Mapping the way to harvesting water from air

ASU expert talks about new technology’s potential to solve water challenges

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Earth’s atmosphere contains about 13 trillion tons of water.

That’s a lot of water to draw upon to help people who are contending with drought, overtaxed rivers and shrinking aquifers.

In fact, technologies that collect water vapor and turn it into pure, liquid water are emerging to tackle global water challenges — and, to help, industries including pharmaceutical and semiconductor manufacturing are pouring money into research and pilot testing.

At Arizona State University, experts in the field recently gathered for the second International Atmospheric Water Harvesting Summit hosted in collaboration with the Ira A. Fulton Schools of Engineering, Global Center for Water Technology, Julie Ann Wrigley Global Futures Laboratory, Arizona Water Innovation Initiative and Southwest Sustainability Innovation Engine. ASU News spoke with Paul Westerhoff, a Regents Professor in the School of Sustainable Engineering and the Built Environment, who chaired the summit.

Question: Collecting useful amounts of water from Arizona’s dry air sounds impossible. How much water is available in our air?

Answer: While Arizona's climate is known for its dryness, there is still a substantial amount of water vapor in the air. Relative humidity typically fluctuates between 10% and 40%, with higher levels at night and during certain times of the year, particularly from May to October. These conditions make it possible to capture water vapor using desiccant-based technology, the most promising method for dry climates like Arizona’s. A desiccant such as silica gel, the stuff in those packets you find in new shoe boxes and medicine bottles, absorbs moisture from the air. Advanced machines use fans to move air through next-generation metal-organic framework desiccants, then release the collected water using heat from solar or other energy sources. Due to rapid advancements in desiccant-based technology, numerous atmospheric water harvesting companies have emerged in Arizona over the past four years.

To put this into perspective, studies estimate that approximately 30 million acre-feet of water moves through the Phoenix metro area annually in the form of humidity. This is an enormous amount, especially when compared with the half million acre-feet that Arizona imports as liquid water from the Colorado River each year — which, by the way, all evaporates back into the atmosphere during use in central Arizona. By using atmospheric water harvesting, we are essentially recovering some of the water that is naturally evaporating from our existing water sources, such as the Salt, Verde and Colorado rivers.

This highlights the potential for atmospheric water harvesting as a viable and sustainable water source, even in an arid climate like Arizona's.

Q: Is the energy requirement a problem? Does it make the process too expensive for real-world uses?

Answer: Today, the cost of atmospheric water harvesting is less than $1 per gallon — already cheaper than bottled water. With continued advancements, costs could drop at least 50 times lower in the near future, making it a viable large-scale water source. Innovations in desiccant-based technology are rapidly improving efficiency and reducing costs. A major breakthrough is that water vapor releases heat when absorbed, which can be harnessed to reduce energy consumption. Just as ocean desalination improved with better membranes and energy recovery systems, atmospheric water harvesting is following a similar trajectory.

At present, while it's not yet practical for large-scale uses like irrigation, it is already cost competitive for ultra-pure water applications. Industries such as semiconductor manufacturing, battery production and pharmaceuticals rely on purified water, which is expensive to produce using traditional desalination. In many cases, atmospheric water harvesting is already a cheaper and more efficient alternative to these conventional methods.

Experts project that within five to 10 years, atmospheric water harvesting will reach cost parity with municipal water, even in arid regions like Arizona. As costs continue to decline and efficiency improves, this technology could become a sustainable and reliable water source for both everyday use and industrial applications.

Q: Could removing water from the air bring any unintended, harmful consequences?

A: Concerns are understandable, but research and modeling studies indicate that the overall environmental impact is minimal. The atmosphere is highly dynamic, with wind constantly redistributing humidity. Even today, many buildings use dehumidification systems as part of their air conditioning, removing water vapor that simply drains away. For example, the ASU hockey arena utilizes desiccant-based dehumidification technology, and while it impacts indoor air, the effects do not extend beyond the building.

Studies conducted on military bases where atmospheric water harvesting is in use have shown that changes in temperature, humidity and wind patterns occur only within a few feet of the devices. This suggests that even when deployed at a large scale, the impact remains highly localized.

If integrated strategically within cities, atmospheric water harvesting could actually offer benefits by reducing outdoor humidity, which in turn could lower overall heat stress in urban areas. This is particularly relevant in places like Phoenix, where excessive humidity can contribute to uncomfortable conditions.

Additionally, the Phoenix metro area has a mixing zone that extends 100–300 meters above the ground, meaning that any localized reduction in humidity is quickly offset by natural atmospheric mixing. This ensures that the broader climate remains unaffected, as new humidity is continually introduced.

Q: How clean is water collected from the atmosphere?

A: Water from the air is extremely pure, containing almost no salts compared to groundwater or ocean desalination. However, there are some airborne chemicals that can be captured in the process, particularly volatile organic compounds that come from nearly anything that you can smell, including perfumes, cleaning products, plants and cooking aerosols. Fortunately, modern filtration and purification technologies are already addressing these concerns. State and federal agencies, along with third-party research organizations, are conducting thorough tests to ensure the long-term safety and viability of atmospheric water. Within the next few years, it is likely that small communities struggling with water shortages will start adopting atmospheric water harvesting as a significant part of their water supply — not necessarily as a replacement, but as a valuable supplemental source. As technology improves and costs decrease, this method could become a major sustainable water solution, particularly for arid regions that lack easy access to traditional water sources.

Q: What were the goals of this year's summit?

A: One important goal was to contribute to developing a 20-year atmospheric water harvesting roadmap. This roadmap goes beyond just the technical feasibility of harvesting water from the air — it explores key questions such as: How much water can be harvested? What is the energy footprint? What is the water quality? Who needs this water?

When designing the agenda, we prioritized representing broad interests of stakeholders from regulators to startup companies and end users. Slightly less than half of the attendees were from academia. Over 22 startup companies represented about 40% of all participants. Around 20% came from government and other stakeholders, including Salt River Project, Arizona Public Service and various end users from multiple sectors. Additionally, we had representation from NGOs, investors, high school students and members of the general public. This fantastic mix of people contributed to an outstanding summit.

In the coming weeks, we will integrate all feedback from the summit into a white paper and a journal publication detailing our roadmap, which we believe is crucial for the entire atmospheric water harvesting community.

Q: What's next for this technology?

A: Atmospheric water harvesting technology is no longer just an emerging concept — it is already being deployed. Hundreds of homes across Arizona are equipped with commercial systems, some of which are powered by solar energy, while others are plug-in systems designed specifically for drinking water.

However, the biggest economic opportunities for large-scale adoption lie in ultra-pure water applications for industrial manufacturing, beverage production and commercial applications. Unlike traditional water sources that require extensive piping and distribution infrastructure, atmospheric water can be generated on site, reducing costs and logistical challenges. Essentially, the atmosphere itself serves as the pipeline, delivering water where and when it's needed.

Exciting and notable developments have already emerged: At least six new companies were established within the past year. One of these startups has secured over $2 million in venture capital funding, while another has launched on NASDAQ. The United States is currently leading in technology development, with over 30 startups emerging in recent years and securing more than $500 million in venture capital funding. The market itself is currently valued at around $800 million per year and is growing at an estimated 8–12% annually.

This technology is poised to revolutionize water access, not just in arid regions like Arizona, but across the entire world. The goal is to provide water at the right time, in the right place, at the right quality and at the right cost — shifting the global paradigm for water sustainability.

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Main image

Water vapor held in the air appears as droplets of dew when it condenses on a cool surface such as this nasturtium leaf. Photo by Joe Rojas-Burke/ASU