NARO-MARCO International symposium

on Nitrogen Cycling and Its Environmental Impacts in East Asia

Tsukuba, Nov 19-22 **2018**

International Congress Center
(Epochal Tsukuba)

NARO-MARCO International Symposium
"Nitrogen Cycling and Its Environmental Impacts in East Asia"
— 2nd International Conference of Nitrogen Cycling and Its Environmental Impacts in East Asia —

Date: November 19–22, 2018

Venue: Oral Session & JSSSPN Special Session (Poster Session)
Hall 200 & Room 202, 2nd Floor, International Congress Center (Epochal Tsukuba)
(https://www.epochal.or.jp/eng/index.html)
Takezono 2-20-3, Tsukuba, Ibaraki 305-0032, Japan
Towards INMS Workshop I
Room "Tachibana", 4th Floor, Okura Frontier Hotel <Main Bldg.>
(https://www.okura-tsukuba.co.jp/eng/)
Azuma 1-1364-1, Tsukuba, Ibaraki,305-0031, Japan
Towards INMS Workshop II
Room 202, 2nd Floor, Epochal Tsukuba

Organized by: National Agriculture and Food Research Organization (NARO)
Monsoon Asia Agro-Environmental Research Consortium (MARCO)
Japanese Society of Soil Science and Plant Nutrition (JSSSPN)
Institute of Soil Science, Chinese Academy of Science (CAS)
National Institute for Environmental Studies (NIES)
Japan International Research Center for Agricultural Sciences (JIRCAS)

Supported by: Organizations
- Ministry of Agriculture, Forestry and Fisheries (MAFF)
- Ministry of the Environment
- Ibaraki Prefecture
- Tsukuba City
- National Institute of Advanced Industrial Science and Technology (AIST)
- Forestry and Forest Products Research Institute (FFPRI), Forest Research and Management Organization
- Ibaraki University
- International Nitrogen Initiative (INI)
- International Union of Soil Science (IUSS)
- Japan Society for Atmospheric Environment
- The Institute of Life Cycle Assessment, Japan
- Japanese Society of Soil Physics
- Japanese Society of Biogeochemistry
- Japan Long Term Ecological Research Network (JaLTER)

Projects and activities
- Towards INMS (International Nitrogen Management System)
- International Decade of Soils 2015–2024

Rationale: Nitrogen is a prerequisite for all living things on earth. The remarkable population growth and economic development of the past half century in East Asia have been realized with a large increase in the anthropogenic production and use of "reactive nitrogen" for

supplying food, energy, and other materials. However, negative impacts to the local, regional, and global environments as a consequence of the excessive use of anthropogenic reactive nitrogen have been concerned and the development of appropriate management system of reactive nitrogen has been an urgent issue in East Asia and the world.

The global-scale international project "Towards INMS" which aims at maximizing the benefit and minimizing the threat from the use of reactive nitrogen has been launched for the 4 year period from December 2017, led by the United Nations Environment Program (UNEP) and implemented by the International Nitrogen Initiative (INI). The Towards INMS activities include "Reginal Demonstration in East Asia" which has been started in collaboration with the nitrogen experts from Japan, China, South Korea, and the Philippines. However, much more researchers, policy makers, and all the stakeholders from different areas are necessary and very welcome to voluntarily participate to Towards INMS.

This Symposium will aim at:

- Share the current information and knowledge and exchange opinions between participants on the nitrogen cycling and its environmental impacts in East Asia and the world
- Discuss on the research results and future directions for solving the regional and global scale nitrogen-related problems
- Contribute to Towards INMS project for realizing sustainable nitrogen use through optimization of nitrogen cycling at various scales
- Provide a forum for planning future cooperation reinforcement between participants, organizations, regions, and countries

This Symposium will be held as one of the activities of MARCO which was organized on December 2006 in Tsukuba, Japan, according to the agreement of the participants from 15 countries in Monsoon Asia. Since that, MARCO has promoted international collaboration for advancing research activities on the issues of agriculture and the environment in Monsoon Asia, by hosting a couple of international symposia or workshops every year, setting up a website as a venue for exchanging consortium information, and helping train the people who will carry on activities under the consortium. For more information, visit http://www.naro.affrc.go.jp/archive/niaes/marco/index.html.

This Symposium is also positioned as the "2nd International Conference of Nitrogen Cycling and Its Environmental Impacts in East Asia" to continue the series of International Nitrogen Conference in East Asia, mainly supported by Towards INMS. The first one have been held in Nanjing, China, on October 19–22, 2017; moreover, the preliminary one had also been held in Tsukuba, Japan, on August 23–24, 2016.

This Symposium includes the Special Session (Poster Session) organized by JSSSPN and will contribute to the international activities of the "International Decade of Soils 2015–2024" by the International Union of Soil Science (IUSS).

This Symposium will also contribute to the world wide activities of the UN Sustainable Development Goals (SDGs) in the 2030 Agenda for Sustainable Development.

Website: http://www.naro.affrc.go.jp/english/events/laboratory/niaes/081536.html

Registration: Free of charge for attending the Symposium, Special Session, Towards INMS Workshop, and Scientific Field Excursion. Further information is available in the Symposium website.

Abstracts: All kinds of studies on "Nitrogen Cycling and Its Environmental Impacts" are invited to submit an Abstract in English for Oral or Poster presentation. The template file of Abstract is available in the Symposium website. The dead line of submission of Abstract is October 1st.

Program:

19 Mon	14:00~18:00	Registration open, Poster setting, Icebreaker
	18:00~21:00	Towards INMS Workshop I
20 Tue	9:00~17:00	Opening Session, Keynote Lectures, Oral & Poster Sessions
	17:40~19:00	Towards INMS Workshop II
	19:00~21:00	Social Gathering
21 Wed	9:00~17:20	Keynote Lectures, Oral & Poster Sessions, General Discussion & Wrap-up Session, Closing Remarks
22 Thu	8:00~18:00	Scientific Field Excursion

Keynotes: Prof. Wilfried Winiwarter, International Institute for Applied Systems Analysis (IIASA), Austria
Prof. Xiaoyuan Yan, Institute of Soil Science, CAS, China
Prof. Timothy Jickells, University of East Anglia, UK

Committees: Organizing Committee

Chair Kentaro Hayashi, Institute for Agro-Environmental Sciences, NARO, Japan
Sadao Eguchi, Institute for Agro-Environmental Sciences, NARO, Japan
Hideaki Shibata, Hokkaido University, Japan
Kazuya Nishina, NIES, Japan
Xiaoyuan Yan, Institute of Soil Science, CAS, China
Xiaotang Ju, China Agricultural University, China
Baojing Gu, Zhejian University, China
Tohru Kawamoto, AIST, Japan
Yoshiko Iizumi, JIRCAS, Japan
Masahiro Kobayashi, FFPRI, Japan
Yuko Itoh, FFPRI, Japan
Hisao Kuroda, Ibaraki University, Japan
Xiaolan Lin, Tokyo University of Agriculture and Technology, (TUAT) Japan
Takeshi Gounai, Horticultural Research Institute, Ibaraki Agricultural Center, Japan
Tatsumi Kitamura, Ibaraki Kasumigaura Environmental Science Center, Japan
Seiko Yoshikawa, Institute for Agro-Environmental Sciences, NARO, Japan
Yasuhiro Nakajima, Institute for Agro-Environmental Sciences, NARO, Japan
Kei Asada, Institute for Agro-Environmental Sciences, NARO, Japan
Hikaru Uno, Institute for Agro-Environmental Sciences, NARO, Japan
Saeko Yada, Institute for Agro-Environmental Sciences, NARO, Japan
Nanae Hirano, Institute for Agro-Environmental Sciences, NARO, Japan
Shin-Ichiro Mishima, Institute for Agro-Environmental Sciences, NARO, Japan
Takeshi Tokida, Institute for Agro-Environmental Sciences, NARO, Japan
Yusuke Takata, Institute for Agro-Environmental Sciences, NARO, Japan

Toshiaki Ohkura, Institute for Agro-Environmental Sciences, NARO, Japan
Kaoru Abe, Institute for Agro-Environmental Sciences, NARO, Japan

Scientific Committee

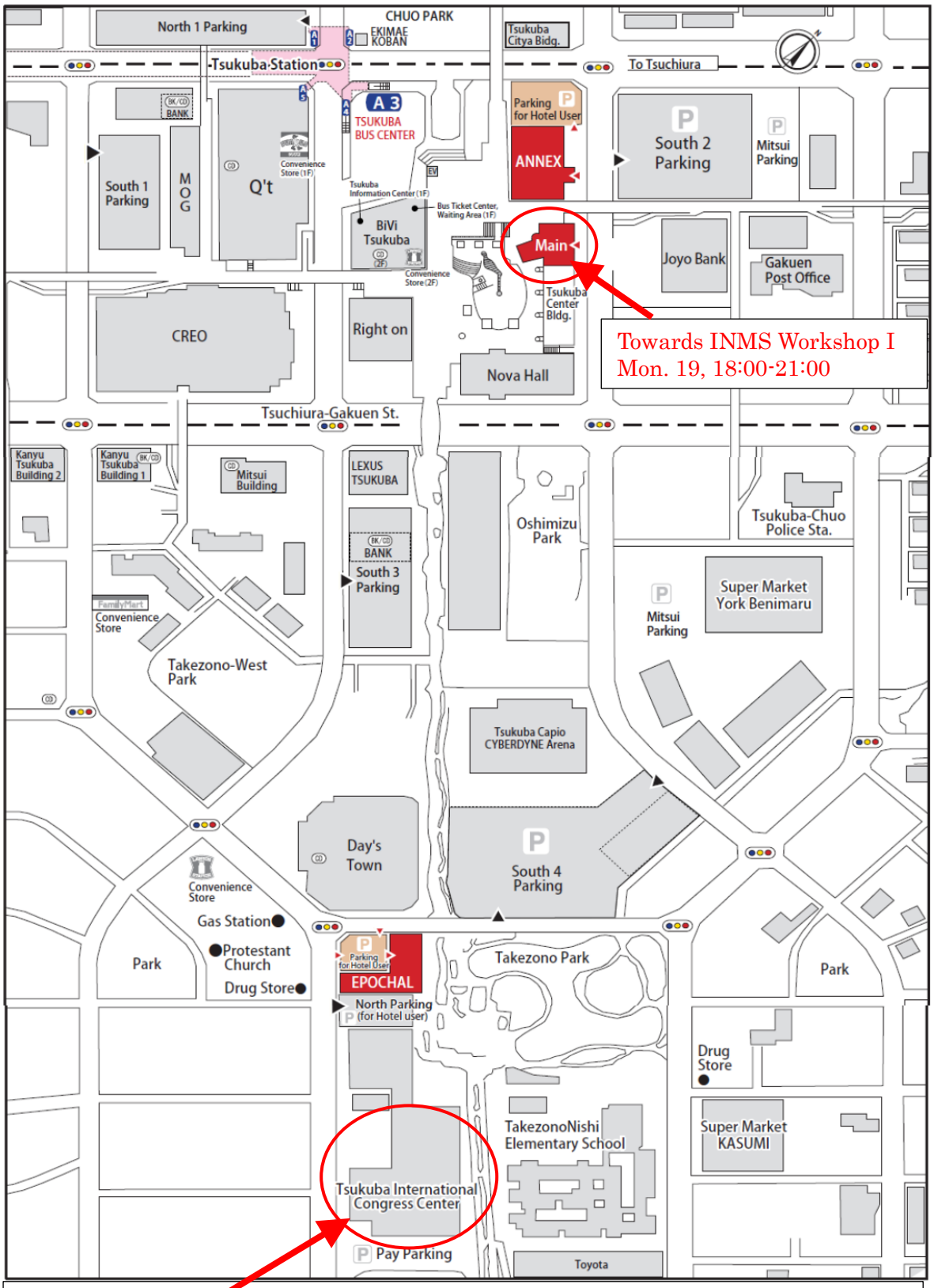
Chair Kazuyuki Inubushi, Chiba University, Japan
Kentaro Hayashi, Institute for Agro-Environmental Sciences, NARO, Japan
Xiaotang Ju, China Agricultural University, China
Xiaoyuan Yan, Institute of Soil Science, CAS, China
Baojing Gu, Zhejian University, China
Yowhan Son, Korea University, Korea
Woo-Kyun Lee, Korea University, Korea
Sadao Eguchi, Institute for Agro-Environmental Sciences, NARO, Japan
Xinyu Guo, Ehime University, Japan
Atsushi Hayakawa, Akita Prefectural University, Japan
Yuhei Hirono, Institute of Fruit Tree and Tea Science, NARO, Japan
Genki Katata, Institute for Global Change Adaptation Science, Ibaraki University, Japan
Koki Maeda, JIRCAS, Japan
Kazuyo Matsubae, Tohoku University, Japan
Kazuhide Matsuda, Tokyo University of Agriculture and Technology, Japan
Akinori Mori, Institute of Livestock and Grassland Science, NARO, Japan
Tetsuya Namba, AIST, Japan
Kazuya Nishina, National Institute for Environmental Studies, Japan
Azusa Oita, Tohoku University, Japan
Hiroki Sasaki, Policy Research Institute, MAFF, Japan
Hideaki Shibata, Hokkaido University, Japan
Junko Shindo, University of Yamanashi, Japan
Eiji Yamasue, Ritsumeikan University, Japan

Conference Overview

Time	19 Mon	20 Tue	21 Wed	22 Thu
8:00 AM		Registration open at Oral Session Hall (Hall 200) during 8:30~16:00 on 20 Nov. Poster set-up at Poster Session Room (Room 202) (Posters are kept put-on the poster panel throughout the Symposium)		Scientific Field Excursion (Bus Tour) Departure: Epochal Tsukuba at 8:00 Visit the Horticultural Research Institute, Ibaraki Agricultural Center at 9:00 (2.5 hrs for lecture and visiting monitoring field) Departure at 11:45 Visit the Tomobe S.A. on the Joban Highway at 11:45 (1 hr for lunch and souvenir) Departure at 12:45 Visit the Ibaraki Kasumigaura Environmental Science Center at 13:30 (2.5 hrs for lecture, exhibision and visiting lotus field) Departure at 16:00 Return to Epochal Tsukuba at 17:00 Please enjoy the taste of food and realize the nitrogen footprint of the agricultural and livestock products of Ibaraki Prefecture!
8:30 AM			*Oral Session Hall (Hall 200) & Poster Session Room (Room 202) open*	
9:00 AM		Opening Session	Oral-13 Dr. Tetsuya Nanba (Japan)	
		Oral-1 (Keynote 1) Prof. Wilfried Winiwarter (Austria)	Oral-14 Dr. Yoko Masuda (Japan)	
		Oral-2 (Keynote 2) Prof. Xiaoyuan Yan (China)	Oral-15 Dr. Abdolmajid Lababpour (Iran)	
10:00 AM			Oral-16 Dr. Parajuli Durga (Japan)	
		Coffee Break	*Coffee Break*	
		Oral-3 Prof. Yowhan Son (South Korea)	Oral-17 Prof. Xuejun Liu (China)	
11:00 AM		Oral-4 Mr. Kiwamu Katagiri (Japan)	Oral-18 Prof. Sheng Zhou (China)	
		Oral-5 Dr. Azusa Oita (Japan)	Oral-19 Dr. Tohru Kawamoto (Japan)	
			Oral-20 Prof. Shenqiang Wang (China)	
12:00 PM		*Group Photo & Lunch Break*	*Lunch Break*	
1:00 PM		JSSSPN Special Session (Poster Session) < Core time for all the poster presenters> (13:00~13:10, Scientific Committee Meeting)	JSSSPN Special Session (Poster Session) (13:30~13:40, Scientific Committee Meeting)	
2:00 PM	Registration open at Poster Session Room (Room 202) 14:00~17:00 on 19 Nov. Poster Set-up (Posters are kept put-on the poster panel throughout the Symposium)	Oral-6 (Keynote 3) Prof. Timothy Jickells (UK)	Oral-21 Mr. Ignacio Santillana (The Philippines)	
		Oral-7 Prof. Gil Jacinto (The Philippines)	Oral-22 Dr. Hiroki Sasaki (Japan)	
3:00 PM		Oral-8 Prof. Woo-Kyun Lee (Korea)	Oral-23 Prof. Baojing Gu (China)	
		Coffee Break	*Coffee Break*	
		Oral-9 Prof. Eric Hobbie (Japan)	General Discussion & Wrap-up	
4:00 PM	*Ice Breaker at Poster Session Room (Room 202)*	Oral-10 Prof. Feng Zhou (China)		
		Oral-11 Dr. Tuong Van Ngoc Hoang (Japan)		
		Oral-12 Dr. Jin Fu (China)		
5:00 PM		*Break*	Closing Session	
6:00 PM	Towards INMS Workshop I "East Asia Demonstration" at the BanquetRoom "Tachibana", 4th Floor, Okura Frontier Hotel <Main Bldg.>	Towards INMS Workshop II "East Asia Demonstration" at the Banquet Room "Tachibana", 4th Floor, Okura Frontier Hotel <Epochal Bldg.>		
7:00 PM		*Social Gathering* *(1F, Restaurant ESPOIR)*		
8:00 PM				

Session 1: Global nitrogen cycling and regional perspective in East Asia (Nov. 20, Tue 9:20-11:50)
Session 2: Nitrogen cycling and human impacts realities across different media and ecosystems (Nov. 20, Tue 14:00-17:00)
Session 3: Reactive nitrogen creation and control by natural processes and human technologies (Nov. 21, Wed 9:00-12:00)
Session 4: Policy challenges for optimizing nitrogen use efficiency towards sustainable production systems (Nov. 21, Wed 14:10-15:10)

AREA GUIDE FOR OKURA FRONTIER HOTEL TSUKUBA



Tsukuba Epochal

NARO-MARCO International Symposium	Mon. 19 14:00 – Wed. 17:20
Towards INMS Workshop II	Tue. 20 17:40-19:00
Meeting Place for Scientific Excursion	Thu. 22 8:00

17.12

NARO-MARCO International Symposium

"Nitrogen Cycling and Its Environmental Impacts in East Asia"

— 2nd International Conference of Nitrogen Cycling and Its Environmental Impacts in East Asia —

PROGRAM

Overview of the Schedule from Monday 19 to Thursday 22 November 2018

Venue:

Oral & Poster Session	Hall 200 (Oral) & Room 202 (Poster), 2nd Floor, International Congress Center (Epochal Tsukuba) Loc. Takezono 2-20-3, Tsukuba, Ibaraki 305-0032, Japan H.P. https://www.epochal.or.jp/eng/index.html
Towards INMS Workshop I	Room "Tachibana", 4th Floor, Okura Frontier Hotel <Main Bldg.> Loc. Takezono 2-20-1, Tsukuba, Ibaraki,305-0032, Japan H.P. https://www.okura-tsukuba.co.jp/eng/
Towards INMS Workshop II	Room 202, 2nd Floor, Epochal Tsukuba

Monday, November 19

Registration

Registration

13:00 *Staff meeting & preparation*

14:00 Registration open at Poster Session Room (Room 202)
Poster set-up (Room 202 is open for browsing Posters during 14:00–21:00 on Nov. 19)

16:00 *Icebreaker at Poster Session Room (Room 202)*

Towards INMS Workshop I

18:00 Towards INMS Workshop I
Room "Tachibana", 4th Floor, Okura Frontier Hotel <Main Bldg.>
Voluntary participation to the Workshop is very welcome!

21:00 *Closing*

Tuesday, November 20

Symposium 1st day

08:00 *Staff meeting & preparation*

08:30 Registration open at Oral Session Hall (Hall 200) during 8:30~16:00

Opening Session

09:00 Opening address
Dr. Makoto Nakatani
Senior Vice-President of NARO, Japan
Greeting from JSSSPN
Prof. Kazuyuki Inubushi
President of JSSSPN, Japan
Greeting from JIRCAS
Dr. Satoshi Tobita
Program Director of JIRCAS, Japan
Congratulatory message from MAFF
Mr. Kazuhiko Shimada
Research Councillor of the Secretariat of AFFRC (Agriculture, Forestry and Fisheries Research Councillor), MAFF, Japan

Session 1: Global nitrogen cycling and regional perspective in East Asia

Moderator: *Kentaro Hayashi, Inst. Agro-Environ. Sci., NARO, Japan*
Baojing Gu, Zhejiang Univ., China

09:20 Oral–1 【Keynote 1】Nitrogen budgets: New insights in environmental transfers of reactive nitrogen compounds
Prof. Wilfried Winiwarter
IIASA, Austria

09:50 Oral–2 【Keynote 2】What determines the fate of nitrogen applied to croplands
Prof. Xiaoyuan Yan
Inst. Soil Sci., CAS, China

10:20 *Coffee Break*

10:50 Oral–3 【Invited】A modeling approach toward estimating the national carbon and nitrogen pools in pinus densiflora forests across South Korea
Prof. Yowhan Son
Korea Univ., South Korea

11:10 Oral–4 Material flow analysis of anthropogenic reactive nitrogen in Japan
Mr. Kiwamu Katagiri
Tohoku Univ., Japan

11:30 Oral–5 Food nitrogen footprints trends and food nitrogen trading in China, India, and Japan
Dr. Azusa Oita
Tohoku Univ., Japan

11:50 *Group Photo & Lunch Break*

13:00~14:00 JSSSPN Special Session (Poster Session)
< Core time for all the poster presenters>

(13:00~13:10, Scientific Committee Meeting)

Session 2: Nitrogen cycling and human impacts realities across different media and ecosystems

Moderator: Xiaotang Ju, China Agric. Univ., China
Hideaki Shibata, Hokkaido Univ., Japan

14:00 Oral–6 【Keynote 3】Atmospheric nitrogen deposition to the oceans
Prof. Timothy Jickells
Univ. of East Anglia, UK

14:30 Oral–7 【Invited】Nutrient loading in episodically hypoxic Manila Bay, Philippines
Prof. Gil Jacinto
Univ. Philippines, The Philippines

14:50 Oral–8 【Invited】Impact of deforestation on total soil nitrogen (TSN) and agro-environmental variables in cropland, North Korea
Prof. Woo-Kyun Lee
Korea Univ., South Korea

15:10 *Coffee Break*

15:40 Oral–9 Does nitrate use control differential sensitivity of ectomycorrhizal fungi to nitrogen deposition? Insights from field and laboratory studies
Prof. Eric Hobbie
Cent. Ecol. Res., Kyoto Univ., Japan

16:00 Oral–10 Improved Jayaweera-Mikkelsen model to quantify ammonia volatilization from rice paddy fields in China
Prof. Feng Zhou
Col. Urban Environ. Sci., Peking Univ., China

16:20 Oral–11 Nitrous oxide emissions from tropical agricultural soil with high ammonium input under aerobic conditions
Dr. Tuong Van Ngoc Hoang
Okayama Univ., Japan

16:40 Oral–12 Importance of subsurface fluxes of water, nitrogen and phosphorus from paddy rice fields relative to surface runoff
Dr. Jin Fu
Peking Univ., China

17:00 *Break*

Towards INMS Workshop II

17:40 Towards INMS Workshop II
Room 202, 2nd Floor, Epochal Tsukuba
Voluntary participation to the Workshop is very welcome!

19:00 *Social Gathering (1F, Restaurant ESPOIR)*

21:00 *Closing*

Wednesday, November 21

Symposium 2nd day

08:00 *Staff meeting & preparation*

08:30 Registration open at Oral Session Hall (Hall 200) during 8:30~16:00

Session 3: Reactive nitrogen creation and control by natural processes and human technologies

Moderator: Yowhan Son, Korea Univ., South Korea
Koki Maeda, JIRCAS, Japan

09:00 Oral–13 Ammonia synthesis by using hydrogen produced from renewable energy
Dr. Tetsuya Nanba
AIST, Japan

09:20 Oral–14 Nitrogen fixing activity of iron reducing bacteria in paddy soils: potent agents for low nitrogen rice production in East Asia
Dr. Yoko Masuda
Univ. Tokyo, Japan

09:40 Oral–15 Estimating the exergy of biocrust nitrogen compounds and its application in the exergetic evaluation of soil restoration technologies
Dr. Abdolmajid Lababpour
Shahaye Hoveizeh Univ. Tech., Iran

10:00 Oral–16 Potential of metal hexacyanoferrates for recovering dissolved ammonia
Dr. Parajuli Durga
AIST, Japan

10:20 *Coffee Break*

10:40 Oral–17 Emission, deposition and air quality impacts of atmospheric reactive nitrogen
Prof. Xuejun Liu
China Agric. Univ., China

11:00 Oral–18 Effects of biochar amendment on vegetable production and its environmental impacts in Shanghai, China
Prof. Sheng Zhou
Eco-Environ. Protec. Res. Inst., SAAS, China

11:20 Oral–19 NH_3 removal at livestock farm with adsorbent for the reduction of NH_3 emission and for the improvement of breeding efficiency
Dr. Tohru Kawamoto
AIST, Japan

11:40 Oral–20 Studies of characteristics of nutrient inputs and nitrogen and phosphorus reduction technologies in orchards in Taihu Lake watershed
Prof. Shenqiang Wang
Inst. Soil Sci., CAS, China

12:00 *Lunch Break*

13:00~14:10 JSSSPN Special Session (Poster Session)
< Core time for all the poster presenters>

(13:30~13:40, Scientific Committee Meeting)

Session 4: Policy challenges for optimizing nitrogen use efficiency towards sustainable production systems

Moderator: *Kazuya Nishina, NIES, Japan*
Morihiro Maeda, Okayama Univ., Japan

14:10 Oral–21 【Invited】Policy formulation and adoption of sustainable sugarcane cultivation system in The Philippines
Mr. Ignacio Santillana
Sugar Regula. Admin., The Philippines

14:30 Oral–22 Evaluating the environmental impact of agricultural policies in Japan: Combination of farm level decision making model and stylized site-specific biophysical model
Dr. Hiroki Sasaki
Policy Res. Inst. MAFF, Japan

14:50 Oral–23 Policy distortions, farm size, and the overuse of agricultural chemicals in China
Prof. Baojing Gu
Zhejiang Univ., China

15:10 *Coffee Break*

General Discussion & Wrap-up

Moderator: *Xiaoyuan Yan, Inst. Soil Sci., CAS, Japan*
Kentaro Hayashi, Inst. Agro-Environ. Sci. NARO, Japan

15:30 General Discussion & Wrap-up

Closing Session

17:00 Closing address
Dr. Hideo Harasawa
Vice-President of NIES, Japan

17:20 *Closing*

Thursday, November 22

Scientific Excursion

Scientific Field Excursion

Understanding nitrogen cycling and its environmental impacts in Ibaraki Prefecture, Japan

08:00 Leaving Epochal Tsukuba

09:00 Horticultural Research Institute, Ibaraki Agricultural Center (2.5 hour stay)
- Lecture on nitrogen use efficiency & nitrogen footprint of agricultural products
- Visiting monitoring field
- Tasting fruit & meat produced in Ibaraki Prefecture

11:45 The Tomobe S.A. on the Joban Highway (1 hour stay)
- Lunch Break & Shopping

13:30 Ibaraki Kasumigaura Environmental Science Center (2.5 hour stay)
- Visiting lotus paddy fields
- Lecture on water use & quality of the Lake Kasumigaura
- Seeing exhibition of the Museum in the Center

17:00 Return to Epochal Tsukuba

Thursday, November 23

Departure of Participants

Note: Shuttle Bus (public transport) from Tsukuba Center Bus Terminal to Narita Airport should be reserved by the day before the departure on the website (http://www.kantetsu.co.jp/bus_reserve/). Or please ask your hotel front desk for the reservation of your Bus. Moreover, you should buy the bus ticket by yourself at Tsukuba Center Bus Terminal.

Have a nice trip!

Monday, November 19 ~ Wednesday, November 22

JSSSPN Special Session (Poster Session)

Note: *For activating the JSSSPN Special Session (Poster Session), the Secretariat of the Symposium is planning to give the **"Best Poster Award"** to one (or more) Poster presenter(s). The Scientific Committee will decide the **"Best Poster Award"** based on the fair discussion, in reference to the voting results from all the participants.*
Please vote for one Poster which you think the best!

P–1 Cancelled

P–2 Preliminary estimation of national nitrogen budget in South Korea: I. Agriculture
Jusub Kim
Department of Environmental Science and Ecological Engineering, Graduate School, Korea Univ., Korea

P–3 Case studies of reusing nitrogen-rich groundwater for crop production by a radiation-controlled low- rate drip irrigation system
Seiko Yoshikawa
Inst. Agro-Environ. Sci., NARO, Japan

P–4 Analysing effectiveness of activities for conserving agro-environment to improve nutrient balances in Korea
Seulbi Lee
Soil and Fertilizer Division, NAS, Korea

P–5 Estimation of nitrogen removal from swine wastewater in activated sludge systems using model simulation
Miyoko Waki
Animal Waste Manage. & Environ. Res. Division, Inst. Livestock & Grassland Sci., NARO, Japan

P–6 Nitrogen fertilization in intensive horticultural systems in China: Challenges and opportunities
Jianbin Zhou
College of Natural Resources and Environment, Northwest A&F Univ. / Key Lab. Plant Nutr. & Agri-Environ. in Northwest China, Ministry of Agriculture, China

P–7 Spatial and temporal variation of anthropogenic nitrogen inputs to the agricultural lands in China
Qinxue Wang
Centre for Regional Environmental Research, NIES, Japan

P–8 Nitrogen use efficiencies of milk and beef productions in Japan
Akinori Mori
Division of Grassland Farming, Inst. Livestock & Grassland Sci., NARO, Japan

P–9 Identification of N_2O producer in dairy manure compost surface
Kouki Maeda
Dairy Res. Div., Natl. Agric. Res. Cent. Hokkaido Region, NARO / Present affiliation: JIRCAS, Japan

P–10 Cancelled

P–11 Changes in nitrogen flows in cultivation and consumption of green tea in Japan
Yuhei Hirono
Division of Tea Research, Institute of Fruit Tree and Tea Science, NARO, Japan

P–12 A study of runoff loads from lotus paddy fields after improvement of agricultural infrastructure
Wataru Iio
Ibaraki Kasumigaura Environmental Science Center, Japan

P–13 Global high-resolution maps of synthetic nitrogen fertilizer use rate applied to cropland during 1961-2014
Qihui Wang
College of Urban and Environment, Peking Univ., China

P–14 Analysis of nitrate dynamics in a nitrogen saturated Japanese cedar and cypress forest using triple oxygen isotopes
Midori Yano
Center for Ecological Research, Kyoto Univ., Japan

P–15 What is the suitable method for extracting NO_2^- from soils? Drawbacks of current methods
Megumi Kuroiwa
Dep. of Biological Sciences, Faculty of Science and Engineering, Chuo Univ., Japan

P–16 Dissimilatory nitrate reduction to ammonium (DNRA) coupled to Fe^{2+} oxidation in the paddy soil
Jinfang Li
Institute of Soil Science, CAS, China

P–17 Role of Microbial Assimilation of Soil NO3- in Reducing Soil NO_3^- Concentration
Yi Cheng
School of Geography Sciences, Nanjing Normal Univ., China

P–18 Identifying groundwater nitrate sources in a rice paddy watershed in Japan: A stable isotopic study
Saeko Yada
Soil, Water and Nutrient Cycle Unit, Inst. Agro-Environ. Sci., NARO, Japan

P–19 Cancelled

P–20 Effects of nitrogen management and straw return on soil organic carbon sequestration and aggregate-associated carbon
Tao Huang
College of Resources and Environmental Sciences, China Agricultural Univ., China

P–21 Application of a process-based nitrogen cycling model: Focused on the Asian monsoon

Youngsun Kim
Department of Land, Water and Environment Research, KICT, Korea

P–22 Cancelled

P–23 Emissions of nitrous oxide (N_2O) from soil surfaces and their historical changes in East Asia: A model-based assessment

Akihiko Ito
NIES, Japan

P–24 Effect of green manure application on nitrous oxide emission in a sugarcane cropland of Okinawa, Japan

Tabito Maeda
Tokyo Univ. of Agriculture and Technology (TUAT), Japan

P–25 Sulfur denitrification in riverbank soils derived from marine sedimentary rocks

Atsushi Hayakawa
Dep. Biological Environment, Fac. Bioresource Science, Akita Prefectural Univ., Japan

P–26 Seasonal variation in soil microbial biomass nitrogen and mineralization activity in a beech forest

Kazumichi Fujii
Forest Soil Division, FFPRI, Forest Res. Manage.Org., Japan

P–27 Examination of analytical method for determining nitrite content in soil

Sadao Eguchi
Div. Biogeochemical Cycles, Inst. Agro-Environ. Sci., NARO (NIAES), Japan

P–28 Cancelled

P–29 Mitigating N_2O emissions from agricultural soils by fungivorous mites

Haoyang Shen
Graduate School of Agricultural and Life Sciences, Univ. Tokyo, Japan

P–30 Survey on clarification of the delay phenomenon of nitrogen leaching from upland fields

Hisao Kuroda
College of Agriculture, Ibaraki Univ., Japan

P–31 The effects of pH and O_2 concentration to the abiotic transformations of NO_2^- in filter-sterilized soil extracts

Naoto Tanaka
Dep. of Biological Sciences, Faculty of Science and Engineering, Chuo Univ., Japan

P–32 Possible sources of ammonium in shallow groundwater of vegetable fields in Central Vietnam

Morihiro Maeda
Graduate School of Environmental and Life Science, Okayama Univ., Japan

P–33 Application of nitrogen removal formula with improved temperature factor

Xiaolan Lin
TUAT, Japan

P–34 Nitrogen removal rate of flooded paddy fields in Japan

Xiaolan Lin
TUAT, Japan

P–35 Relationship between atmospheric reactive nitrogen deposition and plant species loss: A weight-of-evidence investigation

Qun Wang
Department of Life and Environmental Sciences, Univ. of Tsukuba, Japan

P–36 Effects of N deposition and soil nitrogen availability on nitrogen isotope ratio ($\delta^{15}N$) in forest trees in Ibaraki, Japan

Ayumi Tanaka-Oda
Department of Forest Soils, FFPRI, Forest Res. Manage.Org., Japan

P–37 Cancelled

P–38 Regional assessment of nitrogen and sulfur deposition in East Asia using the dry deposition inferential method

Satomi Ban
Japan Environmental Sanitation Center, Japan

P–39 Estimating carbon and nitrogen pools of 70-year-old *Pinus densiflora* forests in central Korea with a forest carbon and nitrogen model

Hyungsub Kim
Department of Environmental Science and Ecological Engineering, Graduate School, Korea Univ., Korea

P–40 Improving denitrification models by including bacterial and periphytic biofilm in a shallow water-sediment system

Yongqiu Xia
Key Laboratory of Soil and Sustainable Agriculture, Inst. Soil Sci., CAS, China
Japan Environmental Sanitation Center, Japan

P–41 Preliminary estimation of national nitrogen budget in South Korea: II. Forest ecosystems

Gwangeun Kim
Dep. of Environ. Sci. & Ecol. Eng., Graduate School, Korea Univ., Korea

P–42 Can N loading mitigate the negative ozone effects on two-species larch seedlings?

Tetsuto Sugai
Graduate School of Agriculture, Hokkaido Univ., Japan

P–43 Dissolved nitrogen dynamics in two forested watersheds with different atmospheric nitrogen inputs in Ibaraki, Japan

Masahiro Kobayashi
FFPRI, Forest Res. Manage. Org., Japan

P–44 Evaluation of ecosystem services related with nitrogen dynamics in Japanese cedar plantations

Yoshiyuki Inagaki
Shikoku Research Center, FFPRI, Forest Res. Manage. Org., Japan

P–45 Composition influence on NH4 adsorption by sodium cobalt hexacyanoferrate (NaCoHCF)
Nan Zhang
School of Life and Environmental Science, Univ. of Tsukuba, Japan

P–46 High Performance Catch & Release Properties of Ammonia Gas at High Temperature by using Cobalt-HCC toward NH_3 recovery technology in N-cycling
Tohru Nakamura
Nanomaterials Research Institute, AIST, Japan

P–47 Ammonium ion recovery system from sewage water for practical application by column-type adsorbent of coper hexacyanoferrate
Hisashi Tanaka
Nanomaterials Research Institute (NMRI), AIST, Japan

P–48 Summary of Japanese reactive nitrogen management policies
Kazuya Nishina
Regional Environmental Research Center, NIES, Japan

P–49 Development of guidance document for the N impact assessment methodology for humans and nature
Hideaki Shibata
Hokkaido Univ., Japan

P–50 Making the guideline of Japanese nitrogen assessment
Kentaro Hayashi
Inst. Agro-Environ. Sci., NARO, Japan

INMS East Asia Regional Demonstration Workshop 2018

Date & Vanue:

Monday 19th November 2018, 18:00–21:00

Room "Tachibana", 4th Floor, Okura Frontier Hotel <Main Bldg.>

(Pick-up micro bus departs from Epochal at 17:45 to the hotel)

Tuesday 20th November 2018, 17:40–19:00

Room 202, 2nd Floor, Epochal Tsukuba

Co-chairs of the East Asia Regional Demonstration, Towards INMS:

Kentaro Hayashi, (Institute for Agro-Environmental Sciences, NARO, Japan)
Xiaoyuan Yan (Institute of Soil Science, CAS, China)

Agenda:

Monday 19th November 2018

18:00–18:30 Introduction of INMS and East Asia Demo (Kentaro Hayashi)

Goal and expected outputs of the workshop (Kentaro Hayashi)

Update in the Marrakesh Meeting in Nov. 2018 (Wilfried Winiwater)

18:30–19:45 Self-introduction (2–3 minutes orally from each participant)

1. Your research field(s) and research interests on nitrogen
2. Your possible contributions to or interactions with East Asia Demo
3. Your Progress regarding INMS (for whom already involved in)

19:45–20:00 Breaking calm before the storm

20:00–21:00 Brainstorming (all participants)

1. International research themes in East Asia
2. Collaborations in East Asia involving other entities
3. Stimulation of research in each country
4. Expansion to other countries in South East Asia
5. Any ideas occurring to you

*Brainstorming might be extended until 21:45 depending on the situation.

Tuesday 20th November 2018

17:40–18:20 Consolidating concrete research themes in East Asia Demo
(Kentaro Hayashi and Xiaoyuan Yan)

18:20–19:00 Convergence and wrapping up (Kentaro Hayashi)

1. Concrete research plan and schedule in East Asia Demo
2. Outputs expected (papers, assessments, and outreaches)
3. Next workshop: when, where, and who organizes
4. Relevant future meetings: INMS-4, N Conference, etc.
5. Any other business

*The summary of the workshop will be presented at "General Discussion & Wrap-up" from 15:30–17:00 on Wednesday 21st November 2018

November 20, Tue 9:20-11:50

Session 1:
Global nitrogen cycling and regional perspective in East Asia

Nitrogen budgets: New insights in environmental transfers of reactive nitrogen compounds

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[2] Institute of Environmental Engineering, University of Zielona Góra, Poland

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ABSTRACT

INMS is a global project towards an International Nitrogen Management System. Its main aim is to assess environmental impacts of nitrogen compounds and to investigate pathways to minimize such impacts. Tools are provided that can be implemented on very different spatial and temporal levels, and on diverse parts of the globe, taking advantage of highly developed infrastructure in some areas or supporting the advancement of remotely operating or simply implementable systems that allow quantification and verification of nitrogen flows and impacts. One key activity towards quantification takes advantage of national nitrogen budgets. Statistical parameters typically available on a country level are the key inputs to quantify nitrogen stocks and flows in environmental pools. Based on a consistent and transparent methodology, comparison between sectors, countries, but also between years can be implemented. Most interestingly, redundancy of information by assessing the identical flows using information about different pools will identify limits in the general understanding of environmental behavior of nitrogen compounds. Examples of comparisons between different countries, and of highly dynamic behavior involving temporary stock changes in the environment will demonstrate the strengths of this methodology to trace nitrogen related processes and identify the responsible release points. With successful implementation on a country scale, investigation of other scales (regional/urban; institutional) may receive further interest.

Keywords: nitrogen budgets, nitrogen pools, stock-flow modelling, policy support

What determines the fate of nitrogen applied to croplands

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ABSTRACT

The main factors affecting the loss, legacy and uptake of nitrogen applied to cropland are discussed.

A modeling approach toward estimating the national carbon and nitrogen pools in *Pinus densiflora* forests across South Korea

Hyungsub Kim[1,※], Jongyeol Lee[2], Seongjun Kim[2], Seung Hyun Han[1], Yowhan Son[1,*]

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ABSTRACT

Forests are important carbon (C) and nitrogen (N) pools among terrestrial ecosystems, and C and N cycles are tightly connected. As *Pinus densiflora* comprises more than 23% (1,785,600 ha) of South Korean forestlands, understanding C and N cycles of the species is important. Therefore, this study aimed to quantify C and N pools of *P. densiflora* forests across South Korea from 1950 to 2015 using IFCANC (Integrated Forest CArbon and Nitrogen Cycle) model, which simulates C and N pools. The simulation units covered 1,116 of 4,271 NFI (National Forest Inventory) plots, where the major species is *P. densiflora*, and each unit represented a forest of 1600 ha. The national scale dataset including temperature, precipitation, net radiation, N deposition, and soil texture were utilized to consider the spatial variation among the units. In addition, each unit was initialized by spin-up process with clear-cut scenario. The simulated total C and N pools by the IFCANC model were 222 Tg C and 6.00 Tg N, respectively. The simulated C pools (124.34 Mg C ha^{-1}) were higher than the NFI data (106.10 Mg C ha^{-1}), yet the simulated N pools (3.36 Mg N ha^{-1}) were lower than the NFI data (5.91 Mg N ha^{-1}). The simulated C and N pools decreased during the first 17 years representing C and N sources (-0.02 Mg C ha^{-1} yr^{-1} and -6.17 kg N ha^{-1} yr^{-1}, respectively). After the first 17 years, the *P. densiflora* forests turned into C and N sinks (1.23 Mg C ha^{-1} yr^{-1} and 4.6 kg N ha^{-1} yr^{-1}, respectively) due to the successful reforestation. This study could contribute to reporting the national C and N pools and to assessing C and N status in South Korean forests.

Keywords: forest carbon and nitrogen, IFCANC model, National Forest Inventory, Korean red pine

Acknowledgement: This study was supported by Ministry of Environment (2014001310008) and Korea Forest Service (2017044B10-1819-BB01).

Material flow analysis of anthropogenic reactive nitrogen in Japan

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ABSTRACT

Reactive nitrogen (Nr) used for economic activities initially takes a form of ammonia (NH_3-N), and is ever-present in our daily lives, not only as fertilizers, but also as chemical products. Under the Paris agreement, demand for ammonia used, for example, for light emitting diodes (LEDs) and as a carrier of hydrogen, is increasing in a transition to a low carbon society. It is necessary to understand features and trends of ammonia and downstream Nr demand for analyzing their impacts in the future. The purpose of this study is to understand characteristics and changes in Nr demand with future economic and technical trends in Japan. Material flow analysis (MFA) was used to examine changes in flows of Nr over time.

The main results of our Nr flow analysis are as follows: 898 Gg-N (Gg = 10^9 g; 2005) and 775 Gg-N (2015) from food & feed to household use; 632 Gg-N (2005) and 500 Gg-N (2015) of fertilizer; and 28.6 Gg-N (2005) and 68.3 Gg-N (2015) of recoveries from sewage sludge to fertilizer respectively. The Nr flows related to food and feed, chemical industry, and fertilizers decreased from 2005 to 2015 (food and feed 13%, chemical industry 26%, and fertilizer 7%). In spite of downturn in Nr demand in chemical industry, industrial usage (884 Gg-N in 2005 to 623 Gg-N in 2015; e.g., chemical products) still accounts for more than 50% of the total NH_3-N demand in Japan (1,262 Gg-N in 2005 and 958 Gg-N in 2015), which is much higher than its global share of 20%. Interestingly, the NH_3-N flow to the semiconductor industry accounted for 0.21%, 0.57% and 1.03% of the industrial use in 2005, 2011, and 2015 respectively. In the future, management of NH_3-N will be even more essential in controlling the Nr flows.

Keywords: reactive nitrogen, industry, material flow analysis, ammonia

Food nitrogen footprints trends and food nitrogen trading in China, India, and Japan

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ABSTRACT

Food production and consumption has many environmental impacts, including nitrogen (N) pollution and the emission of reactive N (Nr; all N species except inert gas of N_2). Food consumption patterns change over time with dietary changes associated with economic development and urbanization. The N footprint is an indicator to quantify how much both virtual and real Nr is emitted to the environment as a result of resource consumption. In this study, we use statistical data and literature to examine the food N footprints of China, India, and Japan from 1961 to 2013 in relation to the changing diet of these three different food cultures in South and East Asia. Our preliminary results of the per capita annual N footprint analysis reveal significant differences between the three countries. The fluctuation and significant rise of the N footprint in China (6.3–7.0 kg-N in 1960s and 1970s to 29.3 kg-N in 2013) is due to the higher consumption of pig and poultry meat and vegetables. The N footprint of India, a country with a large population of vegetarians, slightly increased from 1960s (avg. 11.5 kg-N) to 1980s (avg. 12.6 kg-N) due to the rise in milk, fish and seafood consumption and has been fluctuating since the 1990s (12.6–13.6 kg-N). Japan's N footprint showed a gradual increase from 1960s (avg. 10.7 kg-N), through the 1980s (avg. 14.4 kg-N), and peaked in 1995 (16.4 kg-N) before gradually declining and becoming steady (avg. 15.2 kg-N) as the consumption of fish and seafood increased and then declined along with a constant increase in the consumption of meat. The food N trading of major food items was analysed to provide an overview of in-country and abroad Nr emissions. The overall analysis contributes to a better understanding of the food N footprint in China, India and Japan.

Keywords: virtual nitrogen, food consumption, food trade, nitrogen management, South and East Asia

November 20, Tue 14:00-17:00

Session 2:
Nitrogen cycling and human impacts realities across different media and ecosystems

Atmospheric nitrogen Deposition to the oceans

Tim Jickells [1,*] on behalf of GESAMP WG 38

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ABSTRACT

In this talk I will report the work done by GESAMP WG 38 (an INMS partner) on estimating atmospheric fixed nitrogen deposition to the oceans and their impact. I will consider global emission estimates and also estimates of atmospheric fixed nitrogen deposition to the oceans. I will then compare these atmospheric fluxes to those from rivers and biological nitrogen fixation and consider the effects of this deposition on ocean biogeochemistry. In addition to this global perspective, I will consider in the talk the area of south-east Asia particularly – a region of high N emissions and deposition where impacts of this nitrogen deposition are being reported.

Nutrient Loading in Episodically Hypoxic Manila Bay, Philippines

Lara Patricia Sotto[1], Gil S. Jacinto[1,*], Arthur Beusen[2], Lex Bouwman[2], Cesar Villanoy[1], Mark Clutario[3]

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ABSTRACT

Manila Bay is a major port area adjacent to the megacity of Metro Manila, Philippines. The bay receives the discharge from 4 major sub-watersheds with an aggregate area of about 19,000 km2 and manifests eutrophic and episodic hypoxic conditions. We share results of a study that used a grid-based scaled down version of the global nutrient export from watersheds (Global NEWS) model, statistical data, land use maps, and coefficients to calculate the nutrient loads from the watershed. As much as 66% of the total nitrogen (TN) and 59% of total phosphorus (TP) loading into Manila Bay are derived from point or domestic sources while agriculture accounts for 22% of TN and 30% of TP. Densely populated provinces contributed the majority of the domestic waste load while the rural provinces that are associated with agricultural activities contributed most of the nutrient loads from agriculture. Three major aspects of the nutrient loading problem were tested in the scenario building forecasts: sewage connections and treatment, population growth rates, and phosphorus content regulation in detergents. With the continued high population growth (driven principally by migration into Metro Manila), nutrient loading from the domestic sector will continue to increase. Sewage treatment will help decrease the nutrient load, but tertiary treatment may be required for a significant decrease. However, in the short term, a ban on phosphorus content in detergents could help decrease loads by almost as much as tertiary treatment, albeit at a lesser cost. The tool used in this study provided a relatively quick way to assess the contributions of nutrient sources and to build scenarios and consider options that may be useful for policymakers and management bodies.

Keywords: Global NEWS, sewage, detergents, nitrogen, phosphorus

Impact of deforestation on total soil nitrogen (TSN) and agro-environmental variables in cropland, North Korea

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ABSTRACT

Deforestation in North Korea (PDRK) is becoming synonymous with the environmental change occurring on the Korean Peninsula. The North Korean government has been converting forests mostly to cropland, and understanding this process necessitates research on deforestation with a focus on croplands. Through this research, we estimate the agro-environmental variables of North Korea's total croplands using a GEPIC (GIS based EPIC) model to analyze three land cover types over the past 30 years. To identify changes in the quality of agriculture, Total Soil Nitrogen (TSN), organic carbon loss, and root zone soil water were studied as the agro-environmental variables having an impact on crop productivity. Wind erosion, water erosion, and runoff were selected as the agro-environmental variables having an impact on cropland stability. Using land cover maps that cover the past three decades, it was found that 75 % of the forests converted became cropland, and that 69 % of all converted cropland came from forests. This confirmed that there exists a significant correlation between deforestation and cropland expansion in North Korea. The agro-environmental variables for the past 30 years clearly demonstrate a decrease in TSN, and that wind erosion has had a significant impact on crops. The other variables, however, were better explained as a result of spatial differences rather than impacts from climate change or differences in crops. A quantitative comparison of the converted cropland expanded through deforestation, with the original cropland, revealed a definite negative change in organic carbon loss, water erosion, and runoff regardless of crops. The reason for such a change might be attributable to the topographical characteristics of cropland converted from forests. In terms of nitrogen and soil carbon, TSN decreased with climate change, and organic carbon decreased attributable to deforestation. In addition, TSN and organic carbon could be further reduced by increase in runoff and soil erosion. In other words, two variables related to agriculture nutrition are being reduced by climate and land use change, which could have a direct impact on crop productivity.

Keywords: deforestation, total soil nitrogen (TSN), ago-environmental variables in cropland, cropland expansion, GEPIC

Acknowledgement: This study was supported by Ministry of Environment (2014001310008) and Korea Forest Service (2017044B10-1819-BB01).

Does nitrate use control differential sensitivity of ectomycorrhizal fungi to nitrogen deposition? Insights from field and laboratory studies

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ABSTRACT

Both nitrogen (N) fertilization experiments and laboratory studies can provide insights into responses of natural ecosystems experiencing heavy N deposition. Responses of temperate and boreal forests to N deposition are often mediated through symbiotic (ectomycorrhizal) fungi, although causes of differential sensitivity of fungal taxa are poorly understood. Here, we assessed how nitrogen (N) availability affected ectomycorrhizal functioning in two long-term (6-40 years) N addition experiments in *Pinus sylvestris* stands in Sweden. Sporocarp production declined dramatically with N fertilization but recovered slowly after fertilization stopped, with taxa with proteolytic capabilities particularly sensitive. Both sporocarp C/N and soil C/N increased with fertilization, implying that N uptake per unit fungal growth increased and then declined after fertilization had stopped. Fungal and soil $\delta^{15}N$ patterns across treatments identified fungal N sources, with N acquisition primarily from the S horizon for *Paxillus involutus* and *Suillus variegatus*, from the F horizon for four *Cortinarius* taxa and *Lactarius rufus*, and from the H horizon for *Cortinarius traganus* and *Russula aeruginea*. Laboratory studies with ectomycorrhizal *Pinus sylvestris* supplied with ammonium, nitrate, or ammonium nitrate at low or high N availability suggested that taxa sensitive to N deposition may have limited ability to assimilate nitrate and their supply of carbon (C) from host plants is consequently reduced. These analyses illustrated that responses of fungal taxa across these fertilization gradients partially depended on the horizon of N acquisition and on N acquisition strategies, and we propose that one fungal mechanism of differential sensitivity to N deposition is the variable capability of taxa to use supplied nitrate and resulting consequences for plant C supply.

Keywords: ectomycorrhizal fungi, nitrogen deposition, sensitivity, nitrogen isotopes, species responses

Improved Jayaweera-Mikkelsen model to quantify ammonia volatilization from rice paddy fields in China

Xiaoying Zhan[1], Chuan Chen[2], Kentaro Hayashi[3], Xiaotang Ju[4], Shu Kee Lam[5], Yonghua Wang[1], Qihui Wang[1], Yali Wu[1], Jin Fu[1], Feng Zhou[1,*]

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ABSTRACT

Current estimates of China's ammonia (NH_3) volatilization from paddy rice differ by more than two-fold, mainly due to inappropriate application of chamber-based measurements and improper assumptions within process-based models. Here we improved Jayaweera-Mikkelsen model through modifying the concentration of aqueous NH_3 in ponded water by an activity coefficient. The validity of improved model was supported by high-frequency observations from six experimental stations across China. We then attributed inter-model spreads arising from different approaches of NH_3 volatilization loss from the experimental sites and nationalwide. We found that the improved model could reduce the deviation from ideal behavior of aqueous NH_3 and reasonably capture the fluxes of NH_3 transfer across water-air interface. On average, nationwide NH_3 volatilization from rice paddy fields accounted for 10.9% of the fertilizer N applied under current farm practices, which was less than chamber-based estimations (16.0-21.1%) and process-based model simulation (13.3%). Difference in wind speed between the inside and outside of the chamber and insufficient sampling frequency were identified as the primary and secondary causes for the overestimation in chamber-based estimations, respectively. The overestimations in previous model simulation mainly originated from exaggerated activity of aqueous NH_3. Together our findings suggest that in-depth understanding of NH_3 transfer process and its robust representation in models are critical for developing emission inventories and practical mitigation strategy of NH_3.

Keywords: Jayaweera-Mikkelsen model, nitrogen, dynamic chamber, model simulation, cropland

Nitrous oxide emissions from tropical agricultural soil with high ammonium input under aerobic conditions

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ABSTRACT

Increasing use of nitrogen (N) fertilizer and compost to maximize crop yields in farming systems resulted in increasing N losses through nitrous oxide (N_2O) emissions. Most of the previous studies have been conducted at temperature between 5-25℃ at low N application rates under anaerobic conditions. Nitrous oxide emissions from tropical agricultural soil may be associated with high temperature. Our studies were designed to determine interactive effects of high N application rates in different forms, NH_4^+ and compost, and temperature on N_2O emissions from tropical agricultural soil under aerobic conditions over 28 days. Their interactions in tropical areas are very important and will provide useful information on N management for tropical agriculture. Five-grams of air-dried soil, collected from a vegetable cropping field site in Vietnam, were adjusted to 0, 400, 800, 1200 mg NH_4^+-N kg^{-1} as $(NH_4)_2SO_4$ or amended with 1%, 2% and 4% commercial compost (NH_4^+ added) / chicken compost at 60% water holding capacity were aerobically incubated at 25℃, 30℃ or 35℃ for 28 days. Mineral N contents and N_2O emission rates were determined on days 1, 3, 5, 7, 14, 21 and 28. Nitrous oxide emissions were from autotrophic nitrification, nitrifier denitrification and/or coupled nitrification-denitrification. Cumulative N_2O emissions were significantly affected by N input sources, N application rates and temperature. Cumulative N_2O emissions for 28 days increased with increasing NH_4^+ application rates between 0-800 mg N kg^{-1} or 1-2% (329-694 mg NH_4^+-N kg^{-1}) commercial compost and then decreased to 1200 mg N kg^{-1} or 4% (1386 mg NH_4^+-N kg^{-1}) commercial compost. On the other hand, cumulative N_2O emissions were exponentially correlated with increasing 1-4% (30-120 mg N kg^{-1}) chicken compost for 28 days. In terms of temperature, the lowest cumulative N_2O emissions were observed at 35℃ in NH_4^+ and commercial compost treatments while those occurred at 30℃ in chicken compost treatments. In conclusion, N_2O emissions were not exponentially correlated with high N input and temperature. Higher N input at higher temperature would suppress N_2O emissions.

Keywords: agricultural soil, high N input, interactive effects, nitrous oxide, temperature dependence.

Importance of subsurface fluxes of water, nitrogen and phosphorus from paddy rice fields relative to surface runoff

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ABSTRACT

Rice paddy fields pose a high risk of water pollutions for the surrounding waterbodies through surface runoff and subsurface fluxes. Compared to surface runoff, subsurface fluxes from rice paddy fields has received less attention and is still poorly quantified, mainly due to low-frequency measurements at field scale and limited modeling capability at regional scale. Here we proposed a simplified modeling approach to estimate the subsurface fluxes of water, nitrogen (N) and phosphorus (P) from rice paddy fields, examined their relative importance compared to surface runoff, and extended previous field-scale evidences in a limited sites to a regional biogeochemical paradigm. Based on high-frequency field measurements in Central China and extended datasets across East Asia, our results reveal that subsurface fluxes from rice paddy fields was underrated in previous studies, and were comparable with surface fluxes across East Asia. Their relevant importance was primarily controlled by the magnitude of seasonal precipitation. Subsurface fluxes were the dominant pathway of nutrient losses in xeric rice cropping areas, while surface runoff was the more important process in mesic areas. In the light of the regional differences, we suggest that a spatially flexible set of policies for mitigating nutrient losses from rice paddy fields would be beneficial for the future water-quality improvements in the surrounding waterbodies.

Keywords: nitrogen cycle, leaching, seepage, surface runoff, paddy rice, hydro-climatic condition

November 21, Wed 9:00-12:00

Session 3:
Reactive nitrogen creation and control by natural processes and human technologies

Ammonia synthesis by using hydrogen produced form renewable energy

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ABSTRACT

The synthesized ammonia is one of the starting materials of the nitrogen cycle. Ammonia has been synthesized by Haber–Bosch process. In this process, H_2 is generated from reforming of fossil fuels, so that CO_2 is formed accompanying with NH_3 production. Recently, CO_2-free NH_3 synthesis is of interest, that is, hydrogen is generated from water electrolysis by using renewable energy. On the other hand, utilization of renewable energy results in the supply of H_2 having fluctuating flow rate and ambient temperature and pressure. These conditions for H_2 supply are quite different from the condition in the Haber-Bosch process. Since H_2 is formed from reforming of fossil fuels in Haber-Bosch process, high temperature and pressure H_2 with constant flow rate is obtained. We developed catalyst and process for the usage of the renewable H_2. The concepts of development of process and catalyst are to make possible to operate under various condition according to the fluctuating H_2 supply and to achieve high activities at lower temperature and pressure than HB process, respectively. We have constructed the demonstration plant of the ammonia synthesis from the renewable H_2.

Keywords: Ammonia, Renewable energy, Hydrogen, Catalysts, Demonstration plant

Nitrogen fixing activity of iron reducing bacteria in paddy soils: Potent agents for low nitrogen rice production in East Asia

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ABSTRACT

Japanese farmers' oral tradition says, "Wheat is harvested from fertilizer, while rice is harvested from soil fertility". In fact, good rice growths in non-N fertilized plots are observed in long-term experimental fields all over Japan. Microbial nitrogen fixation greatly contributes to the sustainable nitrogen fertility of rice paddy soils. As the major nitrogen fixers (diazotrophs), phototrophic *Cyanobacteria* and rhizospheric *Alpha-, Beta-,* and *Gammaproteobacteria* have long been studied since early 1900s.

Here, we report predominant but previously-overlooked other diazotrophs found in rice paddy soils. To investigate the diversity of diazotrophs in rice paddy soils, we performed metatranscriptomic analysis using RNA extracted from the soils. As a result, most of the sequences of nitrogen fixation gene (*nif*) transcripts were, surprisingly, derived from *Deltaproteobacteria*, particularly the genera *Anaeromyxobacter* and *Geobacter*, known as iron-reducing bacteria predominated in rice paddy soils. In addition, our *in silico* analysis of soil metagenomic data revealed the ubiquitous presence in various soils of *nif* genes derived from *Anaeromyxobacter* and *Geobacter*. These previously-overlooked diazotrophs could be important drivers of nitrogen fixation not only in rice paddy soils but also other soil environments. However, nitrogen fixing ability of *Anaeromyxobacter* spp. has not been confirmed yet. Therefore, we proved nitrogen-fixing ability of *Anaeromyxobacter* PSR-1 using acetylene reduction assey. As a result, we found that *Anaeromyxobacter* PSR-1. shows high activity of nitrogen fixation in the presence of ammonium at the same or lower level as actual paddy field soils. Its activity of nitrogen fixation was also high in the presence of Fe^{3+} (electron acceptor) at even lower concentration than actual paddy field soils.

Our study provides novel insights into the ecological function of *Anaeromyxobacter* and *Geobacter*, previously considered as iron reducing bacteria, in rice paddy soils and other soil environments. Our findings will contribute to achieve low nitrogen rice production in East Asia.

Keywords: metatranscriptome, metagenome, rice paddy soils, iron-reducing bacteria, nitrogen fixatio

Estimating the exergy of biocrust nitrogen compounds and its application in the exergetic evaluation of soil restoration technologies

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ABSTRACT

Exergy analysis is a powerful diagnostic tool in the evaluation of systems performance both in industrial and environmental assessment. The aim of this study is to present a methodology to calculate the exergy of biocrust nitrogen compounds (NH_3, N_2, N_2O, NO, NO_3, NO_2 and NH_4) widely contribute in nitrogen cycling of soils, agricultural activities, soil restoration technologies and soil thermo-economics. As the biocrust nitrogen compounds are in a complex cycling system, it is necessary to take into account the partial molar Gibbs property of the constituents in the chemical exergy calculation. Adopting the reference environment proposed by literatures, the physical and chemical exergy of pure nitrogen compounds as well as the actual exergy of the various soil nitrogen compounds were obtained. A soil nitrogen budget for exergy calculations and the role of cyanobacteria in nitrogen fixation of our study was based on the thermodynamics tables and data collected across several studies. Results are reported in the temperature range between 5 and 70°C with 5°C intervals. The results may be widely varied for nitrogen species. This fact is partly due to different dead state reference systems can be adopted to calculate exergy. The obtained exergy results could be useful for further understanding of restoration technologies especially in the world's fast growing arid lands. Considerable future work will be required to elucidate a comprehensive perspectives regarding microbial biomass that exists in the soil inside active, dormant, or deceased microbial species and how these different potential fractions may influence nitrogen availability, soil quality, agricultural productivity, and, ultimately, nitrogen cycling.

Keywords: soil nitrogen, chemical exergy, nitrogen fixing, soil restoration, cyanobacteria.

Potential of metal hexacyanoferrates for recovering dissolved ammonia

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ABSTRACT

It is noteworthy that total ammonia emission has been more than double since 1860 to 1993, and may double by 2050. Main sources of ammonia release are livestock waste (39%), industrial source (19%), fertilizer volatilization (17%), biomass burning (13%), natural source (7%), and others (5%). While most of the ammonia in the atmosphere is washed down with rain, excess of it in air is responsible for the particulate materials (PM2.5: $(NH_4)_2SO_4$ 60%, NH_4NO_3 40%). The dissolved ammonia (combined NH_4^+ and NH_3) is also problematic as the acceptable index of it in drinking water set by WHO is 1.5 mg/l, and is even lower, 0.5 mg/l, in many countries. With the basic principle of adsorption of monovalent cation by ion exchange with higher preference for those possessing ionic radius closer to the effective radius of the complex determined by the lattice parameter, metal hexacyanoferrates (MHCF) offer strong selectivity towards Cs^+ ion. Since the radii of hydrated Cs^+, Rb^+, K^+ and NH_4^+ are closer enough (3.29, 3.29, 3.31, 3.31 Å, respectively), the size-based adsorption model supports substantial adsorption of NH_4+ as well. Therefore, a number of MHCFs were tested for their ammonia adsorption behaviour in aqueous solution. Among these, was studied in detail for its application on capturing dissolved ammonia from, for example, irrigation water or the sewage system.

Adsorption test of dissolved ammonia on CuHCF nanopowder was carried out at pH range of 2-10. With 5 mmol/l initial concentration, gradual increase in the amount of adsorption was observed up to pH 9. At pH 10 and higher, a distinct drop was observed because of the sharp drop in the concentration of ammonium ion. Desorption of ammonia adsorbed onto CuHCF was carried out with 1 mol/l KCl solution. Results show the regeneration of the starting material assuring the multiple adsorption-desorption cycles.

Keywords: metal hexacyanoferrate, dissolved ammonia, adsorption, desorption

Emission, deposition and air quality effects of atmospheric reactive nitrogen

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ABSTRACT

Atmospheric reactive Nitrogen (Nr) has induced large impacts on air pollution and ecosystem health worldwide. Emission and deposition of atmospheric Nr have largely increased in China since 1980 due to rapid agricultural, industrial and urban development. But scientific gaps still remain in the regional and temporal variability in atmospheric Nr emission and deposition as well as their air quality effects. To date, the environmental and human health impacts of atmospheric Nr pollution and deposition are of great concern in China. This paper overviews the status of anthropogenic Nr emission and deposition and their linkages to air pollution. The major findings include two aspects: (1) anthropogenic atmospheric Nr (e.g. NH_3 and NO_x) emissions contribute greatly to secondary inorganic aerosol formation and haze pollution; (2) dry Nr deposition is comparable in importance to wet Nr deposition, suggesting that both dry and wet deposition should be quantified simultaneously; (3) measures to improve urban and rural air quality must consider the mitigation of atmospheric Nr species in particular NH_3 which is mainly emitted from agricultural sources like fertilizer application and livestock sector. Future research challenges on atmospheric Nr emission and deposition are discussed as well. China needs to (1) reduce the uncertainties of national emission inventory of various Nr species, especially organic Nr compounds; (2) establish complete national networks for atmospheric Nr concentration and deposition monitoring; and (3) evaluate eco-environmental and health impacts of Nr pollution and deposition in typical ecosystems. Last but not least, Nr deposition modeling tools should be improved and used fully, based on localized parameters and future N regulation.

Keywords: Anthropogenic Nr emission, dry and wet deposition, monitoring networks, spatial-temporal variation, air pollution effects, China

Effects of biochar amendment on vegetable production and its environmental impacts in Shanghai, China

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ABSTRACT

A field trial was carried out in an experimental field that located in the south of Shanghai, China. The aims were to investigate the effects of biochar on vegetable production and its environmental impacts. Soil in the plots was incorporated with straw biochar at four different rates: 0 t hm^{-2}, 10 t hm^{-2}, 20 t hm^{-2} and 40 t hm^{-2}. The treatments were designated CK (control without biochar), C10, C20 and C40. Each of the four treatments was repeated by three replicates. Compound fertilizer was broadcast evenly on the soil surface in each plot before vegetable transplanting. The experimental vegetable of lettuce was transplanted in April 2018. The additional urea fertilizer was applying after two weeks of vegetable growing. During the experiment period, the vegetable yields and plant height were recorded. The GHGs were collected after irrigation and fertilization while infiltration water samples were collected two or three times during the period of planting. The properties of EC, DOC, DN, NO_3^-, NH_4^+ and DP concentrations in the water samples were detected. Soils were sampled before planting and after harvesting, and key chemical properties were investigated.

There was no significant difference of lettuce yields among all treatments. The accumulated N_2O emissions in C10 and C20 treatments were lower than those in CK and C40. The soil organic carbon contents, total nitrogen contents, EC, rapidly available K and rapidly available P increased with biochar amendment, while the soil pH and DOC were similar among all the treatments. The NO_3^- and NH_4^+ concentrations in the water samples of leachate decreased with the biochar amendment compared with the CK. The results showed that 10～20 t hm^{-2} biochar incorporation could be served as an appropriate amendment for mitigating GHGs emissions and reducing nitrogen loss through vertical infiltration.

Keywords: biochar, greenhouse gases, infiltration, methane, nitrous oxide

NH_3 removal at livestock farm with adsorbent for the reduction of NH_3 emission and for the improvement of breeding efficiency

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ABSTRACT

Ammonia, NH_3, known as a precursor of PM2.5, is mainly emitted from agricultural sector to air. Livestock farm has a large contribution in the NH_3 emission. In addition, the odor problem of NH_3 is also often serious. Ammonia generated at livestock barns and composting facilities is usually released by air ventilation, but the method often affects negatively to the growth of the livestock due to the difficulty of temperature control in the barn. On the other hand, if the NH_3-emission into air is stopped, the high concentration of NH_3 in the barn would have a bad influence on the livestock growth.

To solve the problem, we are developing a new NH_3-removal technology with adsorbent. The new adsorbent has been developed by the modification of Prussian blue, one of the porous coordination polymers. The adsorbent can adsorb NH_3 even from trace NH_3-contaminated air less than 1 ppmv. With the technology, we aim not only the reduction of NH_3 concentration in the barn without the NH_3emission, but also the improvement the breeding environment to raise the production efficiency. In this talk, we introduce our concept, and the result of the NH_3 removal in the barn and from the exhaust gas of a composting facility.

Figure NH_3 adsorbent for livestock farm

This study was partly supported by grants from the Project of the NARO Bioriented Technology Research Advancement Institution (the special scheme project on regional developing strategy).

Keywords: ammonia, livestock farm, adsorbent, Prussian blue

Studies of characteristics of nutrient inputs and nitrogen and phosphorus reduction technologies in orchards in Taihu Lake Watershed

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ABSTRACT

Both literature and questionnaire surveys (farmer interview) were used to analyze the characteristics of orchard nutrient inputs, and the typical orchard soil samples were also collected to evaluate soil fertility status in surrounding five towns in Taihu Lake Watershed. The results showed that the average rates of total N, P and K application were N 522、P_2O_5 674 and K_2O 462 kg· hm^{-2}, respectively, in orchard in Taihu Lake Watershed. About nutrient inputs, organic fertilizer accounted for 51.3%、58.3% and 44.0% of total N, P and K application, respectively. The contents of organic matter, total N, P and K were at levels ranging from appropriate to very rich. Available P and K contents were generally at a rich level. The average amounts of N, P and K surplus were as high as N 320、P_2O_5 42 and K_2O 108 kg·hm^{-2}, respectively. Over the 2-year observation period, the N_2O emission factor averaged 1.69%, 1.32% and 1.86% and the NO emission factor averaged 0.03%, 0.27% and 0.17% under OF, CF and OF + CF treatment, respectively. Such results indicated that fertilized peach orchard soil in the Taihu region is an important source of N_2O emissions. In addition, sown grass and organism mulching technology conducted in grape orchard effectively reduced total N, NO_3^--N, total P, and PP concentrations in runoff water. In addition, the application of nitrification inhibitor also reduced total N and NO_3^--N concentrations in runoff water.

Keywords: Fruit orchard, Runoff, N_2O emission, total N, Nitrification inhibitor

November 21, Wed 14:10-15:10

Session 4:
Policy challenges for optimizing nitrogen use efficiency towards sustainable production systems

Policy formulation and adoption of sustainable sugarcane cultivation system in the Philippines

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ABSTRACT

The Philippine sugarcane industry as one of the drivers of the Philippine economy, beginning from its establishment has been in constant struggle to increase its productivity - a challenge which is now more pressing in the face of global competition. To produce more with the same land area is a daunting task and fertilization is acknowledged as one of the single biggest factor that will lead to the attainment of the objectives of improving productivity. So much research has been conducted in the past both by private and government institutions such as the Philippine Sugar Research Institute (PHILSURIN) and the Sugar Regulatory Administration (SRA) on the aspects of breeding and cultural practices among others to improve production, but the environmental impact of the commonly practiced sugarcane production technology was never considered until the SRA-JIRCAS collaborative research to develop a sustainable nitrogen fertilizer application on sugarcane in the Philippines. The said research measured and established the alarming amount of nitrogen leached into the ground water due to inappropriate means of fertilization thereby polluting the only source of domestic water for drinking and other uses of the farmer and the farm workers.

The results of the study “Development of Sustainable Sugarcane Cultivation System in the Philippines” by Toshihiko Anzai, Shinkichi Goto, Shotaro Ando, Arlene Matti, Ma. Lourdes Dormido and Ignacio S. Santillana focused on the aspect of the increasing nitrogen load to the groundwater due to inappropriate fertilizer application needs immediate action as it impacts not only the productivity but more importantly the health of the farmers and their family.

A government policy towards a sustainable sugarcane cultivation system must be in placed to address the problem of Nitrogen fertilizer leaching to the groundwater, at the same time increasing farmer’s income by proper N-fertilization must be developed, and compliance thereto or adaption of such policy must be encouraged and monitored.

Keywords: policy, proper N- fertilization, compliance and monitoring

Evaluating the environmental impact of agricultural policies in Japan

- Combination of farm level decision making model and stylized site-specific biophysical model-

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ABSTRACT

This study investigates the optimal agricultural land use allocation and nitrogen application under a representative Japanese farm. Due to the site-specific nature of many agri-environmental issues, analysis at a disaggregated level is necessary in order to capture the underlying heterogeneity of agricultural productivity and environmental sensitivity across different parcels of land. The framework of this study adopts an integrated approach: an economic model of decision making on representative farms is combined with a stylized site-specific biophysical model that quantifies the impact of different policy instruments on agricultural production practices and on the multiple environmental effects. In the empirical model, land is divided into rectangular parcels which are of the same size and of homogeneous land quality, but heterogeneous as between parcels. The land use classification is assumed as rice paddy, upland crop and abandonment. In this model, “nitrogen runoff” cause eutrophication and “GHG emission”, “soil carbon sequestration”, and “biodiversity” in paddy fields are considered as environmental externalities. Several types of agricultural policy instruments are simulated based on an assumption that each support policy simulate increases payments or market price support equivalents to 10% of the value of each commodity affected by the payment, and applies these to all of the following commodities simultaneously. The effect of market price support (MPS) is not straightforward. Under the parameter setting in this analysis where relatively large farms are assumed, MPS does not necessarily increase nitrogen runoff and total GHG emissions. Because higher profit derived from higher product price allows farmers to use more organic fertilizers this has a positive effect on the yield. The revenue could cover additional costs for input, transport, and spread of manure. Due to the partial transition of chemical fertilizer to organic fertilizer, nitrogen runoff slightly decreases, CH_4 and N_2O emissions increase but carbon sequestration increases because of an increase of the manure application amount. The native plants richness index increases very slightly. Payment based on input use consistently increases nitrogen and GHG emissions, and decreases the habitat quality index value, while agri-environmental payment with fertilizer application constraint constantly improved them. Amongst three types of agri-environmental payments, payment for organic farming (complying with zero chemical fertilizer application) achieves the highest environmental benefit. As a result of sensitivity analysis, a key result from this study continues to hold - but it is true that results rely on the assumption used in the model - and does not hinge on the absolute level of the results obtained.

Keywords: agri-environmental policy, paddy field, policy simulation

Policy distortions, farm size, and the overuse of agricultural chemicals in China

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ABSTRACT

Understanding the reasons for overuse of agricultural chemicals is critical to the sustainable development of Chinese agriculture. Using a nationally representative rural household survey from China, we found that farm size is a strong factor that affects the use intensity of agricultural chemicals across farms in China. Statistically, a 1% increase in farm size is associated with a 0.3% and 0.5% decrease in fertilizer and pesticide use per hectare ($P<0.001$) respectively, and an almost 1% increase in agricultural labor productivity, while it only leads to a statistically insignificant 0.02% decrease in crop yields. The same pattern was also found using other independently collected data sources from China and an international panel analysis of 74 countries from the 1960s to the 2000s. While economic growth has been associated with increasing farm size in other countries, in China this relationship has been distorted by land and migration policies, leading to the persistence of small farm size in China. Removing these distortions would decrease agricultural chemical use by 30-50% and the environmental impact of those chemicals by 50% while doubling the total income of all farmers including those who move to urban areas. Removing policy distortions is also likely to complement other remedies such as easing farmer's access to modern technologies and knowledge, and improving environmental regulation and enforcement.

November 19, Mon 16:00-18:00

November 20, Tue 13:00-14:00

November 21, Wed 13:00-14:10

Poster Session

Preliminary estimation of national nitrogen budget in South Korea: Ⅰ. Agriculture

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ABSTRACT

Agriculture, which accounts for a significant portion of nitrogen (N) budget, is of great importance in N cycle. This study aimed to estimate national N budget for agriculture of South Korea from 2005 to 2014. We assessed the agriculture N budgets categorized into livestock pool (inflow: feed intake, outflow: livestock products, manure applied on agriculture land, and emissions of NH_3 and N gases from manure storage) and soil management pool (inflow: mineral fertilizer, manure application, and atmospheric deposition, outflow: crop removal, NH_3 emissions, and other soil N emissions) according to guidelines prepared by Expert Panel on Nitrogen Budgets. In the livestock sector, the mean N inflow (403.5 kt N yr^{-1}) was smaller than the mean N outflow (580.1 kt N yr^{-1}). Livestock products, manure applied to agriculture land, and emissions of NH_3 and N gases from manure storage occupied 10.9%, 71.5%, and 17.6% of the total outflow, respectively. In soil management sector, the mean N inflow (747.9 kt N yr^{-1}) was greater than the mean N outflow (167.1 kt N yr^{-1}). Mineral fertilizer, manure application, and atmospheric deposition occupied 38.7%, 55.4%, and 5.9% of the total inflow, and crop removal, NH_3 emissions, other soil N emissions occupied 60.4%, 30.5%, and 9.1% of the total outflow, respectively. The manure application to agriculture land was the major N flow in both pools. These results indicate that agriculture in South Korea acts as N sink (404.1 kt N yr^{-1}). More detailed statistics for livestock products and manure storage are required to disaggregate N flows. Also, national-specific emission factors associated with N emissions from manure should be developed to apply the tier 2 method. This preliminary study would be valuable for predicting the emissions of N pollutant, and greenhouse gas in agriculture of South Korea.

Keywords: agriculture, livestock, cropland, national nitrogen budget

Acknowledgement: This study was supported by National Research Foundation (2018RIA2B6001012).

Case studies of reusing nitrogen-rich groundwater for crop production by a radiation-controlled low- rate drip irrigation system

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ABSTRACT

Nitrogen-rich groundwater affected by leached nitrogen (N) derived from agriculture is found around farmland. To reuse nitrogen-rich groundwater for crop production, we used a radiation-controlled low-rate drip irrigation system (RCDI) developed by NARO. RCDI is expected to supply water and nutrient to crop efficiently, because of its smaller irrigation rate (018L h^{-1} $emitter^{-1}$) than and solar radiation dependent irrigation. We conducted two case studies as follows.

(1) Margaret farm. We investigated the effects of low-rate drip irrigation using RCDI (LI) on the N use efficiency and the flower quality compared with that of conventional drip irrigation (CI). The nitrate-N concentration of irrigated water was 5-30 mg L^{-1} (average 18 mg L^{-1}). In the LI plot, the drainage was 33 % and the amount of leached nitrate-N was 50% compared with CI plot. The flower quality of LI plot was superior to that of CI plot. Additionally, 46 kg ha^{-1} of N derived from the groundwater was estimated to be applied as like a N fertilizer in the LI plot.

(2) Tea garden. We investigated the effect of LI on the tea quality and the cost of cultivation compared with those of CI and conventional management (CM). In the CM plot, solid fertilizer was applied, and watering was just rain water. The nitrate-N concentration of irrigated water was about 30 mg L^{-1} in LI plot, and 5 mg L^{-1} in CI plot. The tea quantity and quality in LI plots were superior to those in CI plots and CM plots, nevertheless the fertilized N was about half of CI plots and CM plots. In LI plots, 120 kg h^{-1} of N derived from the groundwater was estimated to be applied as like a N fertilizer, and the fertilizer cost of 140 thousand-yen ha^{-1} was saved and gain of 270 thousand-yen ha^{-1} was obtained in comparison with CM plots.

In conclusion, this new system can contribute to water conservation by reducing fertilizer use and deriving N from groundwater.

Keywords: environmental friendly agriculture, low–rate drip irrigation, nitrogen-rich groundwater, tea, margaret

Analysing effectiveness of activities for conserving agro-environment to improve nutrient balances in Korea

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ABSTRACT

Nitrogen balance means the differences of nutrient input and output on certain agricultural area, revealing a risk of nutrient leak to environment or nutrient use efficiency. Nitrogen balance in Korea have maintained highest level over other OECD countries (245kg/N/ha and 47 kg/P/ha in 2014). For sustainable development of agriculture, it is essential to develop strategies and practices for mitigating nitrogen pressure on agro-environment. For this, the effect of several agricultural conservation practices on nitrogen balance of Korea were analysed using soil surface balance methodology and nitrogen coefficients (OECD default or national specific values –nitrogen production rate from animal manure developed in 2008 have been applied.). Agricultural practices considered in this study are nutrient input management (1) by applying standard fertilization to each crops with fixed amount of animal manure compost (without considering soil organic matter(SOM) content), (2) same as (1) but with different application rate of animal manure compost with considering SOM, (3) increasing energy resources from animal manure (like solid fuel etc.); nutrient output management are to cultivate winter crops(4) silage barley, (5) Italian rye grass ; combination effect of (6) (=(1)+(4)), (7) (=(2)+(4)).

Nitrogen balance in 2014 was 205 kg/ha when applying the animal nitrogen production rate developed in 2008. Nitrogen balance was 131 kg/ha when calculated with standard fertilization with fixed amount of animal manure compost. And nitrogen balance decreased to 111kg/ha with considering SOM. If 50% of animal manure produced used as fuel resources (meaning as 50% input of animal manure to arable land), nitrogen balance was 153 kg/ha. Winter crops (possible area was 60% of paddy field (about 560,000ha) with barley and Italian rye grass have effect on decreasing nitrogen balance to 188 kg/ha and 197 kg/ha, respectively. Nitrogen balance were 113 kg/ha or 93 kg/ha when combined effect of barley and standard fertilization with fixed animal manure compost or with different rate of animal manure compost along with SOM evaluated, respectively. Nitrogen balance decreased to16~ 62% compared OECD reported value in 2014. Nitrogen management policies such as agro-environment conservation program (tentative) need to support farmers and local government for performing these practices and improving nitrogen loading to environment.

Keywords: Nitrogen balance, Soil surface balance, Agro-environment conservation program

Estimation of nitrogen removal from swine wastewater in activated sludge systems using model simulation

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ABSTRACT

Livestock waste management is responsible for significant impacts in public water bodies. Nitrogen (N) contamination is usually one of the consequences. This is particularly relevant in Japan, where livestock waste represents as much as 20% of the total amount of industrial waste generated in the country. Commonly, the liquid fraction available after solid-liquid separation of the livestock waste is treated by the activated sludge process, and then discharged into a public water body. According to government sources, 61% of the swine wastewater produced following this schema is aerobically treated.

An activated sludge model (ASM)-type model considering biological oxygen demand (BOD) and N removal, and including nitrite as intermediate, free ammonia and free nitrous acid as potential inhibitors, and temperature as process parameter was used to simulate swine wastewater treatment. Aeration conditions are a key factor on N removal in such scenario, so continuous and intermittent aeration at several aeration rates was assessed. Influent swine wastewater BOD/N ratios of 2, 3 and 4 were considered. Under continuous aeration, at low dissolved oxygen (DO), N was mainly removed through the nitrite short-cut in simultaneous nitrification-denitrification. Otherwise, under intermittent aeration, N was removed at a wider DO range than previously assessed for continuous aeration. However, energy consumption to achieve satisfactory N removal was almost the same regardless the aeration conditions applied. The higher the BOD/N ratio considered, the more satisfactory the N removal achieved. When the BOD/N ratio was set at 2, critical DO control was required to achieve satisfactory N removal. In such case, additional post-treatment through anaerobic ammonium oxidation (anammox) might be an interesting alternative.

Keywords: swine wastewater, activated sludge model, nitrogen removal, energy consumption

Nitrogen fertilization in intensive horticultural systems in China: Challenges and opportunities

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ABSTRACT

Large areas of cereal production in China have been transferred to fruit trees and vegetables since 1980s. For example, the area under fruit trees has increased from 1.78 million ha in 1980 to 12.2 million ha in 2013, and vegetable production has increased from 3.3 million ha in 1978 to 19.6 million ha in 2011. The nitrogen (N) fertilizer application rates in fruit trees and vegetables are usually higher than cereal crops. Fruits and vegetables together in China have consumed at least 30% of domestic N fertilizer applications, higher than the average in the world. Compared to cereal crops, the application of different organic fertilizers is also common. Therefore, over-input of N in orchards and vegetable production is very severe. It results in a series of problems, including low nitrogen use efficiency (NUE), high greenhouse gas emission, nitrate leaching, eutriphication. The causes for this bad management practice include not enough researches in regard to fruit trees and vegetable crop rational fertilizer recommendations, the low education levels of the farmers, etc. Understanding the migration and transformation processes of N fertilizer in soils of the different orchards and vegetable systems is very important to take strategies to control N loss from orchard and vegetable systems. We'll introduce our studies in orchards and vegetable systems in North China, especially nitrate accumulation in soil profiles in different scales in orchards. The strategies used include adequate application of N fertilizer and manures, fertigation, substituting of mineral N fertilizer with manures, recycling of crop residues, and education of farmers, etc. Our studies indicate that reducing N fertilization for intensive horticultural systems in China decreases N accumulation in soil, and N loss without compromising crop production.

Keywords: nitrogen fertilizer, orchards, vegetable crop, N loss, N management

Spatial and temporal variation of anthropogenic nitrogen inputs to the agricultural lands in China

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ABSTRACT

The anthropogenic nitrogen (N) inputs to the agricultural lands are the major non-point sources of water eutrophication. To realize the sustainable management of anthropogenic N inputs to environment in China, we have estimated both spatial and temporal variation of N inputs to the agricultural lands. Because major sources or sinks are difficult to be measured independently over huge agricultural lands, a mass balance model (Howarth et al., 1996) was used to estimate N input and output, in which the N input was considered as two groups, anthropogenic new reactive N inputs and recycling reactive N inputs. The results of temporal variation showed that the annual mean total N inputs increased by 1.5 times from 35.5 kg/ha in the 1980s (1981-1990) to 52.8 kg/ha in the 2000s (2000-2010), in which the synthetic N fertilizer dominated the N source and showed a 1.7 time increase from 13.6 kg/ha in the 1980s to 23.3 kg/ha in the 2000s. The animal excrement was the second important N source and showed a 1.4 time increase from 10.1 kg/ha in the 1980s to 14.2 kg/ha in the 2000s. The third important N source was human waste, which increased by 1.1 times from 4.4 kg/ha in the 1980s to 4.9 kg/ha in the 2000s. The most rapidly increased N source was the atmospheric deposition, which increased by 1.9 times from 1.7 kg/ha in the 1980s to 3.3 kg/ha in the 2000s.

The intensity of N fertilizer application was enlarged in almost all provinces except the megacity of Beijing and Shanghai, and the most polluted provinces include the Henan, Shandong, Jiangsu, Sichuan and Hebei, where the total amount of N fertilizer was larger than 1.5 million tons. The intensity of the bulk N deposition increased largely in last three decades, and the most polluted provinces include the Sichuan, Hunan, Anhui and Henan Province. As a result, we found that most provinces in the eastern part of China like Shanghai, Jiangsu, Henan, Shandong, Anhui, Tianjin and Hebei, where the total amount of N inputs was over 150 kg/ha in the 2000s, however, those provinces in the western part of China like Xizhang, Qinhai, Xinjiang, Inner Mongolia, Gansu and Ningxia, where the total amount of N inputs was less than 30 kg/ha. Finally, the spatial distribution of its change rate during the last 3 decades shows that, some provinces like Tianjin, Inner Mongolia, Henan, Ningxia, Xinjiang and Heilongjiang, where the total amount of N inputs increased by more than 2 times, only 3 cities and provinces: Shanghai, Zejiang and Qinghai, where the total amount of N inputs decreased. We need solutions to control all these anthropogenic N inputs to agricultural lands.

Keywords: anthropogenic nitrogen inputs, agricultural lands, atmospheric deposition, synthetic N fertilizer, human waste and animal excrement

Nitrogen use efficiencies of milk and beef productions in Japan

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ABSTRACT

To estimate the Nr use efficiencies (NUEs) of animal products, it is necessary to calculate the Nr flows from forage productions to animal feeding (including meat processing in the case of meat production). Livestock productions in Japan make substantial impacts on the Nr flows both in Japan and the other countries because we import most of animal feeds and take more than one third of protein from animal products (MAFF, 2017). The objective of this study was to estimate the national scale NUEs of milk and beef productions in Japan based on the concept of N-Calculator (Leach *et al*., 2012). In the calculations of NUEs, Nr applications for forage crop productions (Hatano, 2017; Mishima & Kohyama, 2010), biological Nr fixations (BNF, Lassaletta *et al*., 2014), feed dosages (MAFF, 2012), Nr in feeds (NARO, 2009), Nr in cattle (Matsumoto, 2000), carcass compositions (Higuchi *et al*., 2017), Nr in milk and beef (MEXT, 2015) were considered. On the one hand, the NUE of forage production calculated by dividing the forage-Nr by the applied-Nr (i.e., the sum of synthetic fertilizers, BNF and manure) was greater in Hokkaido than in the other prefectures. On the other hand, the NUE of animal feeding calculated by dividing the milk-Nr by feed-Nr was greater in the other prefectures than in Hokkaido. Consequently, the NUEs of milk production calculated by dividing the milk-Nr by the new-Nr (i.e., the sum of synthetic fertilizers and BNF) were estimated to be 21% in Hokkaido, 20% in the other prefectures and 20% in the national scale. The NUEs of beef production calculated by dividing the beef-Nr by the new-Nr were estimated to be 5% for dairy bull, 4% for crossbred cattle and 3% for beef breed. The difference in NUE of beef production is mainly arising from the length of feeding period.

Keywords: animal feeding, forage production, livestock production, meat processing, N-Calculator

Identification of N_2O producer in dairy manure compost surface

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ABSTRACT

In order to understand the N_2O production in the compost surface, N_2O, NO and O_2 profile was determined by microsensor measurement. The incubation experiments with fueld/suppressed N_2O production was also performed for compost surface samples to identify the bacterial group which is truly responsible for N_2O production by tracking the change of the bacterial community with DGGE analysis of 16S rRNA gene amplicons. Signinficant N_2O and NO concentrations (up to 645.3 ppm and 8.4 μM) were observed, which clearly shows that significant nitrification/denitrification is occurring *in situ*. The incubation experiment revealed that the bacteria which belong to classes *Sphingobacteria* and *Flavobacteria* seems to be responsible for denitrification and significant N_2O production which occurs just after the pile turning events.

Keywords: N_2O, compost, denitrifying community, microsensor

Changes in nitrogen flows in cultivation and consumption of green tea in Japan

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ABSTRACT

The demand of green tea has been increasing because of its benefits for human health. Meanwhile, large amounts of nitrogen (N) was applied as fertilizer for green tea cultivation in Japan, resulting in environmental problems, including N leaching and high rates of nitrous oxide emissions. To address these problems, the amount of N applied as fertilizer has been reduced. In addition, there has been various changes related to the manner of consumption of green tea in Japan for the last several decades. It is possible that the changes in N application rates in tea garden and changes in the manner of consumption of tea affect N flows. Therefore, we aimed to evaluate the changes in N flows in tea cultivation and consumption in Japan using the concept of N footprint (NF), which is recently developed to link environmental N impacts and consumers. As the indicators of N impacts for environment, we calculated nitrogen use efficiency (NUE), virtual N factors (VNF), and NF. NUE was calculated as a ratio of the N contained in the harvested tea shoots to the N applied as fertilizer. VNF is defined as a ratio of N released to the environment to consumed N. The NUE, VNF, and NF were calculated using the Monte Carlo method with a 100,000-time iteration. A global sensitivity analysis was conducted to evaluate which parameters affect VNF the most. As results, the changes in NUE had three phases: 1) NUE had decreased from 1965 to 1991, 2) NUE had increased from 1991 to 2005, and 3) NUE gradually have decreased since 2005. The changes in VNF was similar to the changes in NUE with three phases. As a result of sensitivity analysis, the parameters related to the extraction efficiency and powdered tea production greatly affect the estimation of VNF.

Keywords: tea (*camellia sinensis*), fertilizer, N use efficiency, N footprint

A study of runoff loads from lotus paddy fields after improvement of agricultural infrastructure

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ABSTRACT

Lake Kasumigaura is the 2nd largest lake in Japan and its basin hosts the largest volume of lotus root production in the country. In Ibaraki Prefecture, lotus roots were cropped by using water pressure and this cropping method would accelerate runoff of lotus paddy soils and bottom sediments in drainage canals into Lake Kasumigaura. Therefore, the runoff loads from lotus paddy fields are considered to be one of the causes of water pollution in the lake. Teno Area in Tsuchiura city (Ibaraki Prefecture) is the first to develop an infrastructure consisting of the concrete levee and to separate irrigation and drainage canals in Japanese lotus paddy fields. This was done over the period from 1995 through 2015. In this study, we studied the changes in runoff loads from lotus paddy fields due to improvement of the infrastructure in this area. In consequence, runoff loads of suspended solids (SS), chemical oxygen demand (COD) and total nitrogen (TN) were largest in March and April. This result would be attributed to the manuring of the basal fertilization and calcium cyanamid in this period. On the other hand, runoff load of total phosphorus (TP) showed its maximum in July and August. As a cause, elution of phosphorate from lotus paddy soils and bottom sediments in drainage canals under lowered dissolved oxygen concentrations can be considered. Furthermore, annual balanced losses of COD, TN and TP from lotus paddy fields were increased compared to those before improvement of the infrastructure. Separation of irrigation and drainage canals decreased soil sedimentation, which would result in increases in their losses.

Keywords: lotus paddy field, agriculture, runoff load, improvement of agricultural infrastructure

Global high-resolution maps of synthetic nitrogen fertilizer use rate applied to cropland during 1961-2014

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ABSTRACT

Synthetic nitrogen fertilizer have been widely used to cropland to increase crop yield globally over the past century. But as an important input of the global nutrient cycles, a high-resolution global dataset is yet lacking. In this study, we first collected a sub-national synthetic N fertilizer consumption dataset for 38 countries from their own statistic organization which totally covered about 86% global synthetic N fertilizer consumption. And we also obtained national consumption data from the IFA (International Fertilizer Industry Association) and FAO (Food and Agricultural Organization) for the other countries. After removing the amount consumed by grazing, we developed a yearly 5 arcmin gridded maps of synthetic N fertilizer use rate in cropland for the period from 1961 to 2014. Our dataset indicated that the amount of synthetic nitrogen fertilizer applied to cropland increased from 10.9 Tg N yr^{-1} in 1961 to 94.7 Tg N yr^{-1} in 2014. And it exhibited a higher spatial variability during the period. The largest consumption regions was the low-latitude in the 1960s but shifted to the northern mid-latitude in the most recent 5 years (2010-2014) due to both cropland area expansions and raised fertilizer application rate in per unit cropland area. Compared to the other research, our dataset also illustrated the spatial pattern more accurately and dynamically by conducting sub-national consumption data in most countries applied a large amount of fertilizer and considering the proportion of grazing fertilization. Our dataset could be used to drive global or regional land surface models to evaluate the impacts of human activities in water quality, greenhouse gases emission.

Keywords: synthetic nitrogen fertilizer; cropland, high-resolution

Analysis of nitrate dynamics in a nitrogen saturated Japanese cedar and cypress forest using triple oxygen isotopes

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ABSTRACT

Increased anthropogenic reactive nitrogen (N) emissions have resulted in excessive N load to forests. Once the N availability exceeds the demand for N, the excess N is lost from the ecosystem, as mainly nitrate: NO_3^- (N saturation). However, these NO_3^- leaching process is not well understood because of complexity of forest N cycle. Recently, oxygen isotope anomaly ($\Delta^{17}O$) has been proposed as a useful tracer for distinguishing atmospherically deposited NO_3^- from microbial NO_3^-. The objective of this study was to investigate the production, consumption and leaching processes of NO_3^- in a temperate N saturated forest in Japan using triple oxygen isotopes of NO_3^-.

The study was conducted in the Oyasan Experimental Forest Watershed in central Japan. The watershed comprised of two catchments. One is re-established forest in1976 (middle-aged), and the other is established forest in 1907(old-aged). Both forests were planted with Japanese cedar (*Cryptomeria japonica*) and cypress (*Chamaecyparis obtusa*). We collected atmospheric derived and stream water NO_3^-, and monitored surface soil NO_3^- using ion exchange membranes. We measured concentrations and isotopic compositions of NO_3^- for each water and extract samples.

We found that, the annual fluxes of NO_3^- leaching were 12.8 and 13.1 kg N ha^{-1} y^{-1} for the middle-aged and the old-aged forest, respectively. Isotopically estimated annual gross nitrification fluxes were 102.6 and 97.2 kg N ha^{-1} y^{-1} for the middle-aged and the old-aged forest, and they were much larger than atmospherically deposited NO_3^- (6.0 kg N ha^{-1} y^{-1}). Both NO_3^- leaching flux and soil NO_3^- supply rate were high during June to October for both catchments. N and O isotopic ratios of NO_3^- of soil and stream water samples were within the range of NO_3^- derived from nitrification. It suggests that high summer temperature stimulated nitrification and a part of NO_3^- accumulated in the soil was leached out to streams.

Keywords: nitrogen saturation, forest watershed, stable isotope ratio

What is the suitable method for extracting NO_2^- from soils? Drawbacks of current methods

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ABSTRACT

Nitrite (NO_2^-) is a pivotal intermediate of various N transformation processes including nitrification and denitrification, which are widely accepted as the major pathways of NO and N_2O emission from soil. Although NO_2^- rarely accumulates in soils due to its fast reactivity, a growing body of evidence is accumulating to show that NO_2^- significantly contributes to N_2O emissions in cropland (Maharjan & Venterea 2013 SBB, Ma et al. 2015 Biol Fertil Soils), pasture (Venterea et al. 2015 Scientific Reports) and non-cropped soils (Giguere et al. 2017 SBB). However, studies approaching soil NO_2^- dynamics are still very limited, possibly because the lack of reliable, simple method for soil NO_2^- extraction and quantification.

For example, Stevens and Laughlin (1995) demonstrated NO_2^- destruction during extraction in 2M KCl. They recommended short-time (10 min.) extraction under slightly alkaline condition (pH=8) in 1:1 soil/extractant ratio. Their approach uses a huge amount of soil and adjusting pH for each soil takes much time and labor. Recently, Homyak et al. (2015) reported that extraction with deionized water (DIW) likely to be a better solution to measure NO_2^- concentrations. However, they did not consider possible effects of microbes (e.g. nitrifier) on NO_2^- production during extraction.

In this study, our objective is to evaluate suitable method for accurate determination of soil NO_2^-. For this objective, we used acidic to neutral forest soils and calculated NO_2^- production and consumption rates during DIW, non-buffered KCl, and buffered KCl extraction using ^{15}N dilution method. In briefly, our results showed that DIW extraction is unsuitable for NO_2^- determination due to biotic/abiotic fast turnover of NO_2^- during extraction. Consistent with previous studies, non-buffered KCl destroyed NO_2^- quickly especially in low pH soil. On the other hand, NO_2^- production during extraction were significantly increased in buffered KCl compared to non-buffered KCl.

Keywords: nitrite, forest soil, ^{15}N dilution method, soil extraction

Dissimilatory nitrate reduction to ammonium (DNRA) coupled to Fe^{2+} oxidation in the paddy soil

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ABSTRACT

Dissimilatory nitrate reduction to ammonium (DNRA) converts the mobile nitrate into ammonium resulting in N retention, which has a positive effect on maintaining soil fertility. Previous studies showed that DNRA often occurred under strict anaerobic condition with abundant carbon sources; however, DNRA may also occur under aerobic condition by coupling with the oxidation of Fe^{2+}. To test this hypothesis, DNRA coupled to ferrous ion oxidation in two typical Chinese paddy soils (Wushan and red soils) were investigated by ^{15}N tracer combined with $^{15}NH_4^+$ oxidation technique. Our results showed that oxygen (DO = 8.47 mg/L) and lactic acid (Lac/N = 2.97 mol/mol) significantly increased DNRA rate of two paddy soils when the exogenous ferrous ion concentration was 0-500 μM. In Wushan soil, the effect of oxygen on DNRA rate was not significant when ferrous iron concentration was 800 μM, and lactic acid significantly inhibited the DNRA rate. In red soil, lactic acid significantly improved DNRA rate after adding 800 μM ferrous iron under aerobic condition, whereas the enhancement of DNRA rate was lower than that of adding 500 μM ferrous iron. Taken together, our results suggest that DNRA can occur under aerobic condition by coupling with the oxidation of Fe^{2+} in the tested paddy soils and the effects of oxygen and carbon source addition on DNRA process depended on the amount of Fe^{2+} and soil type.

Keywords: DNRA, ^{15}N tracer, membrane inlet mass spectrometry, carbon source, aerobic condition, Fe^{2+}

Role of Microbial Assimilation of Soil NO_3^- in Reducing Soil NO_3^- Concentration

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ABSTRACT

The accumulation of NO_3^- in the soil has resulted in increased nitrogen (N) loss through runoff, leaching, and gaseous emissions. Microbial immobilization of NO_3^- as an important process in reducing soil NO_3^- accumulation has been for a long time neglected due to the predominant viewpoint that microbes preferentially immobilize NH_4^+-N. Microbial NO_3^- immobilization is generally carbon (C)-limited, and thus exogenous organic C input may enhance microbial NO_3^- immobilization. However, the effect of the quality and quantity of exogenous organic C input on soil microbial NO_3^- immobilization is poorly understood, and a synthetic assessment on such an effect is lacking. We thus assessed the impact of exogenous organic C type, the application rate of simple organic C (glucose and acetate), complex organic C type (animal manure, plant residue) and the C/N ratio of complex organic C on soil microbial NO_3^- immobilization rate using a meta-analysis. We found that the quality and quantity of exogenous C input affect soil microbial NO_3^- immobilization: microbial NO_3^- immobilization was enhanced with the addition of simple organic C at rates >500 mg C kg^{-1}, or complex organic C with C/N ratios >18. We conclude that specific exogenous organic C input at a high rate or with a high C/N ratio can enhance microbial NO_3^- immobilization and reduce soil NO_3^- accumulation.

Keywords: exogenous organic C input, simple C source, complex C source, C/N ratio, NO_3^- accumulation

Identifying groundwater nitrate sources in a rice paddy watershed in Japan: A stable isotopic study

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ABSTRACT

The stable isotope ratios of nitrate (NO_3^-) nitrogen (N) ($\delta^{15}N_{NO3}$) and oxygen ($\delta^{18}O_{NO3}$) are utilized for identifying the sources of N in various environments. Our objective here was to evaluate basic N dynamics in a rice paddy watershed which collected water from different land uses (e.g. forest, agricultural area, residential area and grassland (golf course)) based on $\delta^{15}N_{NO3}$ and $\delta^{18}O_{NO3}$ in groundwater.

We collected groundwater, ponded water, household wastewater, and precipitation samples monthly in the Sakasagawa river watershed, Ibaraki, Japan, from October 2012 to April 2015. The $\delta^{15}N_{NO3}$ and $\delta^{18}O_{NO3}$ were determined by isotope ratio mass spectrometry after converting NO_3^- to nitrous oxide in a sample vial by the denitrifier method.

Hillside groundwater (240 m a.s.l) of forest area had the lowest NO_3^- (0.24±0.12 mg N L^{-1}), and foothill groundwater (47 m a.s.l) below golf two courses had the highest NO_3^- (4.47±1.48 mg N L^{-1}). Hillside spring water (163 m a.s.l) NO_3^- (1.07±0.24 mg N L^{-1}) beyond the threshold of N saturated forest (1.00 mg N L^{-1} in mountain stream) caused by atmospheric deposition. The mean $\delta^{15}N_{NO3}$ of hillside spring water (163m a.s.l) and hillside groundwater (60, 88, 240 m a.s.l) of forest area, ranged from 0.79 to 2.89 ‰, which were similar to precipitation $\delta^{15}N_{NO3}$ (0.52±1.18‰), and the input of atmospheric N was indicated, whereas the mean precipitation $\delta^{18}O_{NO3}$ (65.0±7.57‰) was significantly different from that hillside water samples (from 3.91 to 8.84 ‰). Hillside ground water of residential area (110 m a.s.l.) had relatively higher $\delta^{15}N_{NO3}$ (8.48±1.93‰) and lower $\delta^{18}O_{NO3}$ (2.97±1.93‰), and overlapped with that of household wastewater (5.92±5.67‰, 6.99±4.65‰, respectively), however NO_3^- (1.50±0.65 mg N L^{-1}) was much higher than household wastewater (0.25±0.31 mg N L^{-1}). Therefore, direct input of atmospheric NO_3^- and household wastewater NO_3^- into the hillside groundwater was not indicated. The lowest $\delta^{18}O_{NO3}$ (2.95±1.45‰) of the foothill groundwater, which had the highest NO_3^-, may suggest chemical fertilizer N coming from the golf course lawn.

Keywords: atmospheric deposition, chemical fertilizer, household wastewater, nitrogen dynamics, rice paddy watershed

Effects of nitrogen management and straw return on soil organic carbon sequestration and aggregate-associated carbon

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ABSTRACT

Soil organic carbon (SOC) sequestration and aggregate-associated carbon (C) can be strongly affected by nitrogen (N) management and straw return. However, an in-depth understanding of the effect of N and straw application on SOC and aggregate-associated C is lacking. After six years of five inorganic and organic N amounts under straw removal and straw return, we investigated SOC sequestration at a depth of 0–60-cm and soil aggregate-associated C in the topsoil (0–20 cm). The results were as follows: (i) the 0–60-cm depth SOC stocks for all treatments except N0 increased by 2.5–25.5% after six years, (ii) sequestered SOC was linearly correlated ($P < 0.01$) with estimates of C input and the rate of C input required to maintain the SOC stock level was 3.68 Mg ha-1 year-1, (iii) application of chemical N increased SOC mainly through an increase in coarse particulate organic matter (POM) and silt- and clay-bound C in macroaggregates, whereas with the organic N-incorporated treatments SOC increased mainly through an increase in intra-microaggregate POM within macroaggregates, (iv) the main mechanism for the formation of macroaggregates was POM bound to primary particles (sand, silt and clay) that formed microaggregates and eventually macroaggregates and (v) intra-microaggregate POM within macroaggregates (imMPOM) is a good indicator of the efficacy of N fertilization and straw management in stabilizing soil aggregates. In conclusion, chemical N incorporated with straw and organic fertilizer can enhance SOC stocks, aggregate stability and aggregate-associated C, which might promote long-term C sequestration.

Keywords: nitrogen fertilizer, organic fertilizer, straw return, soil carbon sequestration, soil aggregates

Application of a process-based nitrogen cycling model: Focused on the Asian monsoon

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ABSTRACT

Nitrous Oxide (N_2O) is one of the most important non-CO_2 greenhouse gases (GHGs), having a global warming potential (GWP) 310 times that of Carbon Dioxide (CO_2) for a 100-year timescale. Of the total N_2O emission (6.3 Tg N yr^{-1}), approximately 67% is induced by agricultural systems such as fertilized agricultural soils and animal production. The rest, i.e. 2.1 Tg N yr^{-1} is resulted from indirect N_2O emissions including nitrogen (N) leaching and runoff, atmospheric deposition, etc. Since the denitrification-decomposition (DNDC) model was first tested against N dynamics of agricultural soils in 1992, several versions of the DNDC such as Landscape-DNDC, NZ-DNDC, DNDC-Rice, etc were developed for different ecosystems. Among these models, the Landscape-DNDC model, which is the integration of agricultural-DNDC and forest-DNDC, has become a powerful tool for prediction of N_2O emission, nutrient leaching and plant growth considering soil properties and weather conditions as well as different agricultural and forest management (e.g., seeding and harvesting date, fertilization and tillage) at site, regional and national scales. Considering these various drivers, the Landscape-DNDC has already tested for different ecosystems in South Korea and Philippines under monsoon conditions and shown the significant simulation outcomes. Therefore, the simulation results of Landscape-DNDC associated monsoon in Asia were investigated and evaluated in this study, which could further help to estimate and assess the effects of climate change response (both mitigation and adaptation) plans and strategies for countries of Monsoon Asia.

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Emissions of nitrous oxide (N_2O) from soil surfaces and their historical changes in East Asia: A model-based assessment

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ABSTRACT

This study assessed historical changes in emissions of nitrous oxide (N_2O), a potent greenhouse gas and stratospheric ozone-depleting substance, from the soils of East Asia to the atmosphere. A process-based terrestrial ecosystem model (VISIT) was used to simulate the nitrogen cycle and associated N_2O emissions as a function of climate, land use, atmospheric deposition, and agricultural inputs from 1901 to 2016. The mean regional N_2O emission rate in the 2000s was estimated to be 2.03 Tg N_2O yr^{-1} (1.29 Tg N yr^{-1}; approximately one-third from natural ecosystems and two-thirds from croplands), more than triple the rate in 1901. A sensitivity analysis suggested that the increase of N_2O emissions was primarily attributable to the increase of agricultural inputs from fertilizer and manure. The simulated N_2O emissions showed a clear seasonal cycle and interannual variability, primarily in response to meteorological conditions and nitrogen inputs. The spatial pattern of the simulated N_2O emissions revealed hot spots in agricultural areas of China, South Korea, and Japan. The average N_2O emission factor (emission per unit nitrogen input) was estimated to be 1.38%, a value comparable to previous estimates. These biogeochemical modeling results will facilitate identifying ways to mitigate global warming and manage agricultural practices in this region.

Keywords: global warming, land use change, nitrogen cycle, regional budget, terrestrial ecosystem

Effect of green manure application on nitrous oxide emission in a sugarcane cropland of Okinawa, Japan

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ABSTRACT

Nitrous oxide (N_2O) is one of the most important greenhouse gases, contributing to climate change. Recently, the incorporation of green manure on sugarcane cropland is widely recommended to improve and maintain the soil fertility in Okinawa, Japan, though it may also increase the N_2O emission. Thus, our objective was to compare the N_2O emissions between the different N source application treatments, i.e., green manure application and chemical fertilizer in Okinawa, Japan.

We conducted a field experiment from August to November 2017 (90 days in total) in a sugarcane field in Kita-daito Island, Okinawa, Japan. Five treatment plots were established: control plot (0N), green manure (*Crotalaria juncea*) plot (148 kg N ha^{-1}; GM), 100 and 300 kg N ha^{-1} chemical fertilizer (ammonium sulfate) plots (100N, 300N), and bare plot (B). We periodically measured N_2O flux and soil inorganic nitrogen (SIN) as a substrate for nitrification and denitrification (total of 43 and 12 times, respectively) with continuous environmental data such as rainfall and soil moisture content (SMC).

There were no clear differences in the fluctuation pattern and peaks of N_2O emissions between GM and 100N, though SIN in GM was significantly lower than that in 100N throughout the experimental period. The higher SMC in GM than in 100N caused the favourable conditions to microbial activity to N_2O emission in GM, resulting in the similar pattern and peak. As a result, there was no clear difference in cumulative N_2O emission between GM and 100N, while the highest cumulative N_2O was recorded in 300N. In conclusion, the incorporation of green manure is an effective management of sugarcane croplands in Okinawa, Japan, considering of not only climate change but also sustainable soil resource management.

Keywords: nitrous oxide, green manure, sugarcane, Okinawa

Sulfur denitrification in riverbank soils derived from marine sedimentary rocks

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ABSTRACT

We examined sulfur denitrification in riverbank soils at headwater catchment having marine sedimentary rock, Japan. In the headwater stream, we sampled riverbank soils at the depth of 1.3-2.0 m (soil A; 2 layers) and 0.0-2.4 m (soil B; 8 layers). The incubation experiment (Exp.1; used soil A1, A2) was conducted for 40 days under anoxic condition. Samples of fresh soil were placed into glass bottles in triplicate. A solution containing nitrate (5 mg-N L^{-1} as KNO_3; N treatment) and nitrate and thiosulfate (5 mg-N L^{-1} as KNO_3 and 10 mg-S L^{-1} as $Na_2S_2O_3$; N+S treatment) were added to the bottles, respectively. Similarly, the incubation experiment (Exp.2; used soil B1-B8) was conducted for 5 days using smaller bottles. NO_3^-, NO_2^-, $S_2O_3^{2-}$ and SO_4^{2-} concentrations in the water were measured. Easily oxidizable sulfur (EOS) content in soils was determined by the difference between H_2O_2-soluble sulfur (H_2O_2-S) and water-soluble sulfur (H_2O-S) contents. NO and N_2O concentration in the headspace gas were measured. DNA was extracted from the soil, and prokaryotic communities were analyzed using polymerase chain reaction (PCR) for 16S rRNA genes. In the Exp.1, NO_3^- concentration decreased with SO_4^{2-}, NO, and N_2O concentration increased especially with higher EOS content soil (soil A2, 1235 mgS kg^{-1}) and N+S treatment, which indicated sulfur denitrification occurred. Result of prokaryotic communities analysis showed denitrifying sulfur oxidizing bacteria (*Thiobacillus denitrificans*, *Sulfuricurvum kujiense*, *Sulfuricurvum kujiense DSM*) in the soil supporting sulfur denitrification. However, in the lower EOS soil (soil A1, 3.9 mgS kg^{-1}), the signals of sulfur denitrification were not detected. In the Exp.2, signals of sulfur denitrification were also detected in the soils with higher EOS content (B4 and B8 layers). We conclude that more NO_3^- will be denitrified in subsoil by sulfur-mediated denitrification owing to the abundance of sulfides in the catchment with marine sedimentary rocks.

Keywords: marine sedimentary rock, denitrification, easily oxidizable sulfur

Seasonal variation in soil microbial biomass nitrogen and mineralization activity in a beech forest

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ABSTRACT

Soil nitrogen (N) is one of nutrients limiting forest productivity in temperate forests. Soil microorganisms could drive N mineralization, while they could compete for N during growth season. Soil microbial biomass and activity could also vary depending on climatic factor (i.e., temperature) or microbial or tree phenology (e.g., rhizosphere affect). We tested whether soil microbial biomass and N mineralization could fluctuate seasonally, depending primarily on temperature. To test this, we selected the temperate forest dominated by *Fagus crenata*, where masting was limited by N stocks in trees. The acidic brown forest soil formed on andesite and volcanic ash (Typic Hapluands in Soil Taxonomy, 2014) was covered with the thick organic horizons (Oi, Oe, and Oa horizons). We measured root exudation in the Oa horizon, soil K_2SO_4 extractable C and N and microbial biomass C and N (MBC and MBN, respectively) using chloroform-extraction method, microbial potentials of depolymerisation and ammonification using casein or arginine assays (Fujii et al., 2018). The results showed that MBC and MBN varied widely in the O horizons while that the seasonal variation in MBC and MBN was relatively small in the mineral soil horizons. The MBC and MBN in the O horizons increased with temperature, root exudation rates, and soil K_2SO_4 extractable C. The microbial potentials of casein depolymerisation (or protease activity) increased with increasing air temperature in the Oi horizon, while protease activities in the Oe and Oa horizons increased in autumn due to ectomycorrhizal response to decrease in soil K_2SO_4 extractable N. Soil K_2SO_4 extractable N (mainly inorganic N) in the Oe and Oa horizons accumulated during winter due to the absence of plant N uptake. The microbial potentials of arginine ammonification (or arginase activity) increased in the latter stage of growth season to winter, consistent with the decrease in tree and microbial N demand and accumulation of inorganic N during winter. Soil microbial biomass and associated N demand could depend primarily on temperature or soluble C source availability, while microbial N mineralization activity is also affected by tree and microbial phenology.

Keywords: arginase, microbial biomass, seasonal fluctuation, protease

Examination of analytical method for determining nitrite content in soil

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ABSTRACT

Nitrite (NO_2^-) is the intermediate product of nitrification and denitrification and serves as a central player in the local- and global-scale biogeochemical cycle of nitrogen (N). Despite of its fundamental importance, in particular as a precursor of nitrous oxide (N_2O), in situ soil NO_2^- content is often reported as below quantification/detection limit and understanding of NO_2^- behaviour in field soil is still limited. Usually, NO_2^- in soil is extracted by potassium chloride (KCl) solution; however, soil acidity is extracted at the same time and the suspended solution pH decreases significantly. Lower pH enhances abiotic reduction of NO_2^- to nitrous acid (HNO_2), of which gaseous form (HONO) is volatilized rapidly during shaking, resulting in significant underestimation of the soil NO_2^- content. Alternatively, use of slightly alkaline KCl solution or water for extracting NO_2^- in soil has been proposed; however, their applicability to Andisols which are characterized by high anion adsorption capacity (AEC) and high humus content has not been examined. In this study, extractability of NO_2^- in soil for different depths of a vegetable field of Andisol to a depth of 2 m was compared between different extractants such as water, KCl solution, slightly alkaline KCl solution (pH >8), dilute sodium hydroxide (NaOH) solution (pH >10), etc. Overall, soil NO_2^- extractability was higher with alkaline solutions, and it was the highest with dilute NaOH solution. However, NO_2^- extractability was highly overestimated for the soil samples of humic horizons because of interference effects of the extracted humic acid on either colorimetric or ion chromatographic determinations. These results suggest that soil NO_2^- should be extracted by alkaline solutions and determined after removing the extracted humic acid; moreover, soil NO_2^- and NH_4^+ should be extracted separately with different solutions because the latter should be volatilized under alkaline conditions.

Keywords: pH, abiotic reduction, soil acidity, potassium chloride, sodium hydroxide, humic acid

Mitigating N_2O emissions from agricultural soils by fungivorous mites

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ABSTRACT

Agricultural soils are main sources of nitrous oxide (N_2O), an important greenhouse gas and ozonedepleting substance. Although efforts have been made to explore methods to mitigate N_2O emissions from agricultural soils, practical mitigation options are still lacking. N_2O emissions from soils are mainly resulted from microbial processes including denitrification and nitrification of soil bacteria, archaea and fungi. However, the involved ecological processes are largely unknown. Here, we show that the fungivorous mite, a dominant group of soil mesofauna, plays an important role in regulating soil N_2O emissions by feeding on N_2O-producing fungi and could be used for mitigating N_2O emissions from agricultural soils. In a sweetcorn field applied with organic fertilizer, we observed a considerable decrease of N_2O emissions and an increase of fungivorous mite abundances after coconut husk (in chips), a natural soil conditioner, was applied to the soil. However, no N_2O mitigation was observed when husk was applied together with miticide. Therefore, we hypothesized that by increasing fungivorous mite abundances, husk application to soils would suppress the growth of N_2O-producing fungi and thus mitigate N_2O emissions. Two microcosm experiments were performed to verify this hypothesis. Firstly, when 40 mites were applied to 200 g of soil, decreases of fungal 18S rRNA gene abundances by 32% and N_2O emissions by 36% were observed, indicating a N_2O mitigation caused by fungi consumptions by mites; Secondly, when 1 g of husk was applied accompanying with mites, a 30% lower N_2O emission and a 77% higher mite abundance were obtained compared to the soil applied with only mites, indicating an enhancement of mite reproduction by the husk application. Our findings reveal an ecological relationship between fungivorous mites and N_2O emissions, which may provide a new strategy for mitigating soil N_2O emissions.

Keywords: Greenhouse gas, N_2O mitigation, N_2O-producing fungi, fungivorous mite, coconut husk

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Survey on clarification of the delay phenomenon of nitrogen leaching from upland fields

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ABSTRACT

Overused nitrogen fertilizer into upland field is change the nitrate nitrogen and leaching from upland fields. Therefore, if there is a closed watershed body such as a lake on the downstream, it is considered as a pollution source of eutrophication. Therefore, it is necessary to clarify the nitrogen dynamics in the lower soil of the upland field. In this study, a boring survey was conducted at five different land use area. We analyzed nitrogen dynamics in the lower soil by conducting a boring survey up to a depth of 10 m in fertilized areas in urban and forest areas and fertilized areas in upland field, greenhouse for melon cultivation, and waste land areas. The investigation area is the Hokota River basin of Lake Kasumigaura in Ibaraki prefecture where nitrogen contamination is remarkable. The waste land has become a swimming pool for nearly 30 years, which had become upland fields in the past, and it was demolished about three years ago. The results showed that nitrate nitrogen components mainly accumulated in the lower soil exceeding 10 mgL^{-1} in upland field with nitrogen fertilizer. In the waste land, the concentration of nitrate nitrogen in the upper layer corresponding to three years after demolition of the swimming pool was very low and the lower layer was found to be high concentration. On the other hand, the nitrogen concentration in the forest with no fertilizer was low, and there was no concentration of nitrate nitrogen in urban areas. From these results, it became clear that nitrogen fertilizer without uptake by crops leaches together with the infiltration water. In addition, since the infiltration rate is about 1 m^{-1}.

Keywords: nitrate nitrogen, upland field, overused fertilizer, infiltration rate, accumulated nitrogen

The effects of pH and O_2 concentration to the abiotic transformations of NO_2^- in filter-sterilized soil extracts

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ABSTRACT

Nitrite (NO_2^-) is an intermediate in a number of soil N transformation processes. Since NO_2^- is reactive, abiotic NO_2^- reactions are expected to be important in the soil N transformations. For example, some reactions contribute to abiotic NO, N_2O, N_2 and NO_3^- production. These abiotic reactions are: the self-decomposition of NO_2^-, reactions of NO_2^- with reduced metal cations, nitrosation of soil organic matter by NO_2^-, the selfdecomposition of HNO_2. (Heil *et al* .,2016). These reactions are influenced by environmental factors such as O_2 availability and pH. Therefore, to clarify significance of abiotic NO_2^- transformations and influence of O_2 availability and pH on these reactions are important to understand N transformations in soils.

In previous studies, sterilization techniques such as autoclaving and γ-irradiation are generally used to investigate abiotic NO_2^- reactions. However, these sterilization methods likely to alter soil chemical and physical properties significantly (Powlson & Jenkinson, 1976). Thus, in this study, we used soil extract sterilized by filtration through 0.20μm filter instead of the sterilized soils. Our objectives are; to investigate whether the soil extract components promote the abiotic NO_2^- transformations or not; and to investigate the pathways of abiotic NO_2^- transformations and the influences of O_2 availability and pH to these reactions.

Soil sampling was carried out at a short steep slope in two temperate forests in the Kanto region. We collected soils from 0-10cm layer of mineral soils at upper, middle and lower part of a slope in each forest. We added $^{15}NO_2^-$ to a final concentration of 1mM to sterilized soil extracts and measured concentration and isotopic ratio of gaseous products (NO, N_2O, N_2), NO_2^-, and NO_3^- using GC-MS. Results indicated that NO was produced pH-dependently, however, production of N_2O and N_2 were accelerated by solute in soil extracts.

Keywords: chemodenitrification, N cycling, nitrite, abiotic reaction, soil solute

Possible sources of ammonium in shallow groundwater of vegetable fields in Central Vietnam

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ABSTRACT

High concentrations of ammonium ions (NH_4^+) were reported in shallow groundwater in vegetable fields located in the downstream areas of the Huong River, Central Vietnam. The objective of this study was to determine possible sources of NH_4^+ in groundwater of the study site. Sewage water would not flow into the groundwater because the fields were more than 50 m away from the residential area. In this study, we tested three hypotheses: (i) NH_4^+ derived from fertilizer or manure applied to the fields was transported to groundwater thorough soil, (ii) nitrate (NO_3^-) produced as a result of nitrification in topsoil was transferred to deep soil and again transformed to NH_4^+ by dissimilatory nitrate reduction (DNRA), or (iii) nitrogen mineralization occurred in deep soil. Soil samples were collected up to 240 cm from a vegetable production field in Quang Thang Commune, Central Vietnam in June (dry season) and November (rainy season) of 2016 and 2017. The groundwater table existed at 60 or 70 cm in June and 30 cm in November. Concentrations of NH_4^+ in PVC pipe wells fluctuated between 1 and 3 mg N L^{-1}. Soil NH_4^+ was not detected in the 30–80 cm layer whereas those contents in the 0–10 and 150–240 cm layers were 2–6 mg kg^{-1} and 5–20 mg kg^{-1}, respectively, indicating that NH_4^+ was not transferred to layers deeper than 30 cm. The absence of a functional gene of DNRA (*nrfA*) in the 150–240 cm soil layer shows that DNRA did not occur in this deep layer. Natural abundance values of ^{15}N ($\delta^{15}N$) for soil NH_4^+ (+3.6 to 5.5‰) were similar to those in soil total N (+1.9 to 3.6‰) in the 150–240 cm layer. In addition, anaerobically incubated soil from the 140–160 cm layer was mineralized by 1–2 mg NH_4^+-N kg^{-1} for 8 weeks. These experimental results suggest that the high concentration of NH_4^+ found in wells results from mineralization of deep soil.

Keywords: ammonium, dissimilatory nitrate reduction, groundwater, mineralization, Vietnam

Application of nitrogen removal formula with improved temperature factor

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ABSTRACT

Tabuchi et al. (1985) proposed a nitrogen removal formula to simply estimate nitrogen removal rate of paddy fields and it is calculated using by inlet nitrogen concentration and temperature. The purpose for this study is to improve general applicability and accuracy of the formula and we proposed a new nitrogen removal formula of $R = X \{0.00002 (D*T)^2 + 0.005\}$. Here, R is the nitrogen removal rate (g m^{-2} d^{-1}), X is the initial inlet nitrogen concentration (mg L^{-1}), T is the temperature (degrees Celsius), and D is the temperature correction factor (D = 1.3). We improved this formula from measured data in a non-infiltration and non-vegetated at flooded paddy field from January 2015 to December 2016.

For verification, we extended the collection period from January 2015 to May 2018, and compared the actual measured value and calculated value of nitrogen removal rate. As a result, it was found that the nitrogen removal rate can be estimated without the measured temperature if the inlet nitrogen concentration is known. We calculated the average of integrated hour temperature from the AMeDAS hour temperature data by Japan Meteorological Agency. Average of integrated hour temperature was calculated from 48 hours before the survey start time (14 o'clock). The value of R^2 changed greatly until 14 hours before the survey time but after that it stabilized between 0.65 and 0.70. Using the average of integrated hour temperature, the R2 value exceeds 0.6. This value was sufficiently accurate even when compared with the actual water temperature. Also, it can be confirmed that the average of integrated hour temperature is no big error if it is AMeDAS data within about 40 km. From the above, it is possible to calculate the nitrogen removal rate over a wide range if the nitrogen input concentration is known.

Keywords: paddy field, nitrogen removal rate, temperature

Nitrogen removal rate of flooded paddy fields in Japan

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ABSTRACT

The aerobic-anaerobic interface formed beneath the submerged soil surface of flooded rice paddy is one of the most active denitrification hotspots not only in the watershed but also in the global environment. Thus, quantitative estimate of in situ denitrification rate in paddy fields is essentially required to develop sustainable management strategies to control the local and global scale nitrogen (N) cycle. This study intended to develop a simple empirical equation to estimate in situ N removal rate in flooded rice paddy field. We used N removal instead of denitrification because the former can be calculated from the N balance of measurable components, whereas the latter is very difficult to be determined in situ. We collected the literatures that include detailed N balance or N removal rate of flooded rice paddy in Japan, measured under various field, lysimeter, and laboratory conditions, to extract or recalculate N removal rate per unit area and unit time by considering all N input and output pathways except biological N fixation and N mineralization/immobilization in soil. The obtained 238 data from 44 literatures which were published from 1976 to 2014 showed that the N removal rate positively and significantly correlated with N input, yielding a regression line with a slope of about 0.256, of which value reasonably coincide with those proposed by Seitzinger (2006) for rivers, lakes, estuaries, continental shelves, etc., as well as by Tabuchi (1986) for paddies and wetlands. The database also showed that the N removal rate in summer is approximately twice as large as in winter; there might be a maximum plateau of about 1 g N m^{-2} d^{-1}; and there would be no significant effects of vegetation cover on N removal rate. These findings should be used to estimate N removal rates in various types of rice paddy fields.

Keywords: denitrification hotspot, nitrogen balance, submerged soil, aerobic-anaerobic interface, biological nitrogen fixation

Relationship between atmospheric reactive nitrogen deposition and plant species loss: A weight-of-evidence investigation

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ABSTRACT

Nitrogen deposition has been recognized as a threat to plant diversity in terrestrial ecosystem. Nitrogen accumulation can change species composition in the ecosystem by driving the competitive interactions and make conditions unfavorable for some species. As the first exploratory investigation, we investigated the relationship between nitrogen deposition amount and plant diversity loss in Japan by collecting the data of the long term of annual nitrogen deposition in eight monitoring sites and the plant species in corresponding sites, and then analyzing the relationship, extrapolating the potential species richness loss based on the finding of Stevens et al. The results showed that the nitrogen deposition amount exhibited an increasing trend over year in most of the monitoring sites in Japan, especially in urban areas. In the Aichi forest, the plant species decreased by 14 species between 1990 and 2010, 9 of which were shrubs. The potential decreased species richness ranged from 1 to 3 as the amount of nitrogen deposition increased in the past two decades. Even this study presents the result of reductions in plant diversity caused by increased atmospheric nitrogen deposition from a weight-of-evidence investigative approach, our finding suggests that species diversity should be protected from the perspective of controlling nitrogen inputs.

Keywords: nitrogen deposition, plant diversity loss, nitrogen control

Effects of N deposition and soil nitrogen availability on nitrogen isotope ratio ($\delta^{15}N$) in forest trees in Ibaraki, Japan

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ABSTRACT

Anthropogenic nitrogen (N) deposition has been disturbed N cycle in forest ecosystem; however impacts of N deposition for plant N source and N-uptake strategies are still unknown. Plant N isotope ratio ($\delta^{15}N$) reflects the $\delta^{15}N$ of the plant N source such as the preference of soil inorganic N (NH_4^+ and NO_3^-) and ectomycorrhizal association. To understand the effect of the changes on soil N status by N deposition for the plants N uptake traits, we compare $\delta^{15}N$ in plant and soil inorganic N between two forest sites where N load levels were different. N deposition was about 1.5 times larger Tsukuba site than that of Katsura site in Ibaraki, Japan. We sampled soil from the upper and lower slope in each site and measured extracted inorganic N concentration and $\delta^{15}N$ by the the denitrifier method for highly sensitive$\delta^{15}N$ determination of inorganic N. We also analyzed leaf N content and $\delta^{15}N$ values of 17 woody species and estimated plant N source using $\delta^{15}N$ values of the soil inorganic N. The NO_3^- dominated through Tsukuba site and the $\delta^{15}N$ value of NO_3^- was relatively constant (-2.6 ± 0.1‰). In contrast, NH_4^+ and NO_3^- dominated in upper and lower slope positions respectively in Katsura. The leaf $\delta^{15}N$ values in Tsukuba were similar with soil $\delta^{15}N$-NO_3^- values in all species; for example, mean leaf $\delta^{15}N$ values in upper and lower slopes were -2.89 ± 0.31‰ and -2.83 ± 0.17‰, respectively. In Katsura site where soil N may be limited, the leaf $\delta^{15}N$ values significantly varied among species compared with Tsukuba site (-3.60 ± 0.58‰ in upper site and -4.72 ± 0.58‰ in lower site). In addition, the leaf $\delta^{15}N$ variation increased with decreasing of soil N content. In conclusion, the increment of soil nitrogen availability by N deposition may modify N source of plant species and decrease variations of plant N absorbing strategies.

Keywords: nitrogen deposition, inorganic nitrogen, nitrogen isotope, sensitive denitrifier method, nitrogen source

Regional assessment of nitrogen and sulfur deposition in East Asia using the dry deposition inferential method

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ABSTRACT

In order to investigate the state of nitrogen and sulfur deposition in East Asia, we carried out a measurement-based assessment on regional scale in cooperation with the Acid Deposition Monitoring Network in East Asia (EANET). We estimated the dry deposition amounts of HNO_3, NH_3 and SO_2 in gas phase, and NO_3^-, NH_4^+ and SO_4^{2+} in aerosol phase by an inferential method arranging for using monthly mean inputs of meteorological data.

The inferential method estimates the dry deposition based on the following equation: $F = C\ V_d$, where F is the dry deposition flux, C is the atmospheric concentration, and V_d is the deposition velocity. The V_d is calculated by inputting meteorological data to the resistance model. Although hourly meteorological data are usually requested, only monthly meteorological data were disclosed in the data reports of EANET. Therefore we arranged the inferential method that reasonably calculates the V_d by inputting monthly meteorological data. To take into account the enhancement of uptake by wet surface, we estimated the ratio of wet surface period within the month based on monthly mean relative humidity.

The total (dry and wet) nitrogen and sulfur depositions in 2016 at 21 sites in 5 countries in East Asia were in the range of 38 (Indonesia, Serpong) to 1.2 (Russia, Mondy) kg N ha^{-1} $year^{-1}$ and 30 (Vietnam, Yen Bai) to 0.4 (Russia, Mondy) kg S ha^{-1} $year^{-1}$, respectively. The high amounts of deposition and the ratios of reduced nitrogen to total nitrogen deposition were relatively high in southern part of East Asia. The ratios of dry deposition to total deposition were high in the inland areas due to the low precipitation.

Keywords: dry deposition, reactive nitrogen, oxidised nitrogen, reduced nitrogen, EANET

Estimating carbon and nitrogen pools of 70-year-old *Pinus densiflora* forests in central Korea with a forest carbon and nitrogen model

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ABSTRACT

Carbon (C) and nitrogen (N) cycles are strongly coupled, and studies modeling forest C and N pools and fluxes have taken attention. This study aimed to develop a forest C and N model, IFCANC (Integrated Forest CArbon and Nitrogen Cycle), by integrating six N cycle processes (N deposition, biological N fixation, N mineralization, nitrification, denitrification, and N leaching) and three N pools (biomass, dead organic matter, soil) into the existing FBDC (Forest Biomass and Dead organic matter Carbon) model, which simulates forest C dynamics. The IFCANC model connects C and N cycles by constraining biomass growth when N availability is low, and adjusting N mineralization rate with C content and C:N ratio of litter. The C pools of 70-year-old *P. densiflora* forests in central Korea were simulated by the IFCANC model. In addition, the IFCANC model was evaluated by comparing the simulated N pools to the observed N pools (n=6). The simulated C pools were 130.31±26.34 (Mg C ha^{-1}), and changes of the pools were 1.34 Mg C ha^{-1} yr^{-1}. The simulated N pools (Mg N ha^{-1}) for biomass, dead organic matter, and soil in 70-year-old *P. densiflora* forests were 0.52±0.10, 0.09±0.02, and 3.17±0.59, respectively, showing an agreement to the observed N pools (r^2=0.98, 0.96, and 0.98, respectively). The changes of N pools (kg N ha^{-1} yr^{-1}) for biomass, dead organic matter, and soil were 0.99, 0.17, and 0.34. The newly developed forest C and N model could be utilized to quantify C and N pools, considering the interaction between forest C and N dynamics.

Keywords: carbon and nitrogen pools, IFCANC model, integrating carbon and nitrogen cycles, model development, Korean red pine

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Improving denitrification models by including bacterial and periphytic biofilm in a shallow water-sediment system

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ABSTRACT

Denitrification is one of the most challenging nitrogen (N)-cycling processes to quantify due to complex interactions among influencing factors. In shallow water-sediment systems, ubiquitous periphytic biofilms consisting of a consortium of algae, bacteria, and nutrients account for additional interactions. The challenge in improving denitrification models is to determine how each factor directly affects denitrification and how those factors indirectly impact denitrification via interactions with other factors. We combined incubation experiments and structural equation modeling (SEM) to reveal the interaction networks of biotic and abiotic factors and their roles in net denitrification. The N species in the sediment exerted much greater control over net denitrification than that exerted by the N species in the water column. In addition, the relative abundances of denitrifier and nitrifier genes in the sediment showed a dominant control over net denitrification that was similar to the control byN species but was affected by abiotic factors. Periphytic biofilm increased net denitrification both directly and indirectly by altering the pH and the dissolved oxygen (DO), dissolved organic carbon (DOC), and N concentrations in the water column and sediment. The overall contribution of periphytic biofilm to net denitrification was less than that of the sediment but greater than that of the water column. Our findings highlight the importance of incorporating bacterial denitrifier and nitrifier genes and periphytic biofilm characteristics during model construction when predicting denitrification in a water-sediment system.

Keywords: N species, denitrification rate, bacterial denitrifiers and nitrifiers, periphytic biofilm, structural equation modeling

Preliminary estimation of national nitrogen budget in South Korea: II. Forest ecosystems

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ABSTRACT

In forest ecosystems, nitrogen (N) is generally considered to be the major factor limiting forest growth, and therefore establishing N budget is being required. This study aimed to estimate national N budget for forest ecosystems of South Korea from 2005 to 2014. Based on "Guidance document on national nitrogen budgets" reported by Expert Panel on Nitrogen Budgets, we calculated the N budget consisting of stocks (biomass, dead organic matter and soil) and flows (inflow: atmospheric N deposition and biological N fixation, outflow: N emissions, leaching and forest products). On average, the total N stock was 38,792.7 kt N. The N stock of biomass, dead organic matter, and soil accounted for 6.4, 4.3, and 89.3% of the total N stock, respectively. The average annual N inflow (123.7 kt N yr^{-1}) was 423% greater than the average annual N outflows (29.2 kt N yr^{-1}). Atmospheric N deposition and biological N fixation occupied 66.6% and 33.4% of the total inflows, and N emissions, leaching, and forest products occupied 5.8%, 92.2% and 2.0% of the total outflow, respectively. These results indicate that forest ecosystems in South Korea act as N sink, and the majority of N stores in the soil. This N budget could not estimate stock changes because data on dead organic matter and soil stock were only available at one period of time. There are not enough data to determine reliable emission factors such as N concentration of tree and precipitation. These uncertainties could be reduced by further investigations about more detailed and verified activity data and emission factors. Our findings would serve as a basis for developing N budget for forest ecosystems of South Korea.

Keywords: national nitrogen budget, forest, sink, flow and stock

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Can N loading mitigate the negative ozone effects on two-species larch seedlings?

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ABSTRACT

The impacts of elevated concentrations of nitrogen (N) deposition and ground-level ozone (O_3) on forest ecosystem have been still concerned in Asia. Effects of N deposition, especially N loading on soil, could promote tree growth and physiological activities to the stage 0~1 as Aber et al. (1989) whereas the excess deposition over stage 2~3 will surely induce nutrient imbalances. On the other hand, elevated O_3 impacts suppress physiological processes such as photosynthetic reactions and finally reduce the plant growth. Larch (*Larix* sp.) has been major afforestation species in Northeast Asian because their high growth rate and adaptability to harsh conditions. However, it has been suffering from biotic stresses, e.g. grazing by voles. Although we developed hybrid larch F_1 (*L. gmelinii* var. *japonica* x *L. kaempferi*) to overcome these difficulties, knowledge for the combined effects of N loading and elevated O_3 on these larches is still limited.

We investigated whether N loading mitigates O_3 impacts on two larch species: the Japanese larch (*L. kaempferi*) and its hybrid larch F_1 or not. In this study, N loading treatment was applied at two-week-intervals using $(NH_4)_2SO_4$ dissolved in 500 ml tap water to simulate recent N deposition such as particulate matter $PM_{2.5}$ [Target level: 50 kg N ha^{-1} yr^{-1}]. We used open-top cambers to expose pot seedlings to elevated O_3 during two growing seasons [Target level: 60 nmol mol^{-1}]. Totally, we set 4 treatments groups: tap water + ambient O_3 (Control); N loading + ambient O_3 (N); tap water + elevated O_3 (O_3) and N loading + elevated O_3 (N + O_3).

Results showed N loading mitigated negative effects of O_3 on Japanese larch. However, in hybrid larch F_1, N loading did not mitigate O_3-induced inhibition on growth and photosynthetic capacity. We concluded that mitigation effect of N loading on O_3 impact varies even between the two species of larch seedlings.

Keywords: nitrogen loading, ground-level ozone, combined effects, larch, hybrid larch F_1

Dissolved nitrogen dynamics in two forested watersheds with different atmospheric nitrogen inputs in Ibaraki, Japan

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Abstract

Long-term excess input of reactive nitrogen into forested ecosystems has caused nitrogen saturation in various regions over the world. In Japan, high nitrate concentrations in stream water have been observed in forested areas surrounding the Tokyo metropolitan area. We observed the concentration and flux of dissolved nitrogen of bulk precipitation, throughfall, litter leachate, soil water, and stream water at two forested watersheds with deferent atmospheric nitrogen input; Katsura experimental forest (KEF) with low deposition and Tsukuba experimental forest (TEF) with high deposition. The nitrogen deposition by throughfall at TEF was almost twice as large as that at KEF, while the depositions by bulk precipitation at two sites were almost the same, suggesting larger dry deposition in TEF. The soil nitrate nitrogen flux at 100 cm depth was lower than 0.5 kg ha^{-1} y^{-1} at KEF, indicating very low leaching of nitrogen from the ecosystem. In contrast, high rate of nitrogen leaching exceeding 50 kg ha^{-1} y^{-1} was observed at the same depth of soil in TEF. The nitrogen runoff as stream water were 1.9 kg ha^{-1} y^{-1} at KEF and 11 kg ha^{-1} y^{-1} at TEF. These results suggest that the nitrogen input in TEF would be much larger than the ecological demand.

Keywords: forest, nitrogen saturation, precipitation, soil water, stream water

Evaluation of ecosystem services related with nitrogen dynamics in Japanese cedar plantations

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ABSTRACT

Ecosystem services related to the nitrogen dynamics of forest ecosystems were evaluated from an economic perspective. The benefits of wood production and medical costs were obtained from published studies and applied for Japanese cedar plantations in Ibaraki prefecture with high and low nitrogen deposition (Tukuba; high deposition site, Katsura; low deposition site). Four ecosystem services evaluated are wood supply, reduction of medical costs by removal of atmospheric nitrogen, medical costs for drinking water, and medical costs for pollen allergy. Similar wood supply benefits emerged between both sites (Tsukuba; 53,200 yen/ha/yr, Katsura; 65,500 yen/ha/yr). In the Tsukuba area with high nitrogen deposition, medical costs were greatly reduced due to the removal of nitrogen from the atmosphere (Tsukuba; 32,900 yen/ha/yr, Katsura; 15,800 yen/ha/yr), while the medical cost of nitrates in stream water was relatively low in both areas (Tsukuba; 2,130 yen/ha/yr, Katsura; 370 yen/ha/yr). The Tsukuba area also featured very high male cone production, which incurred high medical costs for pollen allergy (Tsukuba; 48,230 yen/ha/yr, Katsura; 22,100 yen/ha/yr). These results suggest that analysis of economic values in relation to forest nitrogen dynamics can provide valuable insights into the relative importance of ecosystem services.

Keywords: nitrogen cycling, Japanese cedar forest, wood production, pollen allergy, medical cost

Composition influence on NH_4 adsorption by sodium cobalt hexacyanoferrate (NaCoHCF)

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ABSTRACT

Surplus ammonium has always been a serious problem, especially when it refers to problems such as eutrophication or ammonium inhibition in the anaerobic digestion (AD) process. The removal and fixing of ammonium have been a concern for researchers and traditional methods of precipitation, microbial treatment and membrane separation were brought up. Adsorption methods received huge attention due to its high efficiency and easy operation. Prussian Blue Analogues (PBA), a kind of porous coordination polymer, was recently discovered to be a potential adsorbent for ammonium with excellent performance of both adsorption capacity and selectivity.[1] Sodium cobalt hexacyanoferrate (NaCoHCF) is a kind of PBA and was proved to have an adsorption capacity of 3.97 mol/kg for ammonium, which is a high value compared with conventional adsorbents such as natural zeolite (2.36 mol/kg) and activated carbon (0.23 mol/kg).[2] However, the influence of PBA's composition on NH_4 adsorption by PBA has not been thoroughly studied. In this study, sodium cobalt hexacyanoferrate (NaCoHCF) with the $Fe(CN)_6$/Co ratio ranging between 0.555-0.982 was used for NH_4 adsorption. With $Fe(CN)_6$/Co ratio increasing from 0.555 to 0.809, NH_4 adsorption amount quickly rised from 2.18 mol/kg to 3.82 mol/kg. The increment of NH_4 adsorption amount with composition variation indicated a Na^+- NH_4 exchange mechanism because Na content in the NaCoHCF also increased with the $Fe(CN)_6$/Co ratio. The adsorption kinetic study of NH_4 using the most stable NaCoHCF showed a fast equilibrium time of about 3 hours and kinetic curves can be best fitted with Pseudo-second order model. Langmuir model was used for modelling of the adsorption isotherm and a maximum adsorption capacity of 4.35 mol/kg was estimated for NaCoHCF at its most stable composition.

Keywords: adsorption, ammonium, sodium cobalt hexacyanoferrate, cation exchange

High Performance Catch & Release Properties of Ammonia Gas at High Temperature by using Cobalt-HCC toward NH_3 recovery technology in N-cycling

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ABSTRACT

Ammonia is a crucial material in industrial fields but harmful and odor; thus, its concentration, emission and recycling should be controlled in nitrogen(N)-cycling concept. In recent years, adsorption/desorption of ammonia gas has received considerable attention using sorbents at high temperatures from the viewpoint of practical conversion and recycling technologies, e.g. high-temperature removal of ammonia gas in coal-processing, and removal of unburned NH_3 from diesel engines using selective catalytic reduction at high temperature (150 to 400°C), and removal of pollutants from diesel engines using the selective catalytic reduction at high temperature up to 300 °C. In connection with these related fields, we found that, specifically in researches of gas adsorption-desorption process, cobalt hexacyano- cobaltate (Co^{II}_3 $[Co^{III}$ (CN) $_6]_2$, CoHCC) possesses good adsorption capacities of NH_3 even at high temperatures, with thermal recyclability in adsorption–desorption process. CoHCC is demonstrated to be able to adsorb great volumes of ammonia molecules reversibly even at heating temperatures, which is a bench-top record at present. And surprisingly, the properties of CoHCC can maintain after adsorbing/desorbing ammonia gas, even under moderately humid conditions at high temperatures over 250°C. We expect that temperature swing adsorption (TSA) of NH_3 gas can be applied using CoHCC to catch/release NH_3 gas for practical applications in the field of nitrogen cycling.

Ammonium ion recovery system from sewage water for practical application by column-type adsorbent of coper hexacyanoferrate

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ABSTRACT

In the process of decomposing sewage sludge, the presence of ammonia/ammonium ion is a crucial factor that inhibits its methane fermentation. The ammonia/ammonium ion is generated by decomposing nitrogen-containing organic matter in sewage sludge. Since this ammonium ion is eliminated by nitrification at present, the generated ammonium ion is impossible to recover, and an air-bubbling at this process takes a considerable cost. Therefore, if an efficient ammonium ion recovery is realized, the cost for nitrification and denitrification can be reduced, and one of the ammonium circulation system can be realized by recycling recovered ammonium ion, such as fertilizer etc.

We adopted a pelletized potassium copper hexacyanoferrate (KCuHCF) as an adsorbent because of its high selectivity, high capacity, and quick adsorbability for ammonium ion. Ammonium ion was selectively adsorbed from a sewage sludge filtrate containing various coexisting organic/inorganic ions by passing the filtrate solution through the adsorbent packed in a column. We also succeeded in regenerating the column and obtaining a concentrated solution of released ammonium ion by passing a high concentration of potassium ion solution through this adsorbed column. Even after 50 cycles of ammonium ion adsorption and regeneration test, the column adsorbent showed no obvious deterioration in its adsorption performances.

Part of these experiments was carried out at the Saga City Sewage Treatment Center under the cooperation of Saga city.

Keywords: ammonium recovery, sewage water, column system, copper hexacyanoferrate, adsorption and desorption

Summary of Japanese reactive nitrogen management policies

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ABSTRACT

Japanese reactive N management policies exist in various relevant laws and acts issued by the competent ministries and therefore it is hard to comprehend whole framework of Japanese reactive nitrogen policy. To the initial step of integrated reactive nitrogen management, we have compiled the relevant Japanese law and acts for reactive nitrogen in environment. As far, we have listed about 20 laws and acts, which address the reactive nitrogen issue. The Basic Environmental Law (enactment and implementation in 1993) is the basis of environmental acts and provide basic environment plan. This law defined the environmental quality standards for reactive nitrogen for atmospheric and water environments. For instance, NOx standard value for residential area is 0.04-0.06 ppm as daily average or less. Ground water and drinking water; Nitrate nitrogen & Nitrite nitrogen 10 mg-N/L or less and no detection for a cyanide. For other water environment (i.e., lake, closed water area), they have different standards, according to the purpose of use. The other criteria for reactive nitrogen in atmospheric environment is for NH_3, which was odor intensity defined in Offensive Odor Control Law. Various control laws are established to keep the environmental quality standards by regulating the reactive nitrogen emissions (e.g., Air Pollution Control Law, Water Pollution Control Law, Sewerage Act, Industrial Safety and Health Act, and so on). In specific area, local public entity has own standard and control acts. Also, the acts in the outside of framework environmental basic laws play important roles for reactive nitrogen managements. For example, National Land Survey Act obliges to monitor the water quality for ground water and main water system at national wide. “Act on the Appropriate Treatment and Promotion of Utilization of Livestock Manure” and “Soil Fertility Enhancement Act” are strongly related to the reactive nitrogen management in farming systems.

Keywords: policies, Japanese laws and acts, reactive nitrogen management

Development of guidance document for the N impact assessment methodology for humans and nature

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ABSTRACT

The nitrogen cascade has multiple impacts on humans and nature. In most developed countries, too much reactive nitrogen (Nr) has negatively impacted the environment and human health while less Nr limits food production in some developing countries. Globally, excess Nr to the environment has been recognized as one of the urgent global environment exceedances of the current safe-operating capacity of our planet called the Planetary Boundary. As a part of the Towards an International Nitrogen Management System (INMS) project, we are developing a guidance document for Nr impact assessment methodology for humans and nature with international researchers from around the world. This guidance document aims to provide the methods by which to assess negative and positive impacts of Nr at multiple spatial scales. The complex impacts of Nr take place across multiple sectors, contexts and scales, so we developed a comprehensive matrix of both positive and negative impacts linked to WAGES (Water quality, Air quality, Greenhouse gases, Ecosystem & biodiversity, and Soil quality), and food, energy and societal values for the guidance document. The matrix includes various key indicators and their links to available global models on nitrogen flow, the impact analysis and the economic valuation. This is a first global comprehensive Nr impacts matrix which will be a useful foundation for interpreting model outputs and policy implications of Nr management. We apply the DPSIR (Drivers, Pressures, States, Indicators and Responses) framework to identify key indicators and their relations for impacts for humans and nature. The guidance document will describe integrated assessment methodologies of multiple Nr impacts using current knowledge from published reports. The document will address uncertainty, identify knowledge gaps, and provide policy relevant case studies regionally and globally.

Keywords: Global assessment, DPSIR framework, WAGES clusters, INMS Activity 1.2

Making the guideline of Japanese nitrogen assessment

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ABSTRACT

A national nitrogen assessment aims to grasp the past and current statuses of "nitrogen cascade" in the country. The nitrogen cascade is referred as nitrogen flows between all components of human sectors (e.g., industry and food production) and environmental media (air, soil, water, and sea), and various environmental consequences (e.g., global warming, air and water pollution, and eutrophication) induced by reactive forms of nitrogen (collectively, Nr) emitted via the complex N flows. Therefore, a nitrogen assessment is of good help to establish effective counter measures against harmful impact induced by emitted Nr avoiding pollution swapping. In Japan, a voluntary group is tackling with making a guideline of Japanese Nitrogen Assessment anticipating a national project. The guideline comprises the following chapters: Preface; 1. The Issues of Nitrogen; 2. Japanese Nitrogen Budget; 3. Industries; 4. Crop Production; 5. Animal Production; 6. Fisheries; 7. Human Settlements; 8. Waste and Sewage; 9. International Trades; 10. Atmosphere; 11. Terrestrial Ecosystems; 12. Aquatic Ecosystems; 13. Marine Ecosystems; 14. Human Health; 15. Economywide Nitrogen Flow Analysis; 16. Impact Indicators on Ecosystems; 17. Cost-Benefit Analysis and Life Cycle Assessment; and 18. Laws and Regulations on Nitrogen Management. The present status will be reported in the conference. We hope that our activities contribute to Towards INMS, an international project of the Global Environment Facility, as well as nitrogen-related research in Japan.

Keywords: Guideline, Japan, Nitrogen assessment, National nitrogen budget, Towards INMS

Team JNA-Guideline (as of 1 October 2018, in alphabetical order):
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