# Groundwater from aquifers important factor in food security

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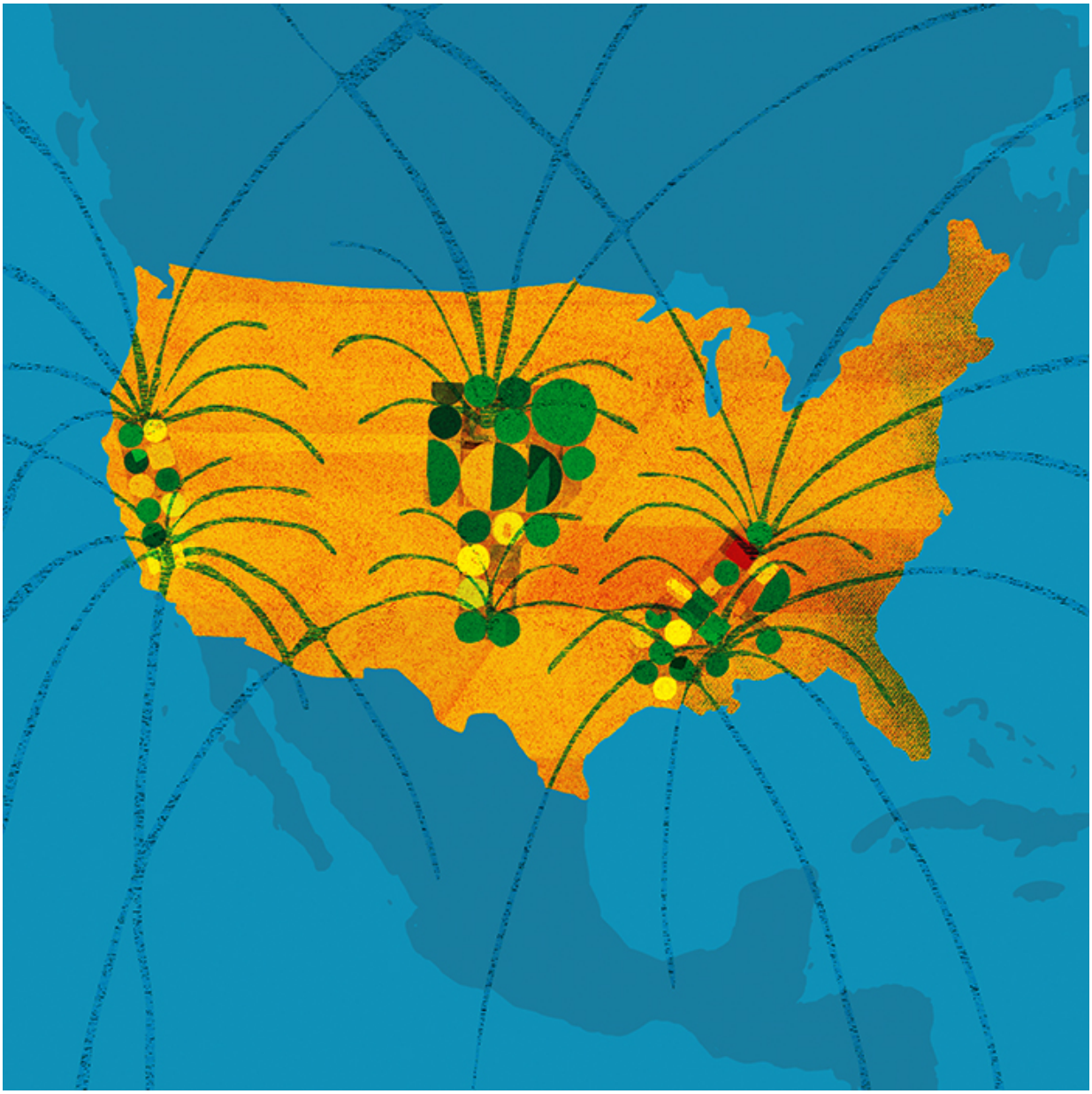

Groundwater from three main aquifers in the United States contributes to food shipped across the country and around the globe, says a new study from civil and environmental engineers at Illinois and Lehigh University. Credit: Tom Sears

Thirsty cities, fields and livestock drink deeply from aquifers, natural sources of groundwater. But a study of three of the most-tapped aquifers in the United States shows that overdrawing from these resources could lead to difficult choices affecting not only domestic food security but also international markets.

University of Illinois professors of civil and environmental engineering Ximing Cai and Megan Konar, along with graduate student Landon Marston and Lehigh University professor Tara Troy, studied groundwater consumption from three main aquifer systems. Reliance on these aquifers intensified so much from 2000 to 2008 that it accounted for 93 percent of groundwater depletion in the U.S. They published their findings in the *Proceedings of the National Academy of Sciences*.

The U.S. Geological Survey identifies the Central Valley aquifer in California, the High Plains aquifer in the Great Plains states, and the Mississippi Embayment aquifer in the lower Midwest as being managed unsustainably, which means that water is being extracted from the aquifer faster than it is replenishing.

"Deep groundwater is like natural gas. If you use it, it takes a while to recharge," Cai said. "Unsustainable usage means the water table is lowered, which makes it more difficult and more expensive to pump water since we have to keep going deeper. It also affects ecosystems associated with the water table, such as streams and wetlands."

The researchers tracked water consumption from the aquifers to see

where the water was going, both in terms of geography and usage. For example, when water was used to irrigate a crop, the researchers tracked where those crops were shipped.

"When we think of water, we think of direct water, the water that comes out of our faucets. But we actually use a lot of embodied water in our everyday lives – the water footprint to produce a product," Konar said. "We looked at the water implicitly being transferred between states and countries in the products."

The researchers found that the vast majority – 91 percent – of embodied groundwater from these three aquifers stayed within the U.S. The remaining 9 percent was exported internationally. They identified the states most heavily reliant on each aquifer, and the breakdown of what was produced using water from each aquifer. For example, the largest percentage of water from the High Plains aquifer irrigated grains, while the largest contribution from the Central Valley aquifer in California went to producing meat. See the infographic for the detailed findings.

The researchers hope that having detailed information on how aquifer water is used, and the complex economic and environmental implications of that use, can help policy makers in their decisions about water resource management.

"The issue here is the tradeoffs. That's the difficulty for the decision makers," Cai said. "There is a tradeoff between the environment and economic profit, and there is a trade-off between the current use and future use. The environment is affected, the food markets are affected, the resources for fisheries are affected. That helps the decision makers understand the issue. I think this information is also important for the public to understand the issue."

The researchers feel that the study is also important for international

leaders, as any decisions will affect global food production and prices. Although the international exports represented a small percent of the overall water consumption, the exported goods account for a large market share in the countries that import them, the study found.

Next, the researchers plan to study major watersheds in the U.S. to gain a more comprehensive picture of natural water resources in the United States. They are interested in detailing water use under variable conditions, both in terms of economic and environmental impact.

"Managing water resources for the future is especially important because future rainfall patterns are going to be more variable, with more droughts predicted," Konar said. "As we're seeing in California, they were really lucky to have aquifers to rely on during a drought. We don't want to deplete these aquifer supplies, so that when we get into these drought situations, we have some emergency backup."

**More information:** "Virtual groundwater transfers from overexploited aquifers in the United States" *PNAS* 2015 ; published ahead of print June 29, 2015, DOI: 10.1073/pnas.1500457112

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