Historical N load from land to East-China sea and riverine N_2O emission in East-Asia

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Abstract

In this study, we evaluated historical N load to sea through the rivers in East Asia using process model VISIT combined with a newly developed VISIT Off-line River Nitrogen scheme (VISIToRN). This model can evaluate the in-stream denitrification rate (i.e., benthic N2O and N2 emission). In the light of historical N load to the sea, major East-Asian rivers showed various trends. Yangtze river had the highest N load to East-China sea and a clear increasing trend in 1961-2010. On the other hand, some other rivers showed plateaus in recent years, and high variations correlated with the runoff due to the relatively small watershed scale.

Keywords: Riverine N_2O emission, denitrification, N fertilizer, N deposition, N manure, East Asia

1. Introduction

East-Asia is known to be a hotspot of reactive N (Nr) pollution and hence to be a biggest source of atmospheric N_2O among the global regions. In the last half century, the use of N fertilizer in this region was rapidly growing up. Not only N fertilizer, various non-point source of N (N deposition, manure) have also increased with land-use change (i.e., cropland expansion). Furthermore, East Asia is fast urbanising in this period, which contributed increase of reactive N as a point source to a river via wastewater release. Therefore, heavy N loading to river ecosystem in East Asia has occurred and resulted in eutrophication especially in coastal areas in this region.

We have already evaluated the amount of direct N_2O emission from this region (Ito et al., 2018). On the other hand, there is a considerable unknown in the amount of riverine N_2O emission induced by benthic denitrification. Such in-stream denitrification process might also play important roles in the N load at the mouth of rivers via reduction of Nr in river waters.

In this study, we focused on the N load and in-stream N denitrification in rivers around East-China sea. East

China sea is located in transboundary region surrounded by East-Asian countries, where is one of the marginal seas in the world. It is essential to quantitively comprehend each Nr source and their historical trends for the effective Nr management in the watersheds and seas. In order to evaluate a historical N load of the rivers and riverine N_2O (N_2) emission, we developed a simple off-line riverine N scheme for global ecosystem models, which simulate N cycling. This study aimed to evaluate historical N load to seas by the rivers and the contribution of major non-point sources and point sources to the N load to seas in East-Asia.

2. Materials & methods

We used a process-based terrestrial ecosystem model "Vegetation Integrative SImulator for Trace gases (VISIT)" (Ito et al., 2018). Spatial resolution is 0.5° × 0.5° in latitude and longitude. Simulation period was 1961-2010. Climate was used in CRU TS3.25 dataset. In this study, we used the simulation results of ecosystem model "VISIT" (Ito et al., 2018) for runoff and N leaching values from natural and cropland ecosystems which are major non-point sources of reactive nitrogen. The list of major N input as follow;

- Land-use: Hurrt et al. (2011)
- N fertilizer: Nishina et al. (2017)
- N manure: Zhang et al. (2017)
- N deposition: Dentener et al. (2006)
- Human sewage: Proportion to the poplulation density

We used "TRIP" for the river-routing. For in-stream denitrification processe, we assumed Michaelis–Menten-type kinetics in "VISIToRN" (VISIT Off-line River Nitrogen scheme). Fig. 1 summurize the simulation setup in this study.

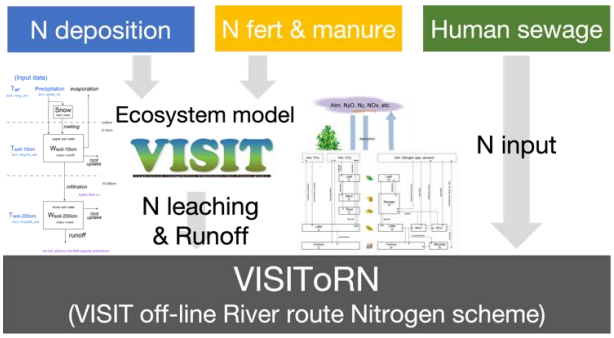

Fig. 1 Schematic representation of N load calculation

3. Result & Discussions

Yantze river had the highest N load (about 6.4 Tg/year at 2001) in East Asia (Fig. 2). Yellow river showed a clear increase trends in N load and almost its doubling in this period (Fig. 2), although discharge in yellow river showed a decrease trends in the simulation period. The expansion of croplands and urbanization drove this increase trends in China. On the other hand, Korean rivers (Nakdong and Han) and Japanese river (e.f. Tone) showed no increase trends in this period and high daily variations due to the small watersheds (positive correlations with the discharges was found in these rivers).

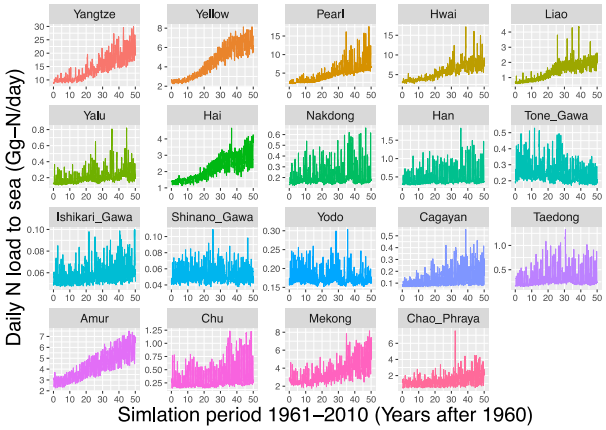

Fig. 2: Daily N load to seas in 19 major East-Asian rivers from 1961-2010. Some rivers don't directly flow into East-China sea.

Riverine N_2 emission in East Asia was about 5% of riverine N load to seas and riverine N_2O emission in Eas Asia was estimated to be about 0.125 Tg/Year. However, these estimates have still highly uncertain. In the presentation, we will show detail contribution of each source to N load in each river and the integreted historical N load to East-China sea.

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