Capturing the externalities: National and watershed scale damages from release of reactive nitrogen beyond the farm, factory, tailpipe and table

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Abstract (1994 characters including spaces; limit is 2000)

Human demand for food, fuel, and industrial products results in the release of 61% of newly fixed anthropogenic N to the environment in the US each year. This 15.8 Tg N yr^{-1} release to air, land and water has important social, economic and environmental consequences, yet little research clearly links this N release to the full suite of effects. Here we connect the biogeochemical fluxes of N with existing data on N-associated damages in order to quantify the externalities of N release related to human health, ecosystems and climate regulation for the US at national and watershed scales. Release of N to the environment was estimated circa 2000 with models describing N inputs by source, nutrient uptake efficiency, leaching losses, and gaseous emissions at the scale of 8-digit US Geologic Survey Hydrologic Unit Codes (HUC8s). We estimated annual damage cost ($USD in 2008 or as reported) of anthropogenic N leaked to the environment by scaling specific N fluxes with the costs associated with human health, agriculture, ecosystems, and the climate system. For the US, annual damage costs of anthropogenic N leaked to the environment in 2000 totaled $289 billion USD. Approximately 57% of the total damages were associated with fossil fuel combustion, driven by the human respiratory health impacts of NO_x as a precursor of ozone and a component of particulates. Another 37% of the damage costs were associated with agricultural N. Damages associated with agriculture were $85.5 billion, largely through eutrophication and harmful effects on aquatic habitat. Through aggressive but tangible improvements in atmospheric emissions, agricultural N use and wastewater treatment, we could reduce N export to the coast by nearly 25% within 30 years. These improvements would reduce the externalities associated with the leakage of N beyond its intended uses in agriculture, transportation and energy without harm to agriculture or technologies dependent on anthropogenic N fixation.