Changing river chemistry affects Eastern US water supplies

August 26 2013

Alkaline minerals wash down from headwater streams and tributaries of the 14,700-square-mile Potomac River watershed to Washington D.C., where the river provides the nation's capital with drinking water and receives treated sewage before emptying into the Chesapeake Bay. High alkalinity can make drinking water treatment more expensive, adds to the regulatory requirements for discharging treated sewage, and compounds the environmental problems of the nation's largest estuary. Credit: Photo: Michael Pennino

Human activities are changing the basic chemistry of many rivers in the Eastern U.S. in ways that have potentially major consequences for urban water supplies and aquatic ecosystems, a University of Maryland-led study has found.

In the first survey of its kind, a research team looked at long-term records of alkalinity trends in 97 rivers from Florida to New Hampshire. Over time spans of 25 to 60 years, two-thirds of the rivers had become significantly more alkaline.

Increased alkalinity complicates drinking water and wastewater treatment, encourages algae growth, and can hasten the corrosion of metal pipe infrastructure. At high alkalinity levels, ammonia toxicity can also harm irrigated crops and fish in rivers.

Among the rivers impacted are those that provide water for Washington, D.C., Philadelphia, Baltimore, Atlanta, and other major cities, the researchers reported. Also affected are rivers that flow into water bodies already harmed by excess algae growth, such as the Chesapeake Bay.

None of the rivers became more acidic. But paradoxically, higher acid levels in rain, soil and water, caused by human activity, are major triggers for rising alkalinity, said geologist Sujay Kaushal of the University of Maryland. Kaushal is the lead author of a paper about the study, published August 26 in the online edition of the peer-reviewed journal *Environmental Science and Technology*.

The researchers hypothesize that acid rain, a by-product of fossil fuel combustion, and acid runoff from mining are hastening the dissolving of rocks and human-made surfaces that are naturally high in alkaline minerals. In a process known as chemical weathering, the acid eats away at limestone, other carbonate rocks, and even concrete sidewalks, dissolving alkaline particles that wash off into streams and rivers.

"It's like rivers on Rolaids," Kaushal said. "We have some natural antacid in watersheds. In headwater streams, that can be a good thing. But we're also seeing antacid compounds increasing downriver. And those sites are not acidic, and algae and fish can be sensitive to alkalinity changes."

Scientists have studied the effects of increased chemical weathering in small mountain streams tainted by acid runoff, where the process can actually help rebalance streams' pH levels. But researchers have not looked at the accumulating levels of alkalinity in downstream reaches of numerous major rivers and evaluated potential causes until now, Kaushal said.

The extent of the change is "amazing. I did not expect that," said noted ecologist Gene Likens, a co-discoverer of acid rain in 1963, who collaborated with Kaushal on this research.

"This is another example of the widespread impact of human impacts on natural systems (which) is, I think, increasingly worrisome," said Likens, of the University of Connecticut and the Cary Institute of Ecosystem Studies. "Policymakers and the public think acid rain has gone away, but it has not."

Beginning in the mid-1990s after Congress amended the Clean Air Act, new federal regulations have reduced the airborne pollutants that cause acid rain. "It may be that these are legacy impacts of acid rain in addition to mining and land use," Kaushal said. "The acid rain problem is decreasing. But meanwhile there are these lagging effects of river alkalinization showing up across a major region of the U.S. How many decades will river alkalinization persist? We really don't know the answer."

The team focused on Eastern rivers, which are often important drinking water sources for densely populated areas and have decades' worth of water quality records. Much of the Eastern U.S. is also underlain by porous, alkaline limestone and other carbonate rocks, making the region more prone to the types of water chemistry changes that the researchers found. This is especially true in the Appalachian Mountains where soils are thin, steep slopes cause erosion, and acid rain from smokestack industries have had a major impact on forests and streams.

Water alkalinity has increased the fastest in areas underlain by carbonate rocks, at high elevations, and where acid rainfall or drainage was high. The researchers also found that the chemical weathering of these carbonate rocks adds to the carbon burden in rivers and streams, in a trend that parallels rising carbon dioxide levels in the atmosphere.

More information: Sujay S. Kaushal, Gene E. Likens, Ryan M. Utz, Michael L. Pace, Melissa Grese, and Metthea Yepsen, "Increased river alkalization in the Eastern U.S," in Environmental Science and Technology, August 26, 2013. pubs.acs.org/doi/abs/10.1021/es401046s

Provided by University of Maryland