Trends in Nitrate, Ammonium, and Total Nitrogen Deposition in the Lake Erie Basin: A 20-Year Analysis

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This study examines changes in nitrogen deposition in the Lake Erie basin since 2000, focusing on five monitoring sites of the National Atmospheric Deposition Program (NADP): Chautauqua (NY10) and Kane Experimental Forest (PA29) in the east, Wooster (OH71) and Roush Lake (IN20) in the west, and Kellogg Biological Station (MI26) in the northwest.

Quantitative analysis revealed consistent decrease in nitrate (NO_3^-) levels across all monitoring sites. The average reduction in nitrate deposition was 33% over the study period, with western sites showing slightly higher reductions compared to the eastern sites. Specifically, the western sites of Wooster (OH71) and Roush (IN20) exhibited decreases of 37% and 35%, respectively, while eastern sites of Chautauqua (NY10) and Kane (PA29) showed reductions of 30% and 31%.

Ammonium (NH_4^+) levels, in contrast, showed cyclic fluctuations with peaks occurring approximately every 7-10 years over the study period. At Kane (PA29), ammonium levels fluctuated by ±15% around the mean value. Wooster (OH71) showed similar fluctuations of ±13%, while Kellogg (MI26) exhibited the highest variability at ±18%.

Total nitrogen deposition, combining both nitrate and ammonium, followed a decreasing trend similar to nitrate. The average reduction in total nitrogen deposition was approximately 30% across the monitoring sites. Chautauqua (NY10) exhibited a 28% reduction, Kane (PA29) 29%, Wooster (OH71) 33%, Roush (IN20) 32%, and Kellogg (MI26) 32%.

Spatial analysis evidenced regional differences in nitrogen deposition trends. The western sites (OH71, IN20) showed higher reductions in nitrate deposition (36% on average) compared to the eastern sites (NY10, PA29) (30.5% on average). This east-west disparity may be due to differences in local emission sources, prevailing wind patterns, or variations in the implementation of nitrogen reduction measures. The northwestern site, MI26, showed nitrate reductions (32%) intermediate between western and eastern sites, suggesting a potential gradient in deposition changes across the Lake Erie basin.

Observed reductions in nitrogen deposition, particularly nitrate, suggest the effectiveness of regulatory measures aimed at reducing nitrogen oxide emissions. However, persistent cyclic fluctuations in ammonium deposition highlight the need for continued monitoring and management of agricultural nutrient runoff.

These findings have significant ecological implications for Lake Erie, potentially helping to mitigate eutrophication and reduce frequency and intensity of harmful algal blooms. The study underscores the importance of NADP's comprehensive, long-term monitoring. These valuable insights could inform adaptive management strategies for the Lake Erie basin, balancing economic activities with ecosystem health in the face of ongoing climate change and land-use pressures.

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