What's nature worth? Study helps put a price on groundwater and other natural capital

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River Kvirila at Sachkhere, Georgia. Credit: Wikipedia

Most people understand that investing in the future is important, and that

goes for conserving nature and natural resources, too. But in the case of investing in such "natural" assets as groundwater, forests, and fish populations, it can be challenging to measure the return on that investment.

A Yale-led research team has adapted traditional asset valuation approaches to measure the value of such natural capital assets, linking economic measurements of ecosystem services with models of natural dynamics and human behavior.

This innovation will enable policymakers to better evaluate conservation and natural resource management programs, make apples-to-apples comparisons between investing in conversation of natural capital and other investments, and provides a component critical to measuring sustainability.

Writing in the *Proceedings of the National Academy of Sciences*, the authors demonstrate how to price natural capital using the example of the Kansas High Plains' groundwater aquifer—a critical natural resource that supports the region's agriculture-based economy.

According to their analysis, groundwater extraction and changes in aquifer management policies, driven largely by subsidizes and new technology, reduced the state's total wealth held in groundwater by $110 million per year between 1996 and 2005. That is a total of $1.1 billion.

Measuring the value of natural capital can allow governments and business to redefine conservation expenditures as "investments," said Eli Fenichel, an assistant professor at the Yale School of Forestry & Environmental Studies and lead author of the study.

"The idea that we can actually measure changes in the value of natural capital is really important," he said. "It shows that in places like Kansas,

where groundwater is a critically important asset, there is a way to measure and keep tabs on these resources as part of a larger portfolio. And in a world where data is more and more available, it should be possible to do this more often. I think that bodes well for guiding policies aimed at maintaining all of society's wealth."

The study's authors say that achieving sustainability requires that wealth—including the value of natural capital, human capital, as well more traditional contributors to wealth—not decline over time. Indeed, such ideas have been advanced by the United Nations and the World Bank. However, a problem with measuring such "inclusive" or "comprehensive" wealth has been measuring the prices of natural capital.

In reference to the Kansas example, Fenichel said, "Most people would agree that losing $1.1. million year over year, or losing wealth at rate of about 6.5 percent for 10 years straight, is poor asset management. Though, it might be reasonable to reallocate assets to a different section of your portfolio. So the loss in water wealth might be ok is it were made up for by investing elsewhere, but if that is not the case, then there is need to be more careful about the rate at which capital is drawn down.

"The key is to convert one form of capital to another in order to allow society to continue to consume more in the future. Because that's what sustainability is really about. It's about the ability for society to go on producing and consuming in a way that provides at least a constant, or perhaps improving, quality of life."

The authors point out that the average annual losses in the value of western Kansas's groundwater aquifer were roughly equal to the amount of the fiscal surplus projected in the state's 2005 budget. So while the annual losses were significant, they say, they were in a range where Kansas could have offset the losses with investments in other areas, such as conservation, education, or infrastructure. The research provides

means to make these types of comparisons.

The authors say that the framework is applicable to the full range of natural capital assets, and are currently working to apply it other forms of natural capital such as fish and forests. It can also be utilized at the project, regional, state, national, and international levels.

"I'm not saying it will be easy or that we're going to be able to measure natural capital prices for everything, everywhere in the world," Fenichel said. "But I think we're showing that it's feasible. And I think we're laying the foundations for others to go out, collect data, and do the calculations to measure the wealth stored in other natural capital assets."

The paper was written in collaboration with researchers from Arizona State University (ASU), Michigan State University (MSU), California State University, Chico and the U.S. National Oceanic Atmospheric Administration.

Erin Haacker, an MSU geological sciences graduate student studying hydrogeology, was asked to participate in the paper because of her expertise on the High Plains Aquifer. "Economics is very complicated, so economists try to simplify where possible—otherwise you would never be able to take a model or method from one location and apply it to another," Haacker said. "But if you don't have a strong foundational knowledge of groundwater, it would be very easy to oversimplify in ways that would make the resource evaluation less realistic, so my role was to ensure that our description of the aquifer was as true to life as possible."

"A critical strength of our approach," said Joshua Abbott, a contributing author from ASU, "is that it combines natural science about resources and social science about human behavior to account for benefits derived from nature. We quantify the changing value of natural stocks by linking

economic measurements of ecosystem services—the income to society depending on nature—with models of natural dynamics and human behavior. Both are shaped by the market context and our policy choices."

More information: Measuring the value of groundwater and other forms of natural capital, *PNAS*, www.pnas.org/cgi/doi/10.1073/pnas.1513779113

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