Urban Nitrogen Metabolism in Xiamen City, China

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1 Introduction

Urban settlements, as highly concentrated areas for production and consumption activities, have become important components in the alteration of regional and even global nitrogen (N) cycle. Anthropogenic increase in reactive nitrogen (Nr) affects both human health and ecosystems, especially in rapidly urbanizing countries (Galloway et al. 2008). Therefore, N flow pathways and quantities in urban ecosystems need to be understood properly in order to effectively control the Nr creation and its impacts.

China's rapid urbanization, industrialization and associated lifestyle changes have led to fast-growing anthropogenic creation of Nr (Gu et al. 2015). This study establishes an urban N metabolism model for Xiamen, a rapidly urbanizing city in China, in 2008, providing insights into regulatory measures to improve N use efficiency and reduce environmental impacts.

2 Methods

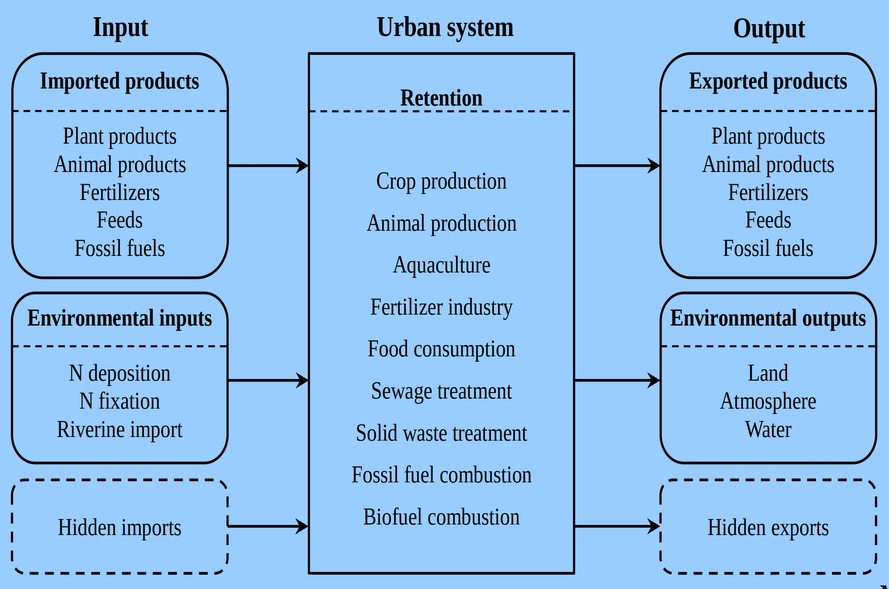

Fig. 1 Conceptual framework of urban N metabolism

- ✓ substance flow analysis to calculate N fluxes between subsystems
- ✓ N in industrial products excluded because of the complexity of industrial products and lack of information
- ✓ component level method to compute N retention within the city by summing up N accumulation within different functional and environmental components
- ✓ N use efficiency:

$$NUE = [(Ih_{plant\ \ food} + Ih_{Animal\ \ food} + If_{Export} - If_{import}) / (Ic_{Fertilizer} + Ic_{Irrigation} + Ic_{Deposition} + Ic_{BNF} + Ic_{Seed} + Ia_{Grass} + Ia_{Residue} + Ia_{Feed})] \times 100\%$$

3 Results and Discussions

● *N Sources and Inputs to Xiamen*

The total N inputs to Xiamen amounted to 103.2 kt in 2008, equivalent to 22.5 times the N applied to Xiamen's farmland in the same year. The N input per capita was 58.5 kg.

- ✓ imported products contributed 65.9 kt, 62% of which from fossil fuels
- ✓ agricultural products comprised 15.5% of the total N input (limited arable land versus large population)
- ✓ N inputs from the environment amounted to 37.3 kt, 76% of which from Jiulong River with N discharged by upstream regions

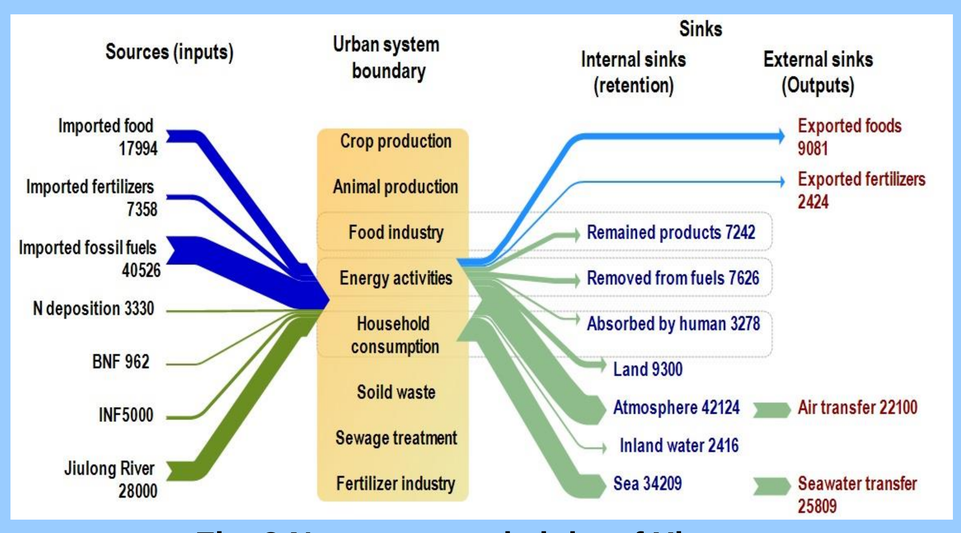

Fig. 2 N sources and sinks of Xiamen in 2008 (Unit: t).

● *N Sinks and Outputs from Xiamen*

88.2 kt of N were released to the urban environment.

- ✓ atmosphere (48%) and seawater (39%) are two major sinks
- ✓ 78% of the N into the atmosphere from energy use
- ✓ N into seawater led to eutrophication and frequent incidence of red tides

● *Urban N Retention*

The total N retention was 52.3 kt (51% of total input) in 2008, equivalent to 26 $t \cdot km^{-2} \cdot yr^{-1}$.

- ✓ 68% accumulated in urban environment, and 32% was retained in products and human bodies

● *N Use Efficiency*

The NUE in the food chain in Xiamen was only 11% in 2008, due to agricultural intensification and lack of N recycling between urban and rural settlements.

- ✓ a little higher than the national average NUE 8.9% (Ma et al. 2010)
- ✓ 25% of the N consumed by households became kitchen residue and ended up in landfills (NUE increased to 14% if these wastes composted and recycled)

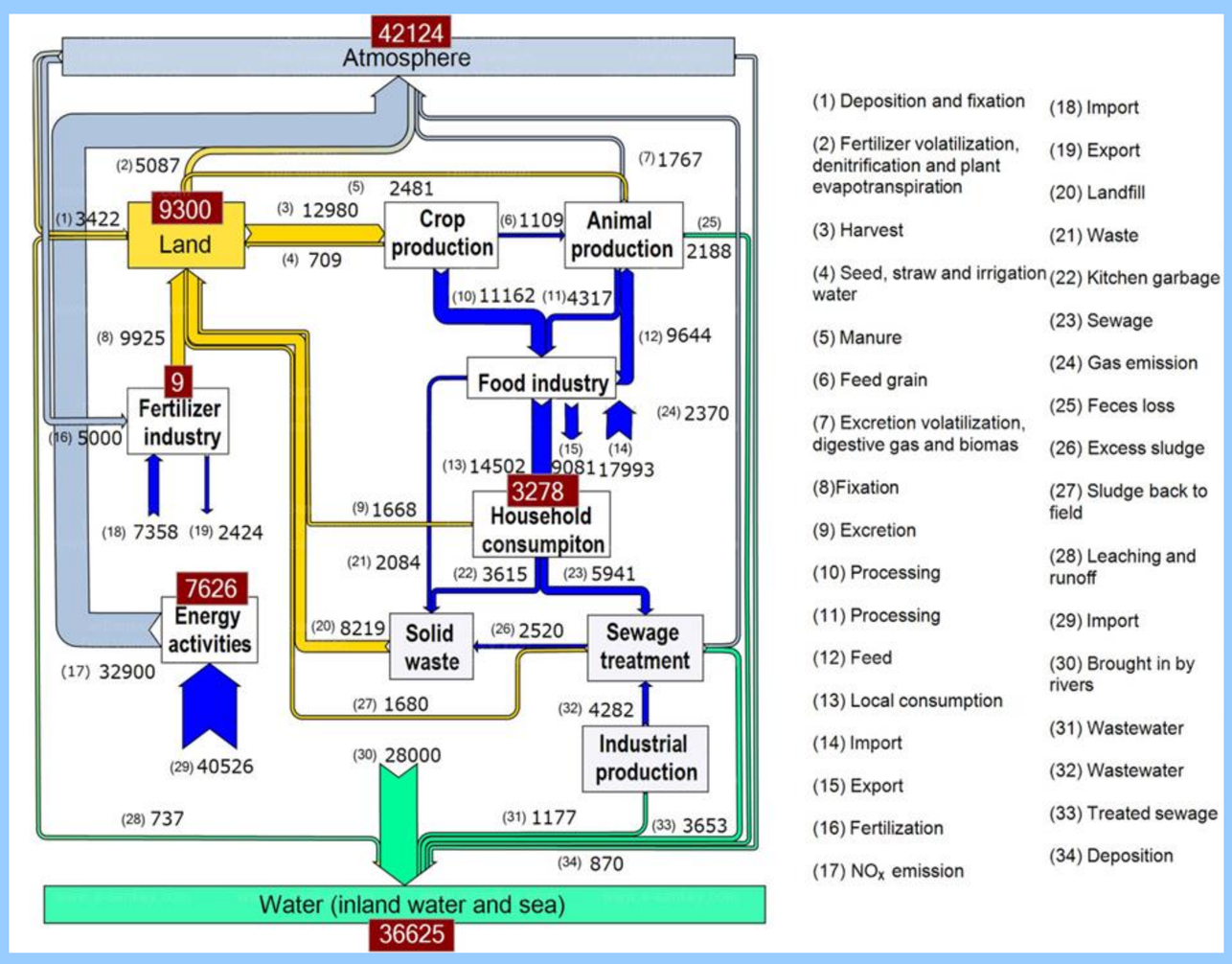

Fig. 3 Urban N metabolism in Xiamen in 2008 (unit: t). The figures in the red boxes represent the volume of N accumulation.

4 Conclusion

- Use of low-N fuels and N-removal technologies for reducing atmospheric N accumulation
- Improve NUE in agro ecosystem through precision farming
- Integrated watershed management programs partnered with upstream cities
- Food waste reduction via lifestyle change and kitchen residue composting

5 References

Galloway, J. N., A. R. Townsend, J. W. Erisman, et al. (2008). "Transformation of the nitrogen cycle: Recent trends, questions, and potential solutions." Science **320**(5878): 889-892.

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