Q&A: Researcher discusses work to solve America's groundwater crisis

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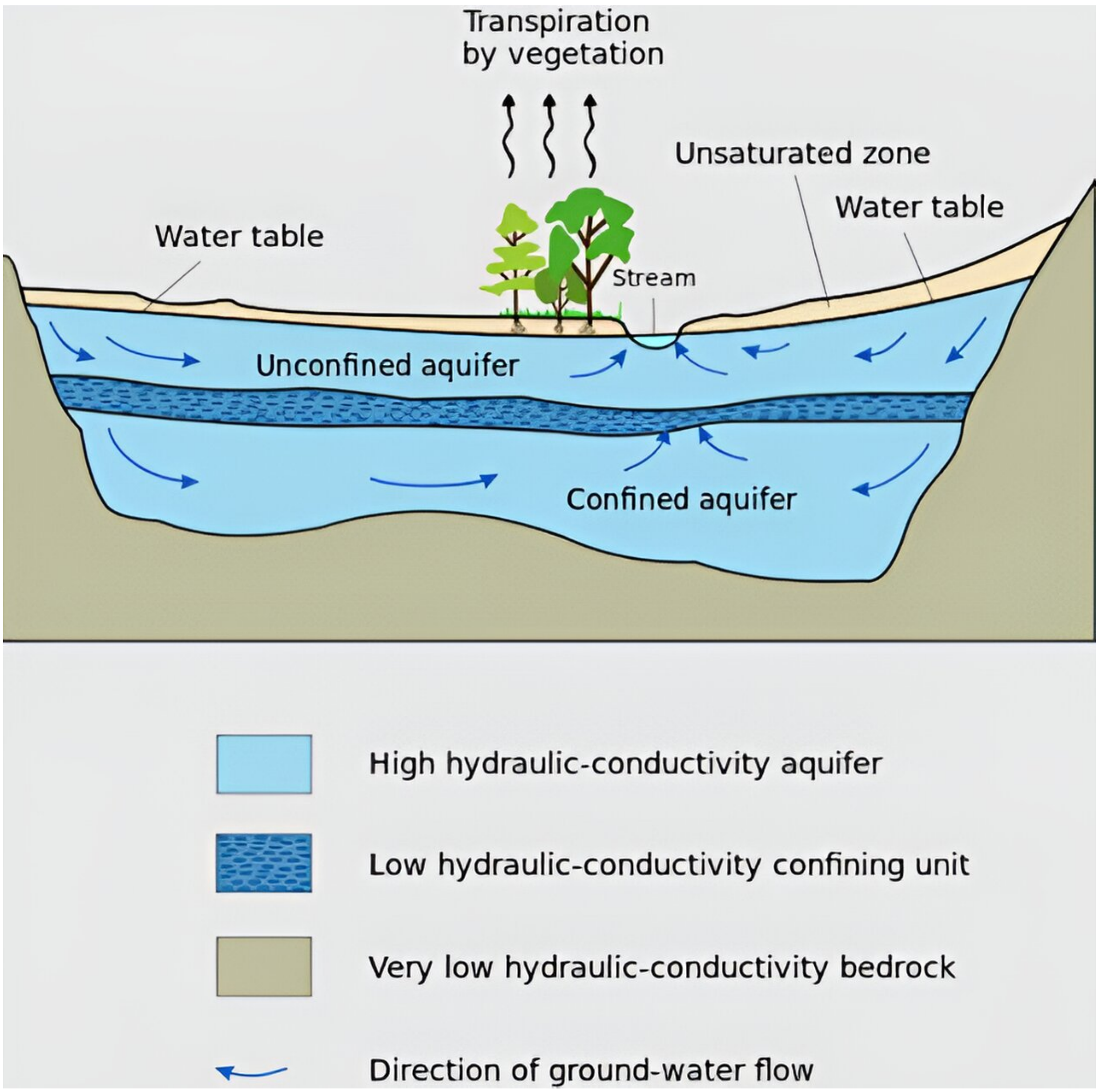

Typical aquifer cross-section. Credit: Public Domain

Beneath the roadways and sidewalks we traverse every day are underground reservoirs that supply a substantial chunk of nation's overall water needs. These groundwater aquifers once sustained America's cities and farmland. Now, according to a New York Times investigation, they could be drying up for good.

Aquifers—geologic formations of layered rock or sediment that filter and hold groundwater—power much of the nation's industry and agriculture. But the growth of cities and industrial farming is fast depleting the country's groundwater—faster than rates of recharge. Additionally, public attention to the problem has been lacking, experts say.

More than a century ago, the movement of groundwater struck officials as "so secret and occult" as to seem ungovernable. That the problem isn't easily visible has made it difficult for scientists to collect data, says James Dennedy-Frank, an assistant professor of marine and environmental sciences, as well as civil and environmental engineering, at Northeastern.

Dennedy-Frank spoke to Northeastern Global News about his ongoing research into the issue, which leverages the power of computing to create models that simulate rates of groundwater depletion, while exploring the environmental factors linked to recharge.

The conversation has been edited for brevity and clarity.

Why don't you start by explaining the problem. What

is going on with our groundwater, and what prompted this big Times investigation?

The problem is we know that reliable water resources are a critical need, and we're seeing a lot of places where water resources are becoming less reliable. The first big Times piece is about declining water levels across the country.

Certainly this is something we've known about—particularly on the West Coast—for a long time. But the Times put together a whole new database of declining water levels nationwide. As we are experiencing more severe drought in lots of places, including over here on the East Coast—in places like Cape Cod, for example, which is very groundwater-reliant—we're seeing groundwater levels drop everywhere.

And that has all kinds of effects. It has effects on the availability of water. A lot of rivers and streams are supported by groundwater, especially through dry seasons. So those rivers and streams are getting lower and flowing less.

They're also, as a result, getting warmer because you have less of that cold groundwater flowing in. That then has potential effects on aquatic life, too. There's a whole set of effects here—and this isn't only happening in the "arid" West, where you tend to hear about it a lot.

Phoenix made the decision recently to restrict the building of homes in certain areas because there wasn't a reliable source of water. That is obviously a really big problem, when you have cities saying they can't build new houses.

The second place the Times looked at was Minnesota, which is not a place that we think of when we think of arid zones. They had a drought back in 2021 and a lot of the big agricultural companies there were pumping a lot of groundwater—in fact, a lot more than their nominal permits allowed.

(I'll say one thing about groundwater, which is that where there are permits, they're not usually well enforced, and in many places there aren't even things like permits, so there are very loose regulations.)

Even in Minnesota—we think of Minnesota as the "Land of 10,000 Lakes," where there is lots of water—there were lots of wells running dry because of the drought, and these agricultural uses were pumping out millions of gallons of water. That's a rough sketch of the problem.

Do we know how much this is a product of climate change specifically?

I don't think anyone has precise numbers on that right now. There are people certainly working on trying to understand it as a climate attribution question—how much of it is climate, how much of it is human-led, etc. There have been many places where groundwater and other water resources have been stressed by human use in the absence of climate change, but climate change is stressing the systems more and stressing systems that we didn't used to worry about as much.

I think the thing that rings true is that better human management can substantially reduce these effects if we were just more thoughtful about our management, and more thoughtful about just how many resources we use and where. The largest single crop in the U.S. is turfgrass; it covers the most area. Lawns in the middle of Phoenix are real big water users. Lots of places in the west have started tackling that issue. But many other places have not.

What are cities and municipalities doing to help solve the problem?

There have been a variety of approaches. Decades ago, the city of Thornton, Colorado bought up land that had water rights associated with it in order to pipe it down to the Denver suburbs.

Recently [the city] has been in legal battles over moving this water, because there are very complicated water laws at play. Last summer on Cape Cod, there were lots of watering restrictions put in place.

Cape Cod, as I noted, is very groundwater dependent, so these groundwater issues are a classic story there. Even in these East Coast systems that we think of as pretty wet, people are being told to limit the watering of lawns.

Tell me about your research and how it's helping the search for solutions.

I am a hydrologist and I primarily do watershed simulations. I use computers to represent these watersheds, with the goal of trying to better understand how we can more sustainably manage them.

Most recently, a lot of the work we've been doing looks at how groundwater is being recharged, and how rain and snow are related to the streamflow and evapotranspiration—so the water coming through the rivers, and the water being used by vegetation.

What we've been seeing is that in at least one mountain watershed in Colorado, more of the water that falls as snow ends up as streamflow, whereas more of the water that falls as rain ends up as evapotranspiration. That has important implications in a world where we have more rain and less snow in the future.

We're doing work to try and track down how much this is fundamental to how rain and snow behave in these systems, both in the western U.S. and here in the east. On the groundwater story, we had a paper out earlier this year which I am a co-author on that looked at these big atmospheric river storms that come into California, and tracked water from these atmospheric rivers versus from other smaller storms.

We found that what most recharged the groundwater in our model of this California watershed is actually the snow from less severe storms. So these really big severe storms recharge that groundwater a lot less. That has important implications as the climate shifts and we see more of these atmospheric rivers.

Where do you think we'll be in a decade's time on this problem?

For a very long time around water, we've muddled along. When things become really severe, we figure out some temporary solution to fix it.

Moving forward, our abilities to simulate and better understand these systems are improving, and I think the hope is that people in management roles and government are using these tools and working with academics to better plan and manage the water resources for those hard-hit areas, and thus push towards a more sustainable future.

But there will continue to be stressors—and we don't know exactly what they will be as the climate shifts.

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