. It's a comforting sight on a scorching day, all that water.

What's disconcerting is the white bathtub ring about 200 feet above the surface.

Talk to the experts, and they'll all tell you the same thing: That ring is never going away again. Between climate change and an ongoing drought, the ring is a stark reminder of another iteration of that hated 21st-century term: the "new normal."

"I think people have come to the recognition that the infrastructure which has served us so well over the last 100 years is not going to do the same job in the next 100 years," ASU research professor Pat Gober said.

That bathtub ring has been growing for years. There's a number every water professional in the Colorado River Basin knows: 1,075.

When the water in Lake Mead behind Hoover Dam drops below 1,075 feet, it will automatically trigger a round of mandatory water-use cuts to each state. Agriculture will take the first hit. Subsequent cuts tied to lake levels become more draconian. The ring is a visible symbol of how precariously Westerners live.

And we do live precariously. Anyone whose air-conditioning has broken during a Phoenix summer or whose car battery has died on the freeway can tell you, it gets unbearable in a hurry. The ancient Hohokam people took off from what is now south-central Arizona during an epic drought in the Medieval Ages.

But 30 million people aren't going to just pick up and leave. If this is the "new

normal," we're going to have to figure out a way to survive here.

There's no magic bullet. It's going to take a range of strategies from experts in law, policy, science, and technology. Some of those strategies are already in place. Some won't exist for another 10 or 20 years.

That's what this story is about. It's about how a wide range of scientists at Arizona State University are putting their broad and diverse expertise toward solving the problem of how people in the arid West will continue to live sustainably, in a place where people basically have no business living at all.

Hoover Dam draws tourists from around the world. Here, a family from Italy fills a water bottle in the 115-degree heat July 27, with Lake Mead's "bathtub ring" visible behind them. Photo by Charlie Leight/ASU Now

"We're realizing that water as a resource is in many realms, and an institution of this breadth is what's needed to address these problems and provide

solutions and study the phenomenon from multiple angles," said hydrologist Enrique VivoniVivoni is an associate professor, School of Earth and Space Exploration, College of Liberal Arts and Sciences; sustainability scientist, Julie Ann Wrigley Global Institute of Sustainability; affiliated faculty, Center for Biodiversity Outcomes, Julie Ann Wrigley Global Institute of Sustainability..

This story is about nuance. Conserve! (But keep your lawn and pool.) Worry about levels in Lake Mead! (But don't worry about every fluctuation or weather event.) Water people know they're sending mixed messages. They're mixed on purpose. They have to be.

"Everything about water is complicated," said Sarah Porter, director of the Kyl Center for Water Policy at ASU. "I love that about water."

Where to begin?

"It's such a big issue," said Karen Smith. "It's so fundamental."

Smith, a faculty associate in the School of Sustainability, teaches a course on water use. She's a veteran water warrior: strategic planner for the Salt River Project, the quasi-governmental agency charged with administering the flows from the Salt and Verde Rivers, one of Phoenix's main water sources; water-quality director at the state Department of Environmental Quality; deputy director of the state Department of Water Resources.

"One of the real problems I think we have when we start to talk about it is where to start," she said. "Where do you start? Do you start with the science? Do you start with the policy, with sort of the politics to go with the economics of it? It's crazy. There's so much to it, and part of the challenge we've had in Arizona is knowing where to begin."

What's going on

"We're all watching the lake levels in Mead," said Pat Gober. "That's the

visual emblem of water infrastructure that's worked for us in the past."

Gober, a research professor in ASU's School of Geographical Sciences and Urban PlanningThe School of Geographical Sciences and Urban Planning is an academic unit in the College of Liberal Arts and Sciences., has won international prizes for her water research. She studies water resources management, decision making under uncertainty and urban climate adaptation.

"We're going to fall below (the 1,075 line) soon, and then we're going to have to figure out a new plan for the future, because the amount of Colorado River water we assumed we were going to get, we're not going to get," she said. "It's a brave new world for us, I think, and that's the symbol of it."

Water and climate people talk about a "new normal" because they don't believe that those lake levels will return to what they were 50 years ago.

"That means we have to change the economy and the culture," Gober said. "It's going to be some kind of radical change."

While changing the economics of water is a relatively simple proposition (more on that later), changing culture is another story.

Across the West, each city dependent on the Colorado River has its own unique challenges, but overarching all is the urgent need for survival in a dry place, whether that's Denver, Las Vegas, San Diego or Phoenix.

The Arizona capital is a river city.

"We've taken the water out of the river and spread it across the landscape," said ASU professor Nancy GrimmGrimm is a professor in the School of Life Sciences, in the College of Liberal Arts and Sciences; Senior Sustainability Scientist in the Julie Ann Wrigley Global Institute of Sustainability; director, Central Arizona–Phoenix Long-term Ecological Research Project, Julie Ann Wrigley Global Institute of Sustainability; co-director, Urban Resilience to

Extremes Sustainability Research Network, Julie Ann Wrigley Global Institute of Sustainability; and affiliated faculty, Center for Biodiversity Outcomes, Julie Ann Wrigley Global Institute of Sustainability., who studies desert streams and how water works in urban ecosystems.

“We call it riparianization of the city, because you’ve turned this what was a single riparian strip along the river into this big blob that’s all green, and when you fly into Phoenix you see that,” she said. “A lot of what we see in terms of the ecology of the city, the kinds of things that we’ve been studying in people’s yards, the vegetation that’s here, the kinds of birds that you see, the soil properties, all of these kinds of things are related to that fact. And if you think about it in historical terms, that water was spread across the landscape initially to create farmlands. Farmland has converted to housing.”

At the turn of the previous century, Arizona had a desolate national reputation because of the desert and violence. It was the wild West, after all. Early boosters of Phoenix created marketing materials around 1910 exhorting people to move to Arizona. Promotional pamphlets usually depicted orange groves and canals. Almost never was a cactus shown. (The same applies to ASU during the same time, where campus was touted as a lush oasis with a huge fountain in front of Old Main.)

“We made the urban environment attractive to people who were coming here,” Gober said. “We created an oasis culture, not a desert culture. This isn’t a desert city. It uses water from all across the West, dammed up in those big dams to make our city look like Chicago and Philadelphia and northern California. Maybe it was a good thing to do 100 years ago, but it’s not going to work for us.”

The ability of the region to grow is a function of the ability to capture and use large amounts of water. The future of arid cities is dependent on our use of water. Gober points out we use water to make the place make sense for us.

To a certain extent, that will have to change out of necessity.

“We’ve totally transformed this landscape, but the work that (ASU) has done looking at the future in terms of climate change, in terms of population is suggesting that we can’t keep doing that,” Grimm said.

A group of wild burros consume a little vegetation and water next to Lake Mead on July 28. The Colorado River, which feeds Lake Mead, is crucial to life of all kinds in the West. Photo by Charlie Leight/ASU Now

The only way to support the current population is by storing water in years of plenty to use in times of shortage. The way we’ve been doing that is by using a massive infrastructure of canals, dams and lakes. The heroic engineering marvels of the 20th century, like Hoover and Glen Canyon dams and the Central Arizona Project canal, gave Westerners stability and the ability to change the landscape.

But now the rains aren’t showing up. Far more people live in the West now than did in the 1930s, when Hoover was built. And the wild cards of drought

and climate change hover over it all.

All of the allocations of Colorado River water that Arizona thought it was going to get have to be rethought. State water managers don't use historical data sets to predict rainfall and snowpack because they're not representative of what's happening now. Arizona's Department of Water Resources uses rainfall records going back to 1988 — what the agency director calls a stress test period — plus models that incorporate climate change.

The problem

If you check the Bureau of Reclamation's website, Lake Mead is often slightly below 1,075 feet. Why isn't everyone freaking out over this?

The lake fluctuates a lot because of rain, evaporation and a host of other factors, according to Porter, of the Kyl Center for Water Policy.

Mead's diminishing levels aren't due to drought: It's over-allocation, which doesn't account for loss. About 1.2 million acre-feet are lost every year because of evaporation, seepage into porous surfaces, and so on.

"The lake level will be going down every year no matter what because of this structural deficit, as it's called," Porter said.

An acre-foot is the measurement water wonks use. They don't talk about gallons. An acre-foot is one acre covered by water a foot deep. (It's about 326,000 gallons, if you must know.) Most water managers call an acre-foot enough water for a suburban family for a year.

According to the Bureau of Reclamation, the lake's surface drops 12 feet per year. When Hoover was built, no one thought about this.

"At the time there was so much water, and we didn't have nearly the demands we have now," Porter said .

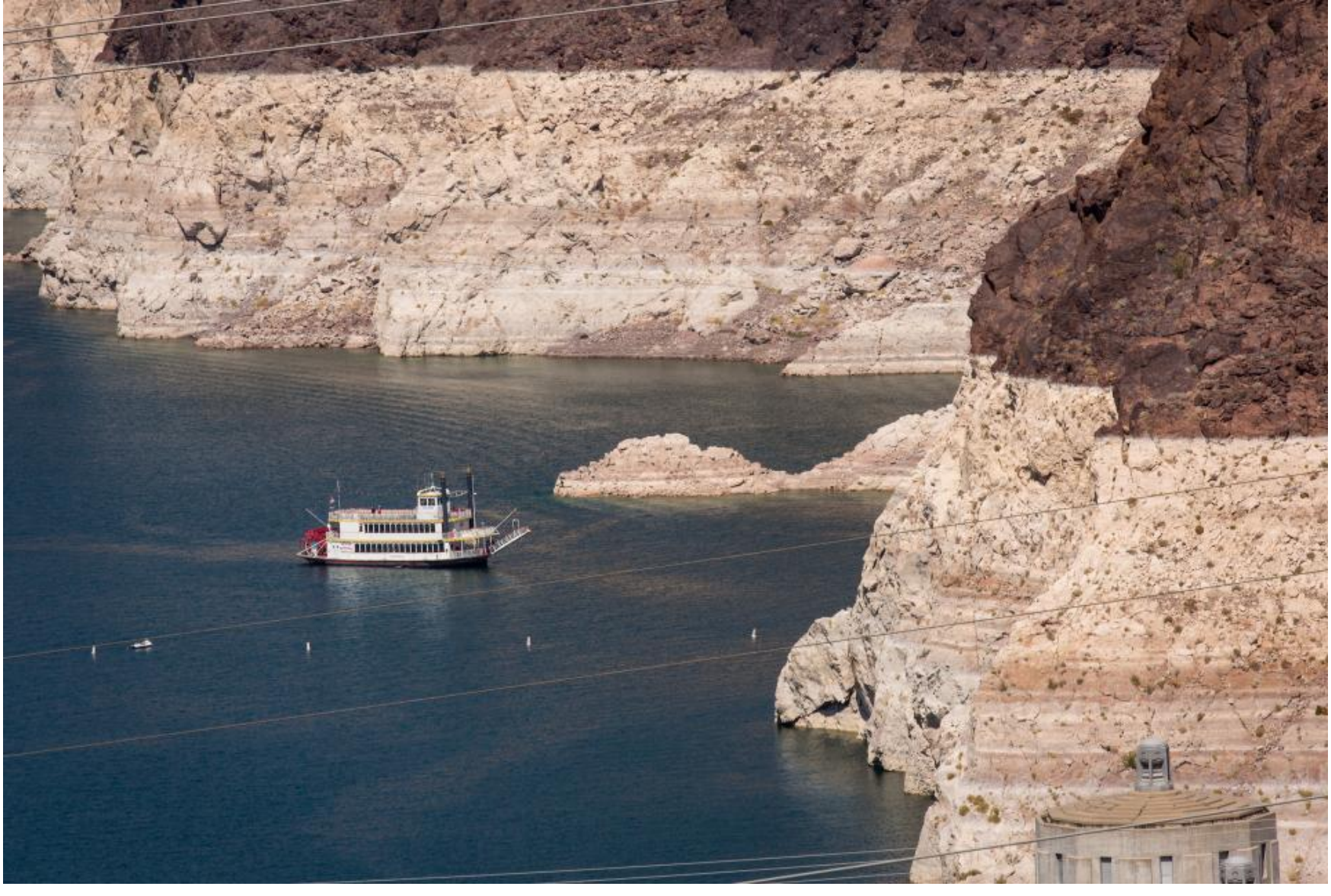
A 2011 study of the Colorado River Basin by the Bureau of Reclamation (motto: “Managing Water in the West”) predicted a 3 million acre-foot gap in 2040.

“Too many straws in it,” said John Sabo. Sabo, a professor in ASU’s School of Life Sciences, has loved to fish since he was a boy. He earned a degree in stream ecology, studied hydrology, and eventually ended up studying water, because everything in Arizona revolves around water.

The Bureau of Reclamation makes its determination for the coming year on Oct. 1, the beginning of the water year. (Like finance, the calendar and taxes, there is a water year.)

An August report by the bureau headed off a shortage declaration by predicting lake levels will be 4 feet above the trigger point at the end of the year. (They also predicted a shortage to be declared in 2018.)

“Levels are not declining as quickly,” Porter said. Conservation “efforts are paying off.”



The Desert Princess paddleboat offers tours of Lake Mead near the Hoover Dam on July 27, with the "bathtub ring" a visible reminder of the volume of water missing from the Colorado River-fed reservoir. Photo by Charlie Leight/ASU Now

This wasn’t a huge surprise to anyone in water management. The Colorado River is not a natural system, Smith, from the School of Sustainability, pointed out. No one wants the shortage declaration and the mandatory cuts that will accompany it, so an enormous amount of shuffling happens to prevent that.

“It's a highly plumbed river,” Smith said. “And so they manage it. So they'll look at Mead, and they'll look at Powell and they'll say, ‘You know, let's take a little bit more from Powell now and bring it down to Mead because it looks like they'll be some better inflows into Powell. … So we'll see what the bureau does when it gets close to 1,075.”

It’s an enormous system to manage. There are two countries, upper- and lower-basin states, treaties, regulatory backgrounds, judicial backgrounds and legal precedents. The whole mess is collectively called the Law of the River.

It’s a delicately balanced system. At a recent water meeting at the state Capitol, one panelist described it as a Rubik’s Cube, with each square representing a different stakeholder. Turn the cube once, and the whole system goes out of whack.

Water managers aren’t expecting a rosy future.

“Climate change is already a huge challenge for us,” said Kathryn Sorenson, water services director for the city of Phoenix. “We can expect that the flows of our local rivers, the Salt and Verde, will diminish and become more variable or potentially turbid. We can expect that we will enter into shortage on the Colorado River and probably stay in shortage for quite some time.”

Climate change, drought, or both?

This is Arizona’s 16th year in a drought. Is this year 16 of a 16-year drought, or year 16 of a 30-year drought? NASA’s most recent research suggests the latter might be the case, with an 80 percent chance to see a 30-year drought by the middle to end of this century.

Droughts are part of natural variability in a desert region, but there is research that suggests they are becoming worse and more frequent because of climate change. Weather patterns in the Pacific that affect the West are changing, but researchers don’t know why.

“(Climate change and drought) are working together, unfortunately,” said state climatologist Nancy Selover, a research professor in the School of Geographical Sciences and Urban Planning. “I wish I could say 43 percent is this and 43 percent is that, but I can’t do that. It’s a fairly complex system.”

The water series

Part 1: The current situation and how we got here.

Part 2, coming Thursday: Science and research.

Part 3, coming Friday: Law, policy, challenges — and some good news.

Top photo: The Mike O'Callaghan-Pat Tillman Memorial Bridge on U.S. 93, a bypass from the old route over Hoover Dam, provides a scenic view of the dam and Lake Mead. Photo by Charlie Leight/ASU Now

Floating new ideas for water solutions

Scott Seckel

Continuing life in the arid West will take a variety of strategies.

October 5, 2016

From desalination to homes with dual pipe systems, scientists and policy analysts exploring wide-ranging strategies

Editor's note: *This is the second in a three-part series examining the work that ASU is doing in the realm of water as a resource in the arid West. Today, we explore technology and innovative approaches.*

To reach the floating docks at Temple Bar Marina on Lake Mead, you have to cross a 200-yard-long gangway stretching across cracked mud flats that used to be the lake bottom.

Mike Reisbig moored his boat there on an August afternoon. The Huntington Beach man, a football coach at Long Beach City College in California, has

been coming to Temple Bar for about 50 years.

“I’ve noticed a lot of changes,” he said. “I’ve been here when the water’s all the way up, going to the spill wells, to where it is today. It’s a scary sight. You don’t know whether you’re going to be able to get your boat on the water anymore or not. It’s such a beautiful place. It’s the only place I’ll bring this boat. … It’s getting scarier each year, trying to figure out how to get it in the water. We seem to figure out a way and get it in. This is the best lake I’ve ever been to, and I’m going to keep going.”

His parents discovered the lake decades ago.

“It just has become one of those things the family does,” Reisbig said. “Believe it or not, I brought a 3-month-old baby up here with this heat in this boat, so she could experience this lake. I know she doesn’t remember any of it, but she comes up here every year. It’s just what the family does. I have yet to find a better place to bring a boat. It’s perfect out here. You’ve got your rough days, and you’ve got your beautiful days. It’s just perfect. It doesn’t get better.”

Mike Reisbig of Huntington Beach, California, hands ropes to his wife, Lori, as they prepare to back out of their slip and begin their daylong excursion on Lake Mead on July 28. His family has been visiting Temple Bar Marina for about 50 years, and he has seen the reservoir's water levels go through many changes. Photo by Charlie Leight/ASU Now

Like Reisbig, hydrologists, policy analysts and researchers are figuring out ways to keep going in the arid West. Here you'll hear about technology and innovation behind water.

Straws in the ocean

It's possible that the West will someday get to the point where new water supplies need to be found. One possibility being discussed in Arizona is building a plant to remove salt from seawater in Mexico on the Gulf of California.

The idea is in the early stages, but the broad outline of how it would work goes like this: Arizona builds it, Mexico uses it, and we take their Colorado River allotment.

Building — and permitting — a plant in California would be so expensive it's not on the table.

"A lot of people are very pessimistic about desalination and its future," Rhett Larson said. "I'm one of the optimists. I actually think that it's going to be a big part of water-supply solutions, and probably sooner than people realize.

"The technology's come a lot further. A lot of people think about desalination as just, 'Well, it's insanely expensive and nobody will ever do it,' but the technology has come a long way and I think it has a really bright future."

Larson is a fifth-generation Arizonan.

"I grew up worrying about water," he said. "I'm one of the weirdos who actually went to law school wanting to be a water lawyer."

Larson, an associate professor in the Sandra Day O'Connor College of Law at Arizona State University, is a senior research fellow with the Morrison Institute of Public Policy and sits on the advisory board of the Morrison Institute's Kyl Center for Water Policy.

A privately owned desalination plant opened in Carlsbad, California, last December. Under a 30-year operating agreement with the San Diego County Water Authority, the plant produces 56,000 acre-feet per year. Most water managers call an acre-foot — one acre covered by water a foot deep — enough water for a suburban family for a year.

"That water's cheaper for San Diego (residents) than pumping the water from the Colorado River," said Larson, pointing out that the river water would require the construction of a pipeline across the state.

Sarah Porter, director of the Kyl Center for Water Policy at ASU, is not a believer.

“I think a lot of the talk about desal (desalination) is wishful thinking,” she said. “People want an easy fix.”

Sarah Porter (pictured addressing the Southwestern Regional Water-Energy Nexus meeting on Sept. 8 in Tempe), the director of the Kyl Center for Water Policy at ASU, thinks desalination is wishful thinking. Photo by Charlie Leight/ASU Now

Desal water from the Carlsbad plant is selling at more than $2,000 per acre-foot. SRP water is about $16 per acre-foot. Putting $2,000 acre-foot water on crops doesn’t make any sense.

“I think if we build a desal plant in Mexico, and that water were used in Mexico as a substitute for Colorado River water, I’m not sure how Mexico’s

allotment of river water results in residential water," Porter said. "The percentage that's agricultural water is extremely cheap water, and it's hard to figure out how you could use ocean desal for crops in a way that made sense."

Desal plants also need constant demand. We usually build infrastructure and then demand catches up with it.

"I don't think we should build something before we have the demand for it," Porter said. "It's a huge investment. ... If we do get desal, (who pays for it) will definitely be municipal users, not growers."

The ick factor

Reusing water is a huge part of the solution to close the demand gap.

"You don't need a new supply if you're reusing," pointed out John Sabo, a School of Life Sciences professor who studies riverine ecology and freshwater sustainability. Reclaimed water is also cheaper than desalinated seawater. "We do need to work at becoming more efficient, because in the future that's going to be our primary source for growth."

ASU's Central Arizona–Phoenix Long-Term Ecological Research (CAP LTER) program studies urban ecology. It has been ongoing for the past 20 years. Biological, physical, engineering and social scientists are studying eight aspects of what happens when you plop a city in a desert. Nancy GrimmGrimm is a professor in the School of Life Sciences, in the College of Liberal Arts and Sciences; Senior Sustainability Scientist in the Julie Ann Wrigley Global Institute of Sustainability; director, Central Arizona–Phoenix Long-term Ecological Research Project, Julie Ann Wrigley Global Institute of Sustainability; co-director, Urban Resilience to Extremes Sustainability Research Network, Julie Ann Wrigley Global Institute of Sustainability; and affiliated faculty, Center for Biodiversity Outcomes, Julie Ann Wrigley Global Institute of Sustainability. directs the project and has worked on it since the

beginning.

One part of the study was looking at the reuse of treated wastewater for drinking water across the United States.

“The findings would be surprising to you, because there’s a lot more reuse of water in that particular interaction — between treated wastewater and reuse as drinking water or as municipal water — than you would think,” Grimm said.

“In some places it becomes really important during droughts. So in Texas, for instance, some of the cities are definitely using a pretty high proportion of the treated wastewater as municipal water supply. So there’s sort of what they call the “yuck” factor, the “ick” factor associated with that, but there’s really quite a lot of research that suggests that the water is quite safe.”

One of Sabo’s ideas is homes with two sets of pipes: one for potable water and one for reused water, which would go into the toilet, onto landscaping, etc. It would be an expensive retrofit, but one that could be gradually phased in. (When electricity came along, not everyone had their homes wired at once, for example.)

Golf courses and fake lakes already use reclaimed water.

“Why can’t everybody have some access for their outdoor watering to treated wastewater?” Grimm asked. “Those kinds of ideas are things that we’re exploring in CAP LTER, with people from the community, so government officials, people from flood-control districts in Maricopa County, various community leaders and so forth, we’ve been having these workshops that are creating what we’re calling sustainable future scenarios for Phoenix.”

A large concrete block that once anchored a dock sits on dry land. The shoreline is now several hundred yards away. Photo by Charlie Leight/ASU Now

Phoenix has been using reclaimed water on a huge scale since the 1960s. It cools Palo Verde Nuclear Generating Station, irrigates farmland and recharges aquifers. The city will use even more in the future, water services director Sorensen said.

“We’ve been pioneers in that, literally decades ahead of other communities,” she said. “Its importance will increase in the future. … That means the value of reclaimed water will increase. It means the importance of really managing our wonderful aquifer here increases exponentially.”

Future H2O

One of ASU’s three main water initiatives is Future H2O, unveiled by Sabo at

a White House Water Summit in March. It's a five-year plan focused on identifying opportunities for domestic and global water security. ASU researchers will partner with private and public sectors to find solutions to difficult water problems. The whole idea is to focus on the situation at hand, rather than hoping it will change.

"Where are the opportunities of the future to do better?" Sabo described it.

It has five pillars, one of which is aimed at averting what water managers call "the Silver Tsunami," the imminent retirement of a lot of water professionals with institutional memory and expertise.

"The opportunity is the next generation is going to be more capable of harnessing the technology that surrounds us because they're embedded in that technology," Sabo said. "They know how to use it. The next generation is going to build on what the incumbents have left us, which in Arizona is quite strong."

Two other areas of focus are:

• Developing funding for an urban landscape design and renovation campaign that reduces residential outdoor water use in at least one Phoenix metro service area by a third by 2025.

• Delivering research and advice to at least 10 of the largest corporate water users in the U.S. to scope, plan and implement restoration projects at scales that improve water reliability in stressed water basins nationwide.

Sabo created a software tool that helps corporations apply analytics to how they use water, simultaneously helping water conservation, habitat restoration and their bottom lines. It's being used by Dow Chemical at their west Texas operations on the Brazos River.

"It tells Dow how to meet their water bottom line for manufacturing by creating wetlands instead of creating gray infrastructure," said Sabo.

The nature of desert cities

One of things Grimm's long-term desert cities project looks at is how storm water moves through the city and how it's handled.

She's interested in the idea that cities are potentially really good experimental test beds for thinking of water as a unified system. She envisions a city water department that manages drinking water, wastewater and storm water holistically.

"Some of that is going on in Phoenix, because Phoenix has been pretty innovative about things like reusing treated wastewater for watering golf courses and filling up fake lakes and things like that," she said.

What happens when you plop a city in the middle of a desert? How does that affect the way water moves and behaves?

"We know very little about that," said hydrologist Enrique VivoniVivoni is an associate professor, School of Earth and Space Exploration, College of Liberal Arts and Sciences; sustainability scientist, Julie Ann Wrigley Global Institute of Sustainability; affiliated faculty, Center for Biodiversity Outcomes, Julie Ann Wrigley Global Institute of Sustainability., an associate professor in the School of Earth and Space Exploration.

Vivoni is interested in how changes in climate and land cover affect water as a resource. He uses observations of sensors and satellite data and computer modeling of hydrological systems.

"The movement of hydrologists studying cities in depth is actually very new," he said.

Most other schools specialize in natural systems hydrology, like rivers, mountain watersheds and wetlands.

"None of them have this special expertise on human-environment relations

in cities, where water is important currency," Vivoni said. "Humans are primarily going to be urban dwellers moving forward. As a species, more than half of us live in cities. We do all these changes around us, and we have almost no clue about how the system works internally.

"Part of my work at ASU is on that angle: understanding, measuring, quantifying and eventually predicting how water moves, is transformed and flows through desert cities. My work focuses on arid and semi-arid areas."

The Temple Bar rock formation glows at sunset on Lake Mead, near the Temple Bar Marina, on July 27. Photo by Charlie Leight/ASU Now

What does climate change and covering land with a city do, in concert or separately, to alter hydrological systems? When it comes to hydrology, codes and regulations don't have much to offer: Don't create more runoff than would have been produced without the development, make sure that water has a place to go, and that's about it.

“We don’t tell our developers, ‘Make sure your development does not increase urban heat,’ ” Vivoni said. “That’s not in our regulations. What I’m trying to get at is we’ve built cities with very little hydrologic and atmospheric science in mind. ‘Just do it. The consequences we’ll figure out later.’ ”

What Vivoni’s group does is provide datasets, models and model outputs that can inform policy from science.

“I think we have to be a little more proactive about our water resources,” he said. “That’s going to require more science in our agency.”

Vivoni feels there needs to be more emphasis put on soft infrastructure: plans, policies, procedures, modeling systems, operational plans that say if the drought is this severe, we’re going to do this; if it’s that severe, we’re going to do that.

“How can we prepare the planners, the cities, the decision-makers with information and knowledge beforehand so that there are plans in place that can be followed under the eventual drought that will eventually hit us someday? That’s squarely in the academic world, and ASU is well-prepared with its social science and natural science expertise to contribute to that.”

Bridging the gap between science and policy is called “sociohydrology.” It’s a recognition that the natural science community hasn’t taken humans into account well enough in their work.

Government used to speak only to consultants.

“We’re at a phase now where academia is starting to play a role,” Vivoni said. The university provides consulting that’s broader than just an engineering goal that needs to be met.

“It can’t only be from one angle,” he said. “It can’t only be from the engineering angle, and it can’t only be from the anthropological angle. It has

to be from some combination of lenses. … We're trying to improve models that can be used in context with stakeholders, to have them have access to tools that can enhance decision-making. I'm at the technical back end of that. I'm not the person with the skills to interface directly with the Phoenix water manager."

How ASU ended up bridging the gap between science and government

Water in the West in general has historically been a by-product of agriculture. Grady Gammage Jr. explained how ASU arrived where it is now.

Gammage (son of ASU's third president) wears a lot of hats. If there's a public or private board making important decisions about the state, you can count on seeing him there. He is an academic, a lawyer, an author, a real-estate developer and a former elected official.

At ASU, Gammage is a senior fellow at ASU's Morrison Institute, the Kyl Center for Water Policy, and a senior scholar at the Julie Ann Wrigley Global Institute of Sustainability. He also teaches at the Sandra Day O'Connor College of Law and at the W. P. Carey School of Business.

When he was in high school, he had a summer job with Salt River Project. "I'd get to drive around and look at the dams," he told an oral history interviewer in 2007. "That was sort of my first exposure to Western water issues a little bit."

"We study water, we think about water, we produce water, we build big water projects, all because of the heritage of the Bureau of Reclamation and John Wesley Powell and the creation of the great Western water projects," he told ASU Now. "That means that the places where water has historically been studied the most are the land grant institutions, where it's a by-product of the study of agriculture. The (University of Arizona) has been the water school, forever, and it is a world leader in hydrology and those kinds of things. That's been weird, because ASU should have been the land grant

school. Agriculture is here; it was never in Tucson. But, for historical reasons, it happened differently. ASU has had to come at this from the non-agriculture perspective."

"I think the niche for ASU is more to focus on the arid West and the way in which water and water rights are managed and adjudicated going into the future. ... The Kyl Center for Water Policy is a really good idea."
— Grady Gammage Jr.

Gammage thinks that's beneficial to the perspective ASU brings to water, because the West isn't about agriculture any more. It's about people and cities.

"Sometimes that historical overhang of the cultural legacy of water in the West distorts the way water is studied and planned and dealt with," he said.

Gammage said ASU's policy orientation — "big-picture water policy" — has evolved over the past 10 or so years.

"I think the niche for ASU is more to focus on the arid West and the way in which water and water rights are managed and adjudicated going into the future," he said. "That's why I'm excited about Rhett (Larson) being here. The Kyl Center for Water Policy is a really good idea. To me, that's the more comfortable niche to exploit: the legal and policy aspects of water. That's what I do; that's what I like. I'm not a scientist."

The water series

Part 1: The current situation and how we got here.

Part 2: Science and research.

Part 3, coming Friday: Law, policy, challenges — and some good news.

Top photo: Lake Mead, by Charlie Leight/ASU Now

Bridging science and policy for better water strategies

Scott Seckel

ASU Decision Center for a Desert City giving policymakers research they can use.

Farms, cities, tribes, utilities all involved in complex water-usage debate.

Part of the challenge in water allocation: Who owns what?

October 6, 2016

Keeping an arid region supplied requires balancing many interests; ASU's experts are connecting research with decision makers

Editor's note: *This is the third in a three-part series examining the work that ASU is doing in the realm of water as a resource in the arid West. Today's focus in on the intersection of law, policy and academia.*

It's 118 at Lake Mead on a July afternoon, but the thermometer on the boat's depth finder says the lake is a cool 67 degrees. Naturally, you jump in. It tastes earthy and mossy, if mossy can be a taste, and ultimately it's what 30 million people survive on.

This is the stuff and place thousands of professionals are focused on. Law, economics, policy and science all underlie this bluish-green water. Some could argue that it begins with the river's watershed in the Rockies of western Wyoming, but it's here, where the water wizards of the Bureau of

Reclamation determine their annual prognostication, that the West makes its stand.

Taking action

The Kyl Center for Water Policy, named after former Sen. Jon Kyl, a distinguished water lawyer, was created about a year and a half ago at Arizona State University to work on water-policy analysis and research. Sarah Porter, a Harvard-educated attorney and former state director of the Audubon Society, was hired as the inaugural director.

She became intrigued with water when she introduced an initiative to protect riparian habitat for bird migration.

“It got me more and more interested in water policy,” she said.

On a Friday morning in August, as the first meeting of the Governor’s Water Augmentation Council convenes down at the Arizona Capitol, a monsoon rain pounds outside.

“It’s raining outside; that’s awesome,” someone says.

Gov. Doug Ducey created the council last October. All of Arizona sits around the table: cattle growers, cotton farmers, cities, wine growers, utilities, tribal nations and communities, home builders, businessmen, attorneys and water professionals. Porter is there representing the Kyl Center.

Sarah Porter, director of the Kyl Center for Water Policy, moderates a panel discussion at the Southwestern Regional Water-Energy Nexus meeting on Sept. 8 at Old Main on the Tempe campus. The purpose of the meeting was to face challenges with innovative, ecologically wise technological solutions. Photo by Charlie Leight/ASU Now

They've been tasked with finding ways to augment water supplies. The state has been divvied into 22 areas. They are to look at each area, learn what the demand and supply imbalances are in each one, and come up with a solution to close that gap.

Today, they're talking about the communications plan and what they want to do in the current fiscal year.

The message they want to get out is that Arizona is a "water success story" — in other words, we're not California.

It’s a message with two competing goals: We need to conserve water, but we’re well-supplied. It’s safe to move here and do business.

“That bathtub ring (at Lake Mead) is not something only people in the Southwest pay attention to,” said Doug MacEachern, the state water department communications administrator.

They’re looking for a balance between rah-rah and everything’s awful.

“We need to tell people it’s going to cost more,” said Ted Cooke, general manager of the Central Arizona Project, the giant canal that shunts water from the Colorado River into central and southern Arizona. “It’s going to take more than new showerheads or toilets.”

“Their costs are going to go up, and that’s real,” said Bas Aja, executive vice president of the Arizona Cattlemen’s Association.

They create a subcommittee to look into funding for augmentation by using reclaimed and low-quality water. If there’s a shortage declaration on the Colorado in 2018, it’s likely that agriculture will need to make up the shortfall with reclaimed water. Porter volunteers to sit on the subcommittee. This is the rubber hitting the road.

They create another subcommittee to look into a partnership with Mexico on building a desalination plant on the Sea of Cortez.

They know people are aware of the value of water. That message is going to be amped up now.

The most complex legal case in American history

The way Arizona water law works is called prior appropriation. The first person to take water out of a river and put it to beneficial use gets a priority date.

If you dig a ditch and divert water out of the river in 1890 and use 10 acre-feet to grow cotton, you have a right, dated 1890, to grow cotton using 10 acre-feet a year. Somebody comes along 10 years later, digs another ditch downstream of you to grow corn with 10 acre-feet — they have a 1900 date. If there's only 2 acre-feet in the whole river, legally speaking, you, with the 1890 date, gets 2 acre-feet and the person downstream of you gets nothing. That's the way water law works.

The Little Colorado River and the Gila River are the two rivers that basically make up all of the surface-water rights in the state that aren't the Colorado. Who has claims on them? Every kind of water user you can think of: big cities, small towns, large utilities, Native American tribes, little farms, big farms, cattle ranches, mines.

And they're all suing each other.

The sun rises at Lake Mead in late July. Photo by Charlie Leight/ASU Now

It's a giant court case that has been technically going on for 40 years, but actually goes back to territorial days. A class-action lawsuit usually involves thousands of people against a small group of defendants. This involves thousands of people fighting each other.

"I don't think it's hyperbole to say that it's the most complex case in American history," said Rhett Larson, the water attorney with the Kyl Center for Water Policy. "Yeah, it's a complete mess."

A water market could improve Arizona's water management. If a clearinghouse or escrow was set up, people could buy and sell water through that escrow for nature or cities or mining.

"Once we have effectively priced water in a market, then maybe we're reaching efficient water allocation," Larson said. "Right now, we can't do that because nobody knows who owns what."

Until the legal cases, collectively called the general stream adjudication, is resolved, Arizona can't have an effective water market because people can't buy and sell water until who owns what has been resolved. The Kyl Center works on the general stream adjudication every day. Ideally, the courts will ultimately make a decree. But not everyone is in a hurry to see the case cleared.

"So a lot of the work that's happening behind the scenes is to find ways, if not necessarily to resolve it, to at least allow small people who want to settle out of it and don't want to pay their lawyers for decades, just to be able to settle out, take some water and leave — and for the others to at least have a faster, smoother process," Larson said. "But there's a lot of skepticism of that too, because if you're going to get ground up into hamburger in the end — do you really want it ground up faster?"

The center has a group of stakeholders who meet several times a month to negotiate. Larson said the work is promising. "We've made a lot of progress in the last 18 months," he said. The Kyl Center acts as a mediator to avoid litigation.

Before worrying about conserving water, people need to worry about understanding water, Larson said.

"Imagine a resource as important as water, to not know who owns it," he said. "A lot of these assured water-supply designations are based on assumptions on who owns what water that might not be true when the adjudication is decided.

"So people are like, 'Oh yeah, we have a hundred years of assured water supply!' And you always feel like going, 'You don't know for sure that you own that water until the court says you do.' … But I don't know, I still hope that there's something that will sort of stoke the fire in people's willingness to resolve the stream adjudication."

Diamonds and water

When economist Adam Smith wrote "The Wealth of Nations," he wrote about the water-diamond paradox. Here's a little tiny, shiny rock that people will pay out the nose for, but it does nothing. And over here is a substance that's everything, but nobody wants to pay for.

It's something Larson wonders about.

"I think it's probably for a lot of reasons, partially because it falls for free out of the sky and people think, 'Why should I pay for that?' " he said. "It's partially because people think of water as a human right, as a fundamental right. I mean, how can you charge me for something that I absolutely need in order to live? And because, you know, in this country we tend to take it for granted. You turn on your taps and clean water comes out all the time, and you just assume this is a part of your life and it doesn't cost much money.

"For some reason we will pay quadruple the amount of its price for movie popcorn, but the idea that you would pay full value for your water is just crazy!"

As the canal manager and the cattleman said at the water council meeting, pricing is on a lot of minds.

"We need to price water in a sane way to communicate to people this is a high-value commodity," said Pat Gober, a research professor in ASU's School of Geographical Sciences and Urban Planning who studies water resources management, decision-making under uncertainty and urban climate adaptation.

Video by Charlie Leight/ASU Now

Water is super-cheap in Arizona. SRP charges $90 a year for irrigation. If you look at a Phoenix water bill closely, most of it goes to sewage fees, garbage fees and some taxes. Very little of it is actually water.

The city of Phoenix Water Services Department spends $175 million annually on operations and management. Of that, $24 million is spent on actual water. The capital improvements budget is $130 million.

“The cost is in the infrastructure,” water services director Kathryn Sorensen said. A section of the redwood water pipes that used to supply the city in the 1920s sits in the lobby outside her office in City Hall, as if to underscore the point. Phoenix has 7,000 miles of water lines spread across 540 square miles. (Now multiply that around the West.)

“As those water lines age, they’re going to have to be replaced if we’re going to continue to have reliable water supplies,” she said. “The cost of that is enormous. We estimate, very roughly, that the replacement cost of the city of Phoenix utility — if you were just to go out and build it starting from scratch — is about $15 billion; $11 billion of that is in pipelines. It’s the cost of the infrastructure that’s going to matter in the future. It’s an enormous cost. And our infrastructure is aging.”

Sorensen is an economist by training.

“I’m intellectually fascinated with the idea and the questions around resource allocation: Who gets what? Of course the most valuable resource here in Arizona is water,” said the Phoenix native. “It’s a very natural fit for me. I knew at a very early age that this is exactly what I wanted to do. I’m one of those of people blessed to have their calling as a career.”

Phoenix has tiered water rates. The more you use, the more you pay. There is also seasonal pricing; water costs more in summer.

“That’s really one of the ways you’re going to get conservation,” Sorensen said.

She knows the cost of water will go up.

“Of course,” she said. “The cost of everything increases over time. When

you talk about water, it absolutely will become more expensive, particularly Colorado River water.

“The impact of that in terms of the end customer will kind of vary. Different cities have different supply portfolios. A city that is more dependent on Colorado River water and a city that is more dependent on Salt and Verde water might expect a different mix on the impact of those costs.”

Agriculture, which uses 67 percent of the water in Arizona, according to the Department of Water Resources, began to pay more in the mid-1990s, when Grady Gammage Jr. served on the board of the Central Arizona Project.

“Historically, water has been free to farmers,” Gammage said. “What they pay for is the delivery cost. In California, the Imperial Irrigation District is still delivering water to farmers at something like $6 an acre-foot. When I was at CAP, we started charging $30 an acre-foot. The questions were could farmers afford it or not?

“The farmers’ view at that point was they had long-term rights to water; they owned the water. It was just getting delivered through the canal. But the contracts they had signed for that delivery required them to pay for the canal at the fully loaded cost of it, and they couldn’t afford that. So we re-cut a deal where they don’t have long-term rights to water anymore. Water is in a kind of limited spot market every year.”

He once sat with a bunch of farmers who told him, “We *have* to be assured we’ll have water every year, and that the price will never vary.”

“I said, ‘Are you ensured that the price of seed will never vary every year? Or that the price of insecticide will never vary every year? Or gasoline or diesel fuel?’ ‘Well, no, but that’s different. Water is different.’ No, it’s not. It’s a commodity, like those other commodities,” Gammage said.

“So what the CAP does now is it tries to price agricultural water at the cost

of getting it here, but on a sort of rolling average so the farmers know three or four years in advance how much water there is going to be, and what it's going to cost, and that can be adjusted. That was hugely revolutionary. They all thought that would destroy agriculture in Arizona, and it's worked out pretty well. The price had gone up fairly dramatically over time."

There's a trade-off between how much you pay for water and how much you pay for food, said John Sabo, a professor in the ASU School of Life Sciences. We eat a lot of stuff because it's cheap and available. We eat baby greens in the dead of summer because water is cheap.

"That's what farms are sitting on: this resource that's only going to go up in value over time," Sabo said. "It's going to force them to become more efficient."

Farms may sell expensive water to cities and use that increased revenue to install things like drip irrigation or switch from low-value crops like alfalfa to high-value crops such as strawberries. We're not going to get to the point where lettuce is $15 a head, though.

"No, because people won't eat it if it's that expensive," Sabo said. "Remember when avocados were $4 each? We only had guacamole during the Super Bowl. ... I think it's more that we'll be focused on eating seasonal things that are cheap, but not all year round."

ASU ecologist John Sabo speaks at the Southwestern Regional Water-Energy Nexus meeting Sept. 8. He says there's a trade-off between how much people pay for water and how much they pay for food. Photo by Charlie Leight/ASU Now

It's not like farmers are acting like drunken sailors. In central Arizona, farmers are required by state law to use water-conservation practices like lining canals, laser-leveling fields and other best management practices. Farmers are legally required to be at least 80 percent efficient, according to the Department of Water Resources.

"Agriculture has become more efficient," Porter said. "We can grow a lot more food with the same amount of water we used 30 years ago."

Good news

"We really have a lot of water (in Phoenix)," Porter said.

Water usage in the city has fallen 30 percent in 20 years.

“We serve 400,000 more people than we did 20 years ago, with the same water,” Sorensen said. “Tremendously successful.”

Las Vegas pays residents to rip out lawns. Tucson has paid out $1.7 million on rebates for rain-harvesting systems. Not all those programs work. A lot of systems have been installed in Tucson, but there’s no decline in demand. In fact, they may be using twice the water they used before. Phoenix hasn’t paid for anything like that, but it’s hitting comparable demand reduction to cities in the region.

“I’m a big fan of the way the city of Phoenix has dealt with landscape issues, which is primarily about education, not about discouraging landscaping through rate adjustments or about paying people to tear out grass,” Gammage said.

What’s causing the drop in demand? Less turf, fewer pools being built, and more efficient appliances. One positive effect of the Great Recession Sabo pointed out was people couldn’t afford to buy new homes, so they remodeled. Remodels almost always involve kitchens and bathrooms, and new appliances are built to be water-efficient. Sorensen expects water use to continue to drop.

“We’re very proud of the way our residents have really embraced a desert lifestyle,” she said. “That’s what it is. Phoenix focuses on the long game when it comes to conservation. We’ve been doing it full-force since the mid-80s, decades before other communities figured out this was important.

“I know it sounds strange, but we don’t want our customers reacting to hydrologic events. We don’t want them reacting to the water levels in Lake Mead or the fact it’s been a 15-year drought, or any of those things. We want them to save water and use water efficiently because it will always be hot and dry here. That’s the mentality we need them to embrace. This is not a

condition. This is not something to react to. This is how to live every day. That strategy has been successful in Phoenix."

In-home efficiency is becoming about as good as it gets, Gammage thinks. And tearing out irrigated tall trees and lush lawns would be a terrible mistake.

"I think we need to be much more discriminating about the appropriate uses of water in the urban environment in the desert," he said. "There are parts of metropolitan Phoenix where retaining the historic landscape — lush grass and trees — is important because it's the heritage of Phoenix. ... In the newer subdivisions we shouldn't have grass in the front yards, where it isn't used."

But in making decisions like that, whether in Phoenix or in other arid cities, there's a dilemma, Gammage said: "You wind up allowing the lush landscape to be preserved for the affluent people, and the lower-income people don't get it."

He's a fan of Tempe Town Lake. It's an amenity, a gathering place, and a place for recreation that is open to everyone.

"It's a good use of water," he said, adding that it "creates ambience and gathering space in the urban fabric."

Tempe Town Lake draws fans in such water experts as Grady Gammage Jr., who praises it as an amenity that offers activities to a wide segment of the population. Photo by ASU

Phoenix has a huge amount of give when it comes to water supplies, said Porter, the directorWhite is also a Senior Sustainability Scientist, Julie Ann Wrigley Global Institute of Sustainability; director, Decision Center for a Desert City, Julie Ann Wrigley Global Institute of Sustainability; professor, School of Community Resources and Development, College of Public Service and Community Solutions; affiliated faculty, Center for Biodiversity Outcomes, Julie Ann Wrigley Global Institute of Sustainability. of the Kyl Center. The Salt River reservoirs are at half capacity, and not every SRP city uses all their supplies. We're far from living on a knife's edge, she said.

"We talk about a supply gap, and we worry about where we're going to get water, but we actually — if we stopped growing, and didn't have any more demand, we wouldn't have a water problem. Even with all the scary threats

to our water supply out there, we wouldn't be having conversations about a water-supply problem," said Porter, who added that the issues are sustaining growth.

Bull in a china shop

One of the challenges is getting two of the main players — scientists and those making decisions in government — talking to each other.

"I think, for some reason, and I don't think it's either side's fault, policymakers and scientists aren't communicating at all," Porter said. "In a lot of disciplines there's an expectation when they publish a paper in a scholarly magazine, someone at the legislature is going to pick it up and read it and act on it. Of course it's absurd to think that if you think about how busy elected officials are and the demands on their attention."

There isn't the beginning of the communication needed, she said, but "there are places at ASU where there are much more deliberate efforts to make those communications happen."

That place is the Decision Center for a Desert City. A research unit of the Julie Ann Wrigley Global Institute of Sustainability, the center conducts climate, water and decision research, and develops tools to bridge the boundary between scientists and decision makers. The 12-year-old center has worked hard to become an example of how academia can work with policymakers.

Dave White is the director and principal investigator of the center.

"This is a problem that we have faced and hopefully overcome to a large degree," White said. "When university researchers conduct research independent of collaboration with policymakers, they often miss critical inputs or critical perspective into the research, that if they were aware of these perspectives they could vastly improve the relevance of the research."

For example, if a scientist talked to a policymaker before embarking on a study, they could set a geographic scope to a political decision-making unit. A study about the Phoenix Active Management Area instead of “greater Phoenix” “could potentially increase the relevance of the study,” White said. (Active Management Areas are five places identified by the state as being heavily reliant on groundwater.)

Dave White (speaking at the Southwestern Regional Water-Energy Nexus meeting on Sept. 8), director of the Decision Center for a Desert City, says the center involves its partners in designing the research. That helpls the results be relevent to policymakers. Photo by Charlie Leight/ASU Now

Research also needs to meet the timing of policymaking. Agencies have deadlines and deliverables, just like the private sector does.

All of which raises the question: Exactly what do public water officials want to know from academia? Where does the rubber hit the road? These six

titles are a random recent sampling of what policymakers want to know, from papers written for the Decision Center for a Desert City.

- neighborhood microclimates and vulnerability to heat stress
- regional relationships between surface temperature, vegetation and human settlement in a rapidly urbanizing ecosystem
- determinants of small-area water consumption for the city of Phoenix
- residents' yard choices and rationales in a desert city: Social priorities, ecological impacts, and decision trade-offs
- the impact of the Phoenix urban heat island on residential water use
- analysis of drought determinants for the Colorado River Basin

'We listen'

Kelli Larson, an associate professorLarson is an associate professor, School of Sustainability; associate professor, School of Geographical Sciences and Urban Planning, College of Liberal Arts and Sciences; Senior Sustainability Scientist, Julie Ann Wrigley Global Institute of Sustainability; center associate director and director of education and mentoring, Decision Center for a Desert City. in the School of Sustainability, said she saw some of the dread policymakers have of scientists early in the center's history.

"There's this new water center opening, and some of the language was to improve water resource decision-making, which, as a decision maker, you might be sitting there thinking, 'We've been working on these issues for 10, 20, 30 years, and now there's this new center, and they're going to improve our decisions?'" Larson said. "It may burn relationships."

The majority of the center's "clients" tend to be technical staff at various agencies: water providers, planners, utility managers. Larson thinks about what they need and the policy implications. The center is proactive; it goes to decision makers, so they don't have to navigate ASU to find the right people. Center staff — some of whom are former policymakers themselves — ask them what they're working on, what their concerns are, what

questions they have.

“It takes time to build those relationships, to build trust,” Larson said. “We’ve been quite successful with that. Part of why we’ve been successful at that is because we listen. I see the planners and the decision makers as experts in their own right. They’re not scientists per se, they’re not researchers, they’re not academics, but oftentimes they do do their own form of research, and they have their own knowledge base. There’s a lot they can offer to our understanding and insights, including informing our research agendas.

“When I first got here, I felt like we were outsiders trying to enter the water community, and now I feel like we’re a part of the water community,” she said. “That feels really good to see that unfold over 10 years.”

And people in government agree that it’s successful.

“They haven’t been (overbearing),” Sorenson said. “That’s exactly the reason we’ve been able to build such good relationships.”

Boundary organization

“One of the things we do really well that a lot of universities are getting into, but we’re on the leading edge of, I’d say, is integrating people into the decision-making process from the beginning,” Sabo said. “We’re very good at understanding the institutional context and the decision-making context of water resources and doing the planning and interface with the science that allows people to contribute to that process.”

The Decision Center for a Desert City (DCDC) calls itself a boundary organization. It is a link between scientists and water-resource practitioners. The goal is to have a space — both physical and intellectual — that creates an institutional connection between the university and its partners.

“We don’t operate in consultancy mode,” White said. “We involve the partners we work with in the design of the studies. The partners are involved

in constructing the framing of the problem, they're involved in constructing the research questions themselves, in designing and carrying out the research studies, and then interpreting and utilizing the results."

The "bathtub ring" is visible above Lake Mead at Hoover Dam. Photo by Charlie Leight/ASU Now

Sorensen and Tom Buschatzke, the director of the Arizona Department of Water Resources — the state's two most influential water leaders — sit on DCDC's advisory board. They, along with the National Science Foundation, which has invested $18 million in the center, evaluate the center every two years. White sits on the mayor's water advisory board.

Science should fill in the gaps and provide evidence for alternatives. It's a fine line to walk, White said.

"If you just throw your hands up in the air and say, 'This is ridiculous!' that's

not going to get you very far," he said. "If you want to have policy-relevant work, then you need to understand how did the system converge this way. … It's not up to us to make those decisions. It's up to us to help to diagnose what the consequences of different decisions are."

Water Sim and the Decision Theater

Because water problems tend to be extremely complex, that makes it difficult for non-water professionals and elected officials to understand them. DCDC has created two opportunities to make them visual.

Water Sim is a software program that models system dynamics. You can fiddle around with various scenarios to see how an El Nino or a thin snowpack will affect water. It's a systems model; it takes a lot of data usually collected separately — like water supply, demand, climate, population and policy data — and puts it together. Users can change one variable and see how it affects the rest.

ASU's Decision Theater provides meeting rooms with large-format ultra-high-definition displays and on-site computer systems, tools and personnel that can provide specialized geographic information systems, systems modeling, business intelligence, and 3-D spatial modeling and simulation, among other capabilities.

With water problems, the importance of visualization really ratchets up.

"A picture is worth 1,000 words, right?" Sorensen said. "One of the things that's been really constructive is to work with DCDC on the Decision Theater. You can bring in policymakers and elected officials and instead of having to sit there and lecture them for three hours on the background of a problem and why it matters and why they should care about it, the Decision Theater helps them visualize it. You can tell the story much easier in a way that makes sense and in a way that's compelling to them."

What policymakers say

Water is immensely complex, even if it's your field, even if you have a PhD. If you really take a look at water problems, what you'll find is they're wicked problems. They're extremely complex. The low-hanging fruit has already been picked.

"The solutions that are left to us to face the challenges of a changing climate and global uncertainty are few and far between, difficult to achieve, and they tend to be incremental in nature," Sorensen said. "And yet ahead of us are enormous risks. As a policymaker, someone who has to actually make sure 1.5 million people in the middle of the desert have water, finding your way through that path is extremely difficult. You have to make decisions at different times with relatively little information and huge amounts of uncertainty.

"That's kind of ASU's focus: How do you make good decisions in such an uncertain world with such wicked problems ahead of you? It has been a really useful and collaborative partnership. We've been thrilled to have been involved with it. ... Water wonks are always a little bit nervous when academics forge their way into policy arenas, but I would say for the most part it's been tremendously successful. It's been a benefit to us, and hopefully to ASU as well."

And many people across many fields at ASU are working to make that happen.

"A place like the Global Institute of Sustainability and DCDC help to serve as a glue for all of us, so that our efforts are bigger than just one professor's efforts," said hydrologist Enrique VivoniVivoni is an associate professor, School of Earth and Space Exploration, College of Liberal Arts and Sciences; sustainability scientist, Julie Ann Wrigley Global Institute of Sustainability; affiliated faculty, Center for Biodiversity Outcomes, Julie Ann Wrigley Global Institute of Sustainability. said. "I think we're starting to make inroads in

increasing our reputation, and attracting great students and doing interesting projects and generating a niche that we can become world leaders in."

The water series

Part 1: The current situation and how we got here.

Part 2: Science and research.

Part 3: Law, policy, challenges — and some good news.

Top photo: The Mike O'Callaghan-Pat Tillman Memorial Bridge on U.S. 93 soars above the Colorado River spillway from Hoover Dam. Photo by Charlie Leight/ASU Now