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Nitrogen: A climate strategy for a post-Trump world

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Extended Abstract

A central goal of the Paris Climate Agreement is holding the increase in global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels (Article 2.1). A recent estimate of the remaining carbon budget that gives humanity a greater than 66% chance of achieving this goal suggests a range of 590–1240 gigatons of carbon dioxide equivalent (Gt CO_2 eq.—Rogelj et al. 2016). Global greenhouse gas (GHG) emissions in 2010 were approximately 50 Gt CO_2 eq., meaning that at current emissions rates, humanity would use its remaining carbon budget in 12 to 25 years (Blanco et al. 2014). The Nationally Determined Contributions (NDCs) submitted to the Paris Climate Agreement in addition to other national pledges, while an important step in the right direction, currently put us on track for a 2.5–2.8 °C increase in global average temperature (CAT 2016). As such, additional actions will be required to meet the 2 °C target. And one issue ripe for increased attention in this area is global nitrogen (N) pollution.

Nitrous oxide (N_2O), a key component of N pollution, is responsible for 6% of annual global GHG emissions in terms of CO_2 equivalents (Blanco et al. 2014). It is also the most abundantly emitted ozone-depleting substance, following the phase-out of more damaging compounds such as chlorofluorocarbons (Ravishankara et al. 2009). However, little attention has been paid to N_2O in international policy circles despite it being in the UNFCCC basket of GHGs, while initiatives devoted to addressing other non-CO2 GHGs such as methane (CH_4) and hydrofluorocarbons (HFCs) have gained traction, e.g., the Climate and Clean Air Coalition and the HFC amendment under the Montreal Protocol (Kanter et al. 2013).

Yet, despite the climate benefits that could be achieved from reducing N_2O emissions, they would likely be a minor component of the overall environmental benefits of reducing N pollution, which would come primarily from avoided water and air pollution (e.g., Brink and van Grinsven 2011; Kanter et al. 2017). This is a particularly salient characteristic of N pollution given the recent political swing in countries like the United States toward economic nationalism. This swing is marked by a shift to policies and rhetoric that prioritize national economic interests ahead (and often regardless) of the international consequences. President Trump's decision to

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withdraw the United States from the Paris Climate Agreement is a major and far-reaching example of this. As a result, the most politically viable climate actions in such an environment are likely to be ones that deliver local non-climate benefits that are as great, if not greater, than the climate benefits achieved internationally. Such local non-climate benefits are also politically salient in rapidly developing economies such as China, where major environment priorities often center on local N-related issues such as air and water pollution.

While there is a rich and growing literature on the co-benefits of climate policy, much of it focused on air quality (e.g., Aunan et al. 2004; Nemet et al. 2010; Harlan and Ruddell 2011), the value of the local environmental and human health co-benefits associated with reduced N pollution is striking, with the benefits to society from avoided air and water pollution dwarfing the climate benefits. This ratio of local to global benefits is significantly greater than estimates for other major climate actions such as the decarbonization of the global energy system, where the air quality benefits from reducing CO_2 (US$49 per ton CO_2) are on the same order of magnitude as the social cost of carbon (US$39 per ton CO_2) (Nemet et al. 2010; USEPA 2016) (Table 1).

Table 1 Emission factors and damage costs (in 2014 US$) for the four main N compounds associated with N pollution

N compound	Emission factor	Damage cost	
		US$ per kg N	US$ per ha
N_2O	0.013	12	16
NO_x	0.05	29	145
NH_3	0.05	17	85
NO_3^-	0.3	49	1470
Total N	0.41	–	1716

The emission factors for NO_x and NH_3 are based on the assumption that the 10% combined emission factor cited in Eggleston et al. (2006) is split equally between both compounds. The damage costs in US$ per hectare assume an N application rate of 100 kg N per hectare. The damage costs in US$ per kilogram N are from Kanter et al. (2017) and are specific to the United States. This is due to the fact that damage costs are calculated based on the public's willingness to pay to avoid pollution, so these numbers are largely a function of a country's GDP per capita. The emission factors are taken from the IPCC (Eggleston et al. 2006)

Addressing global N pollution is an excellent example of what a new international climate policy for a post-Trump world could achieve: important climate benefits that would nonetheless be eclipsed by the local environmental and human health benefits. This could be supplemented by private economic benefits for farmers and the fertilizer industry, driven by more efficient N use and increased demand for more efficient fertilizer technologies and services. Nevertheless, important challenges remain, including the development of integrated approaches to N management, changing and monitoring farmer behavior, and N's central role in agricultural production. Looking forward, a sharper focus on global N pollution from the climate policy community and others could stimulate a more expansive discussion of how to implement strategies in arguably the most challenging sector for climate mitigation: agriculture. Agriculture is not only a major source of GHG emissions; it is also the sector most vulnerable to its effects. An evolving discussion of the challenges of N governance across scales could reveal important pathways forward for managing this critical sector.

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