Atmospheric nitrogen deposition across China

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China is currently experiencing intense air pollution caused in large part by anthropogenic reactive nitrogen (N) emissions. These emissions result in the downwind deposition of atmospheric N in terrestrial and aquatic ecosystems, with consequence of acid rain, smog, eutrophication and loss of biodiversity, associated with human and ecosystem health, greenhouse gas balances and biological diversity. However, we have limited information on the magnitude and impact of this deposition in China. Here we used nationwide data sets on bulk N deposition, plant foliar N and crop N uptake (from unfertilized soils) to evaluate N deposition dynamics and effects across China from 1980 to 2010. Annual bulk N deposition increased by approximately 8 kg N ha^{-1} ($p<0.001$) or 60% from the 1980s (13.2 kg N ha^{-1}) to the 2000s (21.1 kg N ha^{-1}), an accelerating trend compared with historical records. Nitrogen deposition is greatest in industrialized and agriculturally intensified regions; here, rates of deposition are as high as the peak levels of deposition in northwestern Europe in the 1980s, prior to the introduction of N emission mitigation measures there. NH_4-N was dominant in deposition but most of the increase was from NO_3-N deposition, consistent with decreased ratios of NH_3 to NO_x emissions since 1980. Besides bulk/wet N deposition, we also found that dry N deposition (2.4-82.0 kg N ha^{-1} yr^{-1}, measured only in the 2000s), based on the inferential method, contributed to more than half of the total N deposition in China. Evidence from significantly increased foliar N in natural vegetations and N uptake from long-term unfertilized croplands support the enhanced N deposition over China. The increase in foliar N was 5.9 mg N g^{-1} ($P < 0.001$) from the 1980s to 2000s while the increase in N uptake by maize, wheat and rice averaged 11.3 kg N ha^{-1} ($P < 0.05$) during the same period. China is facing an ongoing challenge to lower N emissions, N deposition, and their negative impacts on human and ecosystem health and the climate.

Key words: Air pollution; reduced N; oxidized N, wet and dry deposition; ecological impact

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