

Study: Typhoons bury tons of carbon in the oceans

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A single typhoon in Taiwan buries as much carbon in the ocean -- in the form of sediment -- as all the other rains in that country all year long combined. That's the finding of an Ohio State University study published in a recent issue of the journal *Geology*.

The study -- the first ever to examine the chemistry of stream water and sediments that were being washed out to sea while a typhoon was happening at full force -- will help scientists develop better models of global climate change.

Anne Carey, associate professor of earth sciences at Ohio State, said that she and her colleagues have braved two typhoons since starting the project in 2004. The *Geology* paper details their findings from a study of Taiwan's Choshui River during Typhoon Mindulle in July of that year.

Carey's team analyzes water and river sediments from around the world in order to measure how much carbon is pulled from the atmosphere as mountains weather away.

They study two types of weathering: physical and chemical. Physical weathering happens when organic matter containing carbon adheres to soil that is washed into the ocean and buried.

Chemical weathering happens when silicate rock on the mountainside is exposed to carbon dioxide and water, and the rock disintegrates. The carbon washes out to sea, where it eventually forms calcium carbonate

and gets deposited on the ocean floor.

If the carbon gets buried in the ocean, Carey explained, it eventually becomes part of sedimentary rock, and doesn't return to the atmosphere for hundreds of millions of years.

Though the carbon buried in the ocean by storms won't solve global warming, knowing how much carbon is buried offshore of mountainous islands such as Taiwan could help scientists make better estimates of how much carbon is in the atmosphere -- and help them decipher its effect on global climate change.

Scientists have long suspected that extreme storms such as hurricanes and typhoons bury a lot of carbon, because they wash away so much sediment. But since the sediment washes out to sea quickly, samples had to be captured during a storm to answer the question definitively.

"We discovered that if you miss sampling these storms, then you miss truly understanding the sediment and chemical delivery of these rivers," said study coauthor and Ohio State doctoral student Steve Goldsmith.

The researchers found that, of the 61 million tons of sediment carried out to sea by the Choshui River during Typhoon Mindulle, some 500,000 tons consisted of particles of carbon created during chemical weathering. That's about 95 percent as much carbon as the river transports during normal rains over an entire year, and it equates to more than 400 tons of carbon being washed away for each square mile of the watershed during the storm.

Carey's collaborators from Academia Sinica -- a major research institute in Taiwan -- happened to be out collecting sediments for a long-term study of the region when Mindulle erupted in the Pacific.

"I don't want to say that a typhoon is serendipity, but you take what the weather provides," Carey said. "Since Taiwan has an average of four typhoons a year, in summer you pretty much can't avoid them. It's not unusual for some of us to be out in the field when one hits."

As the storm neared the coast, the geologists drove to the Choshui River watershed near the central western portion of the country.

Normally, the river is very shallow. But during a typhoon, it swells with water from the mountains. It's not unusual to see boulders the size of cars -- or actual cars -- floating downstream.

Mindulle gave the geologists their first chance to test some new equipment they designed for capturing water samples from storm runoff.

The equipment consisted of one-liter plastic bottles wedged inside a weighted Teflon case that would sink beneath the waves during a storm. They suspended the contraption from bridges above the river as the waters raged below. At the height of the storm, they tied themselves to the bridges for safety.

They did this once every three hours, taking refuge in a nearby storm shelter in between.

Four days later, after the storm had passed, they filtered the water from the bottles and analyzed the sediments for particulate organic carbon. Then they measured the amount of silica in the remaining water sample in order to calculate the amount of weathering occurring with the storm.

Because they know that two carbon molecules are required to weather one molecule of silica, they could then calculate how much carbon washed out to sea. Carey and Goldsmith did those calculations with study coauthor Berry Lyons, professor of earth sciences at Ohio State.

Carey cautioned that this is the first study of its kind, and more data are needed to put the Mindulle numbers into a long-term perspective. She and Goldsmith are still analyzing the data from Typhoon Haitang, which struck when the two of them happened to be in Taiwan in 2005, so it's too early to say how much carbon runoff occurred during that storm.

"But with two to four typhoons happening in Taiwan per year, it's not unreasonable to think that the amount of carbon sequestered during these storms could be comparable to the long-term annual carbon flux for the country," she said.

The findings could be useful to scientists who model global climate change, Goldsmith said. He pointed to other studies that suggest that mountainous islands such as Taiwan, New Zealand, and Papua New Guinea produce one third of all the sediments that enter the world oceans annually.

As scientists calculate Earth's carbon "budget" -- how much carbon is being added to the atmosphere and how much is being taken away -- they need to know how much is being buried in the oceans.

"What is the true budget of carbon being sequestered in the ocean per year? If the majority of sediment and dissolved constituents are being delivered during these storms, and the storms aren't taken into account, those numbers are going to be off," Goldsmith said.

As weathering pulls carbon from the atmosphere, the planet cools. For instance, other Ohio State geologists recently determined that the rise and weathering of the Appalachians preceded an ice age 450 million years ago.

If more carbon is being buried in the ocean than scientists once thought, does that mean we can worry less about global warming?

"I wouldn't go that far," Goldsmith said. "But if you want to build an accurate climate model, you need to understand how much CO₂ is taken out naturally every year. And this paper shows that those numbers could be off substantially."

Carey agreed, and added that weathering rocks is not a practical strategy for reversing global warming, either.

"You'd have to weather all the volcanic rocks in the world to reduce the CO₂ level back to pre-industrial times," she said. "You'd have to grind the rock into really fine particles, and you'd consume a lot of energy -- fossil fuels -- to do that, so there probably wouldn't be any long-term gain."

Source: Ohio State University

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