

Combining Nutrient Accounting Tools With Input-Output Life Cycle Assessment For Estimating Nitrogen and Phosphorus Flows In The US Economy

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Abstract

Agricultural activity is the leading cause of nutrient cycle disruption and results in environmental impacts such as eutrophication in water bodies and climate change. In this work, we have combined the Commodity-Specific Net Anthropogenic Nitrogen Inputs (CSNANI) and Phosphorus Inputs (CSNAPI) nutrient accounting models with an environmentally extended input-output life cycle assessment (EIO-LCA) approach thus enabling estimation of N&P flows associated with food products and food waste produced in the U.S. economy.

INTRODUCTION

- The impacts of nutrients (N & P) has contributed to exceeding several planetary boundaries (Campbell et al., 2017)
- There is a lack of study on nutrient flows (N & P) associated with manufactured food and food waste in the supply chain

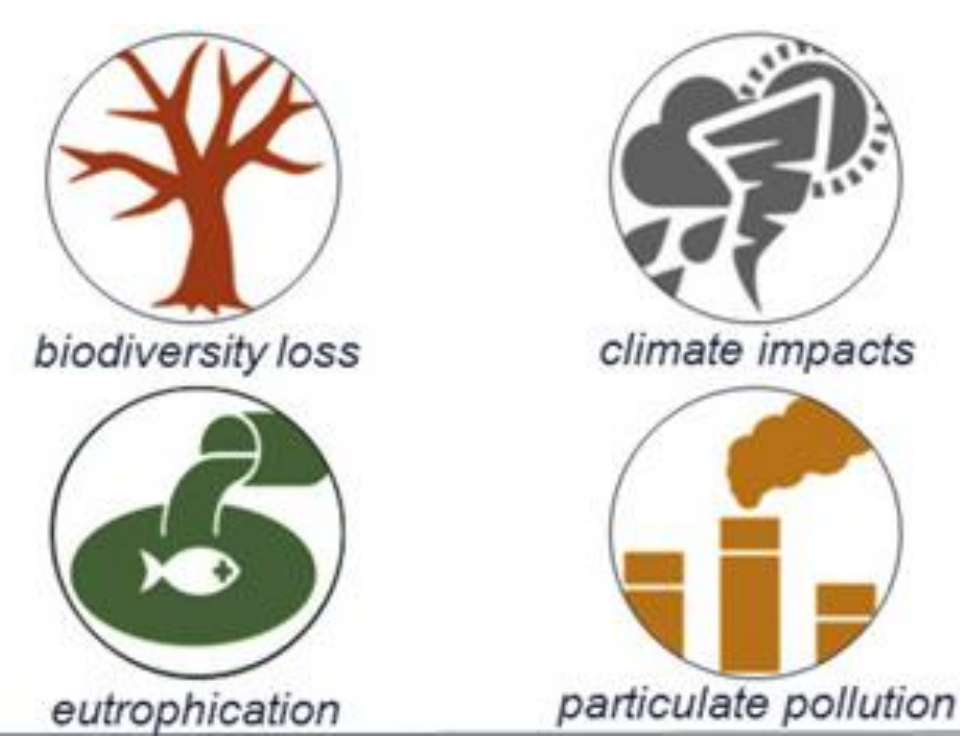


Fig. 1. The impacts of nutrients (Muth et al., 2019)

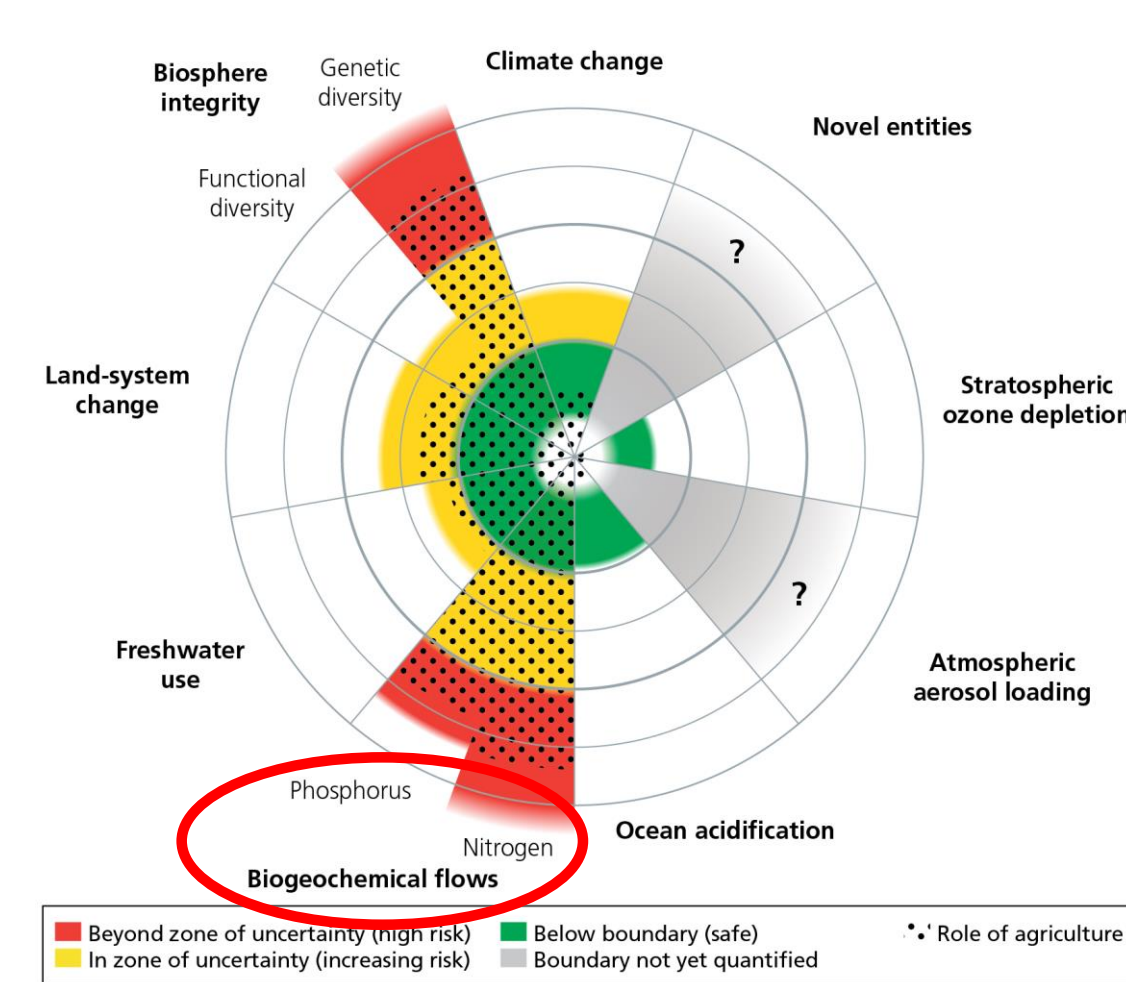


Fig. 2. The status of the nine planetary boundaries (Campbell et al., 2017)

OBJECTIVES

- Estimate the quantity of nutrient flows (N & P) through the U.S. economy by combining nutrient accounting tools with an EIO-LCA model
- Estimate the quantity of N & P flows associated with food waste

METHODS

- CSNANI and CSNAPI (Algren et al., 2018) data were mapped to EIO-LCA to calculate nutrient intensity factors (flows/\$)
- The final demand 'Total US Consumption' and direct requirements matrix (A) from the EPA's USEEIO model, version 1.1 were used (Yang et al., 2017)
- Finally, we estimated the nutrient flows across the supply chain associated with demand across the US economy.
- Figure 3 depicts the flow of methodology

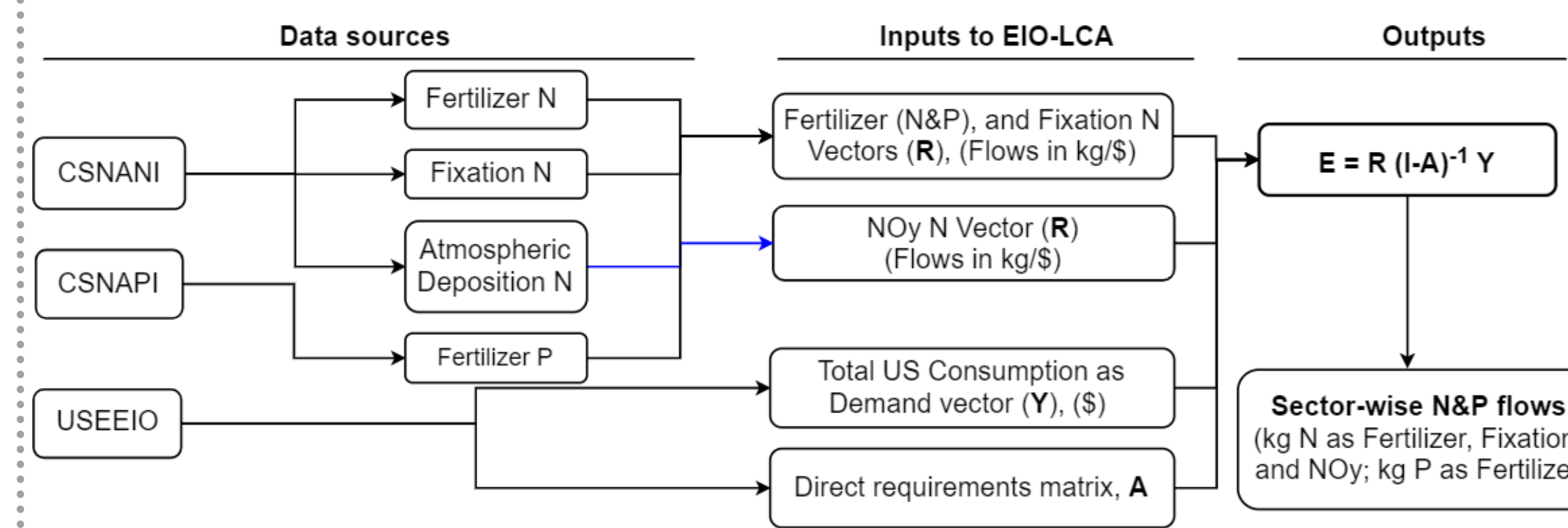


Fig. 3: Representation of methodology used for estimating nutrient flows across the supply chain in the U.S. economy. CSNANI & CSNAPI both are nutrient accounting tools and stand for Commodity-specific Net Anthropogenic Nitrogen Inputs and Net Anthropogenic Phosphorus Inputs. USEEIO is the Environmentally Extended Input-Output model of the U.S. The equation refers to the EIO-LCA mathematical expression.

RESULTS

- The demand made to the 'Food, Beverage, And Tobacco' industry sector category are the leading cause of N & P flows in the U.S., Figures 4, and 6, respectively.
- Figures 5 and 7 represent the N & P flows for the 29 individual sectors included in the 'Food, Beverage, And Tobacco' industry sector category.

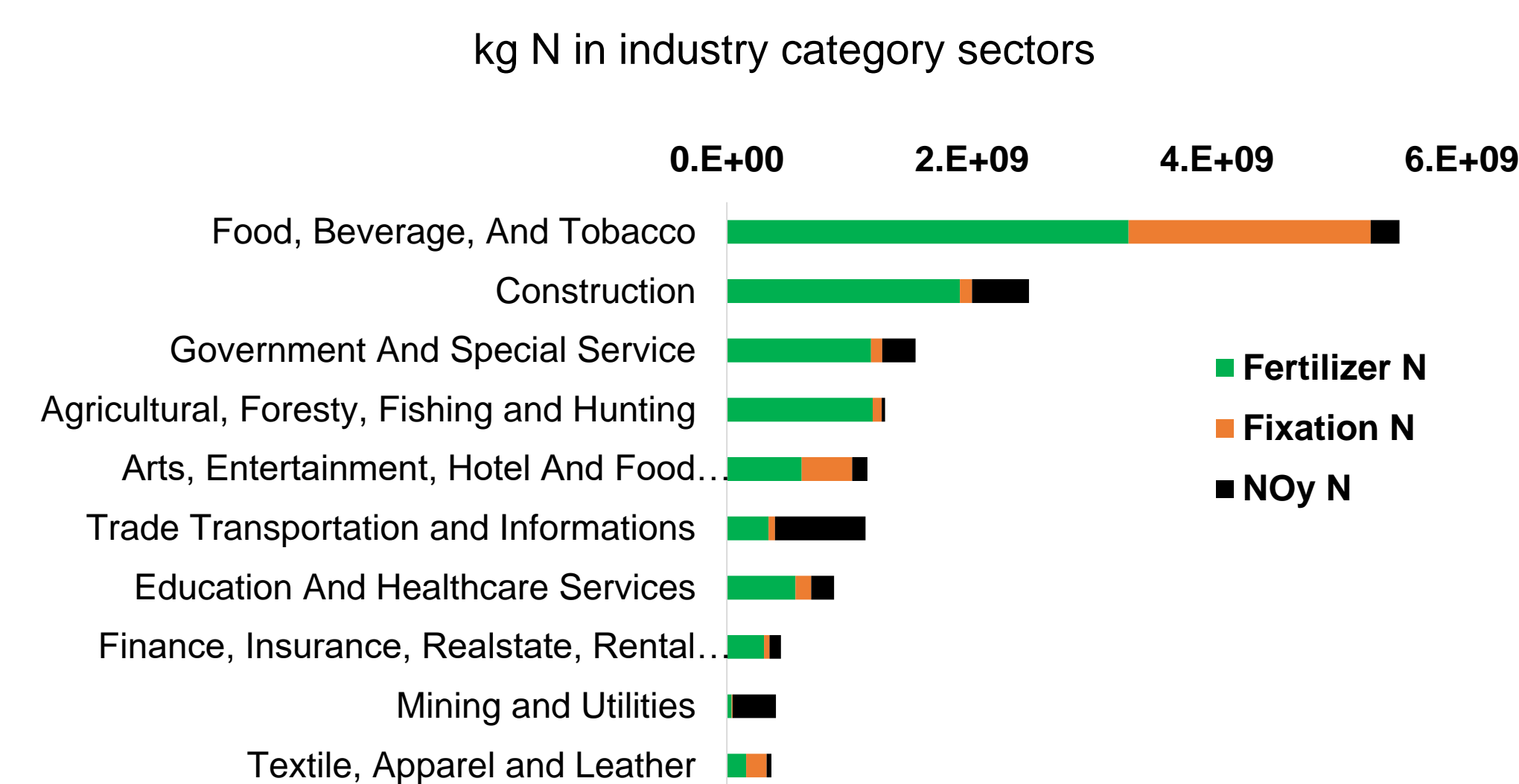


Fig. 4: Top ten industry category sectors with N flows. In order to present all of the results, the 388 sectors in the full model are aggregated into 27 industry categories sectors using a scheme based on the North American Industry Classification System (NAICS).

RESULTS

Sectors in the 'Food, Beverage, And Tobacco' sector lead to the largest N & P flows due to high dependence on agricultural products.

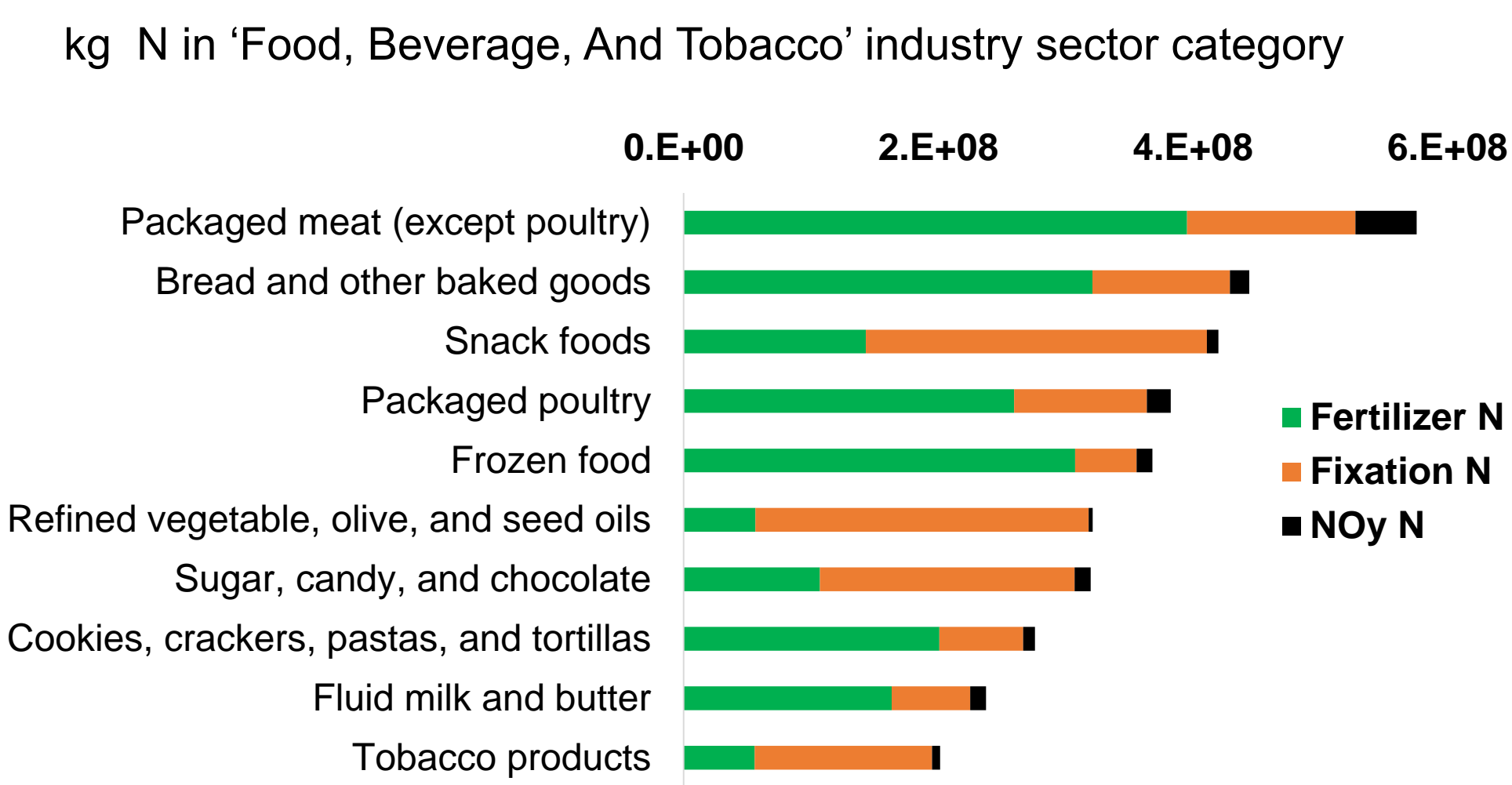


Fig. 5: Top ten sectors with N flows in 'Food, Beverage, And Tobacco' industry sector category

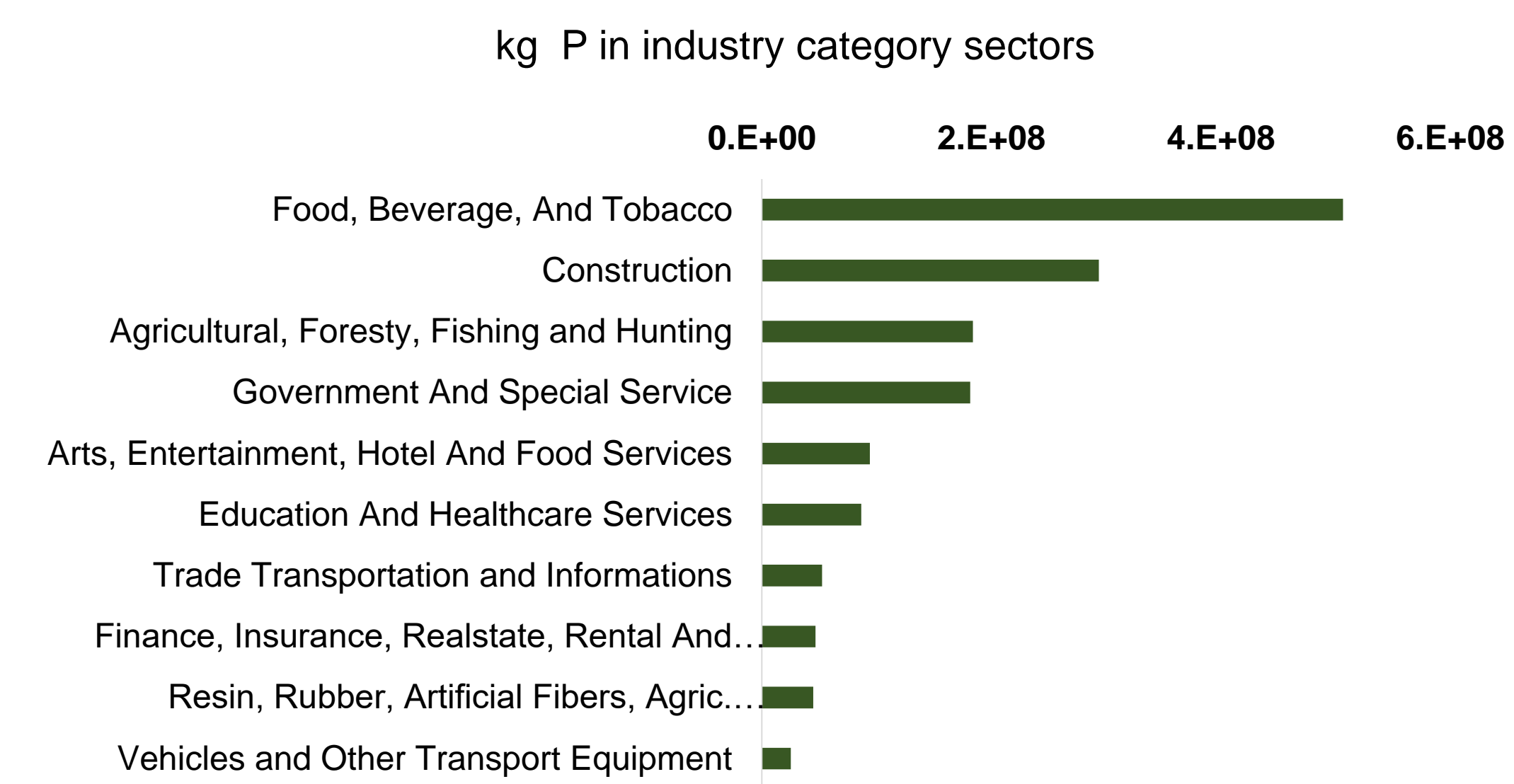


Fig. 6: Top ten industry category sectors with P flow

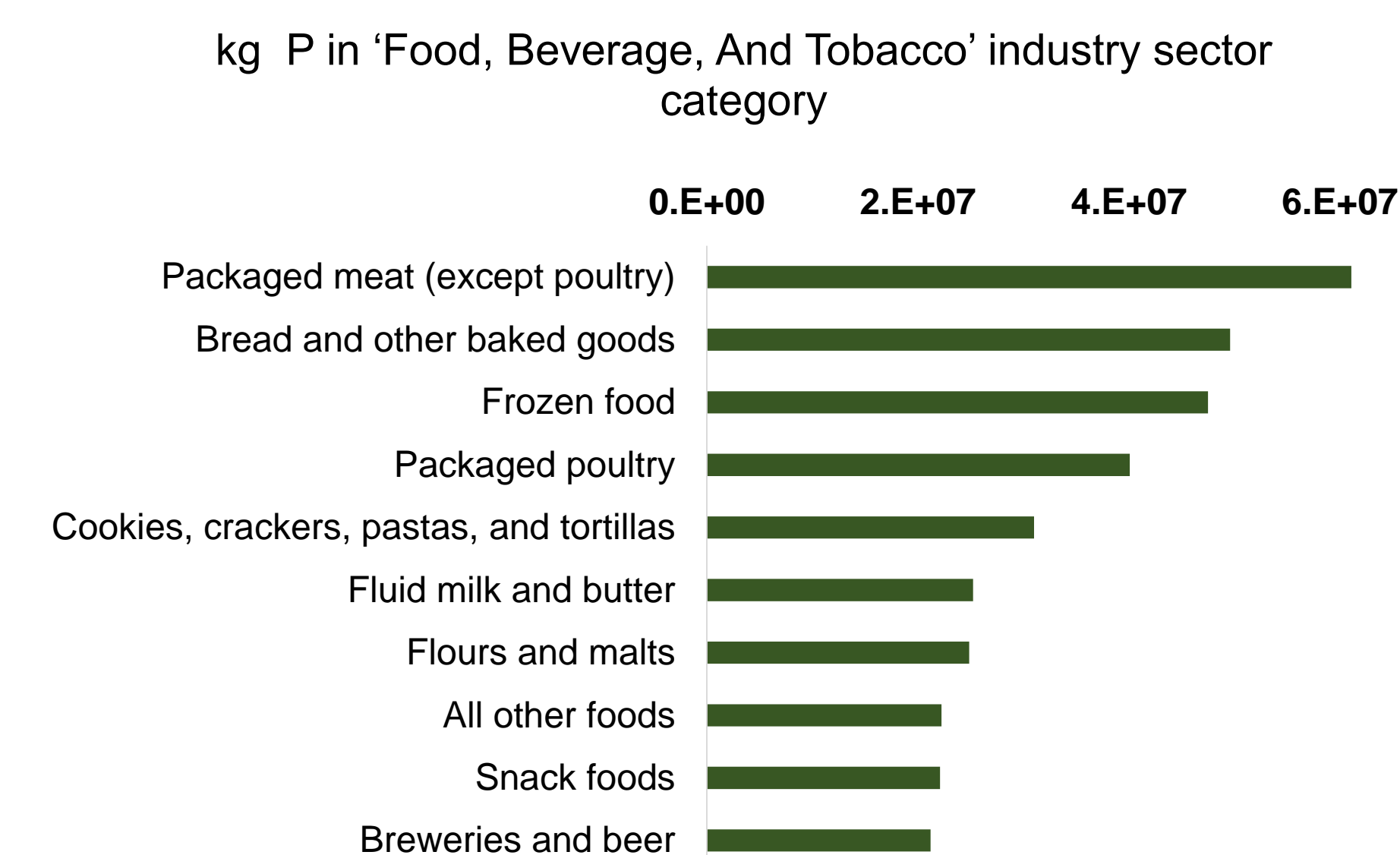
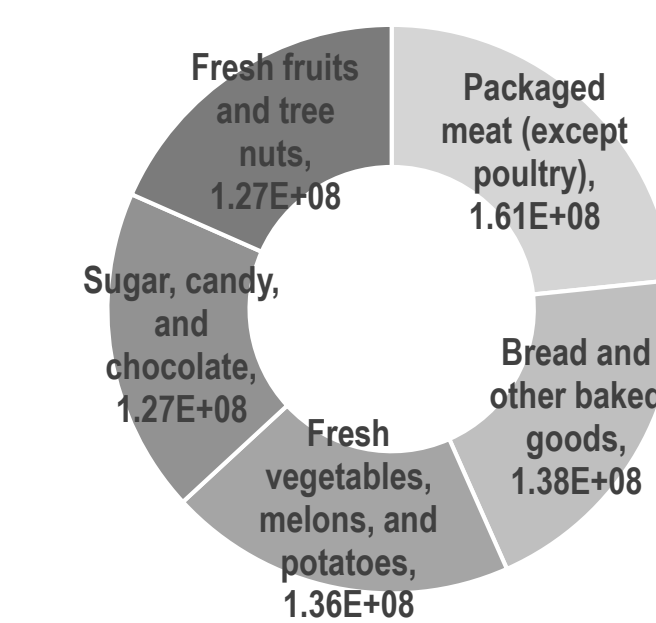


Fig. 7: Top ten sectors with P flow in 'Food, Beverage, And Tobacco' industry sector category

CONCLUSION

- About 90% of total N & P flows are associated with top ten industry category sectors
- About 65% of total N & P flows are associated with the top ten sectors in 'Food, Beverage, And Tobacco' industry sector category
- 'Agricultural, forestry, fishing and hunting' industry sector category ranked lower since people don't directly consume much from these sectors
- We estimated the quantity of N & P flows associated with food waste. Figure 8 represents the top five sectors with N & P flows in food waste

Top five sectors with N flows (kg) in food waste



Top five sectors with P flow (kg) in food waste

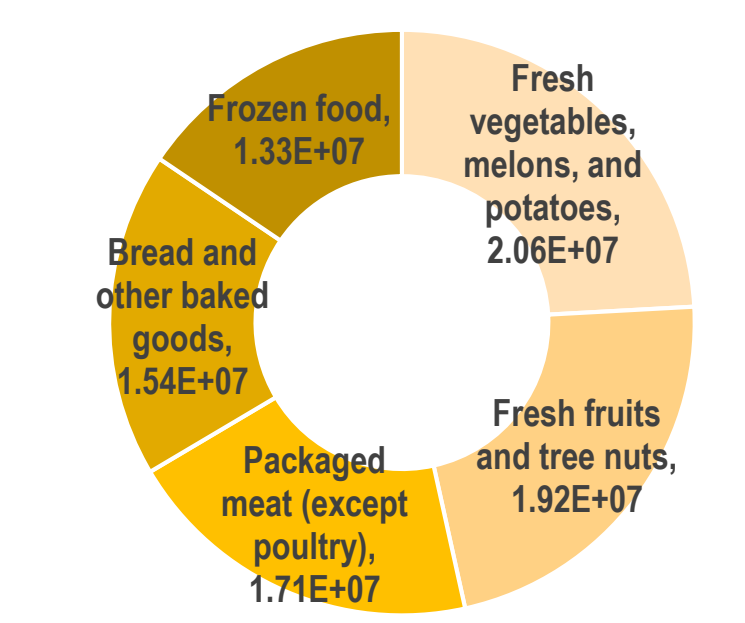


Fig. 8: Top five sectors with N & P flows associated with food waste

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