RESOURCE USE, RECYCLING, AND ENERGY EMISSIONS IN JAPANESE SYSTEM FROM NITROGEN PERSPECTIVE

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Nitrogen (N) is an essential element for plants and animals to grow and to operate. Reactive N (Nr, all N species except inert nitrogen gas, N_2) is an indispensable resource for humans for both food and industrial production, such as N fertilizers, acrylonitrile, urea, and nitric acid. However, 80% of Nr (mainly ammonia, NH_3, from N_2 by Harber-Bosch process) is lost to the environment as Nr and N_2. The total N loss is worth around $200 billion per year[1]. When Nr is lost to the environment, often in forms of nitrogen oxides (NO_x), NH_3, nitrate (NO_3^-), and nitrous oxide (N_2O), it becomes a source of pollution including eutrophication and acidification of ecosystems, formation of particulate matters and ozone, and the greenhouse effect. Energy production and combustion are other sources of Nr emissions. Current anthropogenic Nr creation and resultant emissions exceed the planetary boundary[2]. Thus, it is important to know that how total Nr emissions are effectively reduced considering recycling products. To quantify the effect of recycling, good understanding of economy-wide Nr flows is needed. In this study, we developed an integrated input-output model to trace Nr use and emissions in food, industrial, and energy production in Japan and conducted input-output material flow analysis.

As a first step, we investigated Nr flows between industries using statistical data and literature.

The Nr flows originating from Haber-Bosch ammonia (Fig. 1) show that Japan uses 58% of industrial ammonia for products (mainly via acrylonitrile and urea) other than fertilizer[3]. This ratio is very high compared to the global average of 20%[4]. Energy-related flows will be presented.

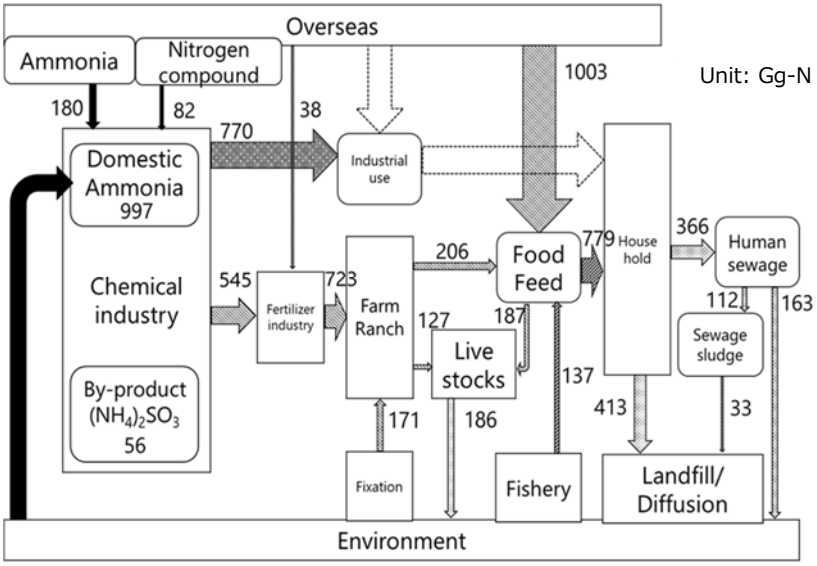

Fig. 1 Reactive nitrogen flows originating from ammonia in Japan (2011) [3]

To examine interactions between sectors, we then developed an integrated input-output model to trace Nr use and to assess emissions by adding a quantified matrix for ammonia, its derivatives, and energy-related Nr to Japanese input–output table for 2011. We used monetary or physical data to allocate the production values and emissions.

The preliminary results show that about 90% of the ammonia derivatives go to sectors of “final chemical products (except medicaments)” (125 Gg (10^9g)-N), medicaments (110 Gg -N), synthetic resins (110 Gg -N), synthetic fibers (97 Gg -N), and “organic chemical products (except petrochemical basic products)” (90 Gg -N) as their first destinations. Comparing the input coefficients of the first destination sectors for ammonia derivatives, synthetic fibers section has significantly high influence on Nr flows (nearly 300 kg-N/million JPY). Results of further analysis including energy-related flows will be presented and key flows for recycling agricultural products will be discussed.

The overall analysis contributes to better understanding of both direct and indirect Nr flows and sector interactions regarding Nr and to identify the key flows for recycling Nr-related products and reducing the total Nr emissions.

References:

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