Game theory proves good engineering makes good neighbors

Professor's ASU- and NSF-backed study reveals how smarter infrastructure can help entire cities work better, together

By Kelly deVos, ASU News
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Picture a sun-scorched Phoenix neighborhood in the middle of summer. A small canal cuts between homes, quietly delivering water to yards via an old method: flood irrigation. It's cheap, it's effective, and it absolutely depends on neighbors working together.

But what happens when that cooperation breaks down?

Paul Grogan is an associate professor of industrial engineering in the School of Computing and Augmented Intelligence, part of the Ira A. Fulton Schools of Engineering at Arizona State University. He is working with doctoral student Mobin Zarreh to tackle a deceptively simple yet deeply consequential problem: How can we design shared infrastructure systems — like neighborhood irrigation networks — that don't fall apart when individuals act in their own best interest?

Real-world research that goes with the flow

Grogan's latest research uses game theory and computer modeling to better understand how people make decisions in systems that require collaboration to function.

His recent project is supported by the National Science Foundation as part of their Division of Civil, Mechanical and Manufacturing Innovation and Engineering Design and Systems Engineering programs. The work, published in the peer-reviewed journal Water Resources Management, focuses on one specific example: flood irrigation in Arizona neighborhoods, where water from a shared canal must be jointly managed and maintained by nearby households.

If even one household drops out, for example by switching to a private drip irrigation system, it increases costs and workload for everyone else. Too many defections and the system collapses.

“This setup is a perfect example of collaborative infrastructure where the success of the system depends not just on good engineering but on sustained human cooperation,” Grogan says.

Game theory that gets your lawn watered

To untangle the web of neighborly incentives, Grogan and his team used a classic scenario from game theory known as the stag hunt. In this model, players choose between a high-reward option that requires teamwork, called hunting a stag, and a low-risk, lower-reward option they can do alone, referred to as hunting a hare. In this philosophical problem, both hunters know they could catch the stag if they cooperate, while working alone they can each easily obtain the far less valuable hare.

In the irrigation context, “hunting the stag” means sticking with the shared canal system. The benefits include low costs and community goodwill, provided everyone participates. “Hunting the hare” is switching to a private system, a choice that’s safe, but more expensive and isolating.

The research team tested different ways of laying out the irrigation infrastructure to see which encouraged the most cooperation. They used simulations and economic modeling to explore how trust and influence flow between neighbors depending on how the system is physically designed.

Their key finding? The way infrastructure is laid out plays a massive role in whether people choose to collaborate or go it alone.

Smart design builds trust

Two network designs stand out. The bus topology, with houses connected to the canal like stops on a bus line, offers the highest economic efficiency. It keeps costs low by sharing infrastructure efficiently. But it isn’t perfect. Downstream users still depend on upstream neighbors, making trust fragile.

The star topology, on the other hand, places every household on equal footing. Everyone connects directly to the water source, reducing dependency and leveling influence. While slightly more expensive, this layout proves the most stable. Cooperation is more resilient, and neighbors are more likely to work together.

Grogan’s research shows that better cooperation isn’t just a matter of better rules or stronger enforcement. Sometimes, it’s about smarter design.

From student to standout

The research also highlights student leadership. The study was co-authored by Zarreh, an industrial engineering doctoral student in the Collective Design Lab that Grogan leads at ASU. Zarreh developed the simulations that validated the theoretical models and gave the study its predictive power.

“Mobin’s contributions went far beyond implementation,” Grogan says. “He shaped the modeling framework and brought new ideas to the table at every stage.”

Grogan notes that Zarreh introduced a high level of focus on water resources and their management to the project. He met with representatives from utility company Salt River Project and attended the 2025 Arizona Groundwater Policy Conference.

This involvement is not unusual in Grogan's lab, where students take the lead in exploring real-world applications of complex systems design.

"It was exciting to see how a theoretical model could be directly applied to something so tangible in our own communities," Zarreh says. "This work deepened my appreciation for how engineering design can influence not just systems but also the way people interact and cooperate."

A mentor who builds more than models

Grogan is no stranger to mentoring students through ambitious, high-impact research. Since joining ASU in 2023, he has mentored multiple students through the Fulton Undergraduate Research Initiative, or FURI, a program that gives undergraduates hands-on experience in academic research.

"I never had a chance to do research as an undergraduate," Grogan says. "Now, I get to help students figure out early whether a research career is right for them."

His students don't just do busywork. They help prototype satellite test beds for NASA. They explore how infrastructure design intersects with human psychology. They build things that might one day affect public policy or save resources.

Grogan's mentoring philosophy is simple: Let students wrestle with real problems. He tasks them with building proof-of-concept systems such as software, simulations and sometimes physical prototypes that become the seeds of larger, funded research efforts.

Engineering a more cooperative future

Grogan's flood irrigation study might seem like a hyperlocal case — just a few neighbors in Phoenix sharing a water system. But its implications are global.

As resources like water become increasingly strained, infrastructure systems everywhere will depend more on cooperation between users. Grogan's work shows that if we want people to work together, we shouldn't just ask them nicely. We should build systems that make collaboration the easiest and most rewarding choice.

Ross Maciejewski, director of the School of Computing and Augmented Intelligence, says Grogan's project is a model for impactful, collaborative research.

"Paul's work stands out because it doesn't just solve engineering problems," Maciejewski says. "His research is designed to help communities function better, together."

This story originally appeared on ASU News.

Main image

Mobin Zarreh (left) discusses water management issues with Paul Grogan (right). Grogan, an associate professor of industrial engineering in the School of Computing and Augmented Intelligence, part of the Ira A. Fulton Schools of Engineering at Arizona State University, and Zarreh, an industrial engineering doctoral student, are using game theory to study how to design shared community infrastructure systems that remain useful even when individuals want to act in their own self-interest. Photo by Erika Gronek/ASU