Sustainable Agriculture Reflected in Cuba’s Water Quality

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Beginning in 1990, Cuban agricultural technology did an about-face as small-scale, organic practices proliferated after the fall of the Soviet Union. And now, just 3 decades later, the country’s river chemistry reflects these sustainable practices, an international team of researchers showed.

Cuban river water has very high levels of cations and anions released by rock weathering, a natural process, and relatively low levels of nutrients linked to fertilizer runoff. That’s good news for preventing harmful algal blooms in Cuba’s coral reefs, which represent a significant source of tourist-driven income for the Caribbean’s largest and most populous nation, the researchers suggest.

Have Minivan, Will Travel

In August 2018, Paul Bierman, a geologist at the University of Vermont in Burlington, and his colleagues convened in central Cuba. The group

included scientists and technicians from American and Cuban institutions.

Biologists, geologists, and physicists rubbed shoulders during the fieldwork, said team member Alejandro García Moya, an Earth scientist at the Centro de Estudios Ambientales de Cienfuegos in Cuba. "We had the opportunity as scientists to share our experience and knowledge with people from different research and science perspectives."

"You can't export material from Cuba without a very thick stack of paperwork that's been signed, stamped, and approved."The team traveled in two yellow minivans and visited 25 rivers across central Cuba. They typically went to two or three field sites per day. At each site, the scientists made measurements of the river water's dissolved oxygen, temperature, pH, and conductivity. They also took water and sediment samples, photographed the area, and recorded the region's geographical coordinates using GPS.
Bierman and his collaborators shipped coolers containing the water and sediment samples to several laboratories in the United States. There were plenty of logistics involved, he said. "You can't export material from Cuba without a very thick stack of paperwork that's been signed, stamped, and approved." But the process is worth it, said Bierman, because scientists based in the United States are eager to work with Cuban samples. "We've got an awful lot of science done."

Weathering at the Surface

The researchers found that rivers in central Cuba contained high loads of dissolved solids produced by chemical weathering of rocks. Using precipitation and runoff estimates, Bierman and his colleagues calculated that on average, roughly 160 tons of rock per square kilometer of land were being transported downriver each year because of chemical weathering. "That's how much mass is being removed," said Bierman. That rate is comparable to the rates of other tropical environments and is in the top 25% of rates globally, the team concluded.

Furthermore, the dissolved solids tended to be correlated with the

surrounding rock type, the scientists showed. That relationship is somewhat surprising, the team suggests, because it implies that river water is in direct contact with weatherable rock. (In tropical climates like Cuba's, chemical weathering should occur far below the surface.) One explanation, Bierman and his colleagues propose, is that tectonic uplift in Cuba—the island is located at the boundary of the North American and the Caribbean plates—provides a constant supply of fresh rock that is continually incised by rivers and dissolved by groundwater.

Mind the Blooms

"The nitrate and phosphate loads coming off of Cuba are a lot lower than what's draining down the Mississippi River."The researchers also showed that Cuban waters tended to contain relatively low levels of fertilizer-associated nutrients such as nitrates and phosphates. "The nitrate and phosphate loads coming off of Cuba are a lot lower than what's draining down the Mississippi River," said Bierman. That makes sense, he said, because area-normalized fertilizer usage in Cuba is roughly half that of the United States. "We put on a lot more fertilizer than the Cubans."

These results were published in January in GSA Today.

Cuba is far from a self-sustaining nation—it still imports roughly 70% of the food its citizens need—but its agricultural practices are a step in the right direction ecologically, said Bierman. They're helping to stave off the adverse effects of fertilizer runoff, for starters. When nutrients like nitrogen accumulate in the water, they can trigger harmful algal blooms, which can produce toxins and literally choke out other forms of life. In the Gulf of Mexico, for example, there's a large low-oxygen dead zone caused by such eutrophication.

Nitrogen runoff is a big problem for many coral reefs worldwide, but Cuba seems to have avoided a similar fate, said Daria Siciliano, a marine ecologist at the University of San Francisco not involved in the research. These results are "very valuable" because they provide an upstream explanation for the health of Cuba's coral reefs, she said.

Bierman and his U.S.-based colleagues plan to return to Cuba in

August to sample rivers in other parts of the country. It’s a “challenge and a huge opportunity” to work in a place so understudied by American researchers, said Bierman. He’s looking forward to continuing to strengthen collaborations with Cuba-based scientists. “The bridges we’ve built for science have gone far ahead of what’s going on politically between our two governments.”