Global cropland N_2O emissions: from soil to fork (1986-2015)

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Abstract

Cropland N_2O emissions are an important component of the global greenhouse gas (GHG) budget. Current estimates of global cropland N_2O emissions include both bottom-up and top-down approaches, but these production-based emission estimates have not been attributed to consumers yet. We aim to fill this gap by applying the FABIO model to a new estimation of N_2O emission by crop and country from 1986 to 2015. FABIO is a physical input-output model assembling FAOSTAT statistics into a consistent input-output framework, which allow tracing the enviornmental impacts embodied in biomass flows along global supply chains.

Keywords: Nitrous oxide, Agricultural GHG emissions, International trade. Consumption-based accounting

1. Introduction

Cropland N_2O emissions are an important component of the global greenhouse gas (GHG) budget. Global N_2O emissions from agricultural activities have been estimated to be 3.8–6.8 Tg N yr^{-1}, accounting for 25–39% of the total global emissions of N_2O (UNEP, 2013)

The accounting of GHG (at national, regional and local levels) generally focuses on emissions and removals derived from the production of goods or services within the borders of the accounted territory (Rypdal et al., 2006). However, the focus on production in GHG accounting diverts the attention away from the drivers of those emissions through international trade, thus negatively affecting the effectiveness of mitigation strategies and contributing to the unsustainability of current food consumption patterns and trends (Davis and Caldeira, 2010).

2. Methods

Cropland direct N_2O emission from 1986 to 2015 were estimated for 65 crop types in 191 countries based on N inputs in the form of synthetic N, manure and crop residues (Figure 1). Total synthetic N application values per country were taken from FAOSTAT (FAO, 2019), and manure N application to cropland from Lassaletta et al. (2014). Synthetic N was distributed among crops based on Mueller et al. (2012), and manure based on West et al. (2014). In both cases, N rates were adjusted to match total country N use in each time step. Crop residue N inputs, including aboveground and belowground crop and weed residues, were estimated using crop-specific coefficcients (harvest indices, root:shoot ratios, weed biomass production, N contents and residue harvest shares) gathered from the literature. N_2O emissions were estimated based on N inputs using a non-linear model (Gerber et al., 2016).

Consumption-based N_2O emissions will be estimated by linking production emissions to trade data using FABIO model (Food and Agriculture Biomass Input-Output, Bruckner et al., 2019). FABIO is a database constructed primarily from the data of FAOSTAT, including biomass flows for 191 countries with a resolution of 130 agricultural products and 50 non-agricultural products (in monetary units) for the period 1986-2015.

3. Results and discussion

This is a work currently in progress thus results are expected to be ready for presentation in the 2020 INI Conference (not available yet).

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References

Bruckner, M, Wood, R, Moran, D, Kuschnig, N, Wieland, H, Maus, V, Borner, J (2019) FABIO-The Construction of the Food and Agriculture Biomass Input-Output Model. *Environ. Sci. Technol.* **53** 11302-11312

Davis, S J, Caldeira, K (2010) Consumption-based accounting of CO_2 emissions. *Proc. Nat. Acad. Sci. USA* **107** 5687-5692

FAO (2019) FAOSTAT—FAO database for food and agriculture. Rome: Food and agriculture Organisation of United Nations (FAO). Available: http://faostat3.fao.org/

Lassaletta, L, Billen, G, Grizzetti, B, Anglade, J, Garnier, J, (2014) 50 year trends in nitrogen use efficiency of world cropping systems: the relationship between yield and nitrogen input to cropland. *Environ Res Letters* **9** 105011

Mueller, N D, Gerber, J S, Johnston, M, Ray, D K, Ramankutty, N, Foley, J A, 2012. Closing yield gaps through nutrient and water management. *Nature* **490** 254

West, P C, Gerber, J S, Engstrom, P M, Mueller, N D, Brauman, K A, Carlson, K M, Cassidy, E S, Johnston, M, MacDonald, G K, Ray, D K, Siebert, S (2014) Leverage points for improving global food security and the environment. *Science* **345** 325-328

UNEP, 2013. Drawing Down N2O to Protect Climate and the Ozone Layer. A UNEP Synthesis Report. Available at:. United Nations Environment Programme (UNEP), Nairobi, Kenya (Accessed 4 June 2017). http://wedocs.unep.org/handle/20.500. 11822/8489

Zhou, M., Zhu, B., Wang, S., Zhu, X., Vereecken, H.,

Rypdal, K., Paciornik, N., Eggleston, S., Goodwin, J., Irving, W., Penman, J., Woodfield, M., 2006. Introduction To the 2006 Guidelines, in: 2006 IPCC Guidelines for National Greenhouse Gas Inventories. IPCC, pp. 1–12.

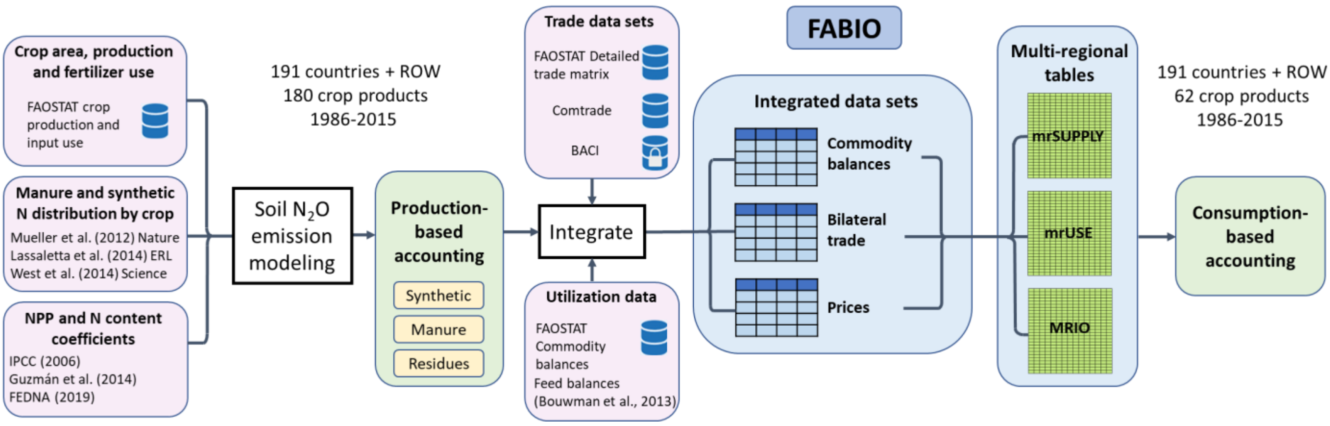

Fig. 1: Estimation of cropland N_2O emisisons by crop, country and year, and application of FABIO model to estimate consumption-based N_2O emissions