Drop in acid rain altering Appalachian stream water

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Appalachian hardwood forests may be getting a respite from acid rain but data from a long-term ecological study of stream chemistry suggests that the drop in acid rain may be changing biological activity in the ecosystem and hiking dissolved carbon dioxide in forest streams.

"These are unexpected results," says David DeWalle, professor of forest hydrology at Penn State. "Rising amounts of carbon dioxide in streams and soil could have implications for the forest ecosystem, and the carbon balance in general."

DeWalle and his colleagues have been monitoring stream water chemistry in the Appalachians since 1990. They are studying the effect of reduced sulfur emissions – required under the Clean Air Act – on the water quality of five streams in Pennsylvania.

"These streams are as pristine as you can get, and we have been sampling them nearly every month over the past 15 years," he says.

Some expected changes in stream chemistry are already showing. Water quality in the streams is gradually improving from the reduced sulfur emissions, and researchers are also seeing less nitrogen from the atmosphere and in the streams.

"This reduction in nitrogen deposition is yet to be seen in many parts of New England," DeWalle says. "We are probably seeing it earlier than others because we are pretty close to the sources of these emissions."

There have also been some unexpected changes. DeWalle and his Penn State colleagues Bryan Swistock, extension specialist, and Anthony Buda and Sarah MacDougall, graduate students, say they are recording rising amounts of dissolved carbon dioxide in all five streams.

DeWalle, whose work is funded by the U.S. Environmental Protection Agency, thinks that by reducing pollutants emitted to the atmosphere, we are creating a different set of conditions for organisms in the soil. The rising dissolved carbon dioxide in the streams, he suggests, might be traced to increased respiration by these organisms.

He explains that organic matter broken down by these organisms generates byproducts such as carbon dioxide, water and residual dissolved organic matter. The increased respiration, he adds, may be gradually increasing soil carbon dioxide and reducing the amount of residual organic matter. As the organisms break down more of the organic matter, there is less of it leaving as dissolved organic matter in stream water.

"There have been some experiments where they added nitrogen to the soil and saw a reduction in soil respiration. We have of course, reduced the nitrogen, and indicators of stream chemistry suggest that this may have caused the opposite reaction and stepped up the respiration," says DeWalle.

Though the stream chemistry data suggests increased respiration in the soil, researchers caution that the hypothesis needs to be tested with experiments that mimic reduced amounts of nitrogen in the atmosphere.

Penn State researchers are already seeing increasing amounts of silica and sodium in streams which may be from the weathering of minerals and sandstone bedrock, caused presumably by the increased carbonic acid in soil and groundwater.

"If you have higher carbon dioxide in the soil, you get more carbonic acid in the groundwater, which increases the weathering of minerals. You would not normally expect weathering rates to increase with reduced acid rain," DeWalle told attendees at the American Geophysical Union conference today (Dec. 12) in San Francisco.

Appalachian forests play a crucial role in maintaining a healthy ecosystem, and support thousands of jobs through the hardwood industry.

"This area is a region bigger than Pennsylvania, where we see declines in both sulfur and nitrogen emissions.

Although that is a positive thing, it is having an influence, it appears, on the forest ecosystem. Higher amounts of carbon dioxide in the soil means more of it ultimately may be emitted back to the atmosphere as a greenhouse gas," adds the Penn State researcher.

Source: Penn State