Buried shells in Houston are no treasure

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(PhysOrg.com) -- Fan-Wei Zeng saw seashells, but not by the seashore. In fact, they were quite far away, and they were skewing the Rice University graduate student's study of the environmental impact of Houston's rivers.

Zeng noticed the shells in the roadbeds of Texas. Builders put them there as far back as the mid-19th century because the materials were plentiful and cheap.

Her studies of the shells have added a small piece to the global puzzle of how human enterprise has altered the natural cycle of carbon dioxide, a greenhouse gas that plays a major role in global warming. Her results were reported recently in the online journal Biogeochemistry.

Zeng and her mentor and co-author Carrie Masiello, a Rice assistant professor of Earth science, analyzed Spring Creek and Buffalo Bayou to quantify how much carbon dioxide these waterways release in a natural process that, under ideal conditions, keeps the atmosphere in balance.

Spring Creek, which runs primarily through rural areas north and west of metro Houston, produced numbers in line with what Masiello had anticipated from a 2005 study she and others had done on the Amazon River. The Amazon releases roughly as much CO_2 to the air and the ocean as the rainforest absorbs through plant growth every year. The same happens in Texas: Carbon moves through the forest to the soil, into waterways and back to the atmosphere (a cycle called ecosystem residence time) in as little as a few years.

Buffalo Bayou, in the heart of Houston, is similar to Spring Creek in the amount of CO_2 released. However, in Buffalo Bayou, radiocarbon dating of CO_2 in water samples from various locations and times showed some carbon was almost 5,000 years old.

"We knew from the isotope data that there was carbonate input to Buffalo Bayou, but we were thinking, 'There's no limestone in this region,'" Zeng said. (Limestone, a sedimentary rock composed of shells and other organic material compacted over millennia, would have accounted for the bizarre readings.)

Then she and Masiello looked down.

"It took us almost six months to figure out what was going on," Masiello said. "When you cut your grass in Houston, the blades don't stay on the surface of your soil for 5,000 years. We thought there was just no way our radiocarbon numbers were right. We walked around for a long time and finally looked at the ground. That's when we saw the shells and thought, 'Where did those come from?'"

The simple answer is Galveston Bay, the main source of hundreds of millions of cubic yards of oyster shells from eons-old beds. Contractors dredged the bay, crushing shells and mixing them with concrete or using them as is for roadbeds until Texas outlawed their operations in the '70s.

"The shell roads built in the early 20th century are buried under the surface, and they're slowly decomposing," Masiello said. "Urban acid rain falls on the shells and dissolves them, releasing a pool of CO_2 that moves into the groundwater. On a rainy day, that CO_2 gets swept out of the soil and pushed into the river. So when we date CO_2 in Buffalo Bayou, it's extremely old because it's carrying the age of these fossil shells."

Masiello and Zeng, a native of China who expects to finish her doctorate this year, set out to fill a gap in the data about how much CO_2 is released to the atmosphere by rivers planetwide. The current estimate is 1 gigaton (a billion tons) per year, about the same amount those rivers deliver to the ocean (where oysters and others put it to good use).

That balancing act is good for the planet, because plant growth naturally compensates for rivers' release of CO_2, Masiello said. On the other hand, there is no natural balance for the CO_2 released by fossil fuel combustion, which puts about 10 times the amount released by rivers into the atmosphere.

"With the Amazon study we had data for the tropics, and because of the concentration of research universities in the northeastern United States, other research groups have generated data in temperate regions," where cooler temperatures slow decomposition. "It's why we put things in the refrigerator," Masiello said.

But the global picture remained incomplete without data from the subtropics. Houston was a good place to start gathering it.

"We looked at Buffalo Bayou as an example of a completely urbanized watershed, while Spring Creek is primarily rural. It has some human footprint, but it is far less developed than Buffalo Bayou. We wanted to contrast those two ecosystems," she said.

Spring Creek gave them a subtropical number to plug into the global carbon cycle model. It also doesn't suffer leaching from buried shells. "There's a line in Texas beyond which it was cheaper to haul gravel for building roads from central Texas than to haul shells from the coast," Masiello said. "It turns out that Spring Creek sits on one side of that line and Buffalo Bayou sits on the other. We didn't do that on purpose."

Buffalo Bayou "doesn't tell us anything about ecosystem carbon residence time," she said. "But it was a surprising new find about the way human activities affect the ecosystems around us."

The researchers did their radiocarbon dating at the Woods Hole Oceanographic Institute in Massachusetts, one of three accelerators in the United States available for precise environmental measurements. The study received support from the Texas Water Resources Institute through a grant supported by the U.S. Geological Survey and the National Institutes for Water Research.

More information: See the paper at: tinyurl.com/Fan-Wei

Provided by Rice University

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