Center for Regional Environmental Research

National Institute for Environmental Studies

VEGETABLE OIL INK

R70

At CRER we're studying the conservation of our regional environment : our

atmosphere, water, soil, and ecosystem.

To preserve our quality of life, NIES (National Institute for Environmental Studies) / CRER (Center for Regional Environmental Research) aims to solve a variety of regional environmental problems arising in our atmosphere, water, and soil, and in our whole ecosystem.

CRER's fields of research range from the urban to the continental scale, and include Japan, East Asia, and South East Asia.

CRER integrates sound scientific knowledge and methods, including field observations, laboratory experiments, and theoretical model simulations, and studies the processes and mechanisms of environmental problems.

Health and Environmental Safety Research Program

NIES promotes eight programs. CRER is working on projects 6 and 7, which are parts of the Health and Environmental Safety Research Program.

8 programs promoted by NIES

■ Issue-Oriented Research Programs

- ■ Low-Carbon Research Program
- ■ Sustainable Material Cycles Research Program
- ■ Harmonization with Nature Research Program
- ■ Health and Environmental Safety Research Program
- ■ Environment-Economy-Society Integration Research Program

■ Environmental Emergency Research Programs

- ■ Environmental Recovery Research Program
- ■ Environmental Renovation Research Program
- ■ Environmental Emergency Management Research Program

Systematic development of risk sciences to achieve the goal of safe and secure society

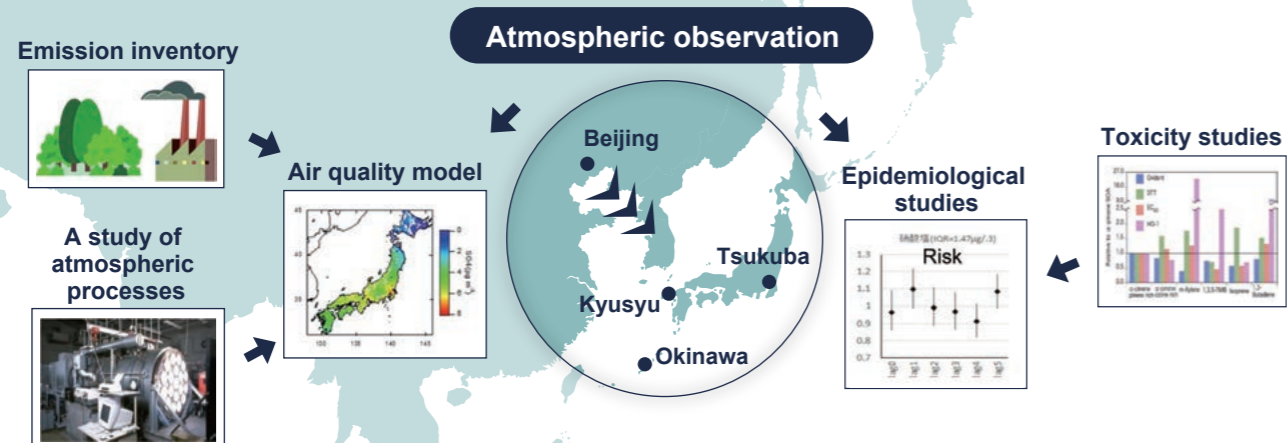|	
PJ 1	Elucidation of the effects on higher- order biological functions and multi/transgenerational epigenetic effects of chemicals
PJ 2	Comprehensive, simultaneous monitoring and analysis of known and new environmental chemicals
PJ 3	Elucidation of the causal relationships among environmental disturbances and ecological communities
PJ 4	Development of comprehensive ecotoxicity test methods for coastal ecosystems
PJ 5	Elucidation of the indoor-, regional-, and global-scale dynamics of chemicals
PJ 6	Development of pollution control plans and alert systems using an improved air quality model, and collection of evidence for adverse health effects
PJ 7	Development of advanced technologies and evaluation methods for conservation of the aquatic environment in Asia
PJ 8	Implementation of scientific achievements within social management framework

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Project 6

Development of pollution control plans and alert systems using an improved air quality model, and collection of evidence for adverse health effects

Research project on atmospheric processes, toxicity, and health effects of air pollutants including $PM_{2.5}$

To achieve the following aims, we develop an improved air quality model and collect evidence of epidemiological studies, then we contribute to construct the safe and secure society.

1. Understand the atmospheric processes of air pollutants, and develop and propose pollution control plans and mitigation strategies;
2. Construct alert systems for high concentrations of $PM_{2.5}$;
3. Collect evidence of the adverse health effects and toxicity of $PM_{2.5}$

Emission inventory

A study of atmospheric processes

Air quality model

Atmospheric observation

Beijing

Tsukuba

Kyusyu

Okinawa

Epidemiological studies

Risk

Toxicity studies

Sub-theme 1

A study for emission inventory and pollution control

- ■ A study for air quality model to improve reproducibility and predictability
- ■ A study for effect of local emission and transboundary air pollution
- ■ Show the air pollution control plan and construct alert systems for high concentrations of $PM_{2.5}$

Sub-theme 2

A study of adverse health effects caused by air pollutants

Epidemiological studies:
Evaluation of adverse health effects caused by air pollutants (PM)

Toxicity studies:
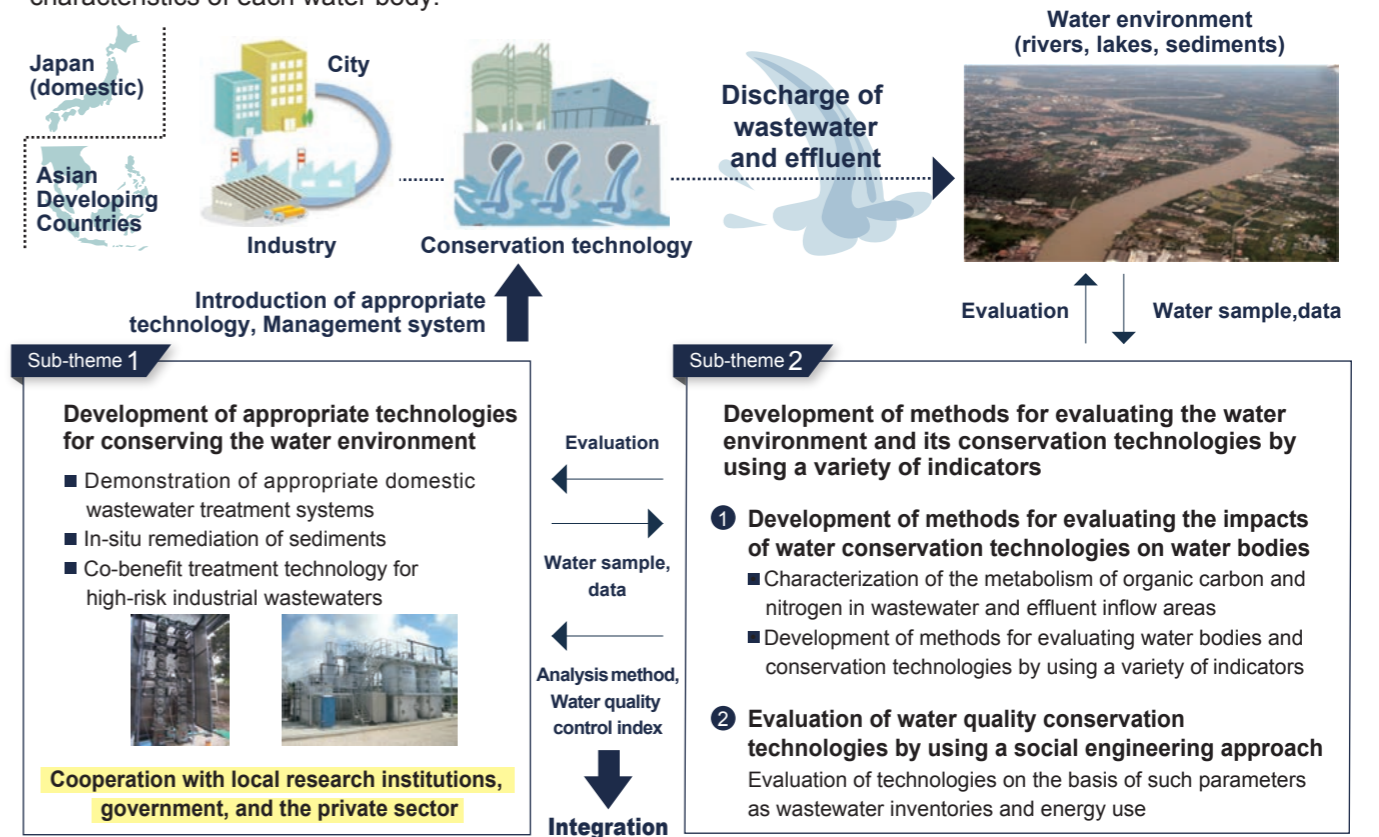Evaluation of toxicity of chemical species including organic compounds and metals

Contribution to the safe and secure society by air pollution control

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Project 7

Development of appropriate technologies for conserving the water environment and methods for evaluating these technologies domestically and in Asia

Research project to develop technologies and assessment methods for water quality conservation

This research project consists of the following two sub-themes: Sub-theme ❶ Development of appropriate technologies for conserving the water environment; Sub-theme ❷ Development of methods for evaluating the water environment and its conservation technologies by using a variety of indicators. By integrating the two sub-themes, we intend to propose management techniques and technologies to suit the resilience and regional characteristics of each water body.

Japan (domestic)

Asian Developing Countries

City

Industry

Conservation technology

Discharge of wastewater and effluent

Water environment (rivers, lakes, sediments)

Evaluation | Water sample, data

Introduction of appropriate technology, Management system

Evaluation

Water sample, data

Analysis method, Water quality control index

Integration

Sub-theme 1

Development of appropriate technologies for conserving the water environment

- ■ Demonstration of appropriate domestic wastewater treatment systems
- ■ In-situ remediation of sediments
- ■ Co-benefit treatment technology for high-risk industrial wastewaters

Cooperation with local research institutions, government, and the private sector

Sub-theme 2

Development of methods for evaluating the water environment and its conservation technologies by using a variety of indicators

1. Development of methods for evaluating the impacts of water conservation technologies on water bodies
   - ■ Characterization of the metabolism of organic carbon and nitrogen in wastewater and effluent inflow areas
   - ■ Development of methods for evaluating water bodies and conservation technologies by using a variety of indicators
2. Evaluation of water quality conservation technologies by using a social engineering approach
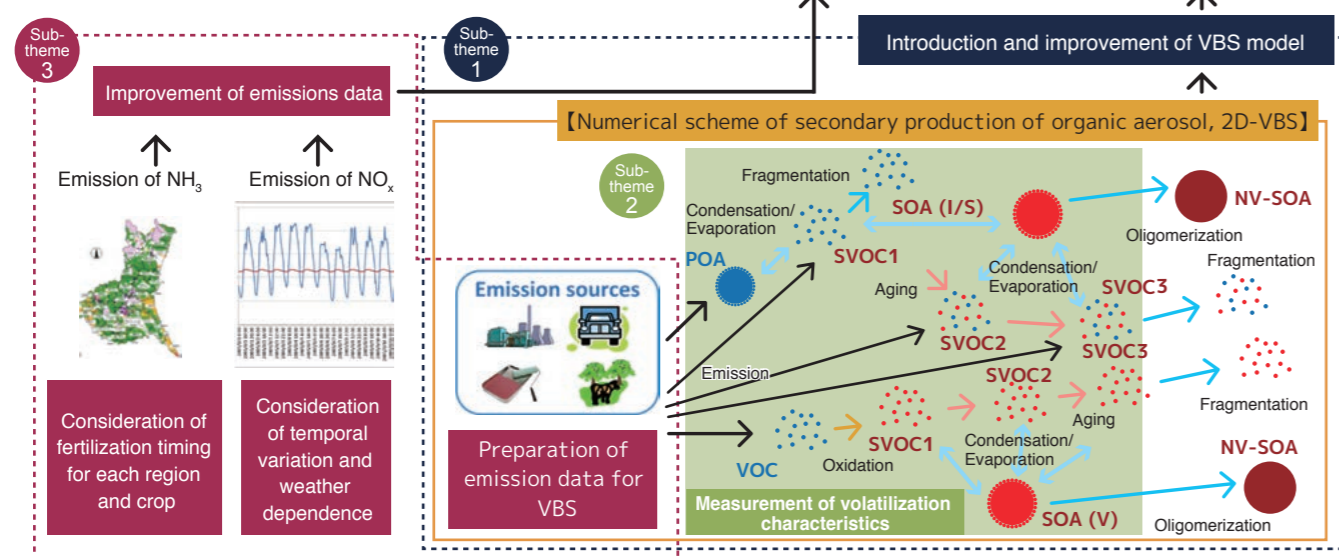   Evaluation of technologies on the basis of such parameters as wastewater inventories and energy use

Proposal of management techniques suited to the soundness and regional characteristics of water bodies

Research introduction

Improvement of aerosol simulation methods
(improvement of simulation models and emission data and evaluation of aerosol volatilization characteristics to improve PM$_{2.5}$ forecasts)

We are studying a method of calculating the secondary production of organic aerosol (one of the main components of PM$_{2.5}$) to improve the accuracy of PM$_{2.5}$ simulations.
The calculation method is being improved by comparing the evaporation behavior of organic aerosols measured in laboratory experiments with the simulated values.

Improvement of PM$_{2.5}$ simulation model

Improvement of nitrate aerosol calculation

Improvement of organic aerosol calculation

Introduction and improvement of VBS model

Sub-theme 3

Improvement of emissions data

Sub-theme 1

【Numerical scheme of secondary production of organic aerosol, 2D-VBS】

Emission of NH$_3$

Emission of NO$_x$

Consideration of fertilization timing for each region and crop

Consideration of temporal variation and weather dependence

Sub-theme 2

Emission sources

Preparation of emission data for VBS

Fragmentation

Condensation/Evaporation

POA

SVOC1

SOA (I/S)

Aging

Condensation/Evaporation

SVOC3

Oligomerization

NV-SOA

Fragmentation

Emission

SVOC2

SVOC3

SVOC2

Aging

Fragmentation

VOC

SVOC1

Oxidation

Condensation/Evaporation

NV-SOA

Measurement of volatilization characteristics

SOA (V)

Oligomerization

Air pollution research in collaboration with local government environmental research institutes

We are continuing to collaborate with about 50 regional environmental research institutes nationwide regarding air pollution problems such as PM$_{2.5}$. Currently, the team is divided into several research groups. They analyze the data from continuous atmospheric environment monitoring, make group-specific observations, and perform a number of other activities to elucidate the mechanisms and factors causing PM$_{2.5}$ to exceed the environmental standards.

Development and improvement of an air-pollution forecast system

Under contract from the Ministry of the Environment, in collaboration with other units such as the Environmental Information Department in NIES, we are working on improving VENUS (Visual atmospheric ENvironment Utility System), an air-pollution forecast system being developed by NIES.
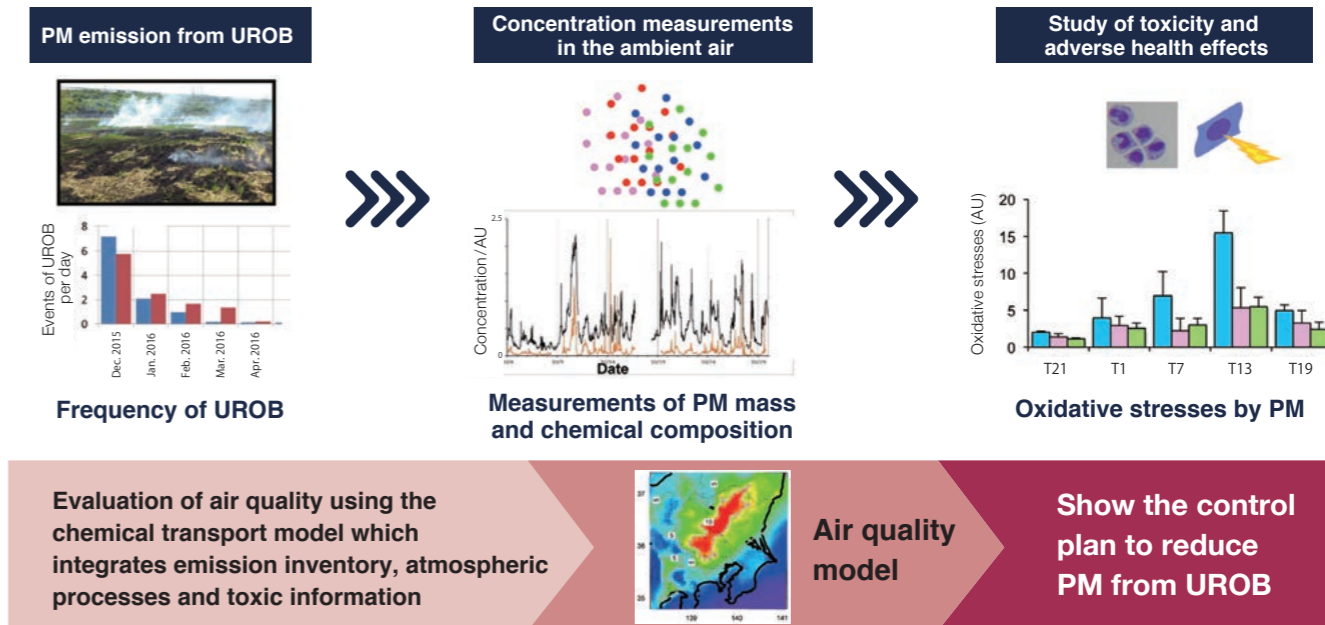
URL http://venus.nies.go.jp/
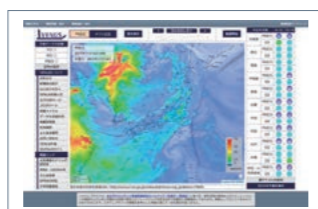
Atmospheric behavior and toxicity study of particulate matters from un-regulated open burning

The residues of agricultural wastes including rice straws are sometimes burned in the open air in Japan. Particulate matters (PM) from Un-Regulated Open Burning (UROB) is considered to be one of the main sources of PM in the atmosphere. In this project, we aim to elucidate UROB and to examine whether the PM from UROB affects the local air quality. In addition, we study the toxicity of PM from rice straws.

PM emission from UROB

Concentration measurements in the ambient air

Study of toxicity and adverse health effects

Events of UROB per day

Concentration / AU

Oxidative stresses (AU)

Date

Dec. 2015 Jan. 2016 Feb. 2016 Mar. 2016 Apr. 2016

T21 T1 T7 T13 T19

Frequency of UROB

Measurements of PM mass and chemical composition

Oxidative stresses by PM

Evaluation of air quality using the chemical transport model which integrates emission inventory, atmospheric processes and toxic information

Air quality model

Show the control plan to reduce PM from UROB

Long-term monitoring of atmospheric pollutants by NIES

Regional Atmospheric Environment Section continues the Long-term monitoring of atmospheric pollutants at Cape Hedo, Okinawa, and Fukuejima, Nagasaki, to monitor the air quality in East Asia
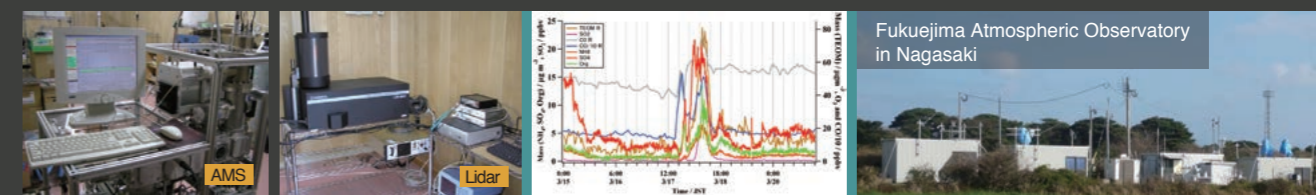
■CHAAMS is one of the Atmospheric Brown Clouds supersite, which joins many institutions.

Fukuejima http://www.nies.go.jp/chiiki/fukuejima/index.html   Cape Hedo http://www.nies.go.jp/asia/hedomisaki/home-e.html

■Measurement items

Physical and optical measurements	Chemical composition
PM$_{2.5}$ mass concentration, vertical profiles, black carbon, particle number concentration, radiation, cloud	Aerosol chemical composition, total nitrate, mercury, metals, polycyclic aromatic hydrocarbons, gaseous species

AMS

Lidar

Fukuejima Atmospheric Observatory in Nagasaki

Shanghai

Tsukuba

Fukuejima

Cape Hedo Atmosphere and Aerosol Monitoring Station (CHAAMS) on Okinawa Island

Cape Hedo

Simulation of air pollution by using a NICAM-Chem model

We are simulating the impacts of air pollutants such as $PM_{2.5}$ on the environment and climate by using a non-hydrostatic icosahedral atmospheric model (NICAM)[1] coupled to an aerosol-chemistry module (NICAM-Chem). The model can simulate air pollution with high resolution (~10-km grid spacing), not only around Japan and East Asia, but also globally, by using the K computer[2]. We are now developing the next generation of the model.

[1] NICAM has being developed by AORI (the Atmosphere and Ocean Research Institute) at the University of the Tokyo, the RIKEN Advanced Institute for Computational Science (AICS), and JAMSTEC (the Japan Agency for Marine-Earth Science and Technology).
[2] The K computer at RIKEN AICS has the highest performance of any supercomputer in Japan.

Global high-resolution simulation

Regional high-resolution simulation
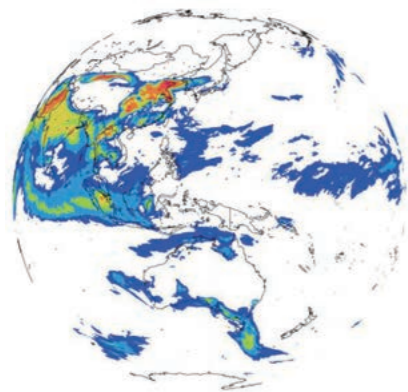
Downscaling and regional analysis

Upscaling and estimation of global impacts

High aerosol loading

Low aerosol loading
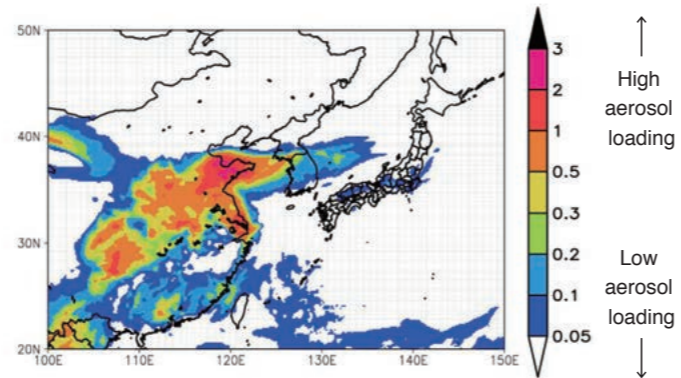
Lidar network observation of Asian dust and anthropogenic aerosols

We are improving our near-ground data acquisition and are producing a dataset for health impact studies in order to more efficiently use the lidar (laser-radar) network, which measures the vertical distribution of Asian dust and anthropogenic aerosols.

Time–height section of Asian dust distribution

(km)

Date
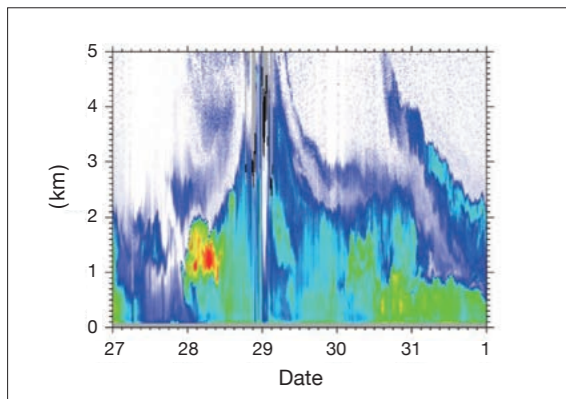
Asian dust density observed at Matsue (Shimane Prefecture) in late May 2014. Warmer color corresponds to higher density.

Night-time view of lidar observation at NIES

Development of a new personal mobility system resulting to reduce CO_2 emissions (in the human transport sector)

To create an environment where drivers of passenger vehicles will willingly switch to using public transportation systems, we are developing a new and compact three–wheel personal mobility system. We are also studying ways to disseminate its adoption by society along with more effective and smoother utilization of the current infrastructure.

In our super-aging society, Japan needs ways to transport the elderly or handicapped people safely and securely. Moreover, in the fields of nursing and welfare, it's very important to optimize the conditions of support between care receiver and caregiver. A care receiver needs to feel able to readily ask their caregiver to help them move about, and the caregiver needs to be able to respond willingly.

The basic concept of this personal mobility system is that it can be used both every day and in emergencies. In everyday situations the user can move safely, securely, and smartly. In emergencies, the mobility system will automatically head to the evacuation area and communicate with emergency systems.

The ultra-compact personal mobility system can be transformed to suit the user type and the purpose of use (multi-purpose mobility).

Sensing or detecting a dangerous hole or obstacle for the personal mobility user
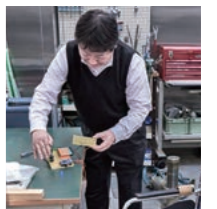
Development of the automatic stopping system

Vehicle Test Facility

This facility can test fuel economy and the characteristics of emissions from low-emission vehicles such as pure electric vehicles and hybrid electric vehicles, as well as from internal combustion-engine vehicles using gasoline or diesel fuels under real-world conditions.

Published values for fuel economy are measured under specific conditions. Because few values have been measured under real-world conditions, vehicle performance has not yet been evaluated properly. This facility has an exhaust-gas dispersion chamber for analyzing exhaust emitted to the atmosphere. It also has an equipment for analyzing in detail the characteristics of gaseous or particulate matter in exhaust.

Automated driver (robot) instead of a human driver

Vehicle on a chassis dynamometer in the environment simulation room

Vehicle exhaust measurement system
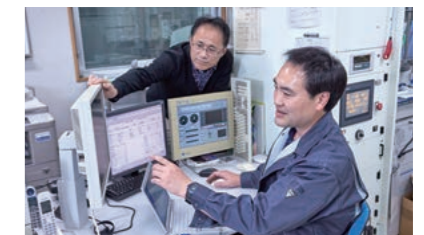
Confirmation of test results

Investigating the mechanism of nitrogen saturation of forests on Mount Tsukuba

Mount Tsukuba has been exalted as a dwelling place of the gods since ancient times. Its beautiful shape was a source of fascination for the Waka poets of the *Manyoshu* (Collection of Ten Thousand Leaves), and the mountain comes alive with pilgrims and hikers on weekends and holidays. However, its forests are being subjected to an environmental problem known as nitrogen saturation. In this phenomenon, nitrogen compounds originating in human activity accumulate in forests via atmospheric deposition over long periods of time, causing levels of mineral nitrogen to become excessive. We regularly visit monitoring sites to collect samples of air, plants, soil, and water from the mountain streams. We then perform a variety of analyses and experiments to elucidate the dynamics of nitrogen compounds in forest ecosystems.

View of Mt. Tsukuba and Mt. Hokyo

Walking to the monitoring site

Sampling the streamwater

Dynamics of phosphorus in Lake Kasumigaura

Nitrogen and phosphorus are key nutrients for phytoplankton growth; once they reach high concentrations, they can cause atypical events of cyanobacterial blooming. In Lake Kasumigaura, the second-largest lake in Japan, cyanobacterial blooming due to eutrophication has been observed. It sometimes causes nuisance odors around the lake.
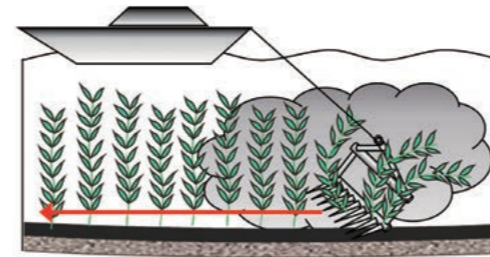

Cyanobacterial blooming in Lake Kasumigaura

To solve the problem, studies to clarify the dynamics of nitrogen and phosphorus are indispensable. Recently, in our laboratory, NMR (nuclear magnetic resonance) spectroscopy, which is also used for MRI (magnetic resonance imaging), has been used to quantify components such as DNA in phytoplankton and sediment.

NMR
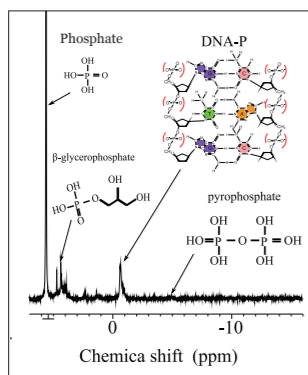
Phosphorus compounds analyzed by NMR

Impacts of macrophyte harvesting on water quality

Recently, aquatic macrophyte overgrowth has become a serious environmental problem in the southern part of Lake Biwa. The Environment Research and Technology Development Project of the Ministry of the Environment has started studying social frameworks based on macrophyte harvest activities as examples of profitable conservation approaches. In this project, our laboratory continues to analyze the effects of macrophyte harvesting on the quality of sediments and water. From our study, we concluded that one way of harvesting increased the short-term risk of sediment elution, but harvesting itself decreased the long-term risk of sediment elution. Our goal is to find the method of harvesting with the least environmental effect.

A new system enables us to extract pore water continuously. This system is good for monitoring the sediment environment with minimal disturbance when sampling.

Schematic image of macrophyte harvesting using customized tools, called *mangan* in Japanese. In harvesting, both resuspension of surface sediments and increased sediment elution are serious environmental problems (created by Prof. S. Ban, Univ. of Shiga Pref.)
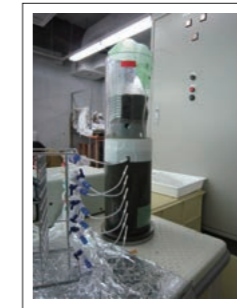
Underwater view in southern Lake Biwa, showing overgrowth of submerged macrophytes (off Karasaki, 23 June 2015)

Research Station for Preservation and Enhancement of the Water Environment (Lake Kasumigaura Water Research Laboratory)


The Research Station for Preservation and Enhancement of the Water Environment, located on the shore of Lake Kasumigaura, is a field station for studies of pollution and water quality recovery in this heavily eutrophicated lake.

This station has been the base for field studies of the lake, its influent rivers, and ground waters. We are analyzing the causes of eutrophication and ways to restore good water quality. We are field testing liquid waste-treatment and resource-recovery systems such as *Johkasou* systems.

CRER is responsible for water quality monitoring in Lake Kasumigaura at three registered GEMS Water (Global Environmental Monitoring System) monitoring sites. GEMS Water is an international institute based in Germany.

Takahama bay
Center of lake
Approx. outlet of lake
Lake Kasumigaura
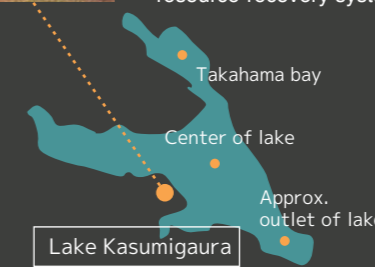
Custom-made online preparation system for nitrate stable isotope analysis

Fast repetition rate fluorometry allows us to estimate photosynthetic activity in the field.
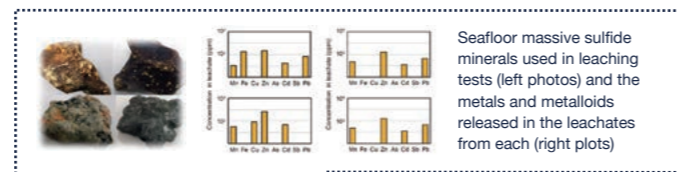

Fridge for storing sample stock

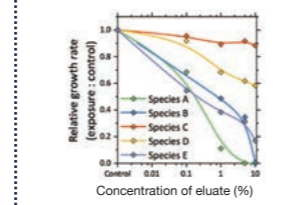# Development of environmental impact assessment tools and techniques for deep-sea mining

Our interest is growing in seabed mineral deposits as next-generation resources globally. The scientific community and mineral resource developers have estimated that there are massive amounts of mineral resources around the Japanese Islands. They expect that, in the near future, these resources will become essential mining targets for Japan, which is poor in land resources. However, the impact of seabed mining on the marine environment remains unclear. Our team is developing technologies for environmental impact evaluation and prediction in the Okinawa Trough, one of the potential mining fields. We are using research cruises and laboratory experiments to evaluate possible pollution mechanisms such as the emission of toxic substances from seabed minerals to seawater, the impact of those toxicants on the marine microbial community, and the physical dynamics of the suspended mineral and sediment particles produced by seabed excavation and disturbance during mining. We intend to integrate these research results into a numerical model, the "Environmental Impact Assessment Model," for future full-scale seabed mining. This study is supported by the Cross-ministerial Strategic Innovation Promotion Program of Japan (FY 2014 to FY 2018).
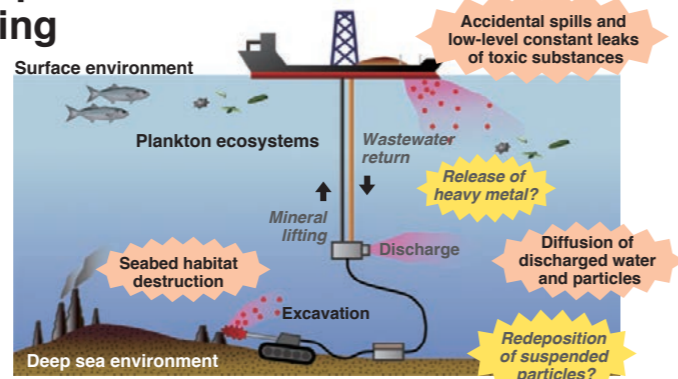
Possible pollution during full-scale mining. Mining and mineral lifting processes carry the risk of affecting both deep-sea and surface environments.

Seafloor massive sulfide minerals used in leaching tests (left photos) and the metals and metalloids released in the leachates from each (right plots)

Example of dose-response curves of various marine phytoplankton species to leachate

Results of leaching tests on seafloor minerals and an ecotoxicological test of the leachate.


Snapshot of our marine observation activities. We aim to elucidate the processes of diffusion and deposition of the suspended particulate matter generated by seabed excavation or disturbance.

Development and evaluation of a technology for amending sediments in coastal seas: application of a benthic microbial fuel cell to sediment amendment in Tokyo Bay
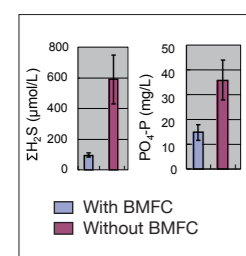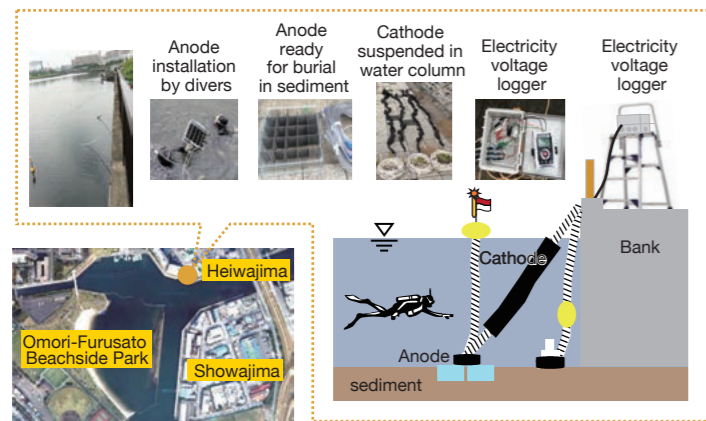
Effect of BMFC on sediment quality
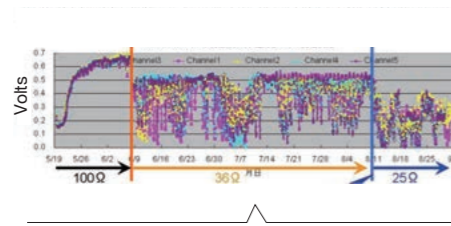
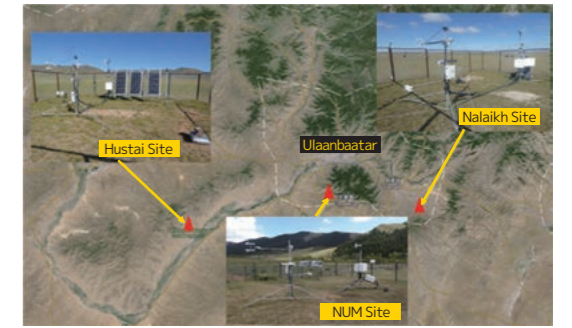Electricity generation by a BMFC deployed in the Gasumio channel, Heiwajima, from May to August 2015

Some coastal seas and estuaries abutting urban areas such as Tokyo Bay suffer from eutrophication and hypoxia. Consequently, their sediments contain large amounts of toxic sulfide and are unfavorable for benthic fauna. Microbial fuel cells (MFCs) can generate weak electricity via the anaerobic microbial metabolism of reductive substances and thus have the potential to promote the removal of sulfide from sediments. We installed and operated a benthic MFC (BMFC) in the bottom sediments of a shallow channel located in inner Tokyo Bay and tested its ability to amend impaired sediment quality. Electricity began to be generated immediately after BMFC installation and power generation was maintained for longer than 3 months. Application of the BMFC significantly decreased the sulfide and phosphate concentrations in the interstitial water in the sediments.

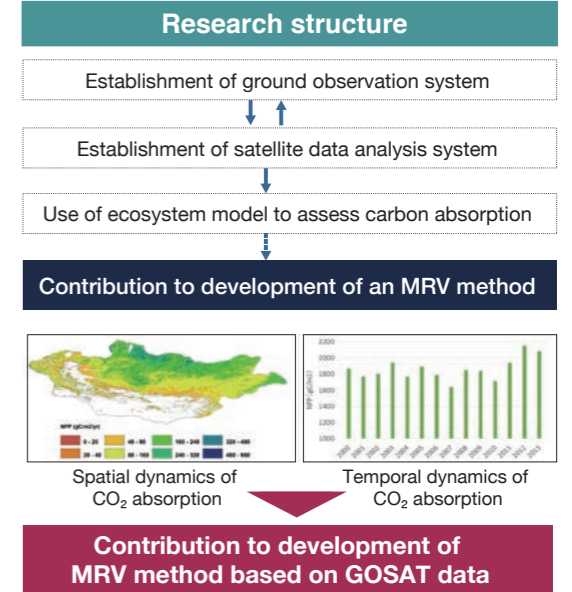This study was conducted in collaboration with Gunma University.

Project to implement MRV and related technological improvements contributing to the Joint Crediting Mechanism in Mongolia

(assessment of CO_2 sequestration by rangeland in Mongolia)

We are partly responsible for the "Project to implement MRV [measurement, reporting, and verification] and related technological improvements contributing to the joint crediting mechanism (JCM) in Mongolia," commissioned by the Ministry of the Environment. This project is presided over by Chuo University in collaboration with Hitachi, Ltd., Keio University, the Overseas Environmental Cooperation Center, and the Japan Research Institute.

Our major research objective is to evaluate CO_2 sequestration by rangelands in Mongolia. Our first task is to establish ground observation systems in typical ecosystems both near an urban area and far from the urban area. With these systems, we can collect data on meteorology, hydrology, vegetation, and CO_2 fluxes. Then, by collecting and analyzing satellite data such as MODIS data, we will use an ecosystem model to evaluate the spatiotemporal distribution of CO_2 absorbed by grasslands. Finally, we expect to contribute to the development of an MRV method based on data from GOSAT (the Greenhouse Gases Observing Satellite).

Establishment of CO_2 flux monitoring system network

Research structure

Establishment of ground observation system

⬇ ⬆

Establishment of satellite data analysis system

⬇

Use of ecosystem model to assess carbon absorption

⬇

Contribution to development of an MRV method

Spatial dynamics of CO_2 absorption

Temporal dynamics of CO_2 absorption

Contribution to development of MRV method based on GOSAT data

Outreach activities at our Summer Open House

Every summer, NIES holds a public event called the Summer Open House. This event gives participants of all ages the chance to learn about current environmental problems and hot research topics. We also set up booths with unique experience-based activities. We are looking forward to welcoming you in the next summer!

Let's learn PM$_{2.5}$

Explanation

After the introduction of PM$_{2.5}$, participants collect the air around them, their breath, and exhaust air from electrical appliances to compare PM$_{2.5}$ concentrations.

Water quality analysis

Presentation

We ask children "What kind of water do you know?" First, they look at and smell the water to give an answer. They then put on protective glasses and measure the water quality. They get to be researchers!
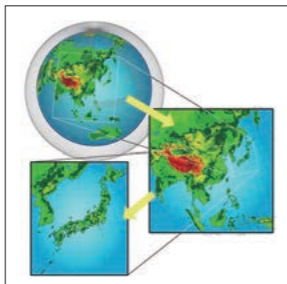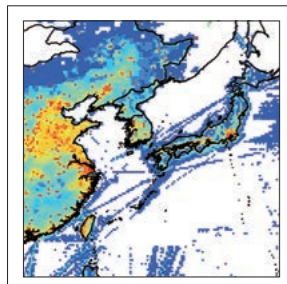
Ultra-compact mobility

Test ride an ultra-compact mobility scooter

An electric three-wheel vehicle was exhibited at the G7 Toyama Environment Ministers' Meeting in 2016. The vehicle proved to be popular. The concept is universal design for use by people of all ages.

Laboratory introduction

## Regional Atmospheric Modeling Section

To elucidate the characteristics of multiscale air pollution —from the city scale through the Asia scale to the hemisphere scale— and evaluate its forecasting, we are conducting research focused on air quality modeling.

Regional Atmospheric Environment Section

Regional transboundary air pollution in Asia is studied by the ground based observation, remote sensing technique and laboratory experiments.
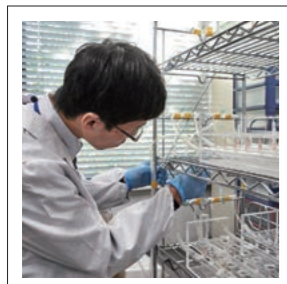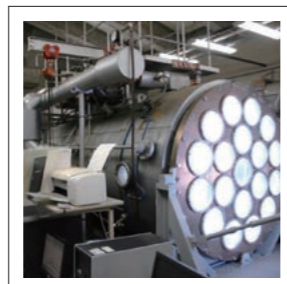
Lake and River Environment Section

We study the material dynamics of water and soil pollution, as well as the environmental effects of this pollution and recovery techniques for its management.

Soil Environment Section

Soils are generated in accordance with natural conditions such as climate and geology and human land use.
They act as buffers to mitigate the influence of anthropogenic pollution and provide places for biological activity and water quality control. This section investigates the relationship between the soil environment and water, air, and organisms, as well as the cycling of materials.

Environmental Systems Engineering Section

Our field of study is the development of appropriate conservation technologies for the water environment and the evaluation of those technologies from a social environment perspective.

Marine Environment Section

We study the following anthropogenic and natural-disaster impacts on pelagic and benthic marine environments and ecosystems around Japan： a pollutant loadings from land and ocean-developments b the Great East Japan Earthquake and subsequent huge tsunami c radioactive materials derived from the Fukushima Daiichi Nuclear Power Plant.
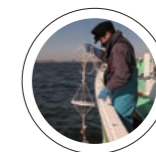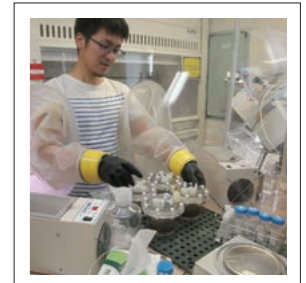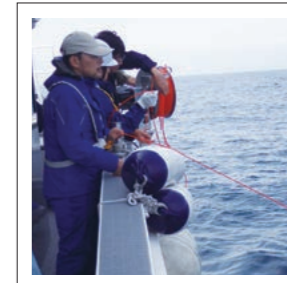
Principal Researcher (Wang)

We are conducting research into vulnerability evaluation and adaptation strategies of regional environments in East Asia by establishing both satellite and ground observation system networks.

Lake Biwa Branch

As leaders in freshwater environmental research, NIES and Lake Biwa Environmental Research Institute are partners on projects that involve local universities and private industry in advancing freshwater environmental research and utilizing research outcomes to benefit local development in the region.

Atmospheric Chemistry Cooperation Research

Kajii Group Web Site
http://www.atmchem.ges.kyoto-u.ac.jp/main-e.html