Global Accounting of Reactive Nitrogen in Municipal Solid Waste

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Abstract

We apply compositional Bayesian regression on municipal solid waste (MSW) data, in order to produce a panel dataset of waste generation with composition and treatment categories for every country for the period 1965-2100. We estimate stocks and flows of reactive nitrogen in landfills and dumps based on this data, using carbon and nitrogen degradation processes. This is of particular importance for countries with open dumps, where leachate is not accounted for in current inventories. Much uncertainty exists around MSW nitrogen accounting, also regarding N2O emissions.

Keywords: Municipal Solid Waste, Future Projections, Waste Leachate

1. Introduction

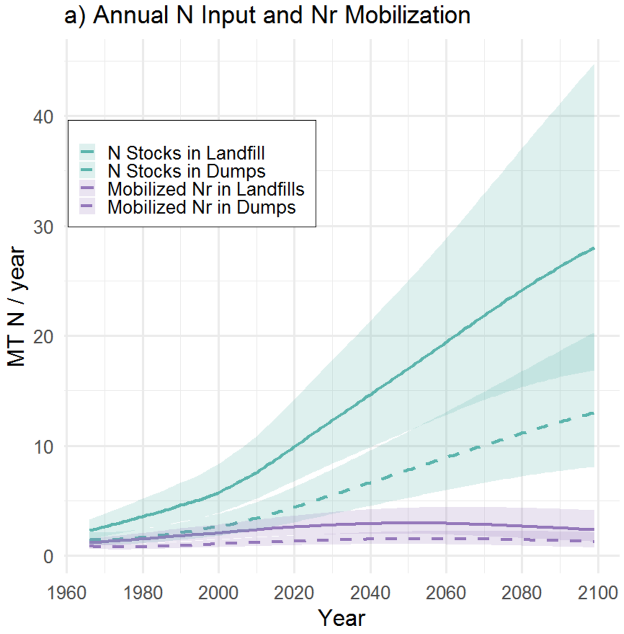
Current data on Municipal Solid Waste at the global scale is lacking. The *What a Waste 2.0* dataset (Kaza et al. 2018) is most complete, and includes waste quantities, as well as percentages of types and treatments in separate datasets, for one year of reporting per country.

2. Methodology

We regress country-level Municipal Solid Waste (MSW) data on per capita GDP, using the Dirichlet distribution to properly handle the compositional nature of the data (Hijazi and Jernigan 2009). The model is projected into the past and future. Based on a constant C:N ratio of 14 for the organic fraction of MSW (Puyuelo et al 2011), we use IPCC greenhouse gas emissions accounting (2006) to estimate the quantity of carbon emitted and thus mobile N potentially released in leachate or as emissions.

3. Results

The vast majority of MSW nitrogen is stored in landfills and dumps. We find global waste production to increase from 1997 Mt in 2015, to 3574 Mt in 2050 (median figures). This includes 716 Mt of organic waste, of which 541 Mt went to landfills and dumps in 2015. This will increase to 1253 Mt and 920 Mt respectively, by 2050.
Nitrogen from MSW accumulates in solid waste diposal systems (SWDS), given our methodology. Yearly input of biological N from MSW in SWDS increases from 4.4 Mt N in 2015 to 5.8 Mt (Figure 4). Of this, only about 10% is mobilized as Nr per year. As such, the overall net accumulated stock of N grows drastically. By 2050, 302 Mt N is accumulated in landfills and dumps globally, along with Nr potentially remaining within the SWDS as well.



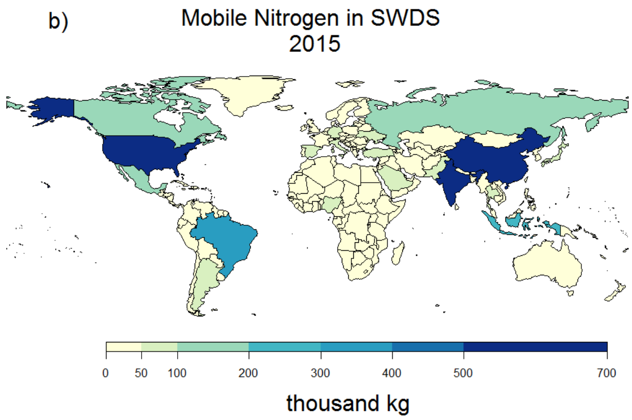


Fig. 1: a) Total nitrogen inputs to stocks and potentially mobilized emissions, global 1965-2100 b) Nitrogen mobilized by degradation processes globally in landfills and dumps in 2015.

4. Discussion

We highlight the large amount of reactive nitrogen still held within landfills and dumps. This stock, along with leachate emissions, is currently unaccounted for in global stock-taking, and can cause severe local pollution, especially in open dumps (El-Fadel et al. 1997). Furthermore, N2O from landfills may contribute up to 20% of that of methane's global warming potential (Ishigaki et al. 2016). As advanced denitrification technologies are implemented in landfills, these may also release significant amounts of N2O (Zhang et al. 2019). N2O emissions are also currently ignored in global emissions accounting and are of importance given the high nitrogen stocks in landfills.

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