Nitrate stimulates greenhouse gas production in small streams

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Nitrous oxide is a potent greenhouse gas that has been accumulating in the atmosphere since the industrial revolution. It is well known that fertilizer can stimulate nitrous oxide production in soils, but less is known about nitrous oxide production in small streams which drain agricultural landscapes. Much of the cropland in the agricultural Midwest is drained by an extensive subsurface drainage network which delivers soil-derived nitrate to small streams where it may be converted to nitrous oxide. Given the large quantities of nitrogen that leach from agricultural soils and the predominance of small streams in Midwestern agricultural landscapes, small streams may an important source of nitrous oxide.

In a study funded by the National Science Foundation, scientists from the University of Notre Dame measured nitrous oxide production rates in sediments collected from small streams across an agricultural land use gradient in southern Michigan. Results from the study were published in the March-April 2009 issue of the Journal of Environmental Quality and were presented in 2006 at the 49th Annual Meeting of the North American Benthological Society.

During 2004 through 2006, twelve streams were sampled approximately monthly each year. Sediment nitrous oxide production rates were measured using anoxic incubations in the laboratory. The study design allowed the researchers to assess spatial, seasonal, and inter-annual variation in nitrous oxide production rates.

The study revealed that nitrous oxide is frequently produced in the sediments of small streams and that production rates were best explained by stream water nitrate concentrations. The highest production rates were observed during the winter and spring of the second year of the study when snow melt and rain flushed nitrate into the streams resulting in elevated stream water nitrate concentrations.

The scientists' findings suggest that nitrous oxide production rates from sediments in small streams are linked to nitrate availability. Therefore management efforts to reduce nitrous oxide production should focus on limiting nitrate transport to stream ecosystems. Such management efforts might entail reduced fertilizer application rates to agricultural soils, restoration of the riparian zone for nitrogen attenuation, or modification of tile drains to reduce nitrogen export to streams.

Dr. Jake Beaulieu, the lead author of the study, is now a postdoctoral research associate with the Environmental Protection Agency. Dr. Beaulieu's current research is focused on nitrous oxide dynamics in large rivers. An important distinction between large rivers and small streams is that large rivers have deeper, more turbid water columns which may support nitrous oxide producing bacteria. The combination of nitrous oxide production in both the sediments and the water column may yield particularly high areal nitrous oxide production rates in large rivers.

More information: The full article is available for no charge for 30 days. View the abstract at jeq.scijournals.org/cgi/content/abstract/38/2/637 .

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