Irrigation's impacts on global carbon uptake

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Globally, irrigation increases agricultural productivity by an amount roughly equivalent to the entire agricultural output of the U.S., according to a new University of Wisconsin-Madison study.

That adds up to a sizeable impact on carbon uptake from the atmosphere. It also means that water shortages - already forecasted to be a big problem as the world warms - could contribute to yet more warming through a positive feedback loop.

The new research quantified irrigation's contribution to global agricultural productivity for the years 1998-2002, estimating the amount of carbon uptake enabled by relieving water stress on croplands. The results published August 25 in the journal *Global Biogeochemical Cycles*, a publication of the American Geophysical Union.

"If you add up all the annual productivity that comes solely due to irrigation, it adds up to about 0.4 petagrams of carbon, nearly equivalent to the total agricultural productivity of the United States," says study author Mutlu Ozdogan, a UW-Madison professor of forest and wildlife ecology and member of the Nelson Institute for Environmental Studies.

The study also shows quantitatively that irrigation increases productivity in a nonlinear fashion - in other words, adding even a small amount of water to a dry area can have a bigger impact than a larger amount of water in a wetter region. "More irrigation doesn't necessarily mean more productivity," Ozdogan says. "There are diminishing returns."

This was already known on the field scale, he says, but is true globally as well. Interestingly, he found that, on average, worldwide irrigation is currently conducted close to the optimal level that maximizes gains. While this may be good news for current farmers, it implies limited potential for irrigation to boost future productivity even as food demands increase.

The study takes an important step toward quantifying how management decisions can impact global carbon balance and assessing the economic worth of water and carbon in irrigated landscapes.

"Now that we have spatially-explicit maps of how much irrigation is increasing carbon accumulation, we have good information about the value of the water going into those areas. We might be able to come up with a value of carbon in those areas as well," he says. "Of course the flip side of this is that, in many places around the world, if we keep irrigating we are either going to run out of water or degrade soils because of salinity issues."

The current study does not factor in any impacts in areas from which irrigation water is drawn. However, Ozdogan says, a better understanding of the links between irrigation, productivity, and carbon will help researchers look at downstream effects of factors that influence each of those elements - for example, how water shortages in agricultural regions may affect regional carbon cycles and climate.

The study continues a history of work from the UW-Madison's Center for Sustainability and the Global Environment that includes the development of several freely available climate and ecosystem models, maps, and datasets (available at http://www.sage.wisc.edu/mapsdatamodels.html). This research was partially supported by a National Aeronautics and Space Administration Applied Sciences Program grant.

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