Studying rivers for clues to global carbon cycle

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In the science world, in the media, and recently, in our daily lives, the debate continues over how carbon in the atmosphere is affecting global climate change. Studying just how carbon cycles throughout the Earth is an enormous challenge, but one Northwestern University professor is doing his part by studying one important segment -- rivers.

Aaron Packman, associate professor of civil and environmental engineering in the McCormick School of Engineering and Applied Science, is collaborating with ecologists and microbiologists from around the world to study how organic carbon is processed in rivers.

Packman, who specializes in studying how particles and sediment move around in rivers, is co-author of a paper on the topic published online in the journal *Nature Geoscience*.

The paper evaluates our current understanding of carbon dynamics in rivers and reaches two important conclusions: it argues that carbon processing in rivers is a bigger component of global carbon cycling than people previously thought, and it lays out a framework for how scientists should go about assessing those processes.

Much more is known about carbon cycling in the atmosphere and oceans than in rivers. Evaluating large-scale material cycling in a river provides a challenge -- everything is constantly moving, and a lot of it moves in floods. As a result, much of what we know about carbon processing in rivers is based on what flows into the ocean.

“But that’s not really enough,” Packman said. “You miss all this internal cycling.”

In order to understand how carbon cycles around the globe -- through the land, freshwater, oceans and atmosphere -- scientists need to understand how it moves around, how it’s produced, how it’s retained in different places and how long it stays there.

In rivers, carbon is both transformed and consumed. Microorganisms like algae take carbon out of the atmosphere and incorporate it into their own cells, while bacteria eat dead organic matter and then release CO_2 back into the atmosphere.

“It’s been known for a long time that global carbon models don’t really account for all the carbon,” Packman said. “There’s a loss of carbon, and one place that could be occurring is in river systems.” Even though river waters contain a small fraction of the total water on earth, they are such dynamic environments because microorganisms consume and transform carbon at rapid rates.

“We’re evaluating how the structure and transport conditions and the dynamics of rivers create a greater opportunity for microbial processing,” Packman said.

Packman is the first to admit that studying microorganisms, carbon and rivers sounds more like ecology than engineering. But such problems require work from all different areas, he said.

“We’re dealing with such interdisciplinary problems, tough problems, so we have to put fluid mechanics, transport, ecology and microbiology together to find this overall cycling of carbon,” he said. “People might say it’s a natural science paper, but to me it’s a modern engineering paper. To understand what’s going on with these large-scale processes,

we have to analyze them quantitatively, and the tools for getting good estimates have been developed in engineering."

Packman was introduced to the co-authors of the paper -- ecologists who study how dead leaves and soil drive stream ecology and who come from as far away as Spain and Austria -- about 10 years ago through the activity of the Stroud Water Research Center in Pennsylvania.

Since then, they have collaborated on many similar projects around river structure and transport dynamics. They are currently working on a project funded by the National Science Foundation on the dynamics of organic carbon in rivers and trying to understand how carbon delivered from upstream areas influence the ecology of downstream locations.

"The broadest idea is really part of global change efforts to understand carbon cycling over the whole Earth, which is an enormous challenge," Packman said.

Source: Northwestern University