'Carbon sink' detected underneath world's deserts

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Scientists followed the journey of water through the Tarim Basin from the rivers at the edge of the valley to the desert aquifers under the basin. They found that as water moved through irrigated fields, the water gathered dissolved carbon and moved it deep underground. Credit: Yan Li

The world's deserts may be storing some of the climate-changing carbon dioxide emitted by human activities, a new study suggests. Massive

aquifers underneath deserts could hold more carbon than all the plants on land, according to the new research.

Humans add carbon dioxide to the atmosphere through fossil fuel combustion and deforestation. About 40 percent of this carbon stays in the atmosphere and roughly 30 percent enters the ocean, according to the University Corporation for Atmospheric Research. Scientists thought the remaining carbon was taken up by plants on land, but measurements show plants don't absorb all of the leftover carbon. Scientists have been searching for a place on land where the additional carbon is being stored—the so-called "missing carbon sink."

The new study suggests some of this carbon may be disappearing underneath the world's deserts - a process exacerbated by irrigation. Scientists examining the flow of water through a Chinese desert found that carbon from the atmosphere is being absorbed by crops, released into the soil and transported underground in groundwater—a process that picked up when farming entered the region 2,000 years ago.

Underground aquifers store the dissolved carbon deep below the desert where it can't escape back to the atmosphere, according to the new study.

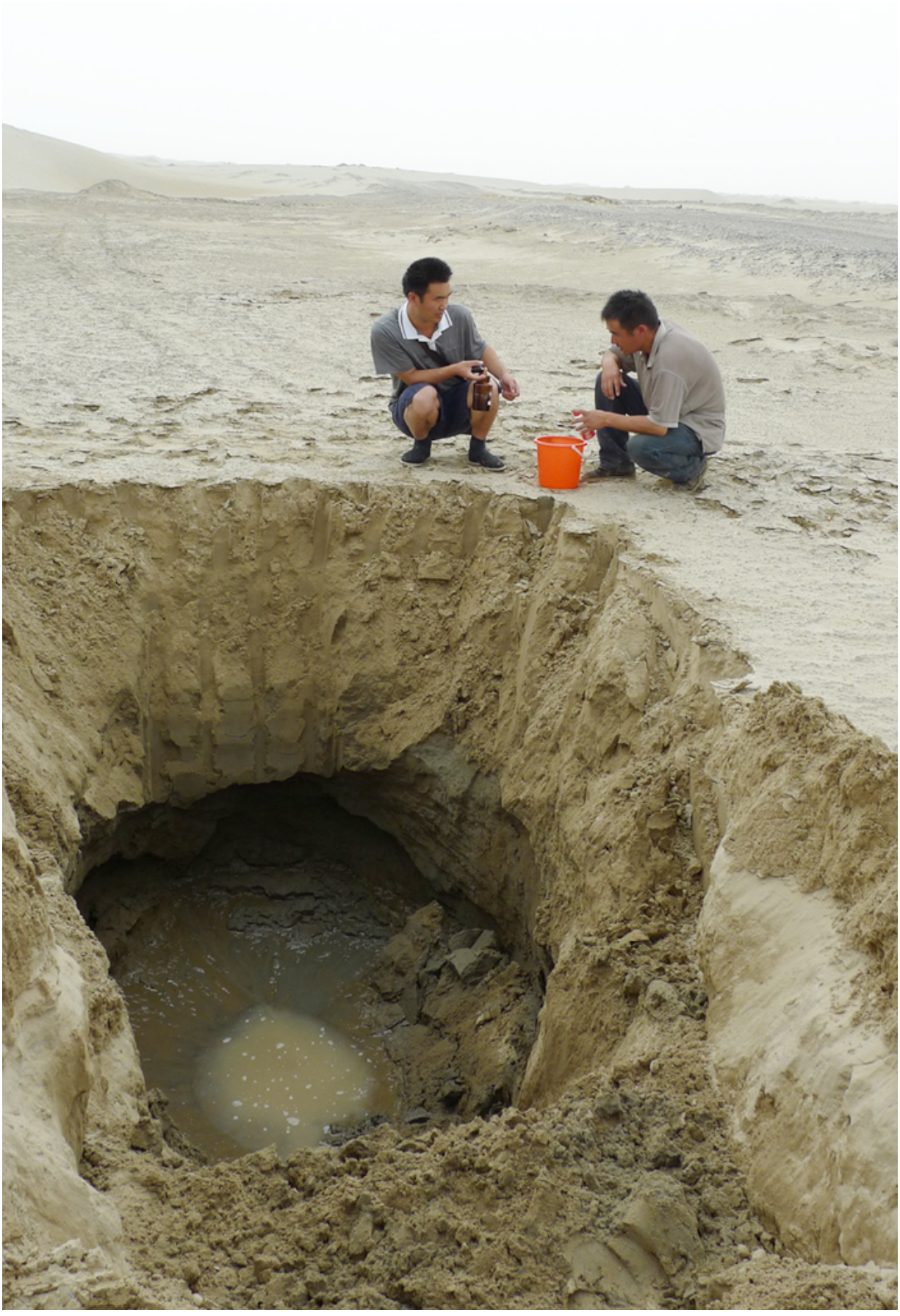
The new study estimates that because of agriculture roughly 14 times more carbon than previously thought could be entering these underground desert aquifers every year. These underground pools that taken together cover an area the size of North America may account for at least a portion of the "missing carbon sink" for which scientists have been searching.

"The carbon is stored in these geological structures covered by thick layers of sand, and it may never return to the atmosphere," said Yan Li, a desert biogeochemist with the Chinese Academy of Sciences in Urumqi,

Xinjiang, and lead author of the study accepted for publication in *Geophysical Research Letters*, a journal of the American Geophysical Union. "It is basically a one-way trip."

Knowing the locations of carbon sinks could improve models used to predict future climate change and enhance calculations of the Earth's carbon budget, or the amount of fossil fuels humans can burn without causing major changes in the Earth's temperature, according to the study's authors.

Although there are most likely many missing carbon sinks around the world, desert aquifers could be important ones, said Michael Allen, a soil ecologist from the Center for Conservation Biology at the University of California-Riverside who was not an author on the new study.



Researchers gathered groundwater flowing under the desert sands. The amount of carbon carried by this underground flow increased quickly when the Silk Road, which opened the region to farming, began 2,000 years ago. Credit: Yan Li

If farmers and water managers understand the role heavily-irrigated inland deserts play in storing the world's carbon, they may be able to alter how much carbon enters these underground reserves, he said.

"This means [managers] can take practical steps that could play a role in addressing carbon budgets," said Allen.

Examining desert water

To find out where deserts tucked away the extra carbon, Li and his colleagues analyzed water samples from the Tarim Basin, a Venezuela-sized valley in China's Xinjiang region. Water draining from rivers in the surrounding mountains support farms that edge the desert in the center of the basin.

The researchers measured the amount of carbon in each water sample and calculated the age of the carbon to figure out how long the water had been in the ground.

The study shows the amount of carbon dioxide dissolved in the water doubles as it filters through irrigated fields. The scientists suggest carbon dioxide in the air is taken up by the desert crops. Some of this carbon is released into the soil through the plant's roots. At the same time,

microbes also add carbon dioxide to the soil when they break down sugars in the dirt. In a dry desert, this gas would work its way out of the soil into the air. But on arid farms, the carbon dioxide emitted by the roots and microbes is picked up by irrigation water, according to the new study.

In these dry regions, where water is scarce, farmers over-irrigate their land to protect their crops from salts that are left behind when water used for farming evaporates. Over-irrigating washes these salts, along with carbon dioxide that is dissolved in the water, deeper into the earth, according to the new study.

Although this process of carbon burial occurs naturally, the scientists estimate that the amount of carbon disappearing under the Tarim Desert each year is almost 12 times higher because of agriculture. They found that the amount of carbon entering the desert aquifer in the Tarim Desert jumped around the time the Silk Road, which opened the region to farming, begin to flourish.

After the carbon-rich water flows down into the aquifer near the farms and rivers, it moves sideways toward the middle of the desert, a process that takes roughly 10,000 years.

Any carbon dissolved in the water stays underground as it makes its way through the aquifer to the center of the desert, where it remains for thousands of years, according to the new study.

Estimating carbon storage

Based on the various rates that carbon entered the desert throughout history, the study's authors estimate 20 billion metric tons (22 billion U.S. tons) of carbon is stored underneath the Tarim Basin desert, dissolved in an aquifer that contains roughly 10 times the amount of

water held in the North American Great Lakes.

The study's authors approximate the world's desert aquifers contain roughly 1 trillion metric tons (1 trillion U.S. tons) of carbon—about a quarter more than the amount stored in living plants on land.

Li said more information about water movement patterns and carbon measurements from other desert basins are needed to improve the estimate of carbon stored underneath deserts around the globe.

Allen said the new study is "an early foray" into this research area. "It is as much a call for further research as a definitive final answer," he said.

More information: Hidden carbon sink beneath desert, onlinelibrary.wiley.com/doi/10 … ytk-41855.5282060185

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