

Nitrogen balances in urban areas: purpose and potentials

W. Winiwarter,^{1,2} B. Amon,^{2,3} Z. Bai,⁴ A. Greinert,² K. Kaltenegger,¹ L. Ma,⁴
S. Myszograj,² C. Nohel,⁵ M. Schneidergruber,⁵ M. Suchowska-Kisielewicz,²
L. Wolf,⁶ L. Zhang,⁷ F. Zhou⁷

¹ IIASA, 2361 Laxenburg, Austria

² University of Zielona Góra, 65-417 Zielona Góra, Poland

³ ATB, 14469 Potsdam, Germany

⁴ CARR, CAS, Shijiazhuang 050021, Hebei, China

⁵ brainbows, 1010 Vienna, Austria

⁶ E.C.O., 9020 Klagenfurt, Austria

⁷ Peking University, Beijing 100871, China

E-mail: winiwarter@iiasa.ac.at

Abstract

While urban improvements most strongly characterize ongoing changes in the human-environment interaction, their influences on the nitrogen cycle so far have received limited attention. Here we develop a mass balance approach, consistent with available literature and with data collection for international reporting of agro-environmental data, and specifically address the role of cities in environmental degradation related to nitrogen compounds. We note that the urban environment not only features high temperature combustion triggering atmospheric emissions of NO_x, or wastewater issues due to high population density, but peri-urban agriculture producing high-value goods is particularly wasteful in its use of nitrogen as nutrient.

Keywords: Urban environment, megacity, peri-urban agriculture.

1. Introduction

Nitrogen pollution is one of the most evident examples of human influence on the global environment. With an anthropogenic contribution at a similar level as the natural nitrogen cycle, environmental reactive nitrogen has been recognized one of the issues exceeding planetary boundaries (Steffen et al., 2015). Nitrogen largely is an agricultural problem, with excess application as a plant nutrient representing the key release process. On the global scale, urbanization constitutes the key driver of anthropogenic impacts. Therefore here we investigate the urban aspects of the human-induced nitrogen cycle.

2. Methods

Based on a thorough literature review, we developed a material balance approach to describe the key flows between urban environmental pools (Fig. 1). We used the software STAN (Cencic and Rechberger, 2008) for a backbone structure to display urban N flows. This is created largely consistent with existing literature, aiming to safeguard availability of long-term data records. Typically such extended time series are available in connection with international agreements and are maintained under national responsibility, also for reactive nitrogen (Winiwarter and Geupel, 2018).

3. Results and Discussion

Cities need energy, and high-temperature combustion processes are well-known to be responsible for NO_x emissions. Also disposal of waste partly relates to nitrogen waste, as in wastewater treatment plants. But also agriculture particularly produces for consumers in cities. Peri-urban animal husbandry (meat and milk production, but also pets) as well as vegetable or fruit production, or even urban lawns aim towards maximizing outputs. Urban nitrogen therefore may represent an easy target to improve resource efficiencies.

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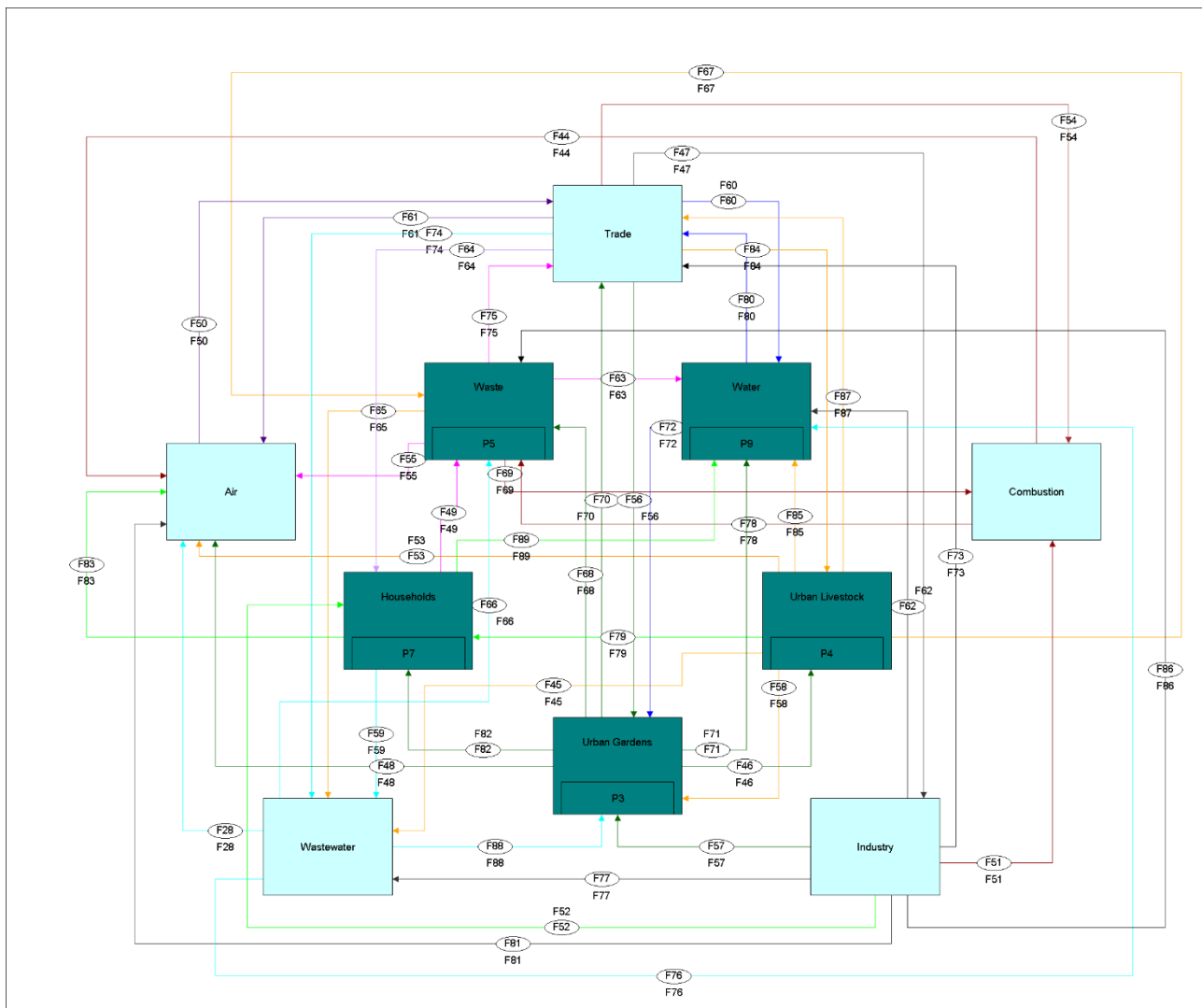


Fig. 1: Pools and flows as a STAN implementation of the core structure of Urban Nitrogen Budgets. Pools in dark color potentially also experience stock changes, i.e. significant amount of reactive nitrogen can be stored or released.