frontiers in Environmental Science

EDITORIAL
published: 20 January 2022
doi: 10.3389/fenvs.2021.829104

Editorial: Nitrogen in the Environment

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Keywords: environment, soil, nitrogen, processes, challenge

Editorial on the Research Topic

Nitrogen in the Environment

OPEN ACCESS

Edited and reviewed by:
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Specialty section:
This article was submitted to Biogeochemical Dynamics, a section of the journal Frontiers in Environmental Science

Received: *04 December 2021*
Accepted: *23 December 2021*
Published: *20 January 2022*

Citation:
Shaaban M, Hatano R, Martínez-Espinosa RM and Wu Y (2022) Editorial: Nitrogen in the Environment. Front. Environ. Sci. 9:829104. doi: 10.3389/fenvs.2021.829104

Nitrogen (N) is essential for life of all living organisms in the universe. Every year, about 67.84 million tons of nitrogen is applied to agricultural land all over the world (Liu et al., 2010). Nitrogen is the only essential element which exists in several forms in soil. The transformations of N takes place by several interactive factors and microbes. The interaction among factors therefore plays a pivotal role in functional maintenance of environment. Nitrogen is always not beneficial to living organisms; excess concentration of N might act as pollutant, thus N may also affect human and environmental health (Robertson and Groffman, 2015). Understanding the importance of N in various ecosystems is thus essential for understanding sustainable development and productivity. In terrestrial ecosystems, N exists in nine different chemical forms corresponding to different oxidative states. Dinitrogen gas (N_2) is the inert form of N and the most abundant in the biosphere. N_2 is transformed to organic N through biological N_2 fixation, and enters biological pools of soil. Subsequently, the fixed-N undergoes several microbial processes; mineralization, immobilization, nitrification, denitrification. Löhnis (1913) was the first scientist who developed the concept of N cycle illustrating that N is transformed from one form to another (Löhnis, 1913; Robertson and Groffman, 2015). Anthropogenic activities have seriously perturbed the global nitrogen cycle. Excessive use of nitrogen for crop production has negatively impacted soil biological diversity, climate, and human health (Liu et al., 2013). However, nitrogen shortage leads us to fall short of proper food demands by limiting both the quantity and quality of crops. The disturbance of the global nitrogen cycle at a large scale presents substantial challenges and requires immediate implementation of strategies for appropriate nitrogen management. Understanding nitrogen transformations and the soil microbes that perform them, as well as proper management of nitrogen for crops, are thus essential for understanding and managing ecosystem health and productivity. Biological and industrial N_2 fixation have far outpaced record denitrification rates in the history and is identified as main reason of N pollution in the environment (Galloway et al., 2008). Therefore, it is an environmental challenge to make managed ecosystems with rational use of N (Robertson and Vitousek, 2009).

In this Research Topic, we received total 13 articles, and finally eight articles after peer review were recommended for publication in Research Topic (N in the environment) by Guest Editors. Among eight published articles, two are review articles, one is method, and five are original research articles. The published articles focused various aspects of N in the environment.

The first article recommended for the publication was authored by Nadeem et al., They studied nitrification and denitrification kinetics and the abundance of ammonia oxidizing bacteria (AOB) and ammonia oxidizing archaea (AOA) in soils sampled from a field experiment 2–3 years after liming. The $N_2O/(N_2O+N_2)$ product ratio of heterotrophic denitrification declined with increasing pH, and the potential nitrification rate and its N_2O yield (YN_2O: N_2O-N/NO_3^--N), as measured in fully oxic soil slurries, increased with pH, and both correlated strongly with the AOB/AOA gene abundance ratio. They proposed that while low emissions from nitrification in well-drained soils may be enhanced by liming, the spikes of high N_2O emission induced by ammonium fertilization at high soil moisture may be reduced by liming, because the heterotrophic N_2O reduction is enhanced by high pH. Another article authored by Xu et al., which explored the comparison of N_2O emission from a cold waterlogged and normal paddy field. They revealed that N_2O emissions from cold waterlogged paddy fields were significantly lower than those of normal rice fields due to the low temperature and higher water content; there may also be complete denitrification that may lead to a decrease in N_2O emissions. In the review article, Mejías et al., reviewed the potential use as an innovative approach to improve nitrogen use efficiency and reduce N losses to the wider environment, analyzing potential shortcomings and future considerations for animal food chains. Su et al., used a fully automated system to continuously measure soil N_2O emissions for 2 years and suggested that sampling between 9:00 am and 10: 00 am is the best empirical sampling time for the intermittent manual measurements. Hayakawa et al., examined sulfur-driven NO_3^- reduction using streambank soils in a headwater catchment underlain by marine sedimentary rock. Many denitrifying sulfur-oxidizing bacteria were detected which dominated up to 5% of the entire microbial population, suggesting that these bacteria are widespread in sulfide-rich soil layers in the catchment. They concluded that the catchment with abundant sulfides in the subsoil possessed the potential for sulfur-driven NO_3^- reduction, which could widely influence N cycling in and NO_3^- export from the headwater catchment. In a review article, Moeller et al., described the current picture of the function of regulatory sRNAs in biogeochemical cycles, with specific focus on the nitrogen cycle. Non-coding small RNAs (sRNAs) regulate a wide range of physiological processes in microorganisms that allow them to rapidly respond to changes in environmental conditions. sRNAs have predominantly been studied in a few model organisms, however it is becoming increasingly clear that sRNAs play a crucial role in environmentally relevant pathways. For example, several sRNAs have been shown to control important enzymatic processes within the nitrogen cycle and many more have been identified in nitrogen cycling organisms that remain to be characterized. Alongside these studies meta-transcriptomic data indicated both known and putative sRNA are expressed in microbial communities and are potentially linked to changes in environmental processes in these habitats. Schleppi and Wessel analyzed the statistical and practical considerations for the design of labeling experiments and also for assessments of natural ^{15}N abundance. According to their findings, the stable isotope ^{15}N is an extremely useful tool for studying the nitrogen (N) cycle of terrestrial ecosystems. Banik et al., conducted a study based on the hypothesis that the combined amendment of biochar and manure could be a better soil amendment than conventional manure application. Manure-biochar treatments significantly increased soil total C, N, and improved soil bulk density. Overall, the manure-biochar application enabled biochar to stabilize the C and N from manure. The authors suggested that biochar could be used to solve N related environmental and agronomic challenges and further improve N use efficiency for sustainable crop production.

All articles published in this Research Topic employed advanced techniques and interesting for the readership of the journal. The Guest Editors of this Research Topic would like to thank all authors, reviewers, and the Editorial team and technical staff of Frontiers in Environmental Science. All of them have collaborated with their great work and involvement in the development of this Research Topic.

AUTHOR CONTRIBUTIONS

MS, RH, RM-E and YW wrote and finally proofed the reading of the document.

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