

# The US nitrogen footprint: An updated approach and comparison

Allison M. Leach<sup>1</sup>, Laura Cattell Noll<sup>2</sup>, Brooke Atwell<sup>2</sup>, Lia Cattaneo<sup>2</sup>, James N. Galloway<sup>2</sup>

<sup>1</sup> The Sustainability Institute, University of New Hampshire, Durham NH, USA

<sup>2</sup> Environmental Sciences Department, University of Virginia, Charlottesville VA, USA

E-mail: allison.leach@unh.edu

## Abstract

Over a dozen countries have calculated their per capita nitrogen footprint, but the assumptions and system bounds sometimes vary. In this paper, we propose a more detailed and improved per capita nitrogen footprint methodology to help ensure comparability and consistency in nitrogen footprint calculations and system bounds. We present a case study for the United States. The focus of the update was the virtual nitrogen factors, which describe nitrogen losses during the food production process. We then compare the US nitrogen footprint to other countries, both in terms of the results and the comparability of approaches.

Keywords: footprint, food production, national

---

## 1. Introduction

The nitrogen footprint approach has been applied in over a dozen countries, including the US, the Netherlands, the United Kingdom (Stevens et al. 20), Germany, Austria, Australia, Japan, China, Tanzania, and more (Galloway et al. 2014). Calculations are in-progress in Brazil, Denmark, Portugal, and Ukraine. Although these calculations often include the major components to a per capita nitrogen footprint, the approaches and system bounds sometimes vary. In this paper, we present an updated and more detailed methodology for calculating a national-scale per capita nitrogen footprint. We present a case study for the US.

## 2. Approach

The original nitrogen footprint approach was presented for the US and included food consumption and production; transport; housing; and goods and services (Leach et al. 2012). This paper presents updates to two key aspects: Virtual nitrogen factors (VNF) and the sewage treatment nitrogen removal factor. The updated VNFs (nitrogen lost to the environment during the food production process) include a proposed approach for uncertainty and weighting across

multiple regions and food types. A new estimate of N removal during sewage treatment in the US is a weighted average across sewage treatment methods. Finally, we compare the US nitrogen footprint and approach to other country nitrogen footprint results.

## 3. US nitrogen footprint preliminary results

Preliminary results suggest that the updated US per capita nitrogen footprint (40–45 kg N/cap/year) is similar to the original result (41 kg N/cap/year; Leach et al. 2012). However, changes did occur within sectors and specific food categories. For example, the beef VNF increased from 8.5 to 13.4 kg N lost/kg N food. Some aggregated categories were split out into more specific categories, such as the original fruits and vegetables VNF (10.6), which decreased for both fruit (5.9) and vegetables (5.1). The original US sewage treatment N removal factor (5%) only considered N that was denitrified during advanced sewage treatment. The updated N removal factor (59%) is a weighted average across all sewage treatment methods in the US, and it includes sludge that is removed and repurposed.

## References

Galloway, JN, W Winiwarter, A Leip, AM Leach, A Bleeker, JW Erisman. 2014. Nitrogen footprints: Past, present, and future. *Environmental Research Letters* doi:10.1088/1748-9326/9/11/115003.

Leach, AM, JN Galloway, A Bleeker, JW Erisman, R Kohn, J Kitzes. 2012. A nitrogen footprint model to help consumers understand their role in nitrogen losses to the environment. *Environmental Development* 1: 40-66.