A Nitrogen Footprint Tool for Communities: A Case Study for Baltimore, MD, USA

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Abstract

The nitrogen footprint tool (NFT) provides a novel way for communities to understand their environmental impacts by quantitatively identifying reactive nitrogen (Nr) lost to the environment due to their collective activities and consumption. The nitrogen (N) footprint method has previously taken this approach at the personal and institution scale. In this study, the nitrogen footprint approach is extended, for the first time, to the community level to calculate the N footprint of Baltimore City, Maryland, USA.

The total N footprint of Baltimore City was ~19,000 MT N or 30 kg N per capita in 2016, dominated by the food production sector (73%), followed by the energy and transportation sectors (15% combined). There was geographic variability among census block groups' per capita N footprint within Baltimore City; likely driven primarily by economic factors. Several management scenarios focused on sustainable food and energy initiatives were explored to better understand what actions may reduce the Baltimore City N footprint over time. The model for the Baltimore City N footprint calculation can be applied to other communities in the United States at the spatial grain of the census block group or any country with this level of data to provide an indicator of nitrogen sustainability.

Keywords: nitrogen footprint, community, food

1. A community-level tool

The community nitrogen footprint is unique to other footprinting tools with regards to its system bounds and audience. The community level tool has systems bounds for activities within the community (ex: city limits) and has the spatial grain of a census block group. The audiace this tool reaches is community stakeholders. The community level tool used nitrogen footprint calculation methods from Catteneo 2016, Leach et al 2012, and Leach et al 2013.

2. Baltimore City's N footprint results

The first community N footprint calculation was completed in Baltimore City, MD using data from the Consumer

Expenditure report (CEX 2016), Baltimore Public Works Department, and the Baltimore Department of Transportation (MDOT 2016). The N footprints of census block groups were calculated and the per capita N footprints (fig 1).

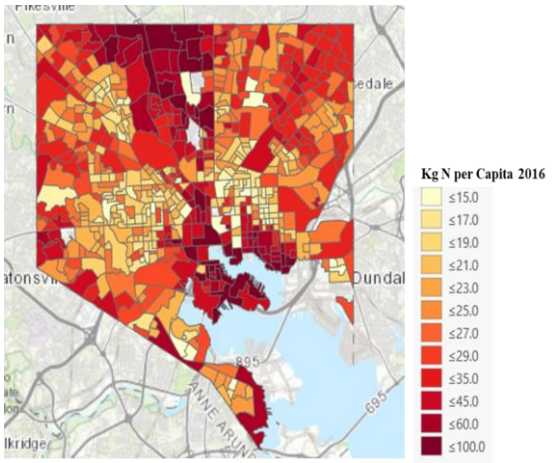

Fig. 1: The N footprint of census block groups within Baltimore City in 2016. The average value is 30 kg N per capita. Values lower than the average are colored in shades of yellow and values higher than the median are colored in shades of red. Complete data sets were not available for gray census block groups.

The correlation between household income and N footprint by census block group was significant (P>0.01) showing a relationship between high income and high N footprint in the city.

3. Reducing Baltimore City's N footprint

After calculating Baltimore City's N footprint, the next step was to determine how to reduce the footprints. Energy scenarios were taken from the Maryland Climate Action Plan (ref) which included: increasing renewable energy use (20%), reducing electrity consumption (10%), and increasing public transportation (10%). Food scenarios were determined based on the most effective N footprint reductions (Castner et al. 2017) which included: cutting 50% of beef in overconsuming census block groups, replacing 25% of beef consumption to beans, fast food resturants replacing 15% of meat-based meals with plant-based meals, and composting 50% of all food waste.

4. Using the community NFT

The community NFT can be used to calculate and analyize the N footprint of any set of census block groups in the US. The results of a community N footprint can be used as an educational tool for city residents, as a metric to more wholstically measure city sustainability, and as a tool to determine feasible and effective reduction strategies.

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