USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: Evaluating Contributions of Atmospheric Deposition to Nitrate in mid-Appalachian Streams by Isotopic Separation

Duration: September 1, 1997 - August 31, 1999

Federal funds requested: 47,304

Non-federal (matching) funds pledged: 94,741

Principal Investigators:

K.W.J. Williard - Pennsylvania State University, Graduate Research Assistant

D.R. DeWalle - Pennsylvania State University, Professor

W.E. Sharpe - Pennsylvania State University, Professor

Congressional District: 5th of Pennsylvania

Statement of critical regional or State water problems:

Atmospheric deposition of nitrate is the most significant input of nitrogen to forested ecosystems, and the mid-Appalachian region receives some of the highest rates of atmospheric nitrate deposition in the United States (Adams et al. 1993, Lynch et al . 1989-1994). Northern temperate forests were long considered to be nitrogen limited systems, but recently this assumption has come under challenge by researchers who have discovered substantial export of nitrate-nitrogen in streams draining relatively un disturbed forested watersheds (Aber et al. 1989, Driscoll et al. 1989, Johnson and Lindberg 1992, Murdoch and Stoddard 1992, and Peterjohn et al. 1996). High rates of atmospheric nitrate deposition in the region could be directly responsible for high nitr ate-nitrogen export. While this phenomenon has been documented in broad surveys of European forested catchments (Dise and Wright 1995), rates of atmospheric nitrate deposition were not strongly correlated to stream nitrate loads in the most extensive surv ey of forested watersheds in North America (the Integrated Forest Study) (Johnson and Lindberg 1992). There may well be a correlation between atmospheric deposition and stream nitrate loads that is not demonstrated by analyses based on rates. Through isot opic separation, it i~ now possible to determine the percentage of stream nitrate which is of atmospheric origin (Durka et al. 1994). Hopefully, this will allow us to establish a more direct link between atmospheric nitrate deposition and stream nitrate l oads.

Increased nitrogen leaching from forested watersheds will contribute to the eutrophication of large downstream water bodies such as the Chesapeake Bay. High nitrate export from forested watersheds could also accelerate leaching of base cations

from soi l and lead to soil acidification and forest decline. The potential regional water quality impacts of forested watersheds reverting from nitrogen sinks to nitrogen sources are quite large, considering the Chesapeake Bay watershed is 60% forested. Policy ma kers and state and federal agencies would be very interested in any increases in nitrogen export from forested watersheds within the Chesapeake Bay drainage because nitrogen increases could seriously impair current and future efforts to rectify eutrophica tion problems in the Chesapeake Bay. Evidence of a direct link between atmospheric nitrate deposition and high nitrogen export in streams could indicate a need for reductions in NOx emissions at the regional and national level.

Statement of results or benefits:

This project will yield an assessment of the relative contributions of atmospheric nitrate to stream nitrate by analyzing isotopic signatures of 180 and 15N in each source. This information will be of utmost importance in the development of a direct li nk between atmospheric nitrate deposition and nitrogen export from forested watersheds. This study will be part of a larger funded study investigating the causes of nitrogen export variations from 100% forested basins. One possible cause is that significa nt proportions of atmospheric nitrate deposition are contributing directly to stream nitrate without being cycled by microbes or vegetation. The proposed study will test this potential cause of stream nitrogen variations, which would not have been possibl e with current funding.

Results will also aid in the determination of the extent of nitrogen saturation within the mid-Appalachians. Here, nitrogen saturation is defined as the availability of nitrogen in excess of biotic demand and it occurs in successive stages that reduces the ecosystem's ability to retain nitrogen. It is hypothesized that larger percentages of atmospheric nitrate in stream nitrate are indicative of a more nitrogen saturated ecosystem, because the microbes and vegetation will have reached their retentive c apacity in a saturated ecosystem so less atmospheric nitrogen inputs will have the opportunity to be cycled.