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NIES Annual Report

2009

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National Institute for Environmental Studies
http://www.nies.go.jp/

Foreword

This annual report is an official record of research activities at the National Institute for Environmental Studies (NIES) in fiscal year 2008 (April 2008 to March 2009), the third year of our second 5-year Research Plan as an incorporated administrative agency.

This year, all research units, most of which were founded or reorganized in April 2006, concentrated on their research plans. About half of NIES's researchers have been involved in four priority programs: Climate Change, Sustainable Material Cycles, Environmental Risk, and the Asian Environment. The other half have performed fundamental and pioneering studies in the six research divisions – Social and Environmental Systems, Environmental Chemistry, Environmental Health Sciences, Atmospheric Environment, Water and Soil Environment, and Environmental Biology – as well as in the Laboratory of Intellectual Fundamentals for Environmental Studies.

Through collaboration with researchers both nationally and internationally, we have produced a number of outcomes for a wide range of environmental issues at the local, national, regional, and global levels. Our research activities and our outreach activities, such as the dissemination of research findings and other environmental information through press releases, our homepage, public symposia, and open campus days, have given us a high reputation as a government-funded institute.

Our NIES Charter says:

> The National Institute for Environmental Studies (NIES) strives to contribute to society through research that fosters and protects a healthy environment for present and future generations. Proud to work at NIES and keenly aware of our individual responsibilities, we will pursue high-level research based on a firm understanding of the interaction between nature, society, and life on our planet.

It is my sincere hope that the readers of this report will maintain an interest in NIES and will offer comments and suggestions on our activities; such input is invaluable for the continuous improvement of our work.

OHGAKI, Shinichiro, D.Eng.
President
October, 2009

Contents

During the 1950s and 1960s, Japan experienced serious environmental pollution problems that accompanied rapid economic growth. In 1971, the Environment Agency was established within the Japanese government to develop measures to counteract serious environmental pollution problems such as Minamata disease, caused by poisoning from organic mercury in factory wastewater, and chronic bronchitis and asthma caused by sulfur oxides emitted from factories in large industrial complexes. In 1974, understanding that research on environmental sciences was necessary and could address public needs, the Environment Agency established the National Institute for Environmental Studies (NIES) in Tsukuba Science City, about 50 km north of Tokyo. NIES is now Japan's primary institute for comprehensive research in environmental science.

During the two decades following the establishment of NIES, rapid technological progress, structural changes in industry, and lifestyle changes created additional issues for environmental science to confront. Moreover, global environmental problems such as climate change, depletion of the stratospheric ozone layer, acid deposition, destruction of tropical rain forests, and desertification attracted greater concern worldwide.

NIES underwent a major reorganization in 1990 to enable it to conduct more intensive research on conservation of the natural environment and on global environmental changes and their effects. The new structure included two research project divisions, six fundamental research divisions, and the Center for Global Environmental Research. In addition, the Environmental Information Center was given the task of providing access to research publications and environment-related databases.

In January 2001, the Environment Agency became the Ministry of the Environment as part of structural changes within the Japanese government. At the same time, NIES established a Waste Management Research Division.

In April 2001, NIES became an incorporated administrative agency, giving it a degree of independence from the national government. The change from government institute to non-governmental status allowed more flexibility in operations, thus enabling the institute to respond with more agility to the demands of society. At the same time, NIES prepared a five-year (2001–2005) plan that corresponded to the objectives of the Ministry of the Environment.

In 2006, NIES embarked on its second five-year (2006–2010) plan and reorganized its research system to focus its resources on four priority research areas: climate change, sustainable material cycles, environmental risk, and the Asian environment. NIES also renewed its resolve to engage in fundamental research in order to respond to emerging and potential environmental issues. In collaboration with many institutions in Japan and abroad, it continues to engage in scientific research on environmental issues.

Researchers at NIES are skilled in various fields, such as physics, chemistry, biology, health sciences, engineering, agricultural and fisheries sciences, law, and economics. Interdisciplinary studies are performed, particularly in the context of our priority research projects. NIES has various types of experimental facilities and remote research stations, such as the Lake Kasumigaura Water Research

Laboratory, the Fuji Hokuroku Flux Observation Site, and the Global Environmental Monitoring Stations in Hateruma and Cape Ochi-ishi.
As of April 1, 2009, the total number of NIES regular permanent staff was 243 (including five foreign researchers). There were also 658 non-permanent researchers, including 58 foreign researchers. The total budget for FY 2008 was 14 229 million yen.

Table 1 Number of Permanent Staff

Research	185	76.1%
Administration	43	17.7%
Environmental Information Center	10	4.1%
Executive	5	2.1%
Total	243	100%

(As of April 1, 2009)

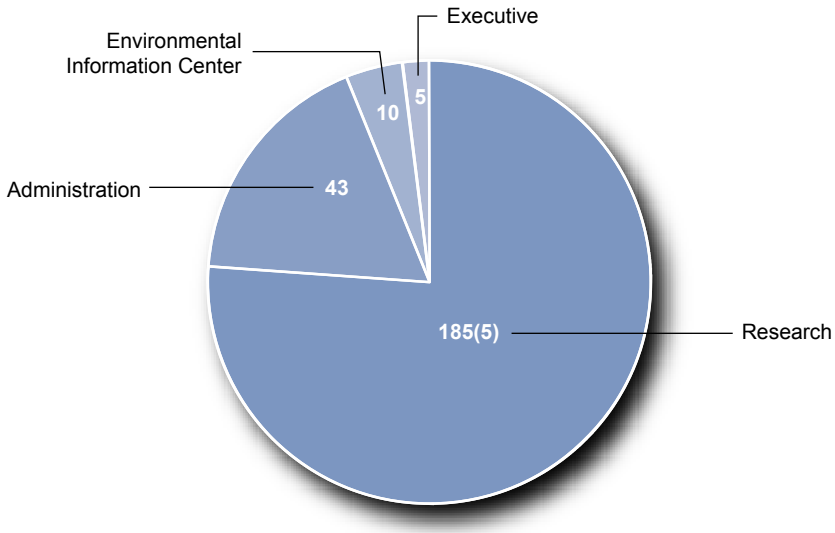
Table 2 Budget for the Second Medium-Term Plan

(Unit: million yen)

	Category	2006-2010 Budget (5 years)	Fiscal 2008 Budget
Revenues	Grant for Operating Costs	48,196	9,675
	Subsidies for Facilities	2,420	499
	Commissioned Work	20,275	4,055
	Others	70	0
	Total	70,961	14,229
Expenditures	Project Costs	30,898	6,119
	Facility Improvements	2,420	499
	Expenses for Commissioned Work	20,275	4,055
	Personnel Expenses	14,795	3,042
	General Administrative Expenses	2,573	514
	Total	70,961	14,229

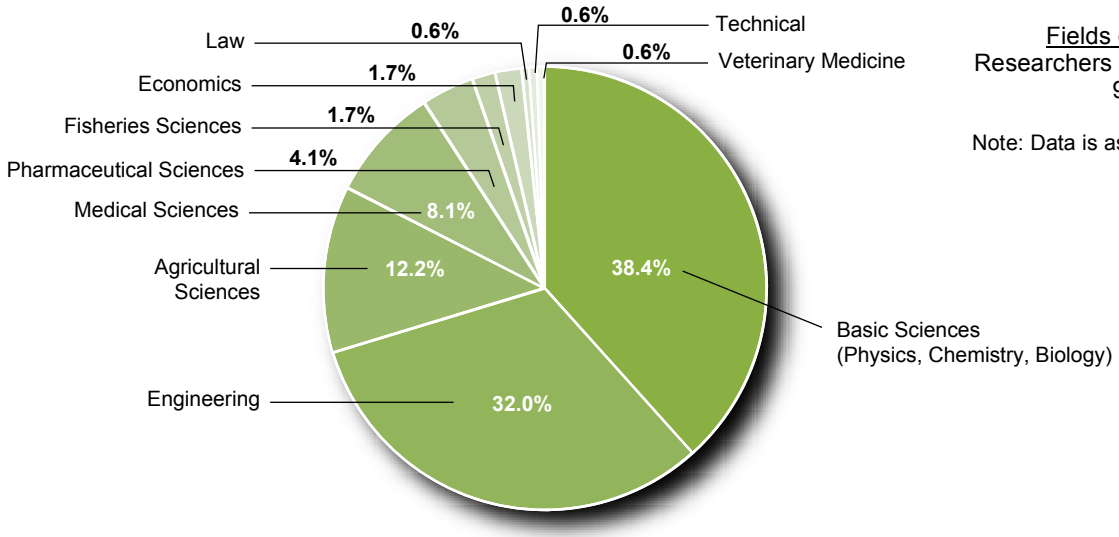
Note: The budget for each annual work plan will be requested and decided each fiscal year, based on the second midium-term (five-year) plan.

Human Resources



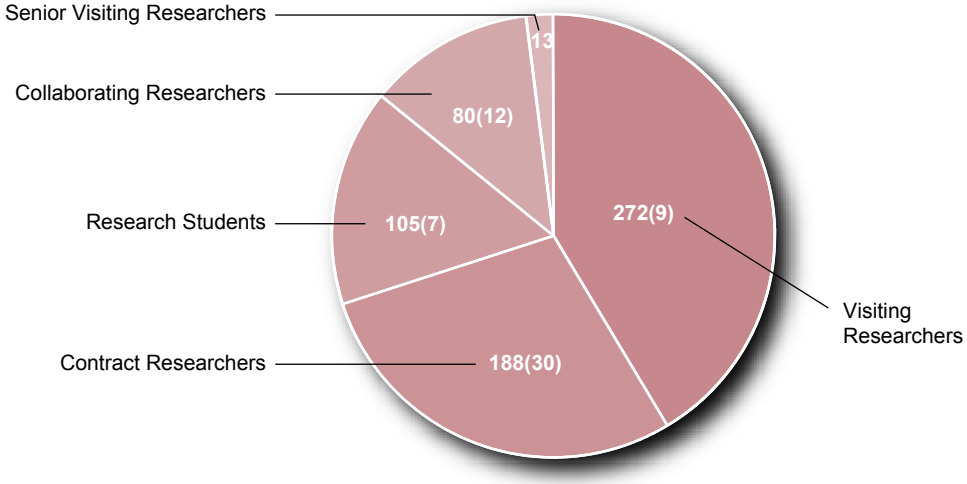
Number of Permanent Staff
243 (5)

Notes: 1. Data is as of April 1, 2009.
2. Figures in parentheses indicate number of foreign researchers.



Fields of Expertise
Researchers holding doctorates
93.5%

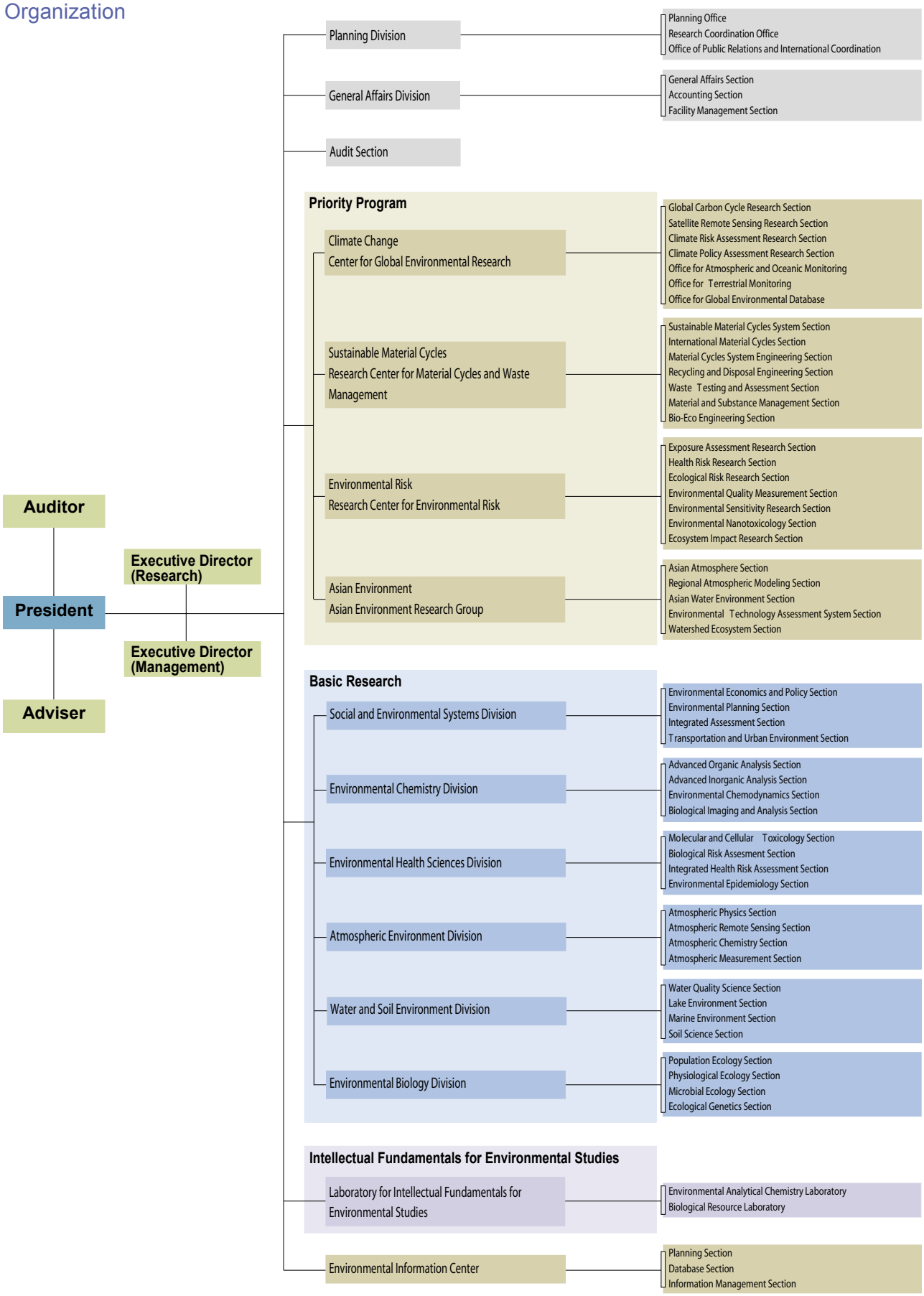
Note: Data is as of April 1, 2009



Number of Visiting Researchers, etc
658 (58)

Notes: 1. Data for "Contract Researchers" is as of April 1, 2009.
(Data for Limited-Term Researchers, NIES Fellows, NIES Post Doctoral Fellows, NIES Assistant Fellows, NIES Research Assistants reflects the total number accepted in FY2008).
2. Figures in parentheses indicate number of foreign researchers.

Organization



Center for Global Environmental Research

The successful launch of GOSAT *Ibuki* on 23 January 2009.

The Center for Global Environmental Research (CGER) was established in 1990 as a focal point for Japan's contribution to global environmental research. To create a foundation for measures targeted at environmental preservation, it has been working to clarify, from a scientific perspective, the effects that humanity has on the environment. As the core organization for research on climate change at NIES, CGER performs research ranging from greenhouse gas observations to climate change predictions, risk assessments, and future scenarios involving a low-carbon society. This research—the "Climate Change" part of the four Priority Programs—is performed through the following four core research projects:

- Project 1 Long-term variation mechanisms of greenhouse gas concentrations and their regional characteristics
- Project 2 Greenhouse gas observations from space and use of the observations to estimate global carbon flux distribution
- Project 3 Assessment of climate risk based on integrated climate, impact, and land-use models
- Project 4 Developing visions of a low-carbon society and integrated analysis of climate policies.

In addition to the climate change research, CGER contributes to the effective implementation of research at the national and international levels and the creation of a network of researchers through strategic monitoring, the creation of a global environmental database, and integration and support of global environmental research. The results of these activities are made available not only to other researchers and related organizations, but also to the general public. Some of the main topics covered by CGER activities are introduced below.

Observational studies of GHGs (Core research project 1)

This project consists of a large variety of atmospheric, oceanic, and terrestrial observations of GHG (Green House Gases) concentrations and their fluxes in the Asia-Pacific–Russian region. Because anthropogenic CO_2 emissions recently increased beyond 8 Pg-C/year, atmospheric CO_2 growth rates also increased from 1.5 ppm/year to about 2 ppm/year. According to atmospheric oxygen and CO_2 isotope observations over the Pacific and at two monitoring sites (Hateruma and Ochi-ishi), about 30% of anthropogenic emissions of CO_2 are taken up by the ocean and 10% by terrestrial plants. Terrestrial uptake seems to be affected by temperature fluctuation, and over the last 3 years the apparent terrestrial uptake was higher than that in 2001–2005. This increased uptake may be due to a lack of weakening of the terrestrial sink because of the absence of large-scale El Niño events in recent years.

As part of this project we studied the response of forest CO_2 sink flux and soil respiration to variable climate conditions at five forestry field sites. To evaluate oceanic sinks, observations in the North Pacific continued, and the trends of the sinks in this area were evaluated.

A new trend in methane concentrations has appeared globally. Methane concentrations were fairly stable after 2000, but in 2007–2008 voluntary

shipboard observations revealed a sudden concentration increase in both hemispheres, except in the 5ºN to 15ºN latitudinal band (Fig. 1). Although such trends suggest increases in methane source strength, the reason is still under investigation.

To investigate greenhouse gas source regions, new observations by Asian cruise ships have begun, in addition to the observations taken by the network of JAL passenger aircraft (CONTRAIL: Comprehensive Observation Network for Trace gases by AIrLiner).

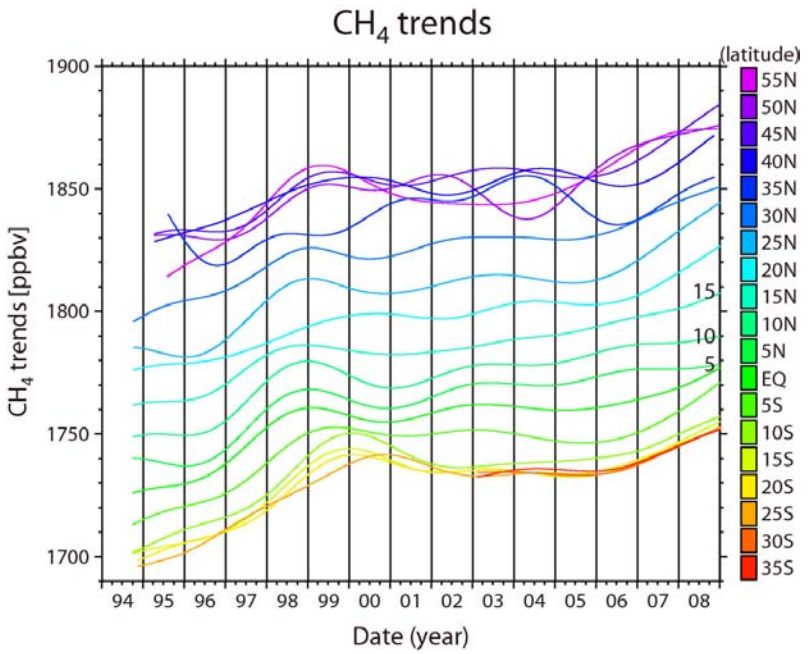


Fig. 1 Atmospheric methane concentration trends in each latitudinal band. Observations were made over the Pacific from commercial cargo ships (e.g. from *Trans Future 5* of the Toyofuji Shipping Co. Ltd).

GHG observations from space (Core research project 2)

The Greenhouse Gases Observing Satellite (GOSAT, named *Ibuki*) was successfully launched on 23 January 2009. We are currently conducting research to determine the precise column abundances of CO_2 and CH_4 from GOSAT observations. GOSAT observes solar radiation reflected from Earth's surface, as well as the degree of light polarization. A vector radiative transfer code (Pstar2b) has been developed to take into consideration the polarization effects possible when retrieving greenhouse gases.

For the accurate validation of GOSAT products with minimum uncertainty, experimental calibration of the validation instruments is required. Measurements of CO_2 and CH_4 concentrations by equipment onboard aircraft, and GPS sonde observations, were carried out simultaneously with FTS measurements at NIES in January 2009.

To process GOSAT data and to estimate CO_2 and CH_4 fluxes on a sub-continental scale, we use model-simulated estimates of surface CO_2 fluxes from natural and anthropogenic sources. The terrestrial biosphere flux is derived by an ecosystem model. The ocean–atmosphere flux is calculated by an ocean biogeochemistry model that assimilates the dissolved inorganic carbon in surface waters with the

ship-observed values. An atmospheric transport model is used to adjust the global distribution of the surfaceCO_2 and CH_4 fluxes to match the GOSAT observations.

Terrestrial ecosystem and land-use modeling (Core research project 3)

In cooperation with the Integrated Assessment Model Group of NIES, we developed a Land Use Change projection model. Using this model, we made spatially explicit land-use scenarios for the period 2000 to 2100, which will be used as RCPs (representative concentration pathways) for the IPCC's fifth assessment report. Under these scenarios, the spatial distributions of built-up areas, croplands, pastures, forests, natural grasslands, and other lands were estimated by using existing land-cover maps, net primary production data, and geographical information. Figure 2 shows cropland as a proportion of total land area in 2000, 2050, and 2100. The greater the red areas, the more extensive the cropland. Generally, there is a global increase in cropland between 2000 and 2050, especially in Africa, which shows a marked increase. In addition, we developed a population and GDP scenario of half-degree grid cells, and we used this scenario to make spatially explicit wood-harvest scenarios.

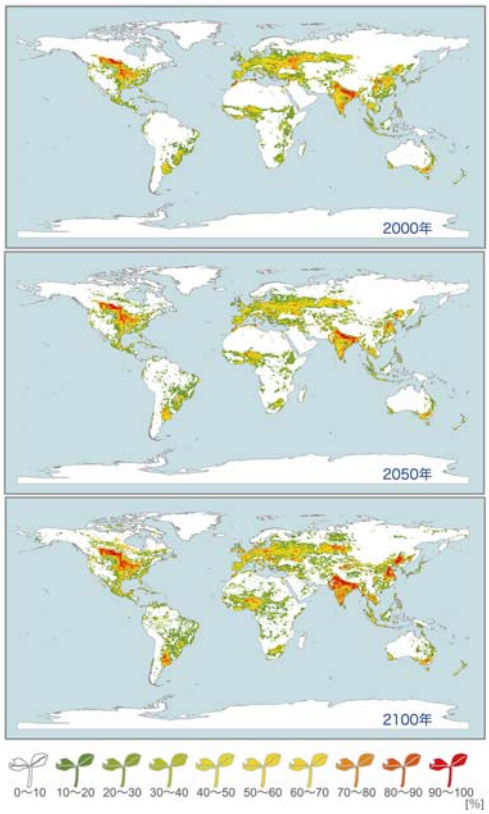


Fig. 2 Global fractional cropland area at half degree resolution. This forecast was made by using our Land Use Change projection model.

Climate policy assessment (Core research project 4)

Based on scenario analyses on climate policy, technological innovations and social innovations such as reform programs for social systems were studied from various viewpoints; for example, when and how such innovations should be implemented and what kind of measures and policies are effective to realize them.

There are also various technological and social barriers to achieving reduction goals, and it takes time to overcome these barriers. Therefore, proper steps must be taken in a due sequence. In studies of the best ways of implementing these innovations, a dozen of actions have been proposed and their effectiveness has been studied with the use of an assessment model. The entire 70% emissions reductions goal can be achieved by these actions, and efforts in the energy demand sectors are particularly important. Cross-sectional and/or additional measures will enable emissions to be reduced further.

A new round of official negotiations on a post-2012 international framework for climate change began after the Bali meeting (COP13) in 2007. We have developed a concrete proposal for the post-2012 climate regime, and have supported the Japanese government's decision-making on this issue. We also co-organized a workshop in October 2008 with the Institute for Global Environmental Strategies (IGES) to discuss the most preferable climate regime for the Asia-Pacific region, and suggested policies related to such issues as adaptation and technology transfer as the keys to an agreement on appropriate climate regime.

The potential for the mitigation of greenhouse gas emissions at the international and national levels in 2020 were evaluated by applying three models to support the policies of the Japanese Cabinet Secretary. First, we used the Enduse[Global] model, which is a bottom-up optimization model with a detailed technology selection framework, to evaluate mitigation potentials and costs, and to analyze greenhouse gases emissions reduction targets in Annex I countries in 2020 under the criteria of equal marginal abatement costs and equal total mitigation costs per GDP. Next, we used the Enduse[Japan] model to evaluate policy packages of mitigation options in more detail and proposed emissions targets for Japan in 2020. We also used the AIM/CGE[Japan] model, which is a computable general equilibrium model, to analyze the impacts of these measures on the Japanese economy.

Long-term monitoring of GHGs and other trace gases

Atmospheric greenhouse gases (e.g., CO_2, CH_4, and N_2O) and other chemical species (CO, NO_x, and SO_x) are monitored by various platforms to find the long-term variations and spatial distributions of these gases. We have two ground-based stations, at Hateruma Island, over 1000 km southwest of the Japanese mainland, and at Cape Ochi-ishi, in northeastern Hokkaido. Commercial ships operating between Japan and Australia, New Zealand, and North America are used to observe the latitudinal or longitudinal distributions of greenhouse gases and the partial pressure of CO_2 (pCO_2) in the surface waters of the Pacific. Routine samplings are conducted by aircraft over three sites in Siberia to measure the vertical distributions of greenhouse gases. In addition, continuous observations of vertical ozone profiles in the stratosphere have been performed by the millimeter-wave radiometers here at Tsukuba and at Rikubetsu, Hokkaido.

UV-A and UV-B on the ground are monitored, and real-time UV indexes obtained at 15 sites in Japan are available to the public via our web page.

The CO_2 mixing ratios observed at Hateruma Station (24.05°N, 123.81°E) have increased by about 29 ppm over the last 15 years (Fig. 3). The averaged growth rate of CO_2 during this observation period was 1.9 ppm/year. Higher growth rates were found in 1997–1998 and 2002–2003, when ENSO events occurred. The amplitude of the seasonal variation at Hateruma is 7.8 ppm—larger than that observed at Mauna Loa, Hawaii. This is because Hateruma is located on the western edge of the Pacific, where continental outflow in winter lifts the seasonal CO_2 maximum and enhances the seasonal amplitude.

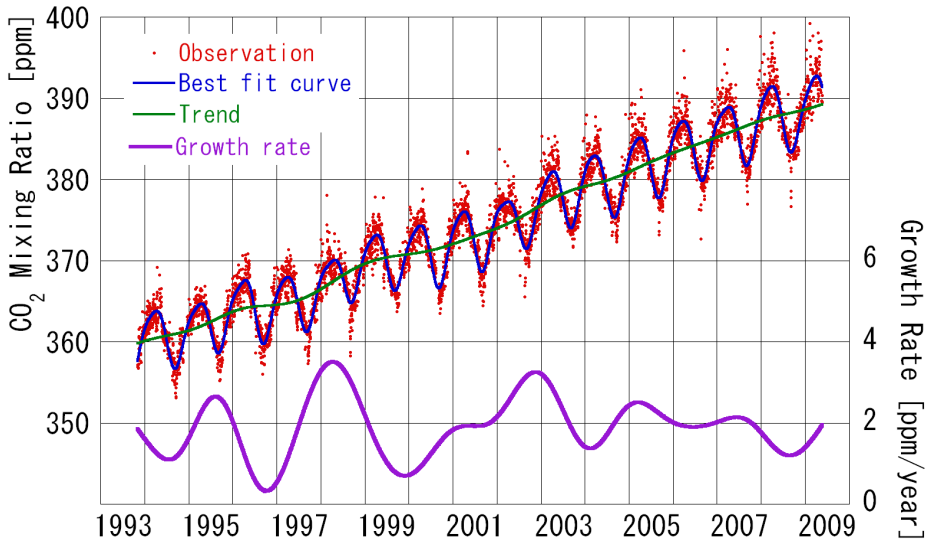


Fig. 3 Time series of CO_2 mixing ratio at Hateruma Station.

Carbon dioxide flux monitoring of terrestrial ecosystems

Long-term monitoring of carbon, water, and energy exchanges between larch forests and the atmosphere and in biological processes has been conducted in three larch forests in Japan to determine how the forests respond to climate change and how the responses depend on tree age and on processes of recovery from natural and artificial disturbances.

[1] The Teshio Carbon Cycle and Larch Growth (CCLaG) experiment site is located in northern Hokkaido; 14 ha of forest was clear-cut and planted to larch saplings in 2003. The clear-felling resulted in decreased photosynthesis and increased decomposition of dead roots and soil organic carbon. This flux decreased over the following 4 years because of the rapid growth of young trees. It took 5 years for the annual carbon balance to stabilize (Fig. 4a). [2] The Tomakomai Flux Research Site was established in 2000 in a mature larch forest, and clear seasonal changes in the carbon uptake dependent on the phenology of the larch trees were observed such as high photosynthesis and respiration during the growing season, and weak carbon exchange during the dormant season (Fig. 4b). [3] The Fuji Hokuroku Flux Observation Site is located in a mature larch forest at the foot of Mt. Fuji. Measurements were started in 2006, and a clear

seasonal pattern of carbon uptake similar to that at the Tomakomai site has been observed over the past 3 years (Fig. 4c).

These three larch forest sites provide useful information to help us understand and predict functional carbon- and water-cycles changes associated with disturbance.

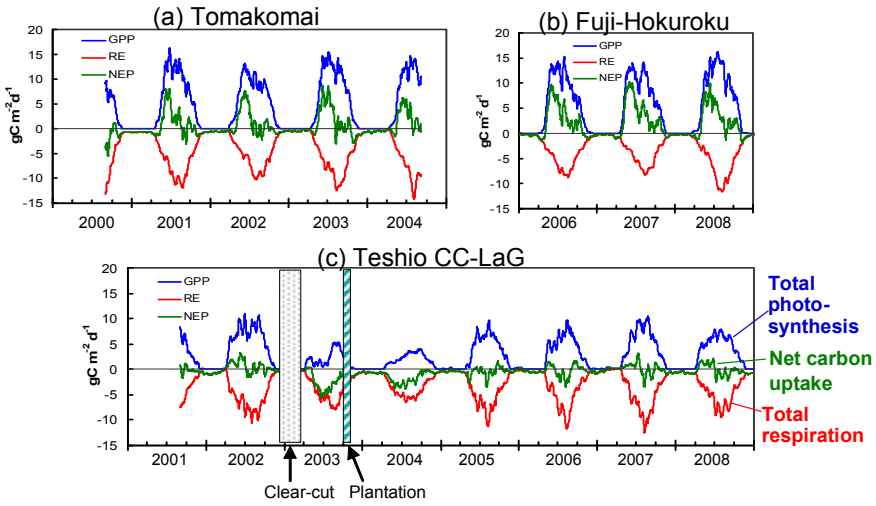


Fig. 4 Seasonal and year-to-year changes in total photosynthesis, total ecosystem respiration, and net carbon uptake observed in three forest sites at (a) Tomakomai, (b) Fuji-Hokuroku, and (c) Teshio CC-LaG.

Global environmental database

We are developing and managing various databases, websites, and data analysis tools for global environmental research and making them available to the public.

The following five database projects were conducted in FY 2008:

1. Development of a global environmental monitoring database and related tools
2. Development of a terrestrial carbon sink model database and related tools
3. Development of a GHG emission scenario database and related tools
4. Development of a GHG emission database and related tools
5. Development of a carbon flow database and related tools.

Carbon Sink Archives (CSA) began development in FY 2006 and was almost completed by the end of FY 2008. CSA is a web-based database and data analysis system for two-dimensional data related to the terrestrial carbon balance. As at the end of FY 2008, CSA contained 14 global net primary productivity (NPP) maps from various terrestrial ecosystem and carbon balance models. A normative NPP map has been developed from these maps (Fig. 5).

Additional surveys of greenhouse gas emissions in China, India, and Thailand were conducted in FY 2008, and a map of Asian greenhouse gas emissions as of 2005 was developed from various energy statistics and a large quantity of point-source data. An Asian emission inventory for black carbon was also developed.

The Asiaflux database, originally operated at the NIES Environmental Information Center, was transferred to CGER and now operates as part of CGER's Global Environmental Database.

The development of a new website, which displays the CO_2 concentrations measured at Cape Ochi-ishi and Hateruma Island in near real time and provides

search and visualization functions for data in the WDCGG (World Data Centre for Greenhouse Gases), has been completed and is now open to the public.

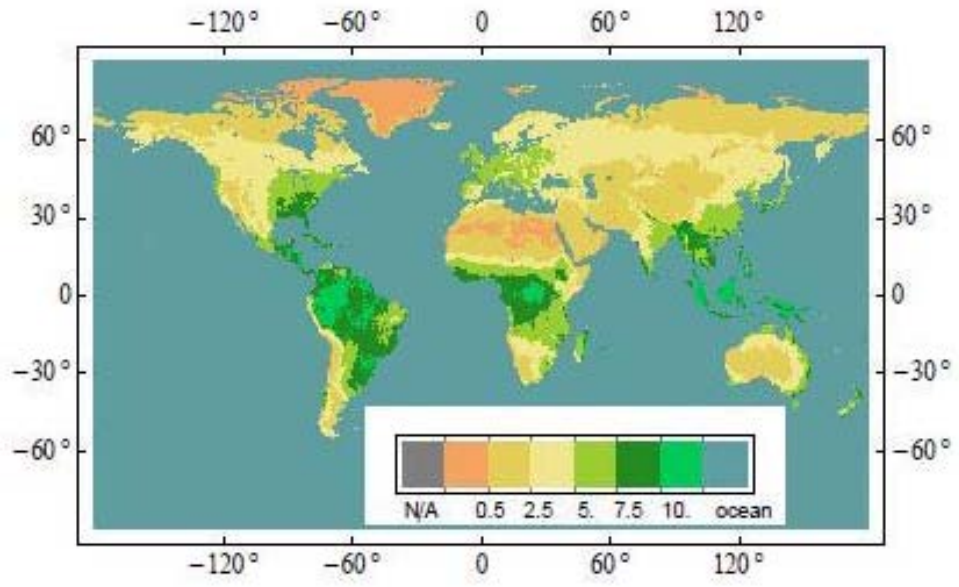


Fig. 5 The normative net primary productivity (t C ha^{-1} $year^{-1}$) map (v. 1.14.1). The mesh size is 0.5°. "N/A" in the legend means "Not Available"

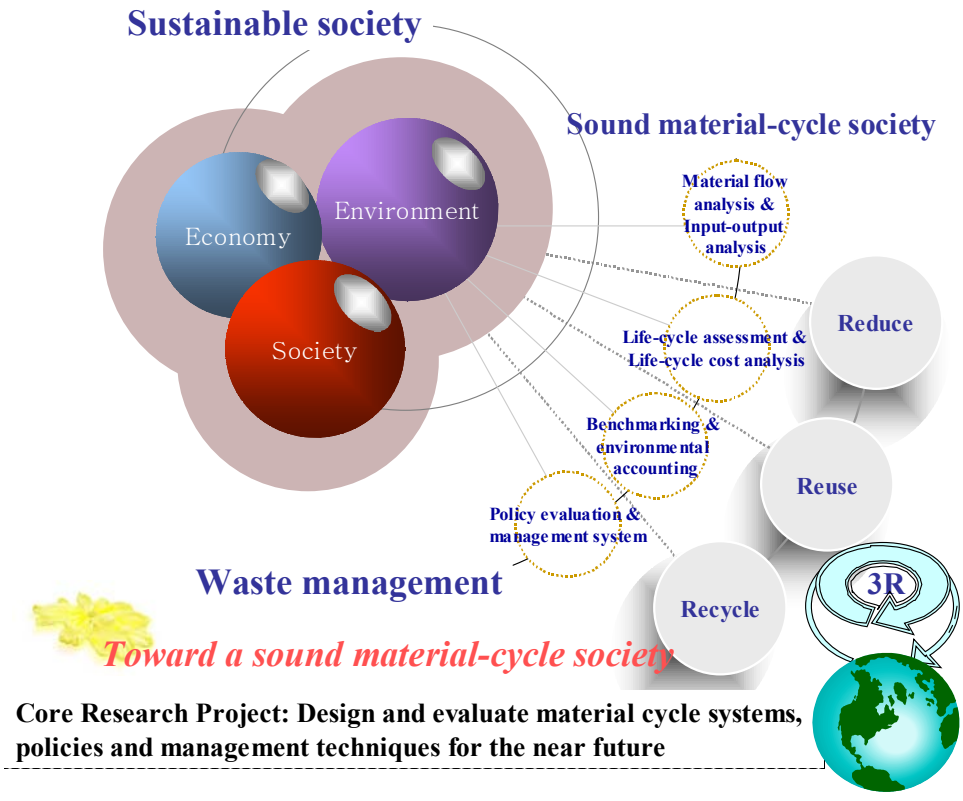
Greenhouse Gas Inventory Office of Japan (GIO)

The Greenhouse Gas Inventory Office (GIO) of Japan is engaged in the development and preparation of annual GHG inventories and a national inventory report in accordance with the United Nations Framework Convention on Climate Change (UNFCCC). Since 2003, in cooperation with the Ministry of the Environment of Japan, GIO has been annually organizing a Workshop on GHG Inventories in Asia (WGIA) to help Asian countries in developing and improving their GHG inventories through the promotion of regional information exchange.

Global Carbon Project (GCP) Tsukuba International Office

The office contributes to the day-to-day management and implementation of the Global Carbon Project and takes the lead in its Urban and Regional Carbon Management Initiative (URCM). It organized an International Symposium on "Realizing Low Carbon Cities: Bridging Science and Policy" and an International Workshop on "Towards Low Carbon Cities: Understanding and Analyzing Urban Energy and Carbon", held from 16 to 18 February 2009 in Nagoya. It also expanded and developed the Urban Energy and Climate Modeling Forum and improved its web-based URCM Resource Centre. The office contributed to Chapter 8, "Energy use in Cities" of the International Energy Agency's *World Energy Outlook 2008* publication and to various ongoing international assessments, namely, the Global Energy Assessment and the International Panel for Cities and Climate Change Assessment. As a result of the office's research activities, several articles have been contributed to journals and a Special Issue of the *Energy Policy Journal* focusing on cities and CO_2 emissions.

Research Center for Material Cycles and Waste Management



Core Research Project: Design and evaluate material cycle systems, policies and management techniques for the near future

Since its foundation in 2001, the Research Center for Material Cycles and Waste Management has aimed to realize a society with desirable material cycles, i.e., reduced usage of natural resources, reduced generation of waste, increased recycling of materials, and appropriate waste management. In accordance with the second 5-year plan of NIES (covering 2006–2010), the center is playing a main role in promoting a research program on "Sustainable Material Cycles" as one of the four Priority Programs. The program comprises four core research projects and other research activities that aim to ensure appropriate waste management.

1. Designing and evaluating material cycle systems and policies / management techniques for the near future (Core research project 1)

This research project aims to develop transition scenarios and specific plans for technological and socioeconomic systems to create a sound material-cycle society (SMS) for the near future (10 to 20 years from now). For this purpose, we have developed several social change scenarios, focusing on material flows and waste management systems in particular and based on scenario planning methodology. We have been also creating a model for quantitative assessment of these scenarios and the effect of various political interventions. Furthermore, we have evaluated existing and potential schemes for waste management and recycling. The following results were obtained in the third year of the project.

We improved an input–output-type material flow model by adding sub-models for describing material stocks and for estimating future materials demand on the basis of future population or number of households. As a case study, we estimated future demand for resources, emergence of wastes, and changes in stock, such as the carbon stock in wood products. In addition, we developed a system to assess the effects of materials and energy recovery from wastes on natural resource consumption, energy consumption, GHG emissions, and wastes sent to landfill. This system is based on life cycle inventory (LCI) analysis, and various technological process data were collected for its development. We applied this system to various recycling activities in Japan during 2000–2005 and showed their importance at the national level. We are continually expanding this type of assessment, categorizing measures toward an SMS as shown in Figure 1.

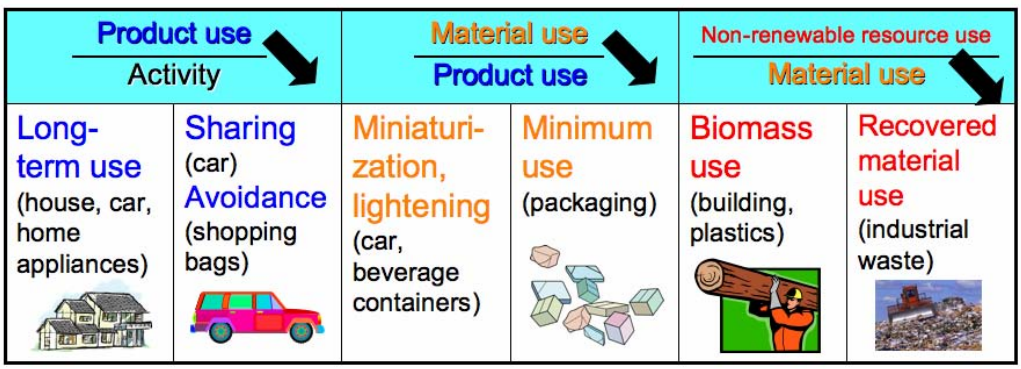


Fig. 1 Types of measures used to reduce non-renewable resource consumption.

We conducted policy research based on a bottom-up approach, evaluating legislation and policies. In a study of deposit-refund systems, we categorized

systems into those for waste, valuables, recyclables, or hazardous products. We examined the characteristics and applicability of these four systems and began developing indicators for waste prevention and the reuse of products. We also began using a top-down-approach research to determine both target materials/products for an SMS and responsibilities that stakesholders in an SMS should bear.

2. Management of hazardous and valuable substances in the life cycles of materials and products (Core research project 2)

Electronics articles such as TV sets and personal computers include many components of different materials. The release of toxic substances from such articles is of great concern during manufacturing, and use, and at the end of the product life cycle. Here we present two detailed case studies to illustrate the behaviors of hazardous substances in the critical phases of an article's life cycle.

Photolysis of brominated flame retardants in plastics under natural sunlight

Polybrominated diphenyl ether (PBDE) flame retardants—especially fully brominated one (decabromodiphenyl ether; DecaBDE)—are used to protect flammable plastics. We compared the photodebromination of technical DecaBDE in high-impact polystyrene (HIPS) and TV casings under natural sunlight conditions with that of technical decabromodiphenyl ethane (DeBDethane), which is an alternative to DecaBDE. BDE-209 (a main component of technical DecaBDE formulation) in pulverized HIPS+DecaBDE samples degraded with a half-life of 51 days (Fig. 2). In contrast, no marked loss of DeBDethane occurred throughout the experimental period of 224 days. In the HIPS+DecaBDE samples, concentrations of polybrominated dibenzofurans (PBDFs) increased dramatically after 1 week of exposure, with a concomitant decrease in BDE-209 levels. Environmentally relevant PBDE congeners were not formed. In the TV casing, tetra- to octa-BDF congener concentrations increased continuously during the experiment. More attention should be paid to the fact that PBDFs are formed by sunlight exposure during normal use as well as in the processes of disposal and recycling of consumer products treated with PBDE flame-retardants.

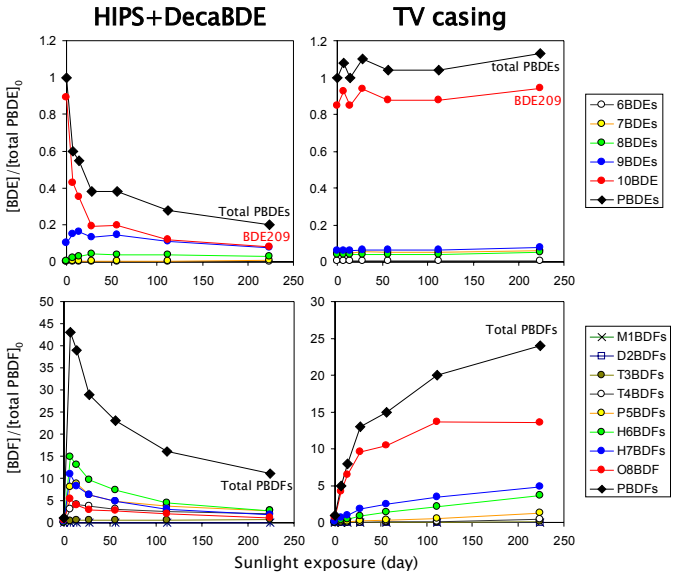


Fig. 2 Degradation and formation of PBDEs and PBDFs of different degrees of bromination from HIPS+DecaBDE and TV casing samples, normalized to [total PBDE] and [total PBDF] at time 0. [A]: molar concentration of compound A.

Evaluation of environmental impact of lead-containing cathode ray tube glass

Massive numbers of cathode ray tubes (CRTs) will inevitably be discarded in the near future. We examined the possibility of the release of toxic metals from CRT glass recycled as construction material or disposed of in landfill. Leaching tests were performed on each of three glass components of CRTs (panel, funnel, and the frit seal bond that joins them) by the Japanese Standard Leaching Test (JLT-13, laid down by Environment Agency of Japan in 1973) using four different kinds of filter. When we used a 1.0-μm glass filter, as specified by JLT-13, the concentrations of lead leached from the frit seal and funnel glass were 2.5 and 0.83 mg/L, respectively, exceeding the landfill regulatory limit of 0.3 mg/L. Scanning electron microscopic observations revealed that the lead in the filtrates derived from microparticles that passed through the filter. An additional leaching experiment showed that even after wash-off of the microparticles, continuous dissolution of lead from the CRT glass surface was present at levels close to the limit.

3. Developing a win–win resource recycling technology for waste biomass (Core research project 3)

Project 3 aims to develop recycling technologies that recover energy and materials from biomass and organize uses for the products. Using laboratory-scale catalytic reformers and fluidized bed gasifiers, we evaluated the usefulness of both reforming catalyst and porous silica at reducing tar under low-temperature (1023 to 1123 K) steam reforming conditions. When the porous silica was located upstream of a Ni-based catalyst bed, the concentrations of PAHs (Polycyclic Aromatic Hydrocarbons) included in the gasified gases decreased. The concentrations of both phenanthrene and pyrene were less than 10

mg/$m^3_N$when porous silica with a large specific surface area was used.

To create sustainable two-stage hydrogen and methane fermentation processes, we investigated the influence of organic loading rates (OLRs) on continuous hydrogen and methane production from food waste with a high total solids content (10%) in a full-scale system (Fig. 3). Food waste, collected from a dining hall at NIES, was used as a renewable source of energy and raw material.

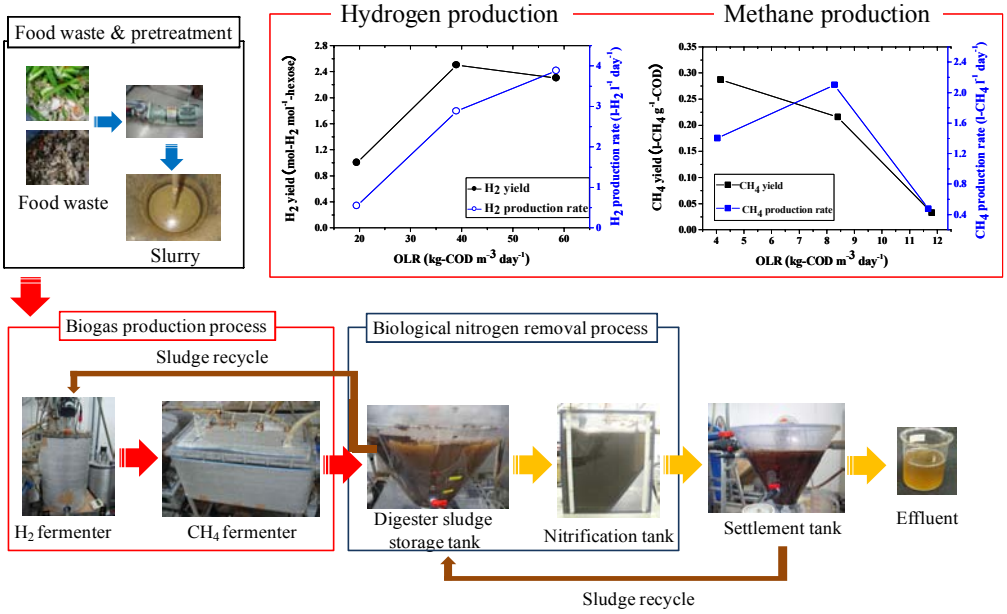


Fig. 3 Development of biogas production from food waste with a high total solids content using two-stage hydrogen and methane fermentation processes.

Hydrogen fermentation was operated at three OLRs: 19.5, 39, and 58.5 kg-COD m^{-3} day^{-1}. The methane fermentation reactor was operated at three OLRs: 4.16, 8.4, and 11.8 kg-COD m^{-3} day^{-1}. The digester sludge was supplied from a sludge storage tank to the hydrogen fermentation reactor to adjust the pH in the reactor to within the range of 5.4 to 5.7. The sludge recycling ratio (flow rate of returned sludge / flow rate of influent) was about 1.0. The results confirmed the feasibility of continuous hydrogen and methane fermentation in a two-stage process using sludge recirculation from the digester sludge tank for nitrogen removal in a full-scale system. The average hydrogen yield from food waste with 10% total solids was 11.1 L-H_2 L^{-1}-fed day^{-1}, and the average methane yield was 47.4 L-CH_4 L^{-1}-fed day^{-1}, corresponding to 62.5% (2.5 mol-H_2 mol^{-1}-hexose) and 82% (287 mL-CH_4 g^{-1}-COD) of the theoretical yield, respectively, without the use of any external chemical buffers. The optimized OLRs for continuous thermophilic hydrogen and methane fermentation were 39 and 4.16 kg-COD m^{-3} day^{-1}, respectively. The alkalinity of the recirculation sludge for pH regulation had a key influence on hydrogen productivity in the hydrogen fermentation reactor.

In another study, we determined the optimum conditions for crystallization in phosphorus adsorption–desorption processes for domestic wastewater treatment. We clarified the operational factors required for adsorption and removal of phosphorus in accordance with the processing scale and phosphorus level. We

also successfully performed phosphorus recovery from excess sludge in a *johkasou* household wastewater treatment system equipped with an iron electrode.

We developed a solvent extraction method for recovering feedstock components from trap grease for making biodiesel fuel (BDF), and then demonstrated that the extracted materials could be converted into BDF by the conventional alkali catalyst method. Furthermore, we improved our superfast BDF production technology using liquefied dimethyl ether (DME) by understanding the phase equilibrium of the BDF synthesis system. The improvement reduced the amounts of DME and methanol required for l BDF production by more than 50%. As another sub-theme in this project, we proposed a method of establishing local sound material cycle (SMC) blocks for waste biomass. This method consists of four processes: information collection by oral survey and workshop; database construction for regional analysis of waste biomass; suggestion of scenarios, taking into account intersystem coordination and technological innovation; and SMC consideration through an analysis of the suggested scenario using the database. Case studies were conducted on food wastes in Ibaraki prefecture and wood wastes in the Tokyo metropolitan area; adequate scales of local SMC blocks for each kind of waste biomass were found to meet the supply–demand balance.

4. Establishing appropriate management networks and technology systems to support sound international material cycles (Core research project 4)

To promote appropriate material cycles in developing Asian countries, we examined the current transboundary movement of recyclable resources and related recycling in each country. In addition, we designed, applied, and evaluated waste management technologies and systems that mitigate disposal and global warming.

We analyzed the material flows of internationally traded recyclable resources, including secondhand CRT TVs exported from Japan. Although the major destination until 2006 was Hong Kong, this changed to other countries after 2007 because of the strengthening of Hong Kong's import controls (Fig. 4). This demonstrates the importance of proceeding with Asia-wide trade controls on secondhand electronics. With the aim of improving e-waste management, we organized the fifth NIES Workshop on E-waste in November 2008 and exchanged advanced information with Asian researchers. We also investigated changes in waste PET recycling and trade between Japan and China, and the significance of these changes, after the economic crisis in 2008.

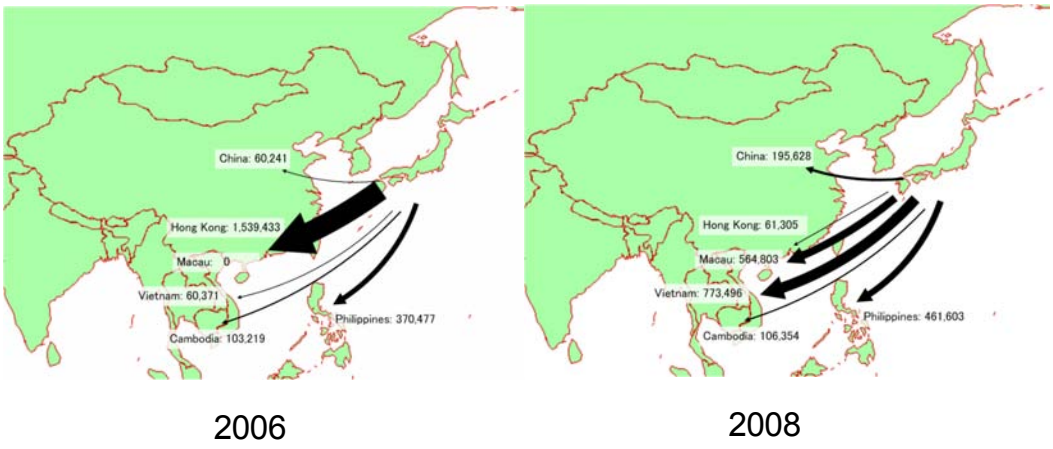


Fig. 4 Material flows of secondhand CRT TVs exported from Japan. (unit: tons)

We analyzed soils from e-waste sites in Bangalore and Chennai, India, for brominated flame retardants such as PBDEs and compared those concentrations with those at reference sites to assess the extent of emissions of these contaminants due to e-waste recycling. The highest PBDE level was found in a soil sample from an e-waste backyard recycling unit in Bangalore (2000 ng/g dry weight). Similarly, soils from e-waste scrapping sites and backyard recycling units in both Bangalore and Chennai had higher levels of PBDEs than soils from reference sites. The diverse and complex PBDE congener distribution patterns in soils from e-waste sites indicate that the contamination sources are diffuse and largely influenced by evaporation, dust dispersion, runoff, and leaching.

Some parameters for the IPCC Waste Model, which are used to estimate methane emissions from waste disposal sites, were obtained from landfill sites in South Asia. The first-order decay constant (k) for tropical landfills in Thailand was estimated at 0.33. The oxidation factor (OX) was lower in Southeast Asia, because the rate of emission was high. The average methane correction factor (MCF) was about 1.0. This means that landfill sites in Southeast Asia are anaerobic. We also started to compile an Asian waste database with technical standards for acquisition of reliable data.

We investigated the regional characteristics of domestic wastewater in China, including pollutant load and quality, quantity, and biomass of wastewater. We established the basic information required to upgrade processing by customizing treatment technologies to suit regional characteristics and to analyze processing functions.

5. Research to ensure appropriate waste management practices

Technologies for crushing and separating industrial waste were classified on the basis of several parameters, including cost and recycling rates. We developed a model for simulating the logistics of industrial wastes and their secondary resources in a virtual space to which classified crushing and separation technologies, landfills, and recycling plants had been allocated. To secure the protection of the environment at final disposal, we proposed three new genres of final disposal: the accelerating stabilization type, the resource stockpile type, and the land-developing type, all of which are appropriate to the quality and quantity

of landfilled waste expected in an SMS. We also used life cycle assessment and life cycle costing to estimate the advantages of off-shore landfills over inland landfills. To establish a flue-gas monitoring method for controlling dioxin emissions in incineration plants, we took measurements in commercial-scale plants. The concentrations of dioxins at the inlet of dust collection device were relatively high. The results suggest that formation of dioxins in the gas-cooling process should be controlled to reduce their emissions from incineration plants by using effective indicators such as a dioxin surrogate in the flue gas.

Appropriate treatment technologies for domestic wastewater, sludge, and garbage were conducted. On the basis of bench-scale examinations of kitchen garbage disposal by disposers and an analysis of the characteristics of kitchen garbage storage and solubilization in small-, medium-, and large-scale domestic wastewater treatment facilities, we determined the optimum operating conditions for these facilities. The amounts of GHGs released from wastewater treatment facilities were determined through a basic examination by inventory analysis.

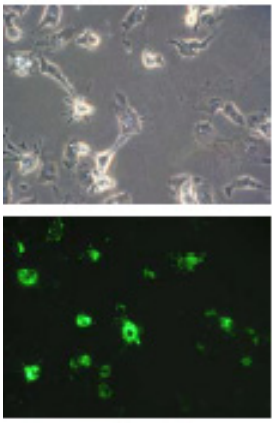
6. Promotion of fundamental research

In an asbestos-related study we standardized the sample preparation procedures and fiber-counting and identification rules in order to test the slag samples by melting of asbestos wastes. For the study we used procedures such as phase-contrast microscopy (PCM), dispersion staining, polarized light microscopy, scanning electron microscopy (SEM), and transmission electron microscopy (TEM). The proposed testing methods were evaluated by interlaboratory studies using simulated slag samples. Chrysotile was successfully detected by PCM, SEM, and TEM in slag samples at 0.01%—a concentration that could not be detected by conventional X-ray diffraction. We also performed an interlaboratory test to examine the quality of airborne asbestos analysis by PCM. The reported results were evaluated by a proficiency score based on the degree of difference from reference fiber counts. In testing using amosite test slides, many of the participating laboratories obtained good proficiency scores.

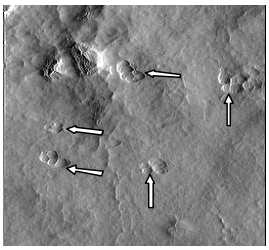
In addition, we have been working toward establishing databases of material cycling and waste disposal processes, material flows, and chemical characteristics of recyclable resources and wastes. These databases will help us not only to design and evaluate material cycle systems, but also to promote appropriate waste management.

Research Center for Environmental Risk

Inhalation chambers used for toxicity evaluation of environmental nanoparticles.
A chronic study has started in July of 2008



A Scavenger receptor MARCO recognizes nanoparticles (green fluorescence)



Detection of nanoparticles deposited on the cell surface by atomic force microscopy (arrows)

The Research Center for Environmental Risk (RCER) is conducting an Environmental Risk Priority Program based on the second 5-year plan of NIES, covering the period 2006–2010. In this program, we perform comprehensive research on how to assess environmental risks, such as the effects of chemical substances, invasive species, and nanoparticles on human health and the ecosystem.

The Environmental Risk Priority Program incorporates the following four Core Research Projects:

1. Integrated exposure assessment analysis of the complex factors involved in chemical exposure.
2. Methods for assessing the health risks posed by environmental chemicals that cause sensitivity reactions.
3. Assessment of health risks associated with environmental nanoparticles.
4. Development of environmental risk assessment methods that take into account biodiversity and ecosystem functioning.

We are also conducting the following research activities on issues that may have future applications in environmental decision-making:

– Fundamental research to improve environmental risk assessment methodologies.
– Collection and dissemination of information on environmental risks.
– Environmental risk assessment practices for regulatory objectives.

1. Integrated exposure assessment analysis of the complex factors involved in chemical exposure (Core Research Project 1)

We aim to establish an exposure assessment process that effectively and comprehensively considers the complex nature of exposure to chemicals. The project will integrate a number of exposure variables, including chemical composition and spatial and temporal scales, to provide a more comprehensive view of the status of exposure to multiple chemicals for future risk assessment. The project consists of three main topics: (1) development of methods of hierarchical exposure analysis based on a geographic information system (GIS) from the regional to the global scale; (2) exposure measurement based on in vitro and in vivo bioassays; and (3) exhaustive development of integrated exposure analysis, as described below (Fig. 1).

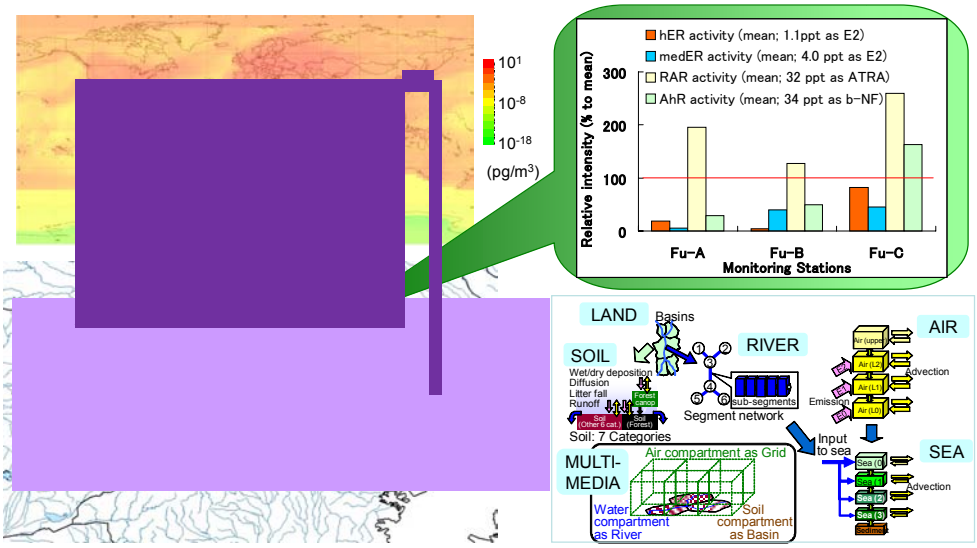


Fig. 1 General concept of the integration of hierarchical modeling outputs and exposure monitoring by bioassays.

Through the use of fate-modeling methods to model the natural and environmental dynamics of chemicals, the development of hierarchical exposure analyses will help us to understand exposure to multiple chemicals. This year we released a regional-scale GIS fate model package with an interface program and data to broaden the use of the model. We performed a case study to derive the global source–receptor relationships of polychlorinated biphenyls to estimate the regional contribution to global levels. We used laboratory experiments to study the sediment–water dynamics of selected hydrophobic chemicals, and we studied methods of estimating emissions of pesticides and their temporal variability, with a case study for paddy field application.

To analyze the complex causes of exposure we are applying bioassays and exhaustive chemical analyses to environmental samples. We have used various bioassays and analyses to perform a nationwide field survey of the waters of 108 rivers. We have also examined airborne mutagenic compounds and polycyclic aromatic hydrocarbons (PAHs) in 11 sites throughout Japan ; studied *in vivo* methods for testing toxicity to aquatic organisms; and performed related basic studies by both *in vitro* and *in vivo* bioassays.

We aim to present the methods and results of our integration of multiple exposures and to be able to analyze various types of data (e.g. socioeconomic) in order to develop effective measures for exposure reduction and control. This year, we have explored methods of integrating GIS-based fate model outputs with geographical variability and assessment of exposure from foods through trading networks.

2. Methods for assessing the health risks posed by environmental chemicals that cause sensitivity reactions (Core Research Project 2)

The aim of this project is to establish experimental models for assessing the

health risks posed by environmental chemicals such as volatile organic compounds, dioxins, and pesticides at low doses in susceptible individuals.

We examined whether a deficiency of toll-like receptors (TLRs), which play a key role in innate immunity, influences nerve growth factor (NGF) expression in the hippocampus of mice exposed to toluene. TLR4 deficient-immunized mice showed significantly low NGF

expression in the hippocampus after toluene exposure. Our result suggest that TLRs are involved the hippocampal neurogenesis in response to environmental exposure to toxic chemicals, in concert with allergic sensitization.

Inhalation exposure to toluene during late fetal life decreased blood testosterone levels and production of 3beta-HSD, an enzyme involved in testosterone synthesis, in the testes of fetal male rats (Fig. 2), suggesting that toluene exposure during development affects brain sexual differentiation and alters the size of sexually dimorphic nuclei which regulates sexual hormones.

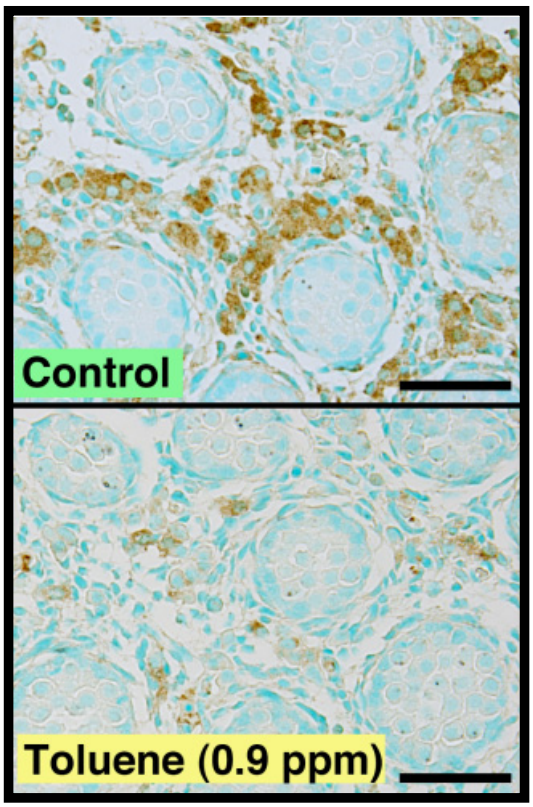


Fig. 2 Decreased production of a steroidogenic enzyme in the testis following low-level toluene exposure.

Exposure of early infant mice to 5 or 50 ppm toluene resulted in significantly decreased expression of transcription factor T-bet and Foxp3 mRNAs in the spleen in late infancy (postnatal day [PND] 21), suggesting that low-level toluene exposure in infancy suppressed immunological parameters related to T cell differentiation.

Mouse pups were exposed to a potent dioxin congener, 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD), through the breast milk of dams that had received a single dose of 15 μg/kg body weight orally after delivery. In

this time-course study, the critical period of susceptibility to the development of hydronephrosis was PNDs 1 to 4. TCDD significantly upregulated the cyclin-dependent kinase inhibitors $p27^{kip1}$ and $p57^{kip2}$, both of which regulate the cell cycle in the developing mouse kidney. These findings suggest that hydronephrosis caused by TCDD treatment is due to TCDD-induced G_1 cell-cycle arrest via $p57^{kip2}$ upregulation, which appears to be mediated by the aryl hydrocarbon receptor.

Oral exposure of neonatal rats to rotenone, a naturally occurring pesticide, facilitated the spontaneous motor activity of the mice as juveniles. Chronic exposure of adult rats caused hypokinesia like that seen in patients with Parkinson's disease.

Maternal exposure to di-(2-ethylhexyl) phthalate (DEHP) during the neonatal period, but not during the fetal period, enhanced atopic dermatitis–like skin lesions related to mite allergen exposure in male mice offspring. Our results support the hypothesis that maternal exposure to DEHP during the neonatal period is at least partly responsible for the recent increase in atopic dermatitis in offspring through exposure via the breast milk.

3. Assessment of health risks associated with environmental nanoparticles (Core Research Project 3)

We have been investigating the biological impacts of ultrafine particulate matter and environmental nanoparticles and determining how these materials behave in the body. Our final goal is to establish health-risk assessment methods that are geared to these kinds of particles rather than to regular chemicals.

Nanoparticle-rich diesel exhaust was generated by an idling diesel engine. We analyzed the size and chemical composition of the nanoparticles in the exhaust. The main components originated from unburned diesel fuel or lubricants. From FY 2005 to 2007 we studied the acute effects of nanoparticle-rich diesel exhaust on the lung and heart in rats and mice. This exhaust caused mild pulmonary inflammation and cardiac dysfunction, suggesting that inhaled nanoparticles have extrapulmonary effects. On the basis of the results of this acute study, in FY 2008 we started a long-term exposure study to determine the chronic effects of nanoparticle-rich diesel exhaust in three strains of mice (A/J, BALB/C, and CB6F1-Tg rasH2). The exposure will continue for a year and a half.

We investigated the interaction of multi-walled carbon nanotubes (MWCNTs) with human bronchial epithelial cells and found that dispersed MWCNTs activated nuclear factor-κB and upregulated the mRNA and protein levels of proinflammatory cytokines in the cells. Scanning electron microscopic analysis indicated that the cell membrane ultrastructure was lost after 8 h of exposure to MWCNTs. In the nanoparticle health effects building we have installed a facility for inhalation of MWCNTs to investigate the in vivo effects of nanofibers. We also developed a simple batch particle generation system to generate airborne MWCNTs for inhalational toxicology studies (Fig. 3). A study of aerodynamically classified particle morphology found that both dissociated fiber-like materials and agglomerated MWCNTs were generated; the former accounted for up to 38% of all particles. The average width of the fibers was 80 nm and the length 3.7 μm.

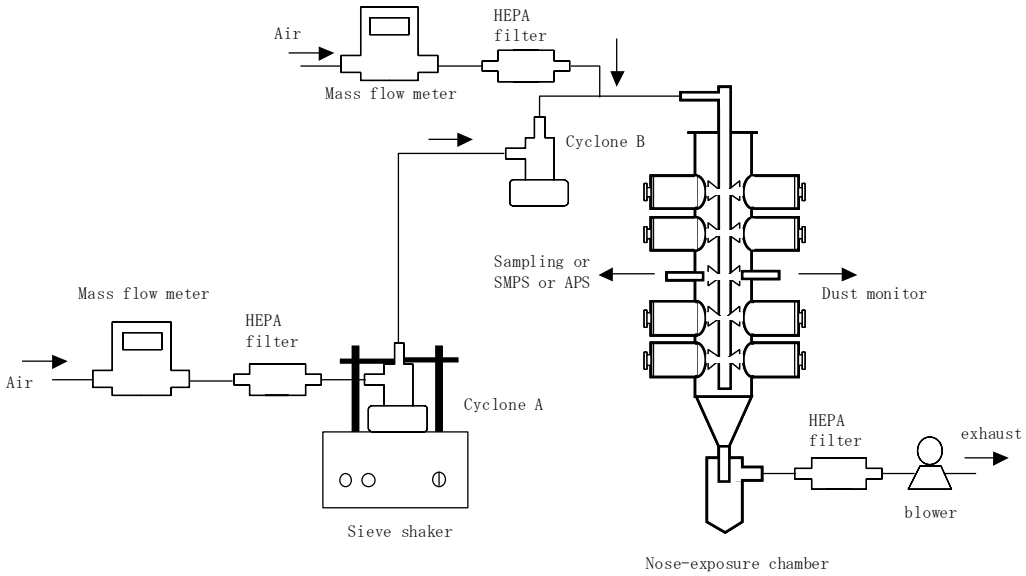


Fig. 3 Schematic diagram of the batch particle generation system used for inhalational toxicology studies. The system includes a chamber for nose exposure to multi-walled carbon nanotubes. SMPS, scanning mobility particle sizer; APS, aerodynamic particle sizer spectrometer.

The toxicity of heat-treated asbestos was determined in both an in vivo animal model and in vitro cell culture system. Intraperitoneal injection of amosite induced acute inflammation in the peritoneal cavity. However, injection of heat-treated asbestos caused only marginal inflammation. Similarly, cells exposed to heat-treated anthophyllite produced smaller amounts of macrophage chemotactic protein-1 and 8-hydroxy deoxyguanosine than did cells exposed to the same concentration of unheated anthophyllite.

4. Development of environmental risk assessment methods that take into account biodiversity and ecosystem functioning (Core Research Project 4)

The purposes of this project are to assess ecological risks and to develop effective risk management methods that take into account biodiversity and ecosystem functioning. On the basis of field observations of various ecological hazards associated with human impacts, biological interactive effects, and the distributions and/or dispersal of invaders, we will establish ecological risk assessment methods that are consistent with theoretical ecological considerations.

We conducted detailed field studies of the life-history traits of the marbled sole, dragonet, and mantis shrimp, and seasonal bottom-trawl surveys of fishes, mollusks, crustaceans, and echinoderms at 20 sampling stations in Tokyo Bay. Possible impacts of environmental stressors, such as hypoxia and high seawater temperature, on the recruitment success of marbled sole and mantis shrimp were analyzed on the basis of field studies and laboratory experiments. The results suggested that (1) the settlement success of mantis shrimp larvae and/or the survival of settled juveniles can be inhibited by hypoxia; (2) the hatching success and/or survival of marbled sole larvae can be inhibited by seawater temperatures higher than 10 ºC during the periods mid-January to early March; and (3) hypoxia

increases the mortality of settled marbled sole juveniles and restricts their spatial distribution.

We investigated the effects of pond management on the occurrence of alien species in 64 farm ponds in Hyogo Prefecture, Japan, through a field survey and interview. In the study region, bluegill sunfish and red swamp crayfish are the most widespread and abundant aquatic invaders. It is generally believed that pond drainage is effective in eradicating alien fish. Contrary to this expectation, draining of ponds did not affect the occurrence of bluegill, but it did affect the presence of red swamp crayfish, which generally occurred in drained ponds. The occurrence of bluegill was generally high where dam water or agriculture drains were used as the major water supply. These alien fish probably migrate from dams or irrigation systems.

Through the investigation of DNA variations in invading populations of the Argentine ant, which is a representative invasive alien ant worldwide, we revealed that the ant expanded its distribution in countries around the Atlantic Ocean and then around the Pacific Ocean port to port along shipping routes. Furthermore, we found that the ant constructed just one super-colony among countries around the Pacific Ocean. We also investigated the present state of distribution and DNA variation of the golden mussel and verified by population genetic analysis that the species has expanded its distribution via artificial flumes and conduits. We advocated a new hypothesis, the “Asian origin hypothesis”, for the origin of chytridiomycosis, a serious emerging disease of amphibians. This hypothesis was the result of investigations into the pandemic state of the disease both in Japan and globally, as well as a study of genetic variation in the causative agent, a chytrid fungus.

To assess impacts on ecosystem function (ecosystem-level trophic transfer efficiency : the fraction by which the total biomass produced by phytoplankton is converted into fish biomass through trophic interactions), we analyzed the community-level dynamics of functional traits in lake zooplankton communities. The minimum ecosystem model yielded the most important model parameter for optimizing trophic transfer efficiency: the ecological efficiency of the primary consumer, which in lake or estuary ecosystems is considered to be grazer zooplankton. Ecological efficiency is defined as the fraction of the total food biomass consumed by a particular grazer species that is converted into population-level biomass; these efficiencies were estimated individually for most zooplankton species that compose a community. After we had constructed a database of zooplankton functional traits, we made time-dependent estimates of mean ecological efficiency from long-term monitoring data from Lake Kasumigaura. Wavelet analysis indicated that the mean ecological efficiency had long-term periodic fluctuations that were synchronous with temperature fluctuations (Fig. 4). These results imply that the ecosystem function of a lake can be assessed by mean ecological efficiency, as evaluated by the minimum ecosystem model.

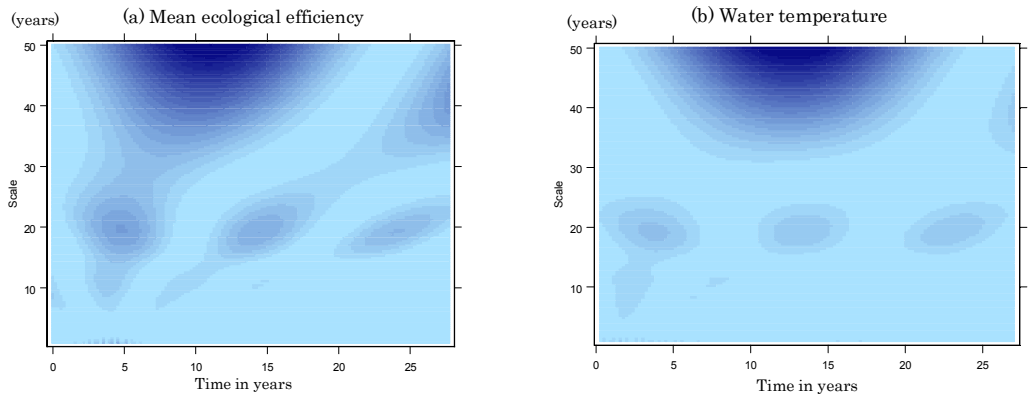


Fig. 4 Local power spectra of various scales (periodicities) of wavelet functions across the total period of long-term monitoring in Lake Kasumigaura for (a) mean ecological efficiency of the zooplankton community, and (b) water temperature. The horizontal axis represents time in years after 1980, and the vertical axis represent the scale (periodicity) extracted from local timeseries data. Darker areas denote stronger power spectra. The results indicate that very long-term changes in both ecological efficiency and water temperature began in about 1990. Shorter-term changes also occurred synchronously in the two measures, strongly suggesting that water temperature is one of the most important forces driving lake ecosystem functioning.

5. Research on upgrading of chemical exposure analysis for environmental monitoring

The purpose of this study is to develop methods for the instrumental analysis and bioassay of chemical substances and their metabolites, thereby improving assessment of exposure to chemical substances for environmental research. We have developed methods that can be used to assess exposure to toluene, a typical volatile organic compound.

Headspace solid phase microextraction gas chromatography –mass spectrometry (SPME-GC/MS) was optimized for the analysis of small blood samples. The limit of determination—0.25 ng (50 ng/mL × 5 μL of blood) —was found from 10σ; this limit was obtained by repeated measurements conducted by the standard solution headspace SPME method. The method was used for the analysis of fetal blood toluene levels to assess how maternal exposure to toluene influences the fetus. Blood toluene levels in both mother and fetus increased in proportion to the exposure concentration . Fetal blood levels were significantly higher than those in controls when measured approximately 20 min after the termination of exposure to 9 or 90 ppm toluene (90 min/day × 5 days). CYP2E1 induction was found in the livers of the mothers, but rarely, if at all, in the fetuses. We also established a method of using Liquid chromatography/mass spectrometry/mass spectrometry (LC-MS/MS) to quantify hippuric acid, a metabolite of toluene, in the amniotic fluid of a fetus.

6. Database system for comprehensive chemical risk assessment

A GIS database was developed to evaluate the present states of ecosystems and to identify the pressures or drivers that affect ecosystems. The study was undertaken in the southwest of Hyogo Prefecture (about 1200 km^2), because this region is characterized by high densities of irrigation ponds and is one of the most important for conservation of freshwater biodiversity in Japan.

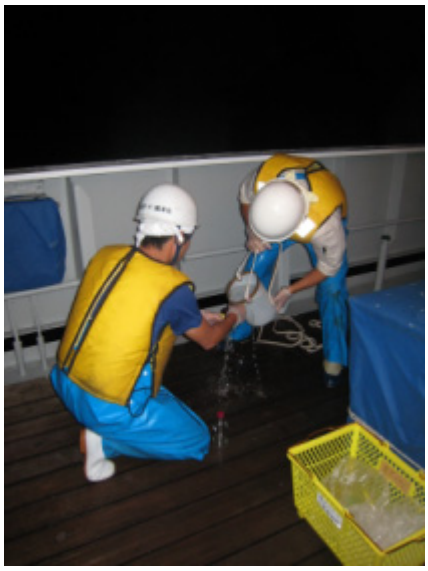
We have collected over 50 sources of geological, biological, chemical, or demographic information in the form of satellite imageries, aerial photographs, topographic maps, and data on land cover, climate, vegetation, soils, population, dams and water pipe lines, land-use restrictions (conservation areas), and use of agricultural chemicals. Aerial photographs were taken in July 2007 and then

orthorectified and geo-coded. Vegetation cover and the occurrence of algal blooms were quantified from the aerial photographs and mask polygon layers created from 1:2500 geo-coded topographic maps. Among aquatic organisms, we focused on macrophytes, which are good indicators of biodiversity and ecosystem functioning in irrigation ponds. Distributions of macrophytes were surveyed in >300 irrigation ponds. We developed another GIS database to analyze historical changes in ecosystems. Data on macrophyte distributions in the 1990s were provided by the Museum of Nature and Human Activities, Hyogo. Data on the distributions of irrigation ponds were obtained from topographic maps for 1985, 1995, and 2005. Historical land uses in these years were estimated from satellite images.

From the land-use data, we constructed a predictive map of macrophyte diversity in the study area. We subsequently extracted several candidate areas for conservation by overlaying socioenvironmental information, such as areas in which urbanization was being promoted, on the map.

Asian Environment Research Group

Seawater sampling device



On-board tracer experiment using stable isotope analysis

The research vessel *Shoyo Maru*, Seikai National Fisheries Research Institute

Field survey of marine ecosystems in the East China Sea
(Core research project 2)

Japan is closely connected to Asia both geographically and economically, and rapid future development is expected in Asia. Therefore, the preservation of the environment and the creation of a society in harmony with nature are crucial to environmental security and a sustainable society throughout Asia. Against this background, the Asian Environment Research Group conducts research on air quality; long-range transboundary air pollution; sustainable management of water environments in terrestrial, coastal, and oceanic areas; and ecosystem management and conservation in catchments such as those of large rivers. In the second 5-year plan at NIES (covering 2006–2010), we have been carrying out three core research projects and other research activities as part of our Asian Environment Priority Program. The Asian Environment Research Group has five research sections, an independent senior research scientist, and two collaborative research sections. These core research projects promote Asian environmental management and will help to establish scientific knowledge and the foundations of policy recommendations to create a society in harmony with nature through international cooperation.

1. Developing methods for evaluating the atmospheric environment of East Asia (Core research project 1)

The regional air quality (e.g. ozone, anthropogenic aerosols, mineral dusts) of East Asia is being investigated through comprehensive field monitoring, the development of an emissions inventory, and transport modeling. The final goal of this project is to develop an integrated method based on observation and modeling that will give us an understanding of the current status of the air quality of East Asia and allow us to predict future changes in the atmospheric environment. Under this project, three sections are working on the following sub-projects: (1) study of regional-scale air quality in East Asia; (2) evaluation and future projection of the atmospheric environment in East Asia; and (3) application of dust and sandstorm data measured by the lidar (light detection and ranging) observation network in East Asia.

Study of regional-scale air quality in East Asia

The **Asian Atmosphere Section** has continued comprehensive observations of the chemical, physical, and radiative properties of aerosols and gases at Cape Hedo Aerosol and Atmosphere Monitoring Station (CHAAMS) in Okinawa, Japan. In addition, the new station for the ground-based observations at Fukue in Nagasaki Prefecture was constructed in fall 2008 with NIES Special Research fund. Here, ozone, NO_x, volatile organic compounds, and total reactive nitrogen are continuously measured. In spring 2009, ground-based observations were performed at both places to coincide with aircraft observations over the East China Sea using the Global Environment Research Fund B-083. In the same period, filter samples for inorganic species, PAHs (polycyclic aromatic hydrocarbons), and heavy metal species were taken at CHAAMS and Fukue made as part of a project on the Impact of aerosols in East Asia on plants and human health funded by

SHIN-GAKUJUTSU of the Ministry of Education, Culture, Sports, Science and Technology, being run in collaboration with several Japanese institutions.

Ammonia and ammonium data measured in spring 2008 during the W-Pass (Western Pacific Air-Sea Interaction Study) campaign period were analyzed. The average ammonia mixing ratio at CHAAMS was 0.61 ppbv, and the ammonium mass concentration was 2.20 μg m^{-3}. The ratio of ammonium ion to ammonia species was often more than 0.9 when transported air mass data were selected by wind direction and wind speed. This indicates that ammonia species are transported in the particulate-associated phase (namely, as ammonium ions in the aerosol). The data obtained from the aerial observation in the spring of 2008 were also analyzed. On 28 March, the aircraft flew from Fukue, Nagasaki, to Cape Hedo, Okinawa, in a prevailing northwesterly wind. The mixing ratio of ozone and sulfur dioxide showed a broad peak during the flight from north to south at about latitude 127º42′N, longitude 29º42′E. Above CHAAMS the mixing ratio of sulfur dioxide and ozone was highest at a height of 2000 m. These findings indicate that the atmospheric species were not distributed uniformly. A simulation revealed that an air pollution band extending from the Shanghai area was the cause of the lack of uniformity of space distribution in this area.

Particle-associated n-alkanes and PAHs were measured in April, June, and October 2008 at Cape Hedo, Okinawa. Transport of anthropogenic aerosols was frequently observed in spring; this trend was basically the same as that found previously in this project. This year, observations were conducted in fall for the first time. PAH and n-alkane levels in fall were close to those in summer, and n-alkanes of biogenic origin predominated. In contrast to the results in spring, little transport of anthropogenic aerosols was observed in fall.

Information on CHAAMS, including an outline of research and a list of instruments, is made available via the CHAAMS home page (http://www.nies.go.jp/asia/hedomisaki/home-e.html), which was opened to the public in fall 2008. Currently, some preliminary results (as graphs) can be viewed.

Evaluation and future projection of the atmospheric environment in East Asia

The **Regional Atmospheric Modeling Section** developed an integrated research system for ground, lidar, aircraft, and satellite observations, chemical transport modeling, and emission inventory development. It used this research system to analyze the current status, historical trends, and future outlook of urban, regional, and trans-boundary air pollution in East Asia.

We conducted long-term simulations of air quality in the East Asian region during 1980–2008 by using a regional-scale chemical transport model (Community Multi-scale Air Quality modeling system, CMAQ) and the year-by-year Regional Emission Inventory in Asia (REAS). By using simulated tropospheric ozone, anthropogenic aerosols, and acid depositions, we analyzed historical and interannual variations and spatial variations in regional-scale air pollution and the impacts of

trans-boundary pollution on air quality in Japan.

Other research activities were: (1) estimation of the contribution of emission areas on a global scale to tropospheric ozone over Japan by using a global chemical climate model (CHASER); (2) estimation of NO_x emissions in China by using inversion modeling systems (RAMS, Regional Atmospheric Modeling System; CMAQ, Community Multiscale Air Quality Modeling System; and 4DVAR, Four-Dimensional Variational data assimilation) and the tropospheric NO_2 column density obtained by satellite observation (Fig. 1); (3) collaboration with Chinese researchers to improve Asian emission inventories; (4) dispatch of a short-range forecast of regional air quality in East Asia, Japan, and the Kanto region via the NIES environmental GIS (geographic information system) site (http://www-gis.nies.go.jp/)(in Japanese); and (5) estimation of the impacts of forest fires in Siberia on air quality in Japan by an integrated approach using ground and satellite observations and a global chemical transport model.

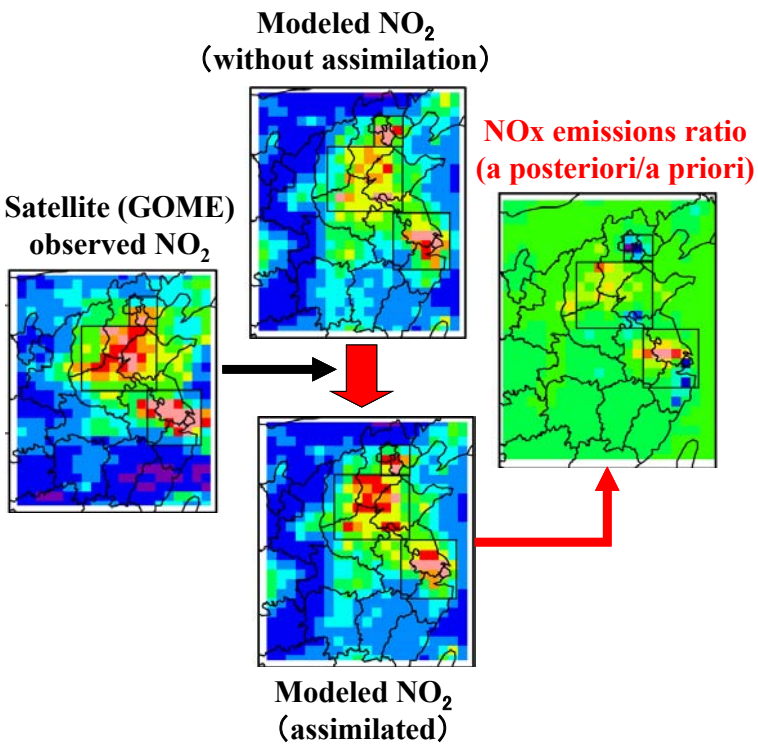


Fig. 1 Schematic diagram of estimation of NOx emissions over East China in July 2002 by using inversion modeling system (from Kurokawa et al. 2009).

Application of dust and sandstorm data measured by the lidar observation network in East Asia

The **Collaborative Research Section** continued the observations of Asian dust using the lidar dust-monitoring network, including a lidar in Beijing and three in Mongolia. Data from the network were processed in real time to derive the vertical profiles of the extinction coefficient estimates for Asian dust and air pollution aerosols. The results were used for analysis of dust events and real-time valida-

tion of dust transport models. Real-time dust extinction coefficient data were also provided for the *kosa* web information service (http://soramame.taiki.go.jp/dss/kosa/) offered by the Ministry of the Environment. A regional 4DVAR data assimilation system was developed for the lidar dust-monitoring network data. The data assimilation system was applied to the analysis of dust events in 2006 and 2007. The results showed that the 4DVAR data assimilation method is useful for accurate estimation of dust emission and transport. The Asian dust distributions calculated with the assimilation system were compared with the data from NASA's space-borne CALIPSO/CALIOP lidar.

2. Development of systems for evaluating regional water and material cycles in East Asia (Core research project 2)

The comprehensive tools needed for sustainable management of the water environment and water resources of East Asia are developed by gathering scientific knowledge and information through strategic international collaborative research. This core research project has been developing a system for the observation and evaluation of water and material cycles in catchment ecosystems by coupling satellite monitoring with an integrated catchment model. The aim is to investigate the health status of catchment ecosystems, oceanic ecosystems, and Asian cities.

Development of a system for the observation and evaluation of water and material cycles in a catchment ecosystem

The Asian Water Environment Section has developed a system for the observation and evaluation of water and material cycles in a catchment ecosystem of East Asia. The autonomous water quality monitoring system established in December 2007 at Xiantao Hydrological Station in cooperation with the Changjiang Water Resources Commission (CWRC) simultaneously measures pH, temperature, dissolved oxygen, conductivity, suspended solids, chemical oxygen demand, total nitrogen, total phosphorus, and chlorophyll-*a*.

Second, we developed high-resolution satellite remote-sensing datasets, which included topography, landform, and water system (2005 data), and land-surface temperature, vegetation index, and net primary production (2001–2008 data) for the Changjiang (Yangtze River) basin. We have also conducted several field surveys since 2006 along the Hanjiang (Han River), one of the largest tributaries of the Changjiang and the source river for the middle route of China's South-to-North Water Diversion Project (SNWDP). The objective of these surveys is to assess the sustainability of rural management and to evaluate the impact of human behavior (in terms of food consumption, lifestyle patterns, and human waste disposal) on N and P flow in the catchment. We have also developed a method of estimating water demand and water pollutant discharge by using an interregional input–output model, and we are trying to use this inventory model to evaluate the structure of water demand and water pollutant discharge in the Changjiang basin.

Third, an integrated assessment model based on the Soil and Water Assessment Tool (SWAT) was improved for the evaluation of non-point source pollution in

catchments. This model has been parameterized in relation to crop growing, soil properties, nutrients, and soil organic matter on the basis of data from local investigations in the Changjiang basin. Through cooperation with our counterparts, we are now trying to validate the model by using observation data and then to simulate the influences of land-use changes, human lifestyle changes, and the SNWDP on catchment ecosystem services and on the water environment of the Changjiang catchment. To make further progress in our international cooperation, we organized a special seminar in Tsukuba, Japan, on "Impacts of the South-to-North Water Diversion Project" on 21 October 2008 in cooperation with CWRC and the Chinese Academy of Sciences (CAS). We then organized an international workshop on "Sustainable Water Resource Management of the Haihe River Basin, one of the Areas Influenced by the South-to-North Water Diversion Project". Finally, our research team joined forces with the Japan-Sino Water Environment Partnership to establish demonstrations of wastewater treatment technologies in rural areas of developing countries.

Investigation of the influence of water from the Changjiang on the marine ecosystem of the continental shelf of the East China Sea

The Asian Water Environment Section is investigating the influence of water from the Changjiang on the oceanic environment and ecosystem. For this objective, we focused mainly on the adverse effect of large amounts of terrestrial N and P loadings from the Changjiang on the marine ecosystem of the East China Sea. To understand the environmental changes occurring in Chinese coastal areas, we promoted a collaborative program with Zhejiang Oceanic University, China (Joint Research Program: "Development of an Adaptive Management System for the Marine Ecosystem and Fishery Resource in the East China Sea", beginning in 2007). In 2008, we established a joint research laboratory at Zhejiang Oceanic University. As part of this collaborative scheme, we continued to assemble basic environment data on Chinese coastal zones in order to develop a hydrodynamic ecosystem model for the East China Sea. In addition, with the Seikai National Fisheries Research Institute, Japan, we have continued periodic investigative cruises in the East China Sea, and in June 2008 we conducted a comprehensive environment-monitoring cruise. We performed an onboard tracer experiment using a stable isotope to quantify nutrient uptake and recycling in plankton ecosystems; and measured micro-turbulent shear stress to determine the correlation between the vertical mixing rate and the vertical distribution of phytoplankton. Cruise data gathered over the past 3 years revealed that the dominant algal class on the continental shelf of the East China Sea in early summer was not diatoms but dinoflagellates.

Development of a comprehensive Circular Economy Urban Simulator to design and evaluate alternative environmental technology and policy scenarios

The **Environmental Technology Assessment System Section** is developing an integrative "Circular Economy Urban Simulator" to evaluate the environmental effects of circular policies in Asian cities. The simulator provides practical scien-

tific platforms covering water resource management, urban energy management, and solid waste management in industrial Asian cities. It consists of an urban environmental GIS database; a technology and policy inventory for circular economies; and integrative analytical models for water and energy migration, socioeconomic transportation, evaluation indicators, and decision-support process design. The integrative analytical model was developed for quantitative analysis of the spatial distribution and migration properties of different flows and stocks of environmental resources, including water, atmosphere, heat, energy, and material recycling, in urban areas. A three-dimensional physically based process model (NICE-URBAN; NIES Integrated Catchment-based Ecohydrology for Urban) was developed to estimate the quantities of water and heat recycling in the study area, covering the atmosphere, soil, and underground water systems. The accuracy of the simulator was verified in the domestic industrial city of Kawasaki. Applications of the model for use in Chinese cities and regions are being developed in cooperation with the Liaoning Provincial Government and the cities of Shenyang and Dalian, along with our counterparts such as the CAS, the Institute for Applied Ecology, and municipal research academies of environmental science. The NICE model was applied to the Biliu River catchment in northern China to evaluate how the environment will change after the completion of the Biliu Reservoir, and to determine how economic development is affecting environmental conditions in the area. Moreover, we performed a NOAA/AVHRR (National Oceanic and Atmospheric Administration / Advanced Very High Resolution Radiometer) satellite image analysis to evaluate whether the simulation result was related to the environmental degradation in the downstream parts of the catchment. To evaluate urban stress instead of economic development, we performed a statistical analysis of decoupling indicators in Dalian City on the basis of the results of a simulation of water-carrying capacity (Fig. 2).

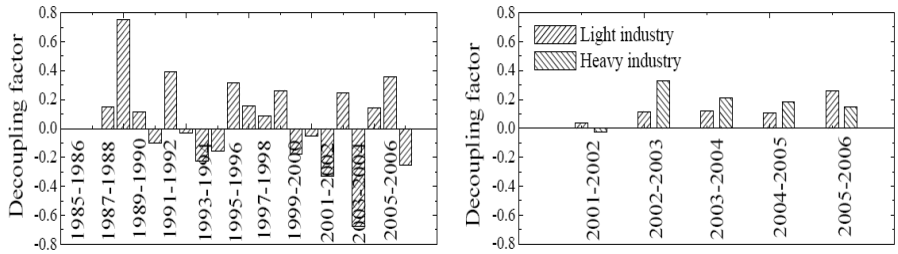


Fig. 2 Annual trends in decoupling indicators between (left) NDVI (normalized difference vegetation index) and water consumption; and (right) industrial water consumption and gross domestic product in the city of Dalian, China.

These methods of assessing the interaction between water source area and water demand area are very effective aids to decision-making on sustainable development in a catchment. The outcome of this research has been submitted for possible publication in the *Journal of Global and Planetary Change* (Nakayama et al. 2008).

We also selected and evaluated an inventory of end-of-pipe–type environmental treatment technologies, cleaner technologies, and industrial symbiotic technologies in Asian cities such as Dalian (Fig. 3). Integrative technology assessment is under way in the Chinese city of Shenyang.

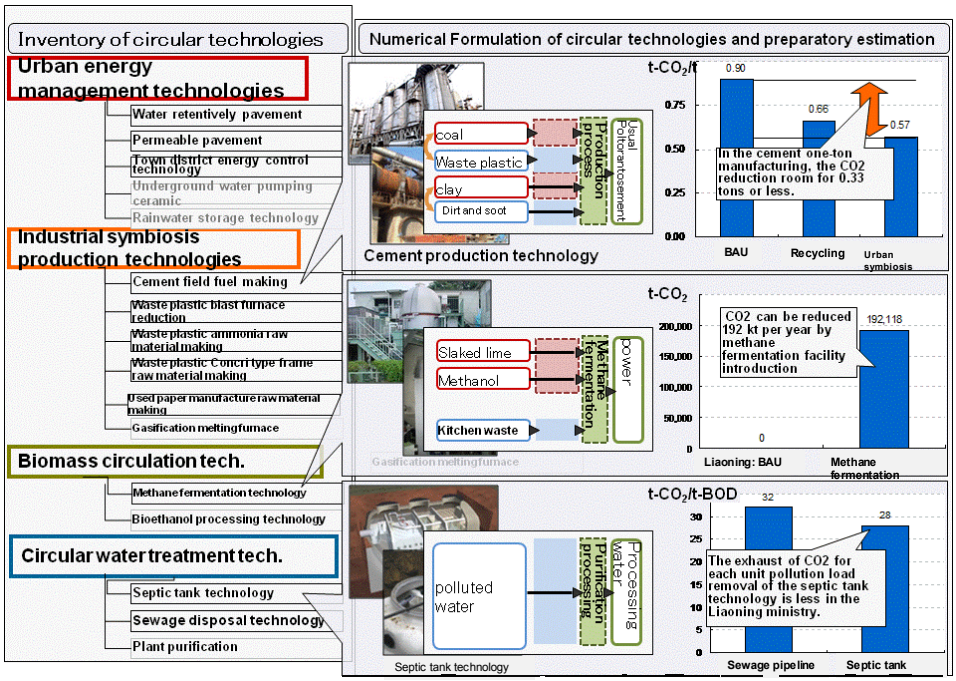


Fig. 3 Inventory of technology evaluated in Asian cities such as Dalian, China.

3. Developing methods for environmental impact assessment of catchment ecosystems in Southeast Asia and Japan (Core research project 3)

Rising in the mountains of Tibet and emptying into the Mekong Delta in Vietnam, the Mekong River flows about 4800 km through six countries in the Indochina Peninsula, draining an area twice as large as Japan. Although the Mekong is located far from Japan, we have had close relationships with Mekong riparian countries through, for example, official development assistance (ODA). The Japanese Government is celebrating 2009 as "Mekong–Japan Exchange Year", promoting further cooperation with these six countries in various fields.

The lower Mekong basin has been experiencing rapid development through the exploitation of hydropower by the construction of numerous large dams, the expansion of agriculture, and an increase in aquaculture production in the form of large-scale instream cage culture. As economic activity increases, the natural environment of the basin and its water quality are deteriorating at an unprecedented rate.

The **Watershed Ecosystem Section** has conducted field surveys in the Mekong basin in an attempt to assess the state of the natural environment, the impacts of various human activities, and future risks associated with these activities. In field surveys, we have collected a total of 205 river water samples at 151 sites throughout the lower Mekong basin (Fig. 4). The samples were chemically analyzed for concentrations of nutrients such as nitrate, nitrite, ammonium, and phosphate. The Mekong's water quality is generally considered good when compared with that of many of the world's great rivers, but nutrient concentrations have increased in the delta (Mekong River Commission 2003). We have examined the basin-wide geographical patterns of nutrient concentrations in relation to the geomorphic, climatic, and anthropogenic factors of the basin.

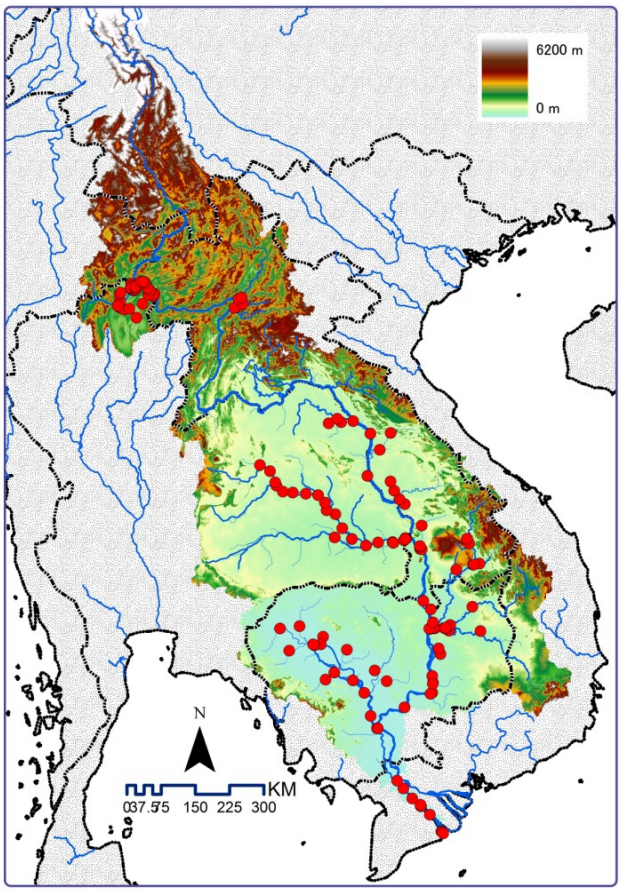


Fig. 4 Water sampling sites in the Mekong River basin. Elevation gradient is shown in color. (Data: CGIAR-CSI SRTM 90 m DEM)

Two areas in the Mekong basin showed particularly higher concentrations of ammonium in the river water (Fig. 5): 1) from Tonle Sap in Cambodia toward the Mekong Delta in Vietnam and 2) on the Khorat Plateau in northeast Thailand, where the Mun River and its tributary, the Chi, drain into the Mekong. These areas are characterized by high population density (Fig. 5) and vast tracs of agricultural or crop lands with extensive irrigation systems (Fig. 6). Production of rice in the delta and non-rice crops such as tobacco and sugarcane on the Khorat Plateau has increased greatly in recent years, with heavy input of fertilizer. Apart from these regional-scale patterns, we found that small tributaries with large settlements could have much higher ammonium concentrations than larger tributaries or the Mekong mainstream (Fig. 5). In contrast, areas such as northern Thailand, Laos, and northeastern Cambodia had generally lower ammonium concentrations. Other nutrients such as nitrate and phosphate showed, to some extent, similar geographical patterns to ammonium.

The increased levels of nutrients in the Mekong basin will undoubtedly worsen the water quality, especially if dams planned for hydropower and irrigation are built, reducing water flows and causing severe algal blooms. However, there are still few quantitative studies of the patterns, dynamics, and impacts of nutrients in riverine systems. With more detailed data on the potential causes of elevated nu-

trient levels (e.g., fertilizer usage and aquaculture production throughout the basin), we will be able to better understand the quantitative aspects of water quality in the world's tenth largest river.

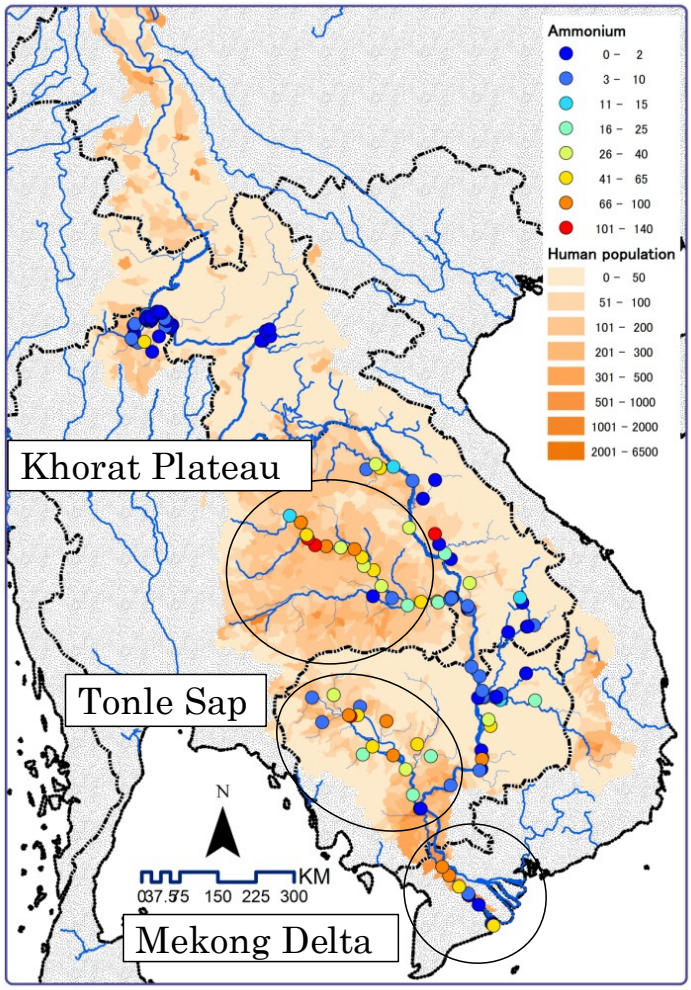


Fig. 5 Geographical pattern of am-monium concentra-tion (μg/L) in the river water of the Mekong delta. Also shown is popula-tion density (/km^2). (Popula-tion data: LandScan 2006)

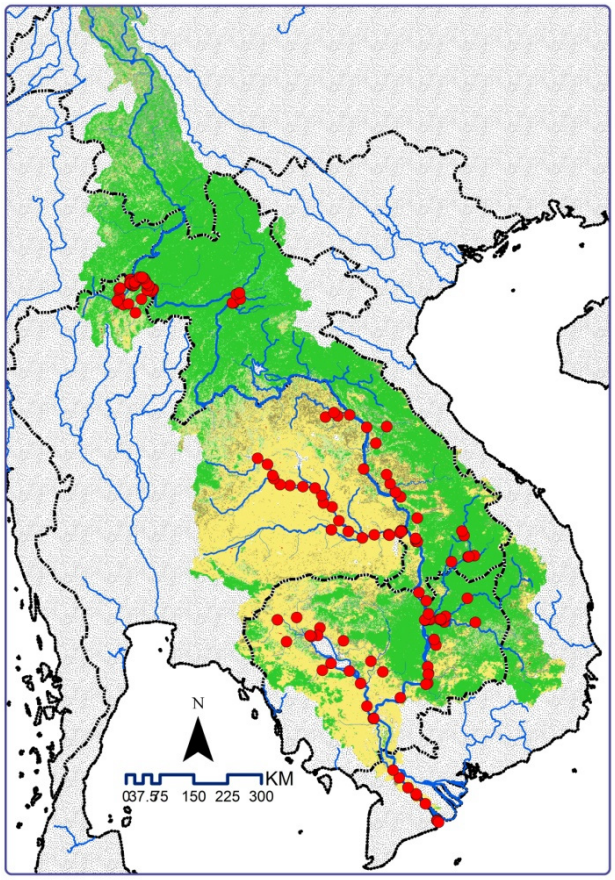
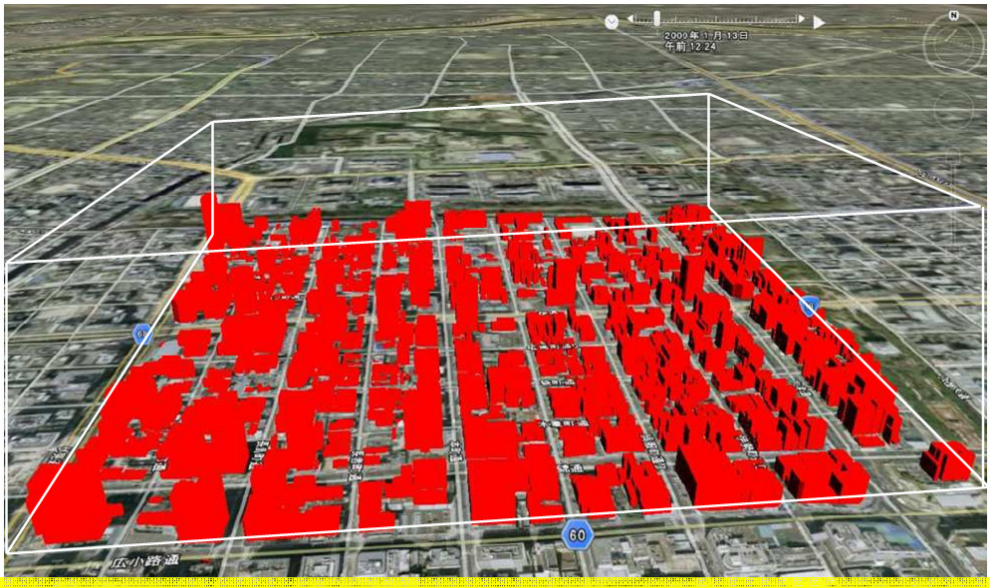


Fig. 6 Land cover in the Mekong River basin. Water sampling sites are shown by red dots. The land cover consists mostly of evergreen forests (green), cropland (yellow), and a mo-saic of cropland and natural vegetation. (Data: MODIS MOD12)

Social and Environmental Systems Division



Building blocks: Average building height 21.5 m
Number of stories: 7 floors (floor height 3.2 m)
Daytime population: About 20,000 people
Day-to-night population ratio: About 500 %
Tree cover ratio: 16 %, Bare land ratio: 18 %

3D-CAD model of Nagoya in 2005 (using Google Earth)
(Yoshida and Ichinose, 2009: Research and Development of an In-formation System for City Block Environmental Evaluation, ICUC-7)

This Division targets the linkages between human activities and the natural environment in order to clarify the relationships between socioeconomic systems and environmental issues. The work of the Division results in proposals for environmental policies. It covers a broad area, from global environmental issues such as global warming to local issues like recycling and lifestyle. There are four research sections:

1. The Environmental Economics and Policy Section studies the economic and policy aspects of environmental conservation, and analyzes the economic and political effectiveness of environmental policies.
2. The Environmental Planning Section works on planning and evaluation techniques and applications relating to environmental conservation, including local goal-setting of environmental policies, and on the prediction and assessment of global warming impacts.
3. The Integrated Assessment Section develops integrated environment–economy models to assess environmental policies, such as those on global warming mitigation and adaptation, and sustainable development policies.
4. The Transportation and Urban Environment Section analyzes urban environmental issues such as air pollution caused by automobiles and the urban heat-island effect caused by mass consumption of fossil fuels in urban areas.

Our main research outcomes in FY 2008 were as follows.

1. Environmental Economics and Policy Section
To investigate a wide range of environmental issues we are studying the interaction between current social and environmental systems by using approaches from social science, natural science, and systems analysis. In addition, we are analyzing the economic impact of environmental policies such as carbon taxes and emissions trading. We are also analyzing the environmental policy decision-making processes in use by various countries and investigating the possibility of international cooperation on global environmental conservation.

(1) Analysis of the effectiveness of information provision on the market valuation of a firm's pollution and on incentives for pollution reduction

Better provision and dissemination of environmental information has recently been proposed as complementing traditional policy instruments for controlling environmental performance. The provision of information to the public comprises a quasi-regulatory mechanism: consumers, investors, the public, and other stakeholders use the information to pressure firms to change their environmental behavior. For example, if investors expect firms with better environmental performance to have lower liability costs because they are less likely to be liable for future environmental problems and thus to have higher future profitability, then publicly held firms with better performance will have a higher stock price, i.e., market value. If the market values environmental performance, firms have an incentive to improve their environmental performance and will have easier access to financial markets. Our case study on the Japanese PRTR (Pollution Release

and Transfer Register) system of releases and transfers of toxic chemicals analyzed the efficacy of this information provision policy.

Our main findings were that (1) the stock market does not value the risk posed by toxic chemical releases and transfers; and (2) even without market valuation, firms posing a higher carcinogenic risk reduce their releases and transfers in order to decrease future potential environmental liabilities. We should note that, in the Japanese PRTR system, suitable and easily understandable information is not readily accessible; the market is therefore unlikely to value the releases and transfers. Therefore, appropriate form and content of the information disclosure protocol need to be considered so that stock markets will value a firm's releases and transfers.

(2) Study of options for enhancing adaptation policy in a climate agreement after 2012

We examined literature and documents to determine how the international community could enhance adaptation policies in a future climate regime. We concluded that (1) international arrangements should facilitate links between international, regional, and national entities and stakeholders and should channel support toward enhanced adaptation planning and implementation at the regional and national levels; and (2) at the national level, arrangements should be put in place to prepare and implement national adaptation plans, which should be supported by rigorous assessments of vulnerability and adaptation.

We identified four areas that need to be focused on to enhance measures for adaptation in the post-2012 framework: (1) streamlining and scaling-up of financial and technological support; (2) establishing a knowledge network for adaptation, and strengthening support for capacity building for the assessment of vulnerability and impact and for the planning and implementation of adaptation measures; (3) cooperating with current and future approaches that are made in other international frameworks outside UNFCCC (United Nations Framework Convention on Climate Change) and improving the accumulation and sharing of information on support for adaptation measures; and (4) establishing institutional frameworks for adaptation.

2. Environmental Planning Section

We are conducting research into the development and assessment of regional plans and basic environmental plans for environmental conservation. In this research, we are investigating new methods of understanding and assessing regional environments by using geographic information systems (GIS). We are also investigating the current status of public awareness and promoting voluntary action by individuals.

(1) Theory and effects of voluntary environmental actions taken by individuals and enterprises

In the search for ways to encourage more participation in voluntary activities, more attention is being given to what motivates people to participate. Participation in voluntary activities is usually explained by rational choice theory, but theoretical predictions have not always concurred with empirical outcomes.

We proposed a theory of volunteer opportunity and verified the theory by using a Web survey. Our central hypothesis was that having access to opportunities leads to higher rates of participation in voluntary activities.

Our analysis of the factors involved in participation in voluntary activities supported the hypotheses based on this theory. For example, number of interests, some of the sources of information related to the area of interest and to specific activities, and other factors connected with participation opportunities had significant positive effects on participation. Factors related to egoistic motives, however, either did not have significant effects or had significant negative effects, and economic models were thus not supported. It was clear that participation in voluntary activities is related to the number of participation opportunities. We suggest that this theory of volunteer opportunity needs to be developed further.

(2) Study of national trends in public interest in environmental issues

We are conducting monthly public opinion surveys to evaluate the levels of public support for environmental policies. Our questionnaires cover "The most important issues in the world" and "The most important issues in Japan." Our sample population consists of 4000 men and women aged at least 20 years and drawn from across the nation. These respondents are randomly selected every month. The response rate for "environmental/pollution" issues (Fig. 1) was about 20% until December 2006; it then rose sharply from January 2007 until July 2007. It then dropped and, after another brief rise in January 2008, stayed at around 40% until dropping to below 20% by September 2008, although it remained one of the top three issues. This change was closely associated with mass media (mainly newspaper) coverage of environmental issues.

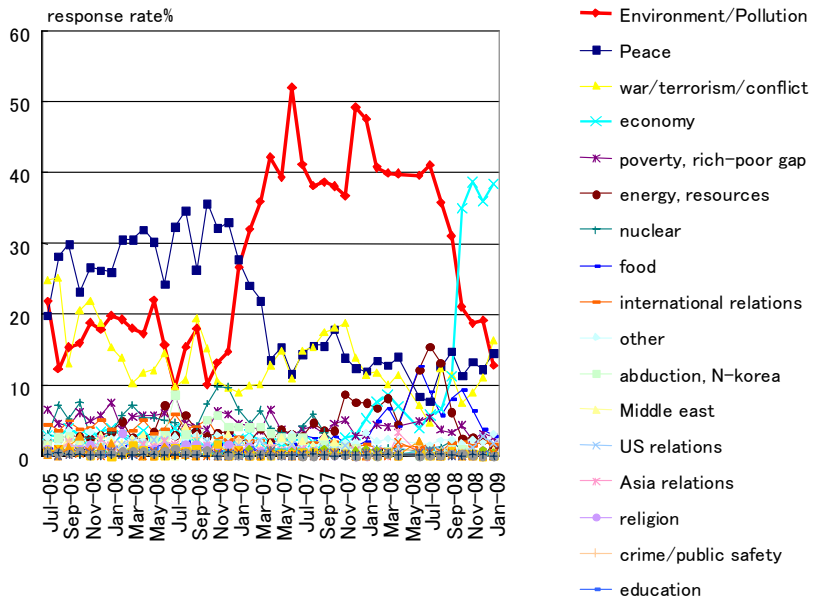


Fig. 1 World's most important issues (nationwide face-to-face public opinion survey, 2000 samples)

(3) Study of strategic urban planning and assessment of low-carbon cities

In the planning and building of low-carbon cities, the use of architectural methods that take into account global environmental conservation generally involves a

reduction in the heat load of buildings. We therefore evaluated the reduction in energy consumption that can be achieved by improving models for efficient heating, ventilating, and air conditioning (HVAC) technologies in office buildings. We are developing a city block information system, which we call Environment and Energy around Building Blocks (EEBB). The logistics of this system are based on optimum control of air conditioning. In this system, energy-saving potential is visualized by using Google Maps and Google Earth (Fig. 2). The use of publicly available remote-sensing and statistical data helps us to evaluate the accuracy of the simulation. Appropriate energy-saving information should be provided to residents and energy managers, for example by using Automated Meteorological Data Acquisition System (AMeDAS, Japan Meteorological Agency) measurements delivered in real time.

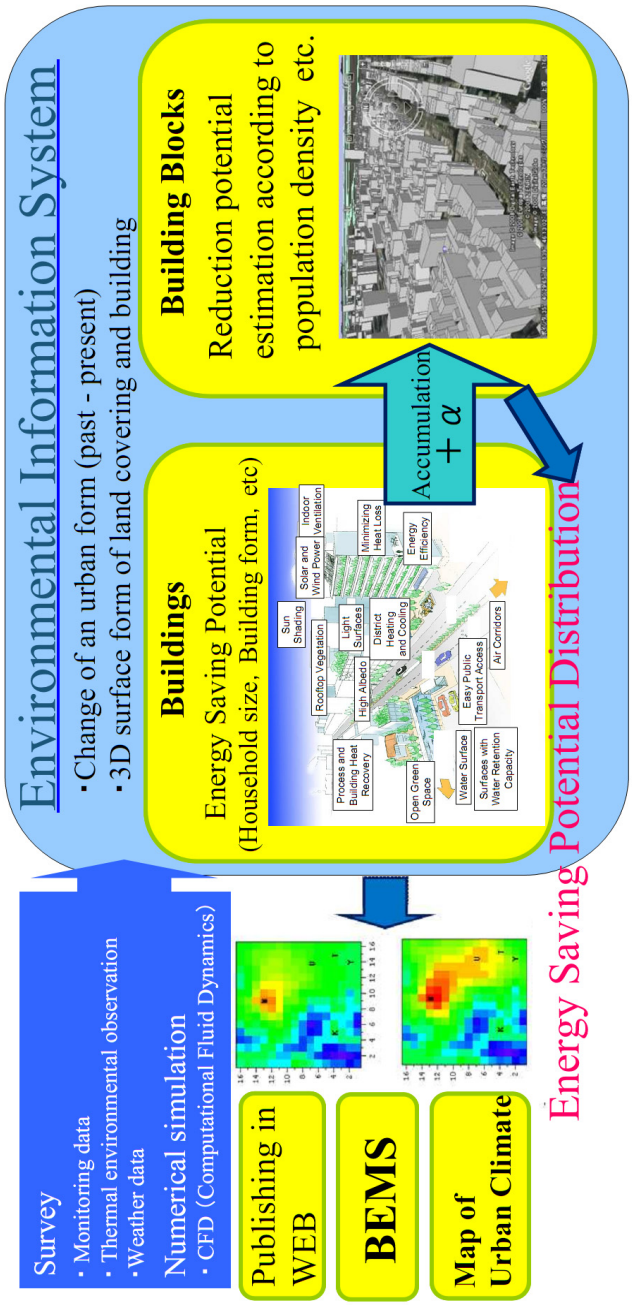


Fig. 2 Flow of research in the Environment and Energy around Building Blocks system (Yoshida and Ichinose, 2009: ICUC-7; 7th International Conference on Urban Climate)

To realize low-carbon cities, Asia needs to reduce the energy expended in cooling. According to our results, which showed that energy expenditure depends on weather and on building plan, it is possible to control air-conditioning efficiency. For example, in the case study of Nagoya, where the sky view factor (SVF: the ratio of radiation received by a planar surface to that from the entire hemispheric radiating environment) was set to 50% or less, by using CFD (computed fluid dynamics) simulations of air temperature around the buildings we could achieve a comfortable temperature by setting the building height to 10 m. The heat balance for cooling reduction was compared among different cases to determine whether or not natural ventilation could be used.

3. Integrated Assessment Section

"Integrated assessment" is a framework for linking the policymaking process with scientific knowledge from a wide range of disciplines. The core tool in integrated assessment is an integrated assessment model, which evaluates policy options for solving various environmental problems. We developed and modified the Asia–Pacific Integrated Model (AIM) to assess climate policy. The model results are provided to environmental policymakers in Japan. The model takes into account the fact that, in developing Asian countries, local environmental problems are more severe than global environmental issues such as climate change. We are expanding AIM to include not only climate problems, but also other environmental issues related to sustainable development. The following three topics were our main activities in 2008:

(1) AIM/Impact[Policy] has been developed to assess anticipated greenhouse gas (GHG) emission paths, GHG concentrations, temperature increases, and sectoral impacts when climate stabilization targets are being set and attained. This model was used to comprehensively examine the extent to which the impacts on Japan will be magnified as warming progresses up to 2100. The results revealed that Japan will be severely affected by even a small temperature rise. The results of this research on climate change impact in Japan, including the results of studies conducted by other institutes, were summarized and reported as an outcome of S-4 of the Global Environment Research Fund, Ministry of the Environment.

(2) A simple scheme to quantify the water-stressed population in each of the world's nations was developed for climate policy assistance models. A lookup table approach was adopted to reduce computational load. The water-stressed population was defined as the number of people living in an area where the water resources are less than 1000 m^3 per person per year. The estimate of this population agreed well with the results of earlier studies performed by standard, computationally expensive approaches. The scheme was incorporated into AIM/Impact[Policy], a climate policy assistance model. The relationship between the stabilization level of global mean temperature increase and water stressed population was analyzed. The results revealed that an increase in stabilization level increased the size of the water-stressed population in northern Africa and the Middle East, whereas the opposite relationship occurred in the remaining regions of the world.

(3) The government of Japan has begun discussions on setting a GHG emission reduction target for 2020. AIM modeling is helping to quantify the emission reduction target. AIM/Enduse[Global], which is a bottom-up-type model of energy technologies on a global scale, estimated the GHG emission reduction potential and marginal abatement cost in Japan and other major countries and regions, such as the USA and EU, for the purposes of international comparison. AIM/Enduse[Japan], which is the bottom-up model for Japan, assessed the detailed GHG emission reduction options and their effects in 2020. AIM/CGE[Japan], which is the economic model for Japan, estimated the economic impacts of the options assessed by AIM/Enduse[Japan]. The results were summarized as six options in the middle-term GHG reduction target for Japan.

4. Transportation and Urban Environment Section

This section pursues studies related to transportation and urban environmental problems. We are using our vehicle emission test facility and onboard emission measurement devices to evaluate the environmental impacts of motor vehicles. We also formulate and evaluate environmental improvement scenarios in transportation and urban systems.

(1) Evaluation of electrically powered transport for personal use

The use of electric bicycles may be a way to reduce CO_2 emissions in the transportation sector. We evaluated the performance of these bicycles. Several volunteers used the electric bicycles for daily transportation in Tsukuba city. Different types of electric bicycles were selected for testing: there were two types of battery and three kinds of supplementary motor use (i.e. a motor assisting the front wheel, the rear wheel, or the pedals). There were also three types of power used to assist in pedaling. Strong assistance resulted in a shorter travel distance before the next charge than minimum assistance (Fig. 3). If standard assistance was used, under the current electric bicycle specifications, regardless of the battery type used or the way in which the motor was applied, electric bicycles could assist human pedaling over about 20 km before a charge would be required.

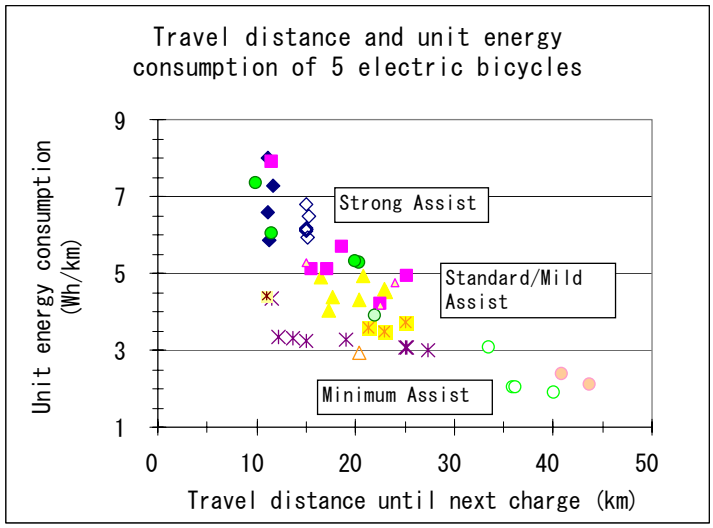


Fig. 3 Performances of electric bicycles: unit energy consumption (Wh/km) versus travel distance until next charge. Strong assistance gave a shorter travel distance before a charge was required.

(2) Study of long-term CO_2 reduction strategies by the transport sector towards a low-carbon society

As part of the transport section scenarios of the Japan Low Carbon Society 2050 Project, we revised our environmentally sustainable transport (EST) scenarios for 2020. The scenarios are now focused on the market penetration of hybrid electric vehicles (HEVs) in the form of production capacity models and on cohort modeling that considers the replacement of aged vehicles (Fig. 4). Outlines of EST 2050 scenarios and policy implications were addressed as part of a combination of countermeasures fitted to suit regional characteristics.

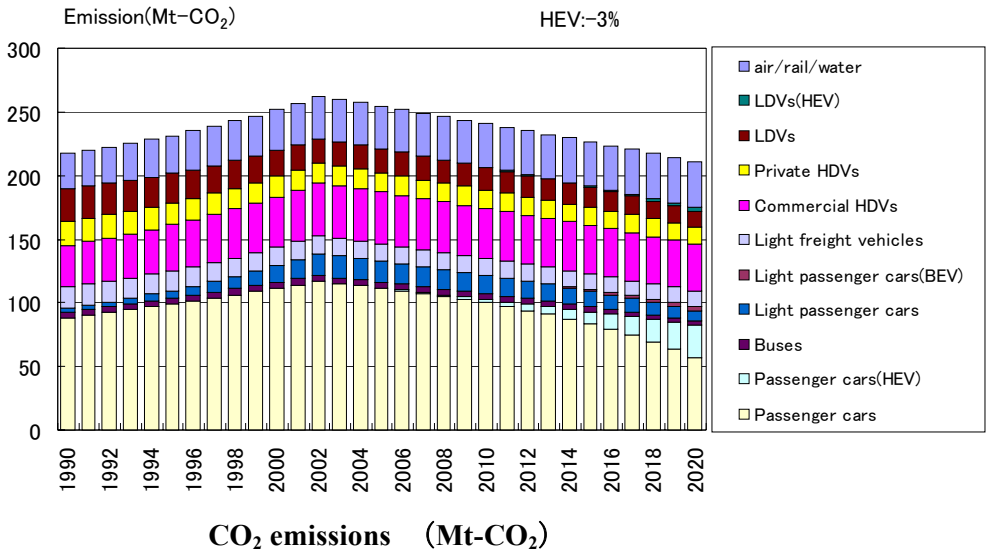
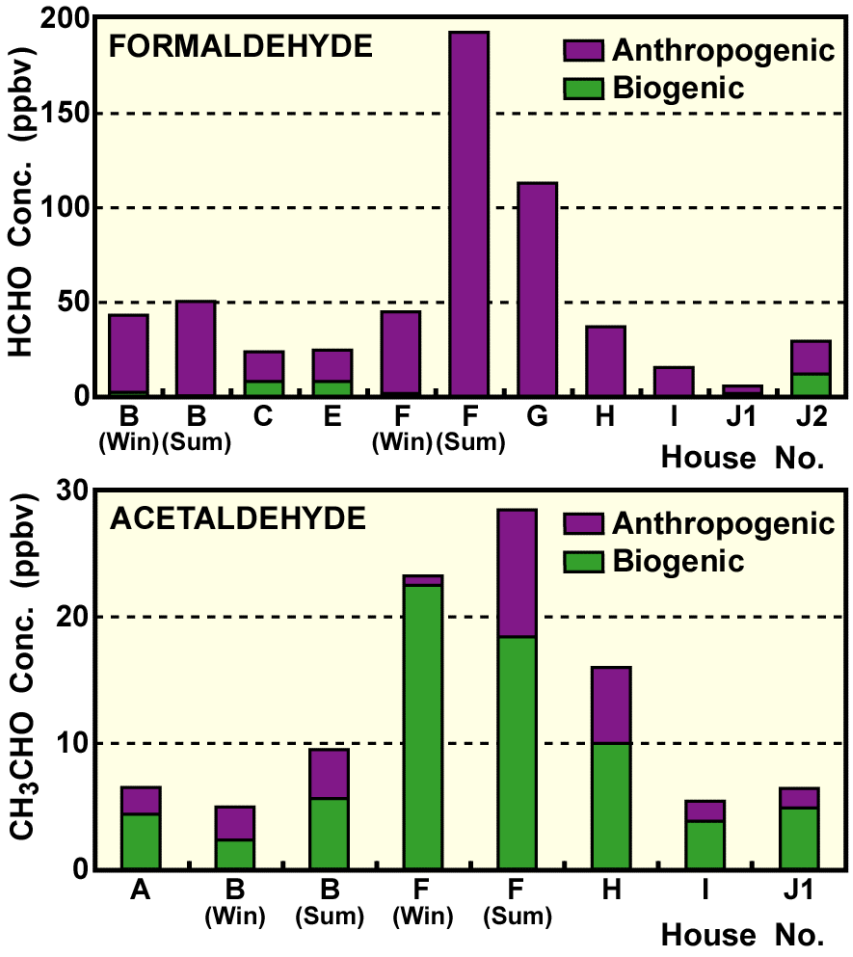


Fig. 4 Hybrid electric vehicle (HEV) scenario: 3% reduction in CO_2 emissions from the 1990s onward; and about 40% of standard passenger cars replaced by HEVs, about 40% of light passenger cars replaced by battery electric vehicles (BEVs), and about 20% of light duty vehicles (LDVs) replaced by HEVs with the expansion of production capacity by 2020.

Environmental Chemistry Division



Concentrations of formaldehyde and acetaldehyde of anthropogenic (fossil) and bio-genic origins in indoor air. These two aldehydes are known to cause sick-building syndrome. Analysis of ^{14}C in the compounds by accelerator mass spectrometry revealed that the majority of the formaldehyde originated from fossil fuel products (without ^{14}C) such as adhesives, paints, and plastics, whereas more than half of the acetaldehyde came from biological sources with natural ^{14}C contents, such as woods.

The Environmental Chemistry Division has been working on the development of various methods of analyzing organic chemicals and elements or isotopes and monitoring their environmental and biological fates and behaviors. It is also working on the analysis of biological responses to pollutant exposure. Various topics have been studied, including global environmental change; the presence and transport of elements or chemicals on global, regional, and local scales; long-term environmental monitoring and specimen-banking; the identification and apportionment of major sources of pollutants; the development of new analytical methods such as nanoparticle analyses and magnetic resonance imaging (MRI) of the central nervous system; behavioral responses to chemicals; and scientific/technical support in regard to implementation of the Stockholm Convention and various environmental issues such as groundwater pollution by organoarsenicals.

The **Advanced Organic Analysis Section** has developed methods for analyzing organic pollutants such as persistent organic pollutants (POPs) in the environment and applying these analyses to environmental monitoring.
We developed revolutionary new methods for analyzing POPs in environmental samples by using comprehensive multidimensional gas chromatography (GC×GC) / high-resolution time-of-flight mass spectrometry (HR-TOFMS). POPs were quantified of in small volumes (about 50 mL) of river water by stir-bar sorptive extraction (SBSE) – thermal desorption (TD)-GC×GC/HR-TOFMS. The method detection limit of several POPs was in the range of 10 to 500 pg/L. The results of analyses of water samples by these methods agreed with the values obtained by conventional methods based on gas chromatography – high-resolution mass spectrometry (GC/HR-MS) (Fig. 1). We confirmed that measurement by HR-TOFMS and separation by GC×GC effectively reduced interference by concomitants. We have also investigated the comprehensive separation of thousands of polychlorinated biphenyl (PCB) metabolites after chemical derivatization. Over 152 peaks of hydroxy-PCBs (methoxy-PCBs) were detected in a river sediment sample by GC×GC/HR-TOFMS. We also used TD-GC×GC/HR-TOFMS in the quantitative analysis of polycyclic aromatic hydrocarbons (PAHs) in atmospheric particles. The PAH values determined by TD-GC×GC/HR-TOFMS, those determined by TD-GC×GC/quadrupole mass spectrometry (QMS), and those determined by the conventional HPLC method agreed reasonably well with each other. We also used TD-GC/QMS to detect perfluoro-alkyl compounds such as fluorotelomer alcohols (FTOHs) and perfluorooctane sulfonamide ethanol (FOSE) in textiles. We detected 8:2FTOH in the range 0.011 to 0.035 μg/m^2 and N-methyl-FOSE in the range 0.006 to 0.022 μg/m^2.
TD-GC/MS achieved sensitive microanalysis of organic compounds in airborne and diesel particulate samples. PAHs in standard reference materials (1649a, 1650b, and 2975 from the National Institute of Standards and Technology) were quantified correctly in only about 20 μg of samples. As a world first, PAHs, n-alkanes, and 17α(H),21β(H)-hopane in diesel and atmospheric particles smaller

than 0.03 μm were quantified by this method. We also investigated the refinement of conventional analytical methods for detecting compounds in various environmental samples. Simple and rapid methods for the analysis of polychlorinated dibenzodioxins were also studied.

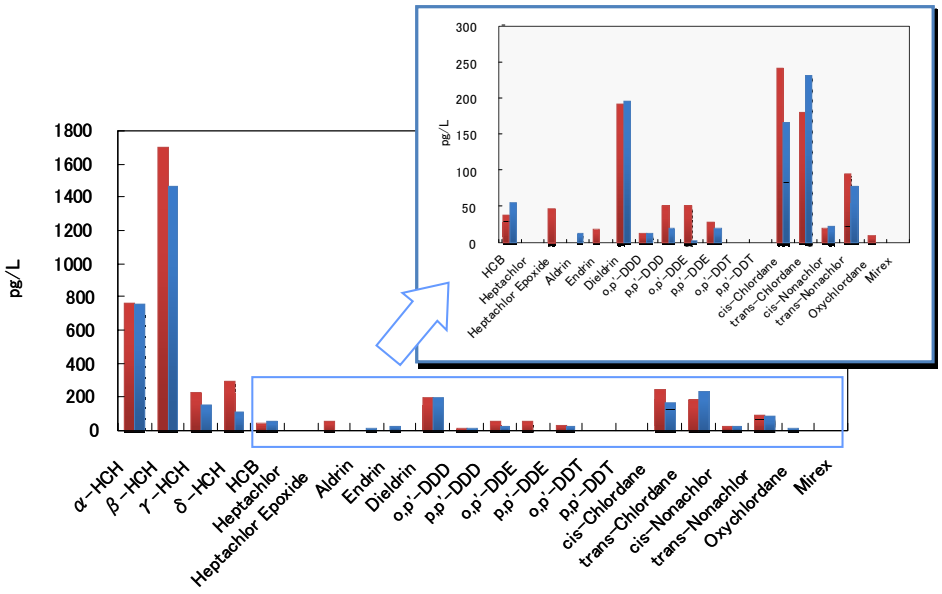


Fig. 1 Concentrations of POPs detected in a river water sample by SBSE-TD-GC×GC/HR-TOFMS (blue bars) and by a generic GC/HR-MS method (red bars). Only 50 mL of water was used for SBSE-TD-GC×GC/HR-TOFMS, against 10 to 20 L of water for the generic method.

The **Advanced Inorganic Analysis Section** has been precisely measuring the stable-isotopic abundance of elements by multi-collector inductively coupled plasma mass spectrometry (MC-ICPMS). The precision of lead isotope analysis was 0.08% for $^{206}Pb/^{204}Pb$ and 0.015% for $^{207}Pb/^{206}Pb$. Lead isotope ratios in various certified reference materials (botanical, zoological, clinical, and geological samples) were analyzed by MC-ICPMS. The values of Pb isotope ratios, including those of the minor isotope ^{204}Pb, are useful for tracing the origins of lead pollution in the environment.

The accelerator mass spectrometry (AMS) facility, NIES-TERRA, conducted about 1400 radiocarbon measurements in FY 2008, including analyses of airborne particles; atmospheric carbon dioxide; fossil carbonate and organic carbon in marine sediments; and marine dissolved inorganic carbon. The AMS has been updated to generate 5 MV more stably for more sensitive analysis. An apparatus for photochemical oxidation of dissolved organic carbon (DOC) collected from seawater was developed for radiocarbon analysis of DOC. It successfully measured $^{14}C/^{12}C$ in DOC. These measurements are important for elucidating the ocean's biogeochemical carbon cycles.

Compound-specific radiocarbon analysis was used for source apportionment of aldehydes (formaldehyde and acetaldehyde) in indoor air in homes. The aldehydes were collected as 2,4-dinitrophenylhydrazine (DNPH) derivatives, which were then separated and purified by preparative chromatographic techniques. $^{14}C/^{12}C$ analysis showed that approximately 80% of the carbon in indoor formal-

dehyde and 30% in acetaldehyde was of fossil origin (see Figure on the front page of this section), indicating that the formaldehyde was derived from adhesives, preservatives, and other chemicals applied to the construction materials, whereas the acetaldehyde came from the wooden materials themselves.
We have developed a super-high-density capacitor based on high-energy-density interfaces. To fabricate nanoporous electrode materials with delaminated structures, we reassembled graphene nanosheets (GNSs) in the presence of rutile SnO_2 nanoparticles. The SnO_2–GNS material exhibits a reversible capacity of 810 mAh/g. Furthermore, its cycling performance is dramatically enhanced in comparison with that of bare SnO_2 nanoparticles.
We have also been investigating the application of elemental mapping and surface analytical methods such as X-ray fluorescence (XRF) analysis, secondary ion mass spectrometry (SIMS), and X-ray photoelectron spectroscopy (XPS) to environmental and geological samples (e.g. mineral and house dusts).

The **Environmental Chemodynamics Section** has been investigating the chemodynamics of natural and anthropogenic volatile organic compounds and of carbon cycles in the ocean.
In situ high-frequency monitoring of halocarbons at Hateruma Island and Cape Ochi-ishi has been done as a part of an observational study for the halogenated greenhouse gas inventory of East Asia. At Hateruma, the increases in baseline concentrations from 2004 to 2008 were 37.0 ppt to 51.6 ppt for HFC-134a; 4.8 ppt to 7.1 ppt for HFC-152a; 20.0 ppt to 22.8 ppt for HFC-23; 1.5 ppt to 3.0 ppt for HFC-32; 173 ppt to 201 ppt for HCFC-22; 19.1 ppt to 21.1 ppt for HCFC-141b; and 16.4 ppt to 20.2 ppt for HCFC-142b. In 2008, the baseline concentrations of PFCs at both stations were 77.8 ppt for PFC-14, 3.9 ppt for PFC-116, 0.6 ppt for PFC-218, and 1.3 ppt for PFC-318.
Partial pressures of 15 halocarbons in surface seawater and the marine boundary layer were measured over the Northwest Pacific in summer as a part of the SOLAS (Surface Ocean – Lower Atmosphere Study) project. Some halocarbons (e.g. methyl chloride, methyl iodide) showed increased partial pressures in seawater in the Oyashio–Kuroshio mixed water region, which has high chlorophyll-*a* concentrations. Phytoplankton activity is likely to be responsible for the halocarbon production in this area. In oligotrophic subtropical areas, the partial pressures of methyl chloride and methyl iodide in seawater increased in positive correlation with the sea surface temperature. Some kind of abiotic process (e.g., photochemical production, chlorination) might be contributing to the production of those compounds in these subtropical seawaters.
We continued a study of the dynamics of organic carbon transported to the ocean through rivers by taking carbon isotope measurements of riverine particulate and dissolved matter. The results suggest that carbon isotopes of particulate organic carbon are useful tools as tracers of sources and behavior. Since summer 2003, surface waters samples for radiocarbon measurement have been collected between Japan and the USA by cargo ship, with the help of a shipping company. As a first step, to investigate the regional $\Delta^{14}C$ surface distribution in the North Pa-

cific, samples collected in the summer of 2003–2007 were measured by using NIES-TERRA (Fig. 2). Although the long-term decreasing trend in $\Delta^{14}C$ in the surface waters since the 1970s is still continuing, the decrease in the last 5 years has been less distinct.

To study high-ozone episodes in northern Kyushu, high-frequency monitoring of non-methane hydrocarbons in the atmosphere was begun at Fukue Island, Kyushu, in November 2008.

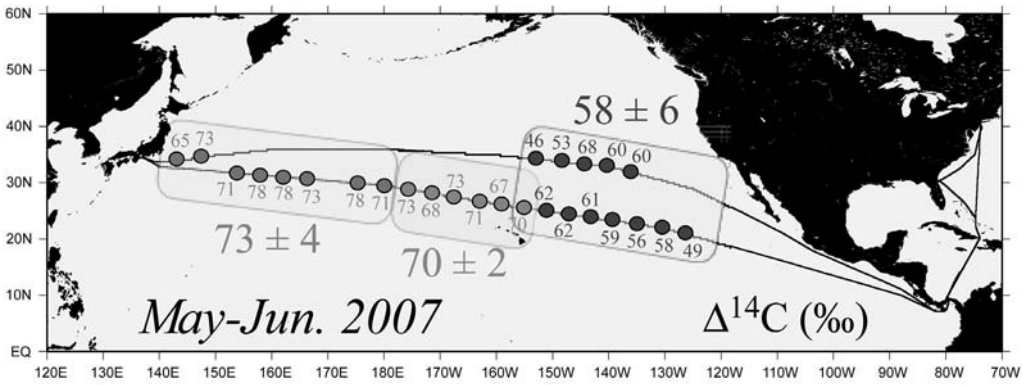


Fig. 2 Horizontal distribution of radiocarbon changes ($\Delta^{14}C$) in surface waters of the North Pacific, May–June 2007. Red, orange, and blue dots mark the Kuroshio current, North Pacific current, and California current, respectively, as defined by the tempera-ture and salinity of sur-face waters.

The **Biological Imaging and Analysis Section** has been developing methods and instruments for detecting and analyzing the *in vivo* responses of biological systems to various environmental factors. The long-term objective of this section is to establish methods of monitoring human health and ecosystem soundness in noninvasive and nondestructive ways.

We have collected brain images from over 150 healthy human subjects in order to extract quantitative indicators characterizing the modern Japanese brain. We focused on quantifying the concentration of regional ferritin iron ([Fe]) in the brain, because we found that [Fe] is linearly correlated with the apparent transverse relaxation rate of tissue water in the brain, which is observable by MRI. Excessive Fe in living organisms is known to cause various diseases through oxidative stress, including neurodegenerative conditions such as Alzheimer's and Parkinson's diseases, which are suspected to be closely related to the presence of regional Fe. We examined the possibility of quantifying [Fe] in 54 subjects on the basis of the linear relationship, and found that it can be quantified within ±20% in most brain regions. We further refined the method by taking into account the contribution of the macromolecular fraction, in addition to that of Fe, to the transverse relaxation rate. By this refinement the quantification accuracy was improved to ±2 mg/100 g fresh weight.

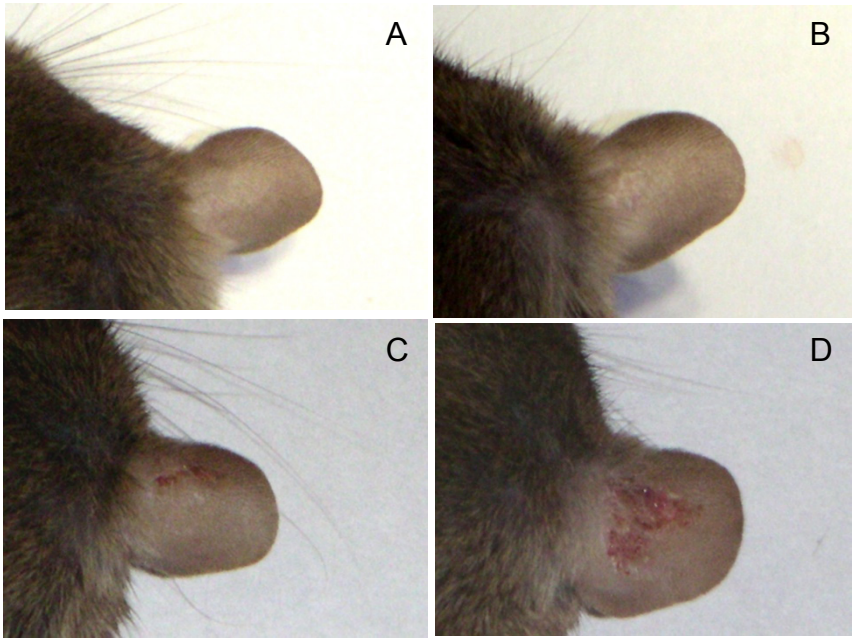
We developed a highly sensitive method of quantifying metabolites in the human brain by using a two-dimensional constant-time PRESS sequence. However, measurement took a long time. To overcome this problem, we proposed and developed a novel quantitation method whereby several sets of spectra could be obtained in one measurement after reconstruction from shared time domain data. We validated this method in experiments on solutions containing brain metabo-

lite mixtures and confirmed that T_2 correction was possible. We then used it to quantify glutamate in the human brain; the calculated concentration was 8 mM, in good agreement with previously reported values.

In a study of the health effects of diphenylarsenic acid (DPAA), 7.5 to 30 ppm DPAA was administered to mice in their drinking water for 49 weeks. Behavioral tests (ambulatory activity tests, rota-rod test, and spontaneous alternation test) were performed during administration. Animals were sacrificed at 13, 26, or 49 weeks after the start of DPAA administration, and we measured phosphate-activated glutaminase (PAG) activity, kidney-type glutaminase (KGA) expression, glutamate decarboxylase (GAD65/67) expression, neuron-specific class III beta-tubulin (Tuj 1) expression, and glial fibrillary acific protein (GFAP) expression in the cerebellum. DPAA impaired coordinative motor ability as measured by the rota-rod test, and increased spontaneous motor activity in the spontaneous alternation test. DPAA also suppressed PAG activity. These observations suggest that DPAA could affect some human brain functions at concentrations as low as actual environmental level.

For the remediation of natural environments it is very important to isolate microorganisms that effectively degrade various kinds of chemical pollutants in water and soil environments. For this purpose, we developed a micro-fluidic electrochemical microdevice to measure the metabolic activities of various microbial cells. We used it to measure the activity of a single cell of a two-hybrid yeast used to detect endocrine disruptors, and to measure the photosynthetic activity of cyanobacteria, with the aim of rapidly assessing the growth potential of toxic cyanobacteria such as *Microcystis* in eutrophic water environments. In the near future we will need to develop a recyclable microdevice for practical use. We therefore developed a glass microarray sensor device for iteratively measuring microbial activity.

Environmental Health Sciences Division



Effects of titanium dioxide nanoparticles on atopic dermatitis–like skin lesions induced by mite allergen. Shown are the macroscopic features 24 h after the last intradermal injection of mite allergen. (A): treatment with vehicle; (B): treatment with titanium dioxide (particle diameter 50 nm); (C): treatment with mite allergen; (D): treatment with mite allergen and titanium dioxide.

The mission of the Environmental Health Sciences Division is to study the potential effects of environmental chemicals (e.g., endocrine-disrupting chemicals, dioxins, arsenite, phthalate plasticizers, metals, and air pollutants) and physical agents (e.g., heat stress, UV radiation) on human health. We aim to use the information as a scientific basis for the risk assessment of these agents, alone or in combination. We perform both epidemiological and experimental studies. In the latter, we use laboratory animals as experimental models, and we use organs and cells to elucidate the mechanisms underlying toxicities. In particular, we are interested in hypersensitive populations that are susceptible to the harmful effects of environmental stress—especially subjects with allergic or immunological disorders. Below, we highlight our progress in several study areas.

The **Director** researched the effects of environmental chemicals on several cardinal features of allergic diseases and clarified the mechanisms of action of these chemicals *in vivo* and *in vitro*. He has demonstrated that systemic exposure to some kinds of environmental chemicals can enhance atopic-dermatitis–like skin lesions, possibly via the activation of immune cells such as antigen-presenting cells and lymphocytes. Furthermore, he examined the effects of environmental chemicals on lifestyle-related diseases, including obesity, diabetes mellitus, and fatty liver.

In the **Molecular and Cellular Toxicology Section,** we have been studying how a variety of environmental chemicals affect biological and physiological functions. Our recent focus has been on epigenetic effects, such as DNA methylation changes and histone modifications, and on alterations in the functions of transcription factors.

In FY 2008, we investigated the effects of long-term and maternal exposure of mice to inorganic arsenic, and we also studied the effects of this chemical on cell lines. The results of the long-term exposure experiments showed that arsenic suppressed the expression of a tumor suppressor gene and induced transcription-suppressing histone modification in the promoter region of the gene. We also studied DNA methylation status in the livers of male mice fed a standard diet (methyl-sufficient diet, MSD), a methyl-deficient diet (MDD), or a methyl-deficient diet with water containing inorganic arsenic (MDD + As). Levels of methylated DNA (5-methylcytosine) in the liver decreased in the order of MSD > MDD > MDD + As. Addition of arsenic to the diet reduced the amount of the methyl-group donor, S-adenosylmethionine (SAM), thus supporting the notion that arsenic is methylated and consumes SAM in the body, and reduces DNA methylation. Arsenic exposure also reduced the amount of mRNA of DNA methyltransferase 1 (*DNMT1*), suggesting that suppression of *DNMT1* expression is involved in global DNA hypomethylation by arsenic. We also found that arsenic exposure affected the amounts of some microRNA species.

In a maternal exposure experiment, we exposed pregnant mice to inorganic arsenic from gestational day 10 through day 18 and investigated the livers of male pups when the pups reached 18 months of age. Previous studies using the same

experimental system reported that exposure increases the incidence of liver tumors in the male pups. Another study reported that maternal exposure affects DNA methylation status and expression of the estrogen receptor (ERα) gene in the male pups, and suggested that the epigenetic modulation of ERα expression leads to increased tumor incidence. The results of our experiment confirmed that such maternal exposure increases liver tumor. We also found that expression of some genes was altered by maternal arsenic exposure, although no change in ERα expression was detected. We will continue our investigation to seek the link between the affected genes and the occurrence of liver tumors.

We also studied methods to effectively detect changes in global DNA methylation status by using methylation-sensitive arbitrarily primed PCR (MS-AP-PCR), and we established optimum conditions for detection. Using the methylated DNA immunoprecipitation-sequencing (MeDIP-Seq) method, we launched a genome-wide study of the DNA regions that are affected by arsenic (Fig. 1).

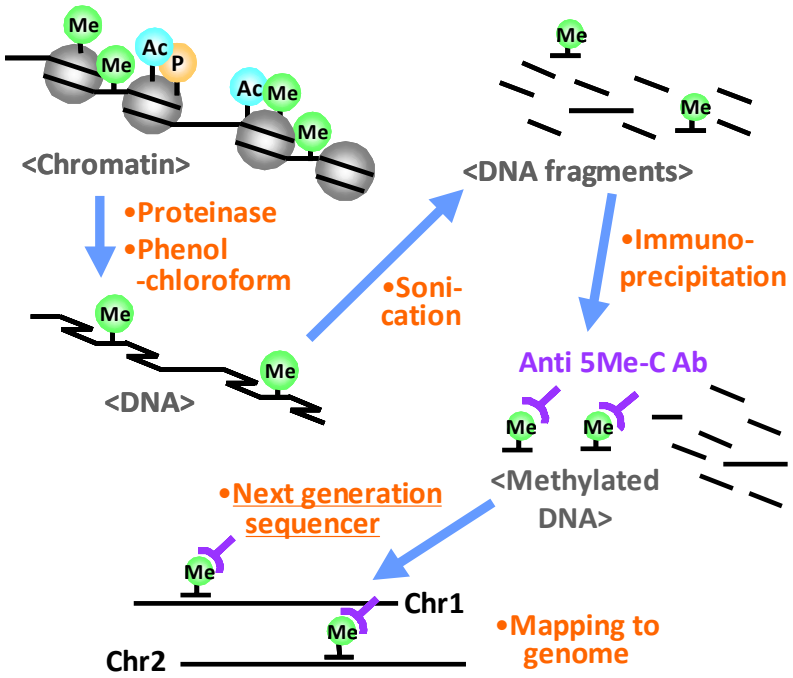


Fig. 1 Method used for MeDIP-Seq (methylated DNA immunoprecipitation-sequencing).

In the **Biological Risk Assessment Section**, we estimate and elucidate *in vivo* and *in vitro* whether and how environmental pollutants facilitate or derange immune systems. *In vivo*, we are examining the effects of environmental chemicals, nanoparticles, and nanomaterials on preexisting sensitivity disorders such as allergic diseases and inflammatory lung injury. *In vitro*, we are elucidating the impacts of these materials on various cells, including antigen-presenting cells, lymphocytes, and epithelial cells, in the context of differentiation, maturation, activation, and proliferation. In 2008, we obtained some interesting and substantial findings and partly reported them in English, as follows:

1) Exposure to titanium dioxide (TiO_2) nanoparticles in the presence of skin barrier dysfunction can exacerbate atopic dermatitis related to mite antigen

via helper T(Th)2-biased immune responses (Fig. 2).

2) Diesel exhaust particles (DEP) aberrantly promote antigen-specific Th immunity (Fig. 3) possibly via inappropriate activation of dendritic cells *in vivo* and *in vitro*.
3) Pulmonary exposure to nanomaterials (including latex nanoparticles and carbon nanotubes) exacerbates acute septic lung injury (Fig. 4) and subsequent systemic inflammation with coagulation dysfunction in mice.
4) Differentiation of bone marrow–derived dendritic cells is more intense in atopy-prone NC/Nga mice than in other strains of mice.
5) Subacute inhalation exposure to diesel engine–derived nanoparticles does not exacerbate a model of murine allergic asthma.
6) Di-(2-ethylhexyl) phthalate (DEHP) alters the expression of differentiation/maturation markers on peripheral blood mononuclear cell–derived dendritic cells.
7) Evaluation of the phenotypic markers and functions of bone marrow–derived dendritic cells and splenocytes from mice can be useful for *in vitro* screening to detect enhancing effects of environmental toxicants on allergic diseases.

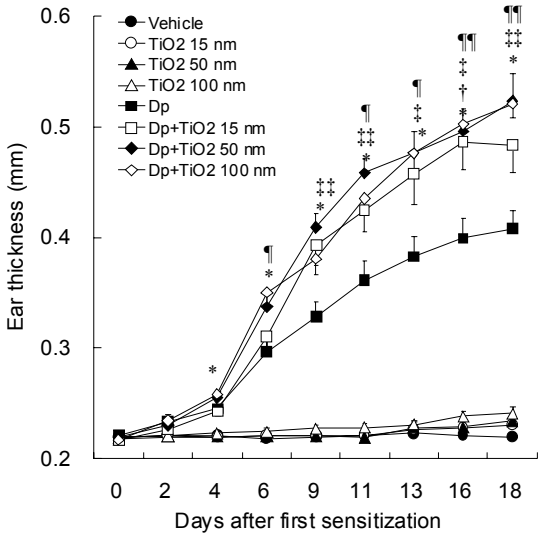


Fig. 2 Effects of TiO_2 nanoparticles (15, 50, or 100 nm in diameter) on thickening of atopic-dermatitis-like skin lesions of the ear induced by mite allergen (Dp). We measured ear thicken-ing 24 h after each intradermal Dp injection. Data are means ± SE of 11 animals per group.
* $P < 0.01$ Dp-treated groups vs. vehicle group
† $P < 0.05$ Dp + TiO_2 15 nm group vs. Dp group
†† $P < 0.01$ Dp + TiO_2 15 nm group vs. Dp group
‡ $P < 0.05$ Dp + TiO_2 50 nm group vs. Dp group
‡‡ $P < 0.01$ Dp + TiO_2 50 nm group vs. Dp group
¶ $P < 0.05$ Dp + TiO_2 100 nm group vs. Dp group
¶¶ $P < 0.01$ Dp + TiO_2 100 nm group vs. Dp group

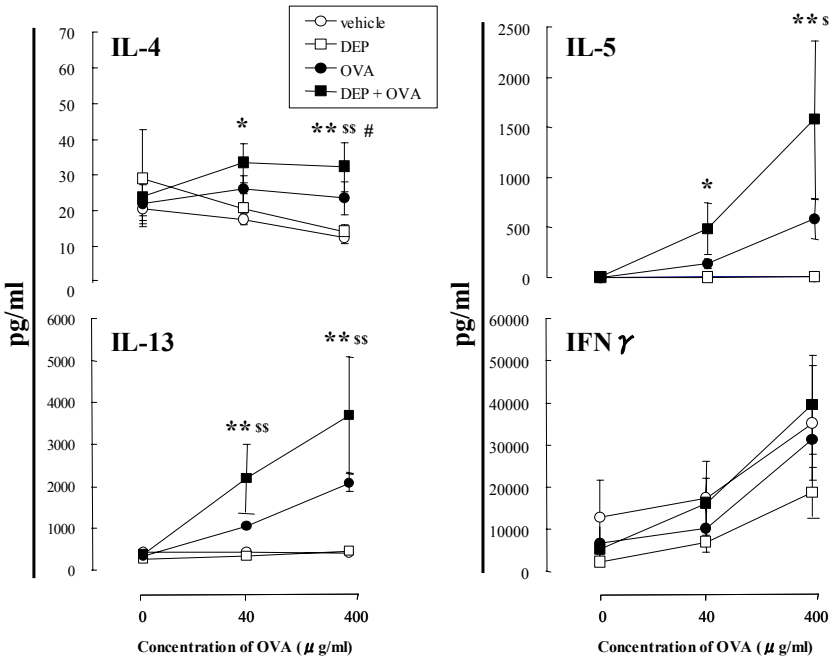


Fig. 3 *In vivo* exposure to diesel exhaust particles (DEP) + ovalbumin (OVA) amplified the production of interleukin (IL)-4, IL-5, IL-13, and interferon (IFN)-γ by splenic mononuclear cells after in vitro stimulation with OVA. Four groups of ICR mice were intratracheally administered vehicle, DEP, OVA, or DEP + OVA for 4 weeks. The spleen was removed 24 h after the last intratracheal instillation. Cytokine production by splenocytes was determined by ELISA. Results are presented as means ± SE. * $P < 0.05$ vs. vehi-cle, ** $P < 0.01$ vs. vehicle, $ $P < 0.05$ vs. DEP, $$ $P < 0.01$ vs. DEP, # $P < 0.05$ vs. OVA.

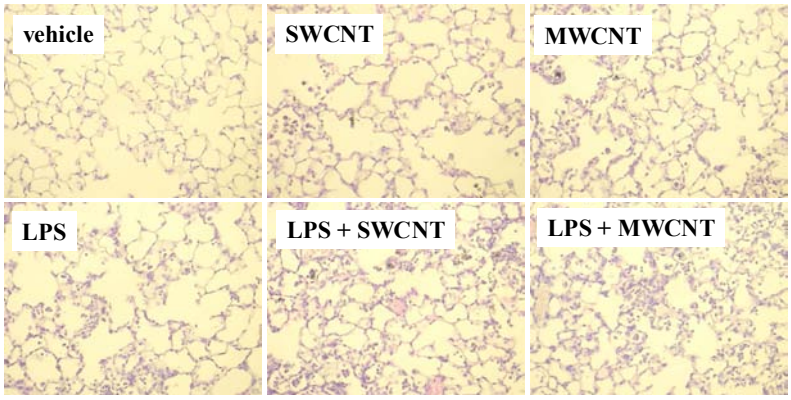


Fig. 4 Pulmonary exposure to two types of carbon nanotubes (single-walled, SWCNT; and multi-walled, MWCNT) modestly worsened neutrophilic lung inflammation induced by lipopolysaccharide (LPS). Twenty-four hours after intratracheal administration of vehicle, carbon nanotubes, LPS (33 μg/kg), or LPS + CNT, mice were sacrificed and their lung histology was assessed by hematoxylin and eosin staining. Original magnification ×400.

The **Integrated Health Risk Assessment Section** conducted epidemiological and experimental research with the financial support of the Ministry of the Environment (MOE), the Global Environmental Research Foundation (GERF), and the New Energy and Industrial Technology Development Organization (NEDO). One study assessed the future health impacts of heat and air pollution under global warming. We evaluated future air pollution–related health risks by forecasting photochemical oxidant (Ox) concentration distributions for 2031–2050 and 2081–2100, and by estimating the excess mortality risk. We then projected risk maps of photochemical oxidant–related mortality in several districts in Japan, including Kanto, Kansai, and the Seto Inland sea region. Another study assessed the development of novel culture substrata for tissue and stem cells that grow and differentiate on basement membranes (BMs) *in vivo*. We focused on BM formation by several kinds of animal and human epithelial cells *in vitro*, and on processing BM extracellular matrices to culture the substrata by removing only the covering epithelial cells without impairing the newly formed lamina densa underneath. On the novel substrata, airway epithelial basal cells could be induced to terminally differentiate into ciliated cells in the same way as *in vivo* (Fig. 5).

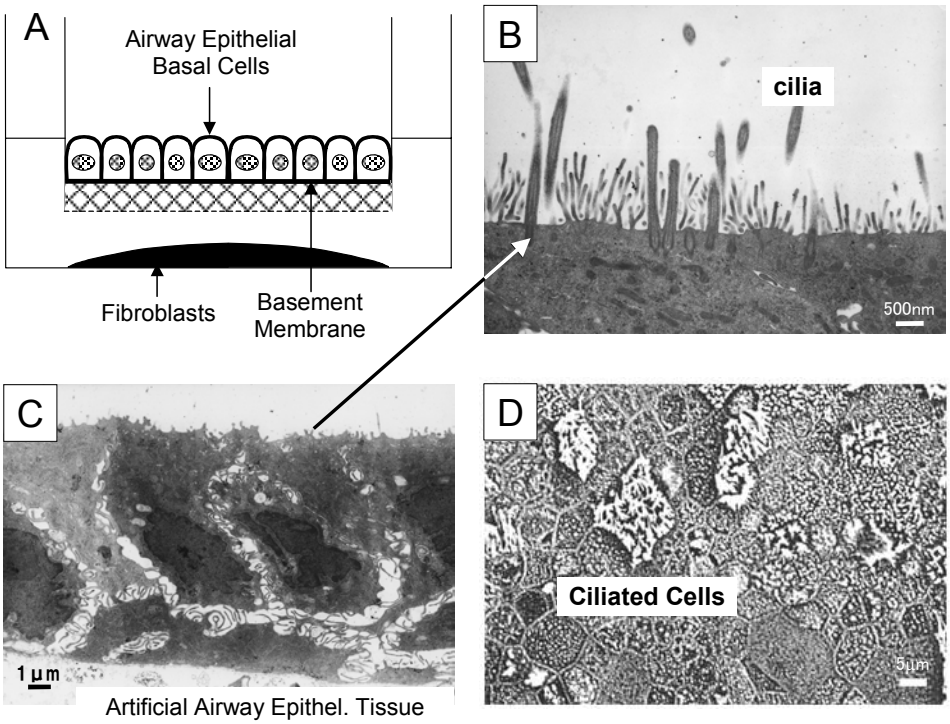


Fig. 5 Reconstruction of airway epithelial tissue from epithelial stem cells of imma-ture basal cells. Rat airway epithelial basal cells were seeded onto a synthe-sized basement mem-brane (sBM) substra-tum and air-lift cul-tured in the presence of pulmonary fibro-blasts in DMEM/F-12 supplemented with retinoic acid (A, C). After 2 weeks of cul-ture, terminally dif-ferentiated ciliated cells appeared (B, D).

We also launched an epidemiological study among adults in Beijing, China. Two-week panel studies including pulmonary function tests and exposure measurements were repeated quarterly. The results revealed the short-term detrimental effects of exposure to airborne particulate matter on daily pulmonary function.
We established a system by which patients with heat disorders were monitored by

an emergency transportation network covering 18 major cities in Japan. Using the data obtained, we created a system to provide the newest number of these heat-disorder patients on the home page. We then established a heat warning system by which the forecast heat index (wet bulb globe temperature) for all prefectures and the measured heat index in six cities are provided via a home page.
We also engaged in research conducted by MOE on short-term morbidity and mortality in relation to air pollution and an epidemiological study of traffic-related air pollution exposure and respiratory health.

The **Environmental Epidemiology Section** has been engaged in research on the health effects of environmental exposure. Our current focus is the development of epidemiological methods and their application to assessments of the health impacts of air pollutants. We conducted detailed analyses to investigate the short- and long-term health effects of exposure to fine particulate matter ($PM_{2.5}$). We report the findings below:

1) We examined the short-term effects of $PM_{2.5}$ on heart disease mortality in nine Japanese cities from 2002 to 2004 by using a generalized linear model adjusted for ambient temperature, relative humidity, seasonality, and day of the week. The area-specific results were combined by meta-analysis with a random-effects model. Of 67,897 deaths from heart disease, we observed a significant positive association between heart disease mortality and $PM_{2.5}$ at lag 0 (the day of death) over all age groups. In the age-stratified analyses, the effects of $PM_{2.5}$ on acute myocardial infarction, cardiac arrhythmia, and conduction disorders were large at lag 0 for the younger population (0–64 years). On the other hand, the associations were not clear for the elderly (Fig. 6).

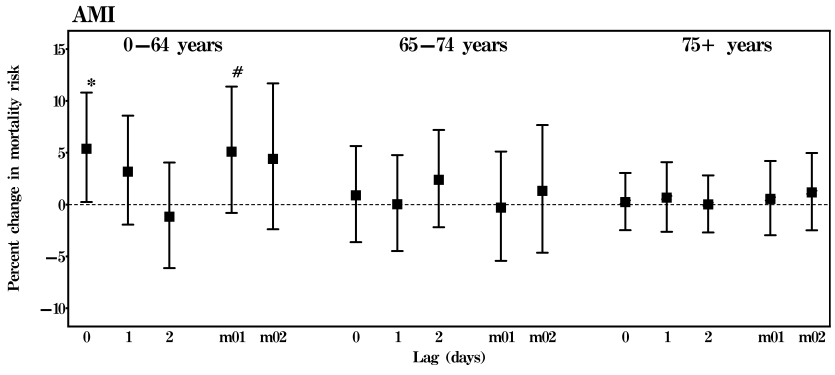


Fig. 6 Percentage changes in mortality (95% CI) from acute myocardial infarction by age category, adjusted for ambient temperature, relative humidity, sea-sonality, and day of the week. lag m01: 1-day moving average (aver-age of exposures on day of death and 1 day be-fore death); lag m02: 3-day moving average (average of exposures on day of death and 1 and 2 days before death)

2) We estimated the short-term effects of $PM_{2.5}$ on daily mortality in 20 Japanese cities by using the Generalized Additive Model (GAM), Generalized Linear Model (GLM), and time-stratified case-crossover analysis. We compared the three methods, adjusting for meteorological variables and co-pollutants, in area-specific analyses. In the area-specific analyses the point estimates of log relative risks were similar by all three methods, but the standard errors of the

estimates obtained by case-crossover analysis were larger than those obtained by GAM and GLM. GAM gave the smallest point estimates when we compared the combined values. Combined results showed that a 10 μg/m^3 increase in $PM_{2.5}$ for the single-pollutant model at lag1 was associated with a 0.53%, 0.77%, and 0.88% increase in all-cause mortality for the GAM, GLM, and case-crossover analysis, respectively. These findings provide evidence for the short-term effects of air pollutants on daily mortality in Japan and suggest that it is necessary to take into consideration differences in the estimates obtained from different statistical models.

We are also engaged in other ongoing epidemiological studies. One is the cohort-based study to examine the effect of long-term exposure to particulate air pollutants on mortality. We are analyzing 24-year follow-up data from the National Integrated Project for Prospective Observation of Non-communicable Disease And its Trends in the Aged (NIPPON DATA). Another is the "Study On Respiratory disease and Automobile exhaust" (SORA) project, organized by MOE in 2005, to examine the adverse effects of traffic-related air pollution on respiratory health. The SORA project consists of three studies: (1) a cohort study of schoolchildren, (2) a study of infants, and (3) a study of adults. We developed a model to estimate each participant's exposure to traffic air pollutants (elemental carbon and nitrogen oxides) by using information on traffic volumes, vehicle emission rates, meteorological conditions, types of road construction, and distance to roadways.

Atmospheric Environment Division

Clouds over the Pacific Ocean
(photo: H. Yamagishi)

The aim of the Division's research is to understand and solve atmospheric environmental problems ranging from urban air pollution to trans-boundary and global issues. The Division consists of four sections: the Atmospheric Physics Section, which conducts research on numerical modeling and data analysis of atmospheric dynamics and climate systems; the Atmospheric Remote Sensing Section, which studies the atmospheric environment by using remote sensing techniques such as lidar (laser radar); the Atmospheric Chemistry Section, which conducts research on the temporal and spatial distribution and reactions of reactive organic compounds in the atmosphere; and the Atmospheric Measurement Section, which conducts field research on natural and anthropogenic trace species. Observation of ozone-depleting species and the polar stratospheric cloud over Antarctica is being tackled independently by this Division. Many of the members of this Division also work for Priority Research Programs such as the Climate Change and Asian Environment programs.

Attribution of polar warming to human influence

Because of the positive feedbacks associated with the melting of ice and snow, the polar regions have long been expected to warm strongly as a result of anthropogenic climate change. However, the surface temperature changes in both polar regions have not yet been attributed to human influence. We assessed the causes of the observed polar temperature changes by using an up-to-date gridded data set of land-surface temperatures and simulations from Model for Interdisciplinary Research on Climate (MIROC) 3.2(medres) and other three coupled climate models. To test for presence of anthropogenic or natural response in observations of polar temperatures, we used a detection and attribution analysis to compare simulated and observed changes. As an example, the anthropogenic regression coefficient was significantly greater than zero in both the Arctic and the Antarctic. The observed changes in the Arctic and Antarctic temperatures were not consistent with internal climate variability or natural climate drivers alone, and were directly attributable to human influence.

CCM simulation of the breakup of the Antarctic polar vortex in the years 1980–2004 under CCMVal scenarios

We used a Center for Climate System Research (CCSR)–NIES chemistry climate model (CCM) to examine the changes in breakup time of the Antarctic polar vortex in the years 1980–2004. The data from the National Centers for Environmental Prediction / the National Center for Atmospheric Research (NCEP/NCAR) and the data from the European Center for Medium-Range Weather Forecasts Reanalysis (ERA40) were also used for trend analysis of the breakup time. The CCM calculations were performed with two ensemble members for the REF1 scenario of the chemistry climate model validation (CCMVal) and one ensemble member for the REF2 scenario. Calculated and observed breakup times are shown in Figure 1. We observed a delay trend in the breakup time of the Antarctic polar vortex for the period 1980–1999 in the NCEP/NCAR and ERA40 data. A similar trend was also obtained from the CCM simulations, with statistical significance

for one ensemble member of REF1 and for REF2. Because the trends in observations of the Eliassen-Palm flux from the troposphere and its deposition in the lower stratosphere are consistent with an advanced breakup date of the polar vortex, and because the trends in the CCM simulations were very small, it is likely that Antarctic ozone depletion made some contribution to the delay during the period 1980–1999. From 2000 to 2004, the NCEP/NCAR data showed a large variation in breakup time, making the delay trend obscure. It is likely that the large variation in wave flux masked the effects of the ozone loss during that period. The REF2 simulation showed a dramatic change in the period 2000–2004, but the two ensemble members of REF1 did not.

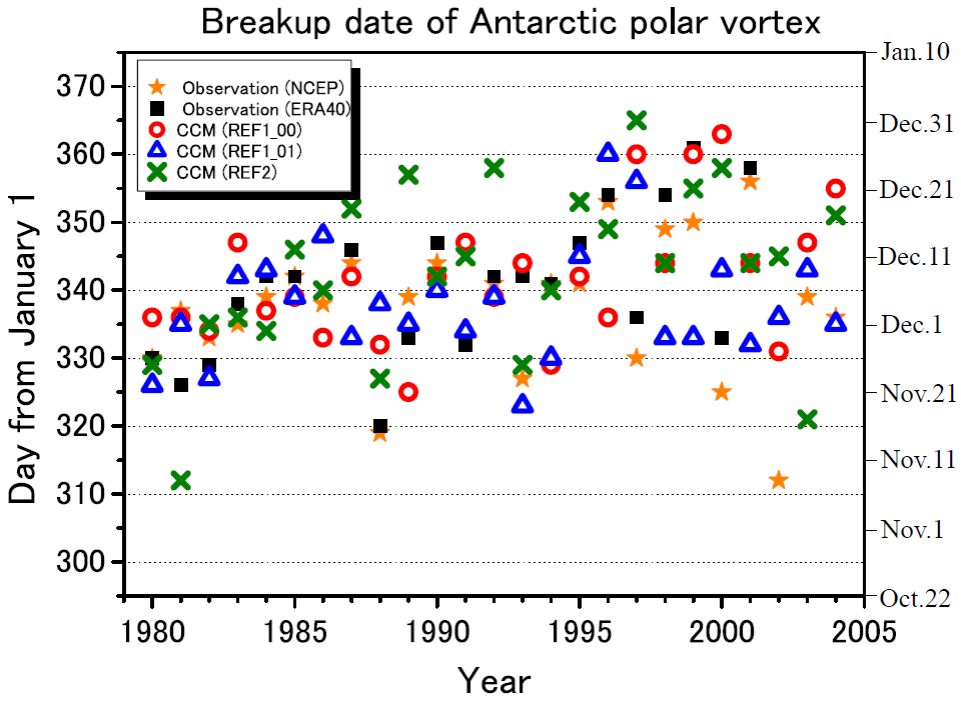


Fig. 1 Date of breakup of the Antarctic polar vortex as a function of the years 1980 to 2004. Solid symbols denote the breakup date calculated from the observation data. Open symbols and crosses denote the breakup date calcu-lated with CCM for the CCMVal REF1 and REF2 scenarios, respectively.

Algorithm to retrieve aerosol optical properties from high-spectral-resolution lidar and polarization Mie-scattering lidar measurements

A new algorithm was developed to estimate the vertical profiles of extinction coefficients at a wavelength of 532 nm for three aerosol types (water-soluble, soot, and dust particles). The algorithm uses data measured with a high-spectral-resolution lidar (HSRL) and a Mie-scattering lidar (MSL). The extinction and backscattering coefficients at 532 nm for total aerosols were derived from HSRL measurements; for data from the MSL measurements the receiving signal intensity at 1064 nm and total depolarization ratio at 532 nm were used. The mode radii, standard deviations, and refractive indexes for each aerosol component are prescribed by the optical properties of aerosols and clouds database; the optical properties for each aerosol component were computed from Mie theory on the assumption that their particles were spherical and homogeneous,

except in the case of dust particles. To consider the effect of nonsphericity for dust particles, the dust lidar ratio at 532 nm was assumed to be 50 sr, the value reported for Asian dust from other observational studies. We performed a sensitivity study of the retrieval errors; the errors in the extinction coefficient for each aerosol component were found to be smaller than 30% and 60% when the measurement errors were 5% and 10%, respectively. The algorithm was applied to the HSRL + MSL data measured at Tsukuba, Japan, and plumes consisting of water-soluble aerosols, soot, or dust, or their mixture, were retrieved (Fig. 2). The results were consistent with those from simulations with a global aerosol transport model. Introducing the dust lidar ratio significantly improved the correlation between the retrieved dust concentration and the aerosol depolarization ratio at 532 nm derived from HSRL + MSL, in comparison with the use of a spherical dust optical model for data retrieval.

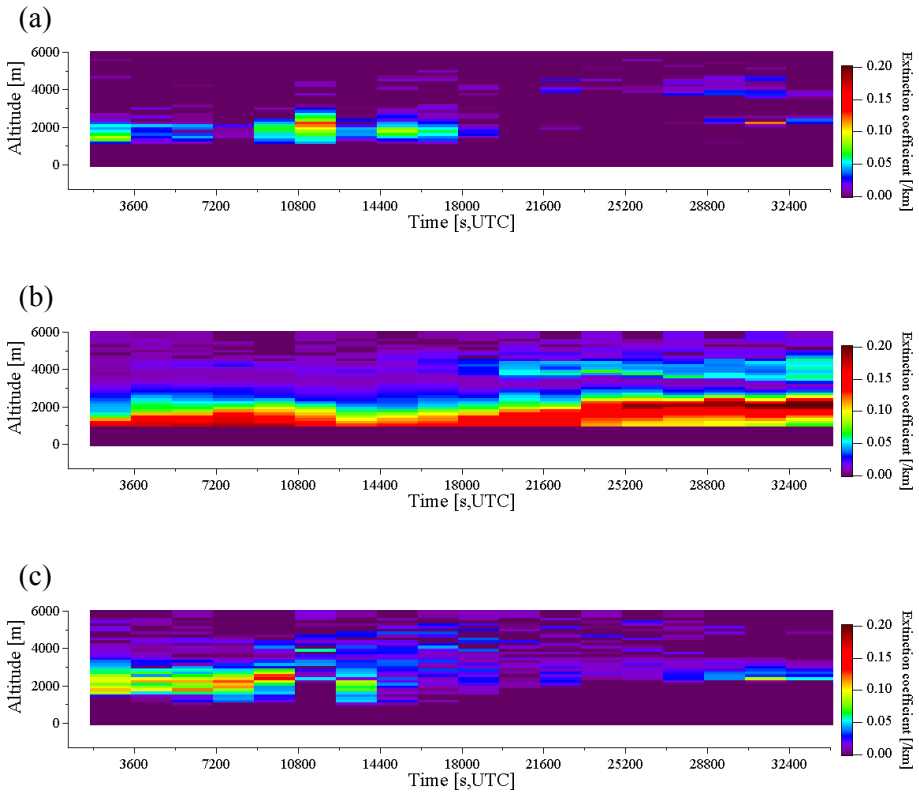


Fig. 2 Time–height cross-sections of ex-tinction coefficients of (a) water-soluble, (b) dust, and (c) soot particles retrieved from data measured on 8 April 2005. The figure indicates a dust plume around 4km, a water-soluble component and dust mix in the planetary boundary layer (PBL) formed be-low 2.5km, and soot particles partly mixed in the upper layer of the PBL.

Discrimination and quantification of isomeric compounds by two-stage proton transfer reaction mass spectrometry

A two-stage proton transfer reaction mass spectrometry (PTR-MS) technique was developed to achieve more selective mass spectrometric (MS) detection of selected volatile organic compounds (VOCs) than that achieved with commonly used PTR-MS instruments. In this technique, the normal proton transfer reagent, H_3O^+, was mixed with a chosen volatile organic compound, designated VOC_1, upstream of an analyte gas flow. This process makes protonated VOC_1, which in turn can react with VOCs (designated collectively as VOC_2) with proton affinities

larger than the affinity of VOC_1 in an analyte gas stream. This approach can also be used to differentiate isomeric VOCs, which are notoriously difficult to distinguish by conventional PTR-MS with H_3O^+ as the reagent ion. For example, in using protonated acetone as protonated VOC_1, $[M+H]^+$ ions were formed from ethyl acetate, whereas 1,4-dioxane, an isomer of ethyl acetate, did not give $[M+H]^+$ ions. The PTR-MS–derived concentrations agreed quantitatively with those independently determined by Fourier transform infrared (FT-IR) spectroscopy. In addition, interfering fragment ions formed from alkyl benzenes at *m/z* 79 ($C_6H_7^+$) could be distinguished from the *m/z* 79 ion arising from protonation of benzene. Use of this method would therefore prevent overestimation of benzene concentrations in air samples in which both benzene and alkyl benzenes were present.

Atmospheric O_2/N_2 measurements at two Japanese sites: estimation of global oceanic and land biotic carbon sinks and analysis of variations in atmospheric potential oxygen

Atmospheric O_2/N_2 and CO_2 mixing ratios have been measured at Hateruma Island and Cape Ochi-ishi in Japan. Figure 3 shows the CO_2 mole fraction, O_2/N_2 ratio, and atmospheric potential oxygen (APO) observed from 1997 to 2006 at Hateruma and from 1999 to 2006 at Cape Ochi-ishi. Global carbon sinks were estimated from the tracer APO, calculated as the weighted sums of the observed O_2/N_2 and CO_2, and from global CO_2 data from the Global Monitoring Division of the National Oceanic and Atmosphereic Administration, Earth System Research Laboratory, (NOAA/ESRL) flask sampling network. The oceanic and land biotic sinks were 2.4 ± 0.7 and 0.5 ± 0.9 Pg C $year^{-1}$, respectively, for the 7-year period July 1998 to July 2005, and 2.1 ± 0.7 and 1.0 ± 0.9 Pg C $year^{-1}$, respectively, for the 6-year period July 1999 to July 2005. The 7-year estimates were based on the Hateruma data only, whereas the 6-year estimates were obtained by using data from both Hateruma and Cape Ochi-ishi. The estimations included an ocean outgassing correction of 0.48 Pg C $year^{-1}$. The instantaneous rates of change in the APO trends showed large interannual variability, with peak-to-peak amplitudes of about 30 per meg $year^{-1}$. Winter anomalies in the APO trend were the major contributors to the interannual variability, and the oceanic O_2 influx associated with winter ventilation may be an important cause of the variability in APO.

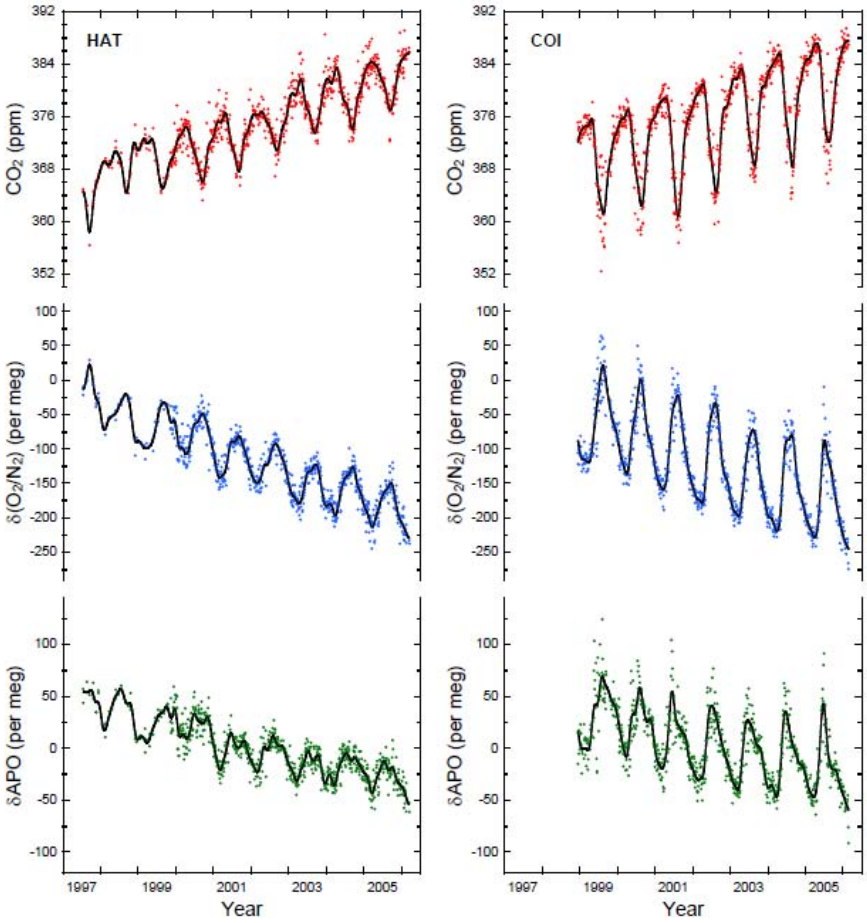
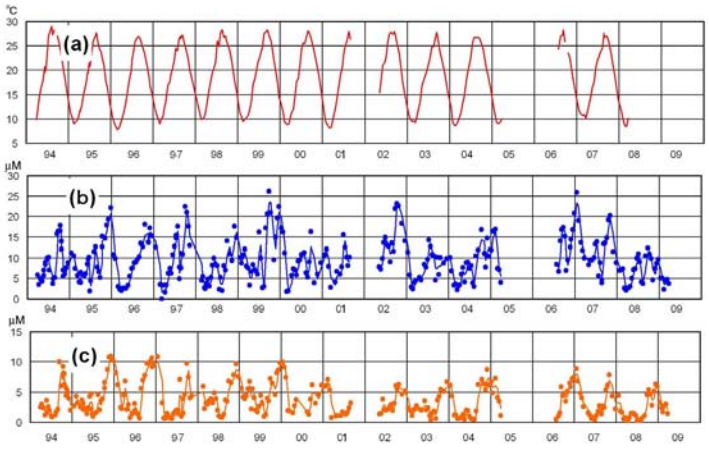


Fig. 3 Time series of observed (top) CO_2 mole fraction, (mid-dle) O_2/N_2 ratio, and (bot-tom) atmospheric po-tential oxygen at Hateruma (left panel) and Cape Ochi-ishi (right panel). Each point is the average from rep-licate flasks collected at the same day. Solid lines indi-cate smooth-curve fits.

Water and Soil Environment Division

Long-term Monitoring of the Interactions between the Watersheds and the Semi-Enclosed Sea Using Ferryboats



Eutrophication and the resilience of waters to this condition in semi-enclosed seas such as the Harima-Nada basin (circled) in the Seto Inland Sea (bottom right) result from a complicated interplay among discharge from watersheds and marine processes ranging over physical, chemical, and biological factors. Use of a ferryboat as a platform (bottom left) is a cost-effective way to achieve long-term and seasonally resolved time-series data. The graphs show time-series data from 1994 to 2009 in the Harima-Nada basin: (a) water temperature; (b) dissolved inorganic nitrogen concentra-tion; and (c) dissolved silicate concentration.

The Water and Soil Environment Division undertakes research from a variety of approaches on the environmental pollution and ecological changes that occur via the media of water and soil. This research includes the long-term monitoring of rivers, lakes, and coastal seas (see Figure on the cover of this section) to assess these changes, and the development of technologies to mitigate the environmental deterioration.

Isolation of the dichloromethane-degrading bacterium *Hyphomicrobium* sp. DN58

One of the tasks of the **Water Quality Science Section** is to develop biotechnology-based methods to improve polluted environments. Dichloromethane (DCM) is a volatile chlorinated organic compound that has been used widely as an organic solvent. It is one of the contaminants most frequently detected in groundwater and is a suspected carcinogen. DCM pollution is a societal problem, because inhalation exposure has resulted in optic neuropathy and hepatitis. To develop a DCM bioremediation technology, we obtained enrichment cultures from biofilms that had been exposed over several years to wastewater containing DCM. We were then able to isolate *Hyphomicrobium* sp. DN58 from these enrichment cultures, which contained DCM as the sole carbon source (Fig. 1). DN58 is strictly aerobic and Gram-negative, and its growth is poor. From its morphological properties and the sequence of its 16S rDNA gene, it was identified as belonging to the genus *Hyphomicrobium*. To evaluate its DCM dehalogenation rate, we determined the growth and DCM concentration of the strain on mineral medium containing 10 mM DCM as the sole carbon and energy source. The dehalogenation rate of DN58 was higher than in previous reports of the other bacterial isolates.

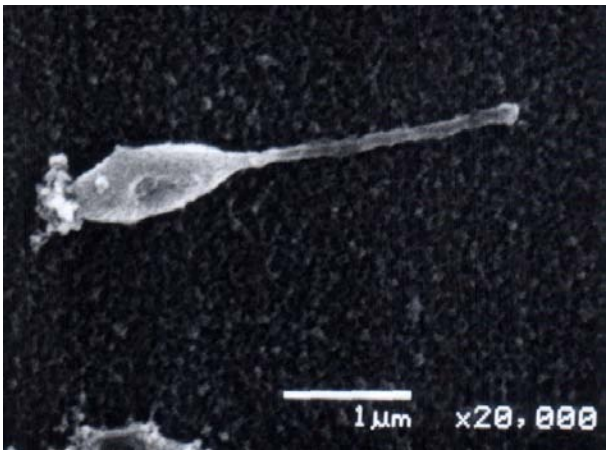


Fig. 1 Electron micrographs of the dichloromethane (DCM) degrading bacterium *Hyphomi- crobium* sp. DN58 grown on dichloro-methane.

Studies of the factors regulating forest soil organic carbon density in the cool temperate zone

Soil organic carbon (SOC) is a major component of the carbon cycle. The **Soil Science Section** is studying Japanese forest soils with steep topography in the

cool temperate zone to investigate the relationships among the area of distribution of Andic (volcanic ash) soils (which are well known for their large amounts of SOC), the quantity and quality of SOC, the geographic conditions, and a long history of land use. The study area is located at the source of the Arakawa River in Ohtaki, Chichibu, Saitama prefecture, and covers 33,000 ha. Altitude ranges from ca. 340 to 2480 m. The underlying rocks consist mainly of slate, sandstone, shale, chert, semischist, granite, limestone, and diabase tuff, as well as several types of volcanic tephra. This area has been used for afforestation with Japanese cedar (*Cryptomeria japonica*) and hinoki cypress (*Chamaecyparis obtusa*). It also contains natural forests, slash-and-burn agricultural areas, commons, Imperial forests and shrine forests. We surveyed soils at more than 70 sites. The stock of SOC in the study area ranged widely, from 30 to 151 Mg ha^{-1} in the top 30 cm. The stocks of SOC in the mineral soil horizon were significantly correlated with the stocks of Andic soil constituents, expressed by oxalate-extractable Al and Fe (Al_o, Fe_o) and/or of pyrophosphate-extractable Al (Al_p), but the clay content in each soil showed no such correlations. Densities of Andic soil constituents, as expressed by Al_o or Fe_o, in the forests of planted conifers (particularly *C. japonica*) were low where the slope was steep and the altitude was low. In contrast, no similar tendencies were found in the natural broad-leaved forests（Fig. 2). The slope gradient may influence soil stability and the deposition of parent materials. The low-altitude correlation may be related to ease of traffic access from villages and frequency of land use. Even long before the planting of *C. japonica*, areas at low altitude might have been used for slash-and-burn agriculture, for fuel gathering, or as commons. These uses might have caused soil erosion over wide areas over a long time. The results of the survey suggest that stock levels of SOC on Andic soils are closely related to not only the quantity of volcanic ejecta covering the area, but also to the topographic characteristics and the history of human activities such as afforestation, deforestation, and common grazing.

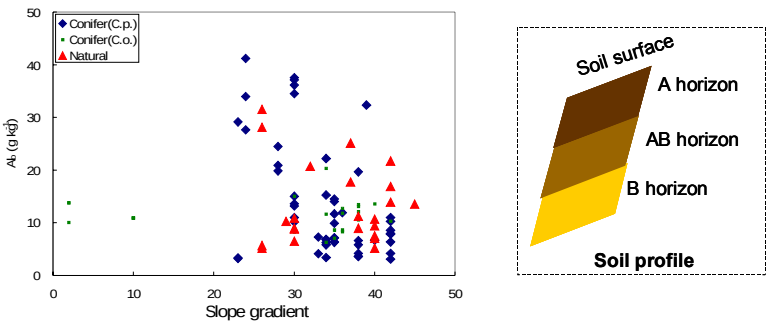


Fig. 2 Relationship between oxalate-extractable aluminum content (verti-cal axis) in the AB and B horizons and slope gra-dient (horizontal axis). The soil horizon is de-fined as a layer of soil with characteristics pro-duced by certain soil-forming processes; it is shown schematically in the figure at right for slopes such as those in our study. The results for the A horizon are not shown here but were similar to those for the other horizons.

Analysis of dissolved organic matter in a Japanese lake

One of the studies being performed by the **Lake Environment Section** assessed lake environments, focusing on the processing of DOM (dissolved organic matter). A steady increase in recalcitrant DOM has been observed in several lakes in Japan, and this increase could indicate a new type of lake water pollution. Accumulation of recalcitrant DOM in lake water—a phenomenon that has not been considered before—will clearly influence the way in which lakes must be managed for environmental protection. It also suggests a serious challenge for drinking water management, because recalcitrant DOM could be a major precursor of the trihalomethane produced by chlorination during water treatment. Therefore, detailed evaluation of the characteristics of DOM in lake waters is urgently needed. We have been quantifying various components, including neutral sugars, enantiomers of amino acids, and isotopic composition, as part of our analysis of the bioavailability and characteristics of lake water. Data on these biomolecules and isotopic compositions are important in regard to the origin and degradability of DOM (Fig. 3).

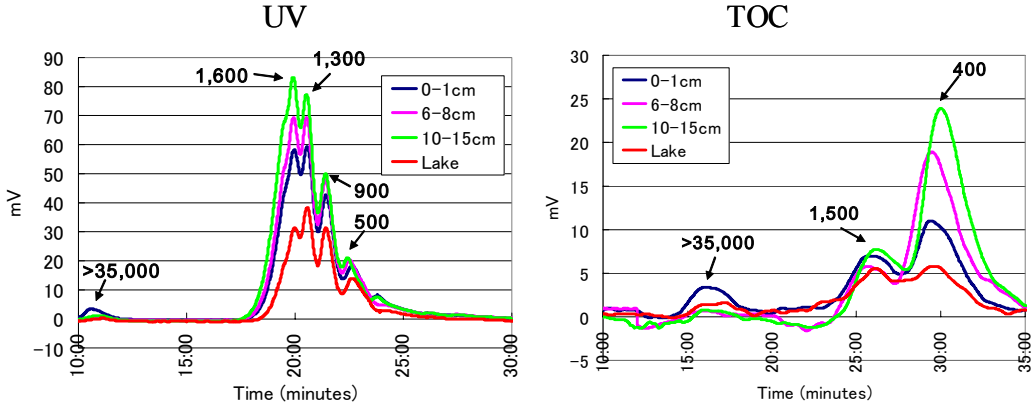


Fig. 3 Chromatographic peaks (UV, left; TOC, right) and apparent molecular size (shown at each peak; unit: daltons) in the pore water of sediments of different depths and in lake water of Lake Kasumigaura. The increase in DOC did not correspond to the UV absorbance, indicating that sediments with in-creased DOC had low UV absorbance.

Besides these measurements, the molecular size of DOM is important for determining the reactivity of DOM. Size-exclusion chromatography (SEC) with ultraviolet (UV) absorbance detection has commonly been used to determine DOM size, but this system can detect only DOM with UV absorbance. Furthermore, because the degree of UV absorbance differs with each compound, it is difficult to conduct quantitative analyses of the size distribution of DOM. We have therefore developed an SEC system with UV absorbance and on-line total organic carbon (TOC) detectors. Using the system, we have measured various water samples, including those from Lake Kasumigaura and its sediment pores. We found that the increase in dissolved organic carbon (DOC) concentration with depth in pore water samples is due to an increase in the abundance of low-molecular-weight and low-UV-absorbance DOC.

Hypoxia generation and evaluation of its impact on benthic biota

The **Marine Environment Section** has been involved in a research project on hypoxia generation and the evaluation of its impact on bivalves in Tokyo Bay. This characteristic Japanese semi-enclosed coastal sea suffers from severe hypoxia. Our work is divided into the following four areas: (1) evaluation of biodegradability of pelagic organic matter from different sources; (2) measurement of sediment oxygen consumption rates and their correlations with sediment characteristics; (3) influences of hypoxia on survival and growth of bivalve species; and (4) development and refinement of a three-dimensional numerical simulation of hydrodynamic circulation. We obtained some distinct results in these areas by using rigorous field and experimental studies (Fig. 4) and computational simulations. In FY 2008, we conducted some additional studies to confirm these results. These additional studies indicated that particulate organic matter, which comprises mainly phytoplankton biomass, can be intensively degraded and has great potential for oxygen consumption in the water column. We also found that sediment oxygen consumption proceeds biphasically; its rate depends upon not only the sulfur and/or organics content, but also the sediment grain size distribution (Fig. 5). A simple model simulation showed that the contribution of sediment oxygen consumption to total oxygen consumption in the water column of Tokyo Bay could be much bigger than that of pelagic organic matter degradation.

Fig. 4 Multiple online dissolved oxygen (DO) sensor system for measuring sediment oxygen consumption. DO microsensors were inserted into the centers of the rubber caps, which were plugged into the top of each core tube containing sediment. Because there was no headspace, the top of each DO sensor in the rubber cap touched the upper water layer of the sediment core. Each core sample was incubated in a water bath held at the same temperature as that at the site in Tokyo Bay from which it was extracted.

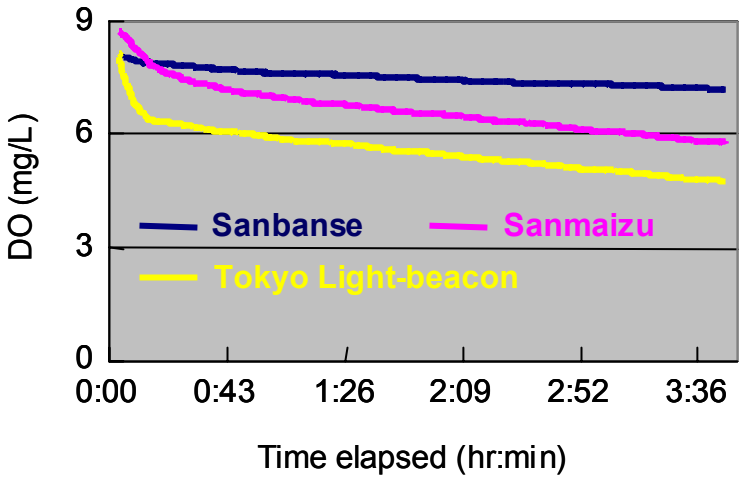


Fig. 5 Results of sediment oxygen consumption measurement in Tokyo Bay in July. Sediment cores were sampled from various sites in the bay: Sanbanse, a shallow sandy site; Sanmaizu, an occasionally hypoxic, shallow (ca. 6 m) muddy site; Tokyo Light Beacon, ca. 15 m water depth, chronically hypoxic, and with a reductive sediment.

Environmental Biology Division

A wild orchid, *Cephalanthera falcata*, growing in Tsukuba city. This is one of numerous plant species at risk of extinction. Once lost, these natural species will never return. We need to know the species at risk of extinction, the main causes of the risk, and how we can avoid losing this natural heritage.

The mission of the Environmental Biology Division is to help conserve biodiversity and ecosystem functions. In the pursuit of this mission, our activities include ecological, physiological, and molecular genetic studies. The Division consists of four sections: Population Ecology, Physiological Ecology, Microbial Ecology, and Ecological Genetics. The staff of the four sections are collaborating on the following tasks.

Studies of the conservation of threatened species

The Ogasawara, or Bonin, Islands are oceanic islands that have never been connected with continents or continental islands. They are famous for their high levels of endemism in some terrestrial plant and animal groups. These endemic species are vulnerable to extinction and have been listed in the Red Data Book of Japan as endangered and threatened. We have been studying the freshwater and brackish-water fauna of the islands, which has not been extensively analyzed. We found caridean shrimps, one of the groups representative of the macroinvertebrates in the streams of Japan and its adjacent regions, in the islands' streams. Among nine species of caridean shrimp that we collected, we found two species, *Paratya boninensis* (Fig. 1) and *Palaemon ogasawaraensis*, that are endemic to the islands. Both of the endemic species were distributed over narrow ranges. The former was found in several headwaters on the islands of Chichi and Haha, and the latter was found in a few brackish-water streams of Chichi Island. Both the headwaters and brackish waters are likely to take high priority for habitat-based conservation of these endemic shrimps.

Fig. 1 Left: Female of the endemic shrimp *Paratya boninensis* collected on Chichi Island in the Ogasawara group. Right: Typical habitat of the shrimp.

The Chironomidae are a group of insects related to mosquitoes. They form one of the most abundant components of the freshwater ecosystem of the Ogasawara Islands. We assessed the vulnerability of the habitats of endemic chironomid species. A total of 17 species of Chironomidae were recorded, among which eight were endemic to the islands (Fig. 2). Three had never been reported in the islands before. We also found a species that we suspect has not yet been named. Endemic chironomids were found in streams that are relatively stable and numerous on the islands. However, these aquatic environments are likely to be affected by the recent decline in rainfall levels in the islands.

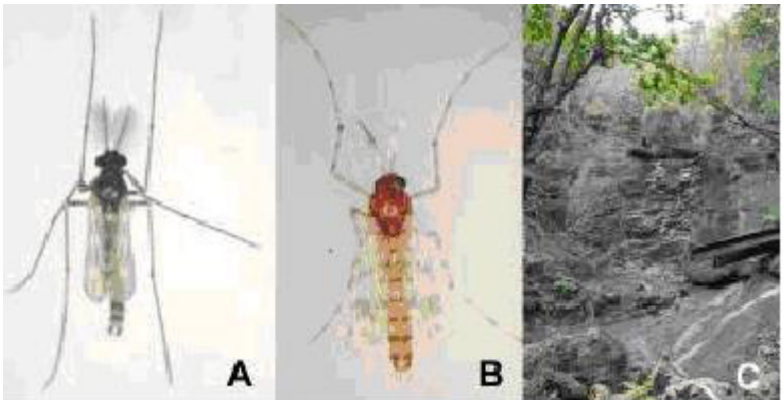


Fig. 2 A. *Macropelopia ogasasextdecima*, a chironomid endemic to the Ogasawara Islands. B. *Ablabesmyia prorasha*, a species recorded on the Japanese mainland and in the Ryukyu and Ogasawara Islands. C. Typical habitat of the several chironomids endemic to the Ogasawara Islands.

Vegetation height is useful information for classifying vegetation types. Remote sensing by aerial photographs has been used to obtain the surface structure of forest canopies with a wide range of heights. However, it was not clear whether this method was applicable to estimation of the heights of herbaceous plants, which requires greater accuracy because these plants are much shorter.

We estimated vegetation height in Watarase Wetland in the Kanto plain, which is covered mainly by reeds (*Phragmites australis*) and Amur silvergrass (*Miscanthus sacchariflorus*) about 3 m high, using digital aerial photographs obtained with an airborne sensor (ADS40, Leica Geosystems). From photographs taken just after a controlled burn in early spring we estimated ground elevation, and from photographs taken in August we estimated the elevation of the surface of the vegetation cover. Vegetation height was obtained by subtracting the former from the latter (Fig. 3). The results agreed well with the height of maximum leaf density by ground survey.

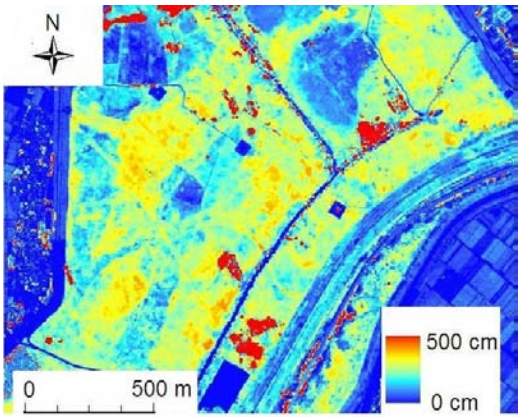


Fig. 3 Vegetation height in part of the Watarase Wetland, as estimated from digital aerial photographs. Height was estimated as the difference between the land surface elevation in mid summer and that after burning of the area in early spring.

Studies of the structure and function of ecosystems

In peat mires, the decomposition of plant residues by microbes, and the mineralization that follows, occur slowly under soil conditions of low temperature, high moisture content, low oxygen, and acidity. Peat mires are therefore poorly fertile

and are covered by unique types of vegetation. Recently, it has been suspected that microbial functions (e.g., decomposition and mineralization by microbes) in these mires have been changing over significant areas of land because of the inflow of soil and nutrients from surrounding farms and forests through rivers and other artificial sources. We are developing a method of evaluating microbial functions in wetlands by measuring the enzyme activities of soil microbes. A field study in the Kushiro Mire in Hokkaido, the northernmost of the four main islands of Japan, demonstrated that increases in the activity of phosphatase, which mineralizes organic phosphate to inorganic phosphate, depended on increases in mineral soil contamination from roads constructed on the banks in the mire. Such enhancements of mineralization activity might change the supply of nutrients to plants, causing changes in the vegetation.

Studies of the effects of environmental stress and climate change

The morning glory cultivar Scarlet O'Hara is a sensitive indicator plant for ozone. When the concentration of ozone is about 0.08 ppm or higher, symptoms appear on the leaves by the next day. These symptoms—small white or brown patches—indicate the death of leaf cells. Before the appearance of these symptoms, or even when the symptoms do not appear at all, expression of a group of genes is induced in the leaf cells, reflecting the stress caused by the ozone. To evaluate ozone stress in plants quickly and accurately, we are developing a method for diagnosing ozone stress by gene expression. Expression of the defense genes is being investigated in leaves of field-grown morning glory exposed to ambient ozone in several cities in Japan to find genes suitable for stress diagnosis. Induction of the expression of a candidate gene (gene A in Fig. 4) by ambient ozone has been demonstrated in leaves without visible symptoms, suggesting the possibility of diagnosing ozone stress by using gene expression.

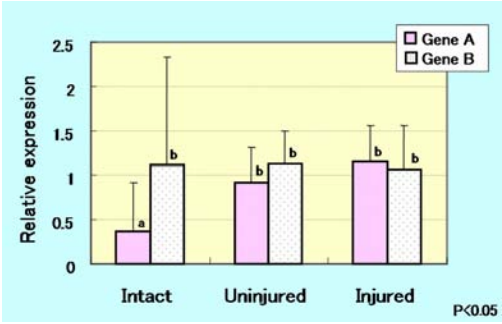


Fig. 4 Relative expression levels of defense genes in the leaves of field-grown morning glory plants. Intact leaves were collected in early summer when the ambient ozone level was low. Apparently ozone-damaged leaves, as well as intact ones, were collected in mid-summer, when the ozone level was high. The results show that of the two genes tested, gene A is a good candidate for the detection of ozone stress.

To avoid loss of crop production as a result of future increases in ozone levels, we are investigating the effects of ozone at the gene, protein, and metabolite levels on rice, a staple food in Japan and Asian countries, where heavy ozone pollution is predicted. Our current results show that ozone affects various important cellular processes, including photosynthesis, respiration, amino acid and secondary metabolite biosynthesis, and signal transduction of environmental stimuli, in

rice seedlings. Further studies will contribute to the development of ozone-tolerant rice cultivars.

It has been hypothesized that global warming has an increased impact on ecosystems at high elevations. We therefore set up a long-term observation network to monitor climatic conditions and ecosystem responses at different altitudes on the Qinghai-Tibetan Plateau. We observed increased daily variations in air temperature at high elevations. Further, ecosystem respiration, as indicated by the amounts of CO_2 released from the soil and vegetation, showed greater temperature sensitivity at higher elevations than at lower ones (Fig. 5). These results agreed with the above hypothesis, but further observations are needed to confirm this conclusion.

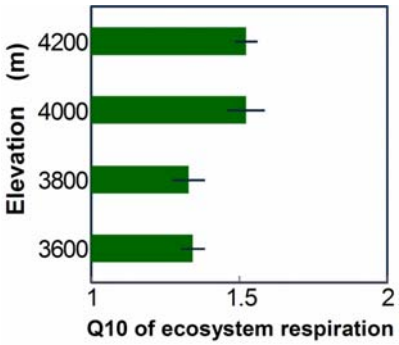


Fig. 5 Left: Measurement of ecosystem respiration (soil CO_2 flux) in grassland at Haibei, on the Qinghai-Tibetan Plateau. Right: Q_{10}, the rate of increase of ecosystem respiration in response to increasing soil temperature, measured at different altitudes. Ecosystem respiration at higher elevations was more sensitive to temperature change.

Studies of invasive alien species and genetically modified organisms

Millions of tonnes of agricultural products are now imported by Japan, about one-tenth in the form of oilseed rape (*Brassica napus* L.) seeds. About half of the imported rapeseed has been genetically modified for resistance to herbicides. Some of these imported seeds are likely to be dispersed unintentionally during their transport within Japan. In 2005, we started a census of oilseed rapes growing along a 20-km stretch of a major road. Oilseed rape plants were found each year, but the number of plants varied substantially during the 4 years of the study: 2162 plants in 2005, 4066 in 2006, 278 in 2007, and 390 in 2008. Herbicide-resistant plants were found every year from 2005 to 2008: 35 plants in 2005, 8 in 2006, 5 in 2007, and only 1 in 2008. These plants are likely to have had their origins in seeds spilled during transportation of cargo from the port, since there are no potential natural seed source plants for *B. napus* near this road.

Other studies

Blooms of floating seaweeds, such as *Ulva* species, covering intertidal flats are known as green tides. We are monitoring the appearance of green tides on Yatsu tidal flat in Tokyo Bay. On the tidal flat, the bloom area increased after 1995 and covered 27.1 ha in May 2002. Even in winter, the green tide covered 4.7 ha when first observed in 1999, but had increased to 17.5 ha by January 2002. We found that expansion of the green tide was related to warm winters, an increase in salinity, and the unintentional introduction of alien *Ulva* species.

Recently, algae have attracted attention as biomass energy resources because of their high diversity and productivity. We examined the use of the green colonial microalga *Botryococcus braunii* in liquid fuel production (Fig. 6). To find the highest-performance strains suitable for outdoor mass-culture, we surveyed a wide range of microalgal groups under various conditions, including different pHs, salinities, and temperatures. We established two strains of *B. braunii* resistant to high salinity.

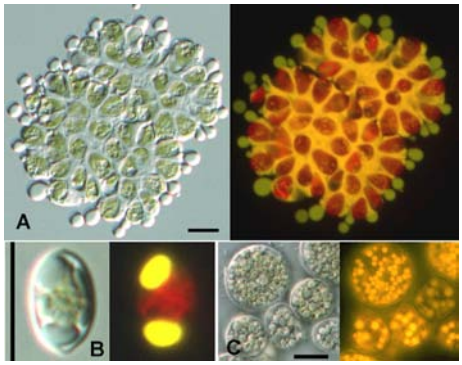


Fig. 6 Oil-producing strains of algae. Differential interference contrast images (clear) and fluorescent images (colored) showing yellow fluorescence of hydrocarbon stained by a dye. A: Strain of *Botryococcus braunii* screened under alkaline conditions. Note the oil droplets around the cells. B and C: Strains of unicellular green algae screened under saline conditions. Note the oil granules in the cells. Scale bar = 10μm.

Generally, ecosystems divided by geographic barriers evolve independently. Terrestrial ecosystems divided by ocean is an example. However, the recent development of transportation systems voids the effects of these barriers. Consequently, nowadays biota evolved on each continent is being mixed as if ecosystems were united. This mixing of biota could have a great impact on species diversity and food web structure. By using a virtual food web model we conducted a computer simulation of mixing of biota and investigated the effects of this mixing on species diversity and ecosystem structure. After the ecosystem fusion, species diversity in each single ecosystem dramatically increased because of the invasion of new species from the other ecosystem (Fig. 7a; about a 40% increase). However, many native species became extinct under the influence of predation pressure from invasive predators and competition among invasive species. Consequently, global species diversity decreased severely (Fig. 7b; about a 20% decrease).

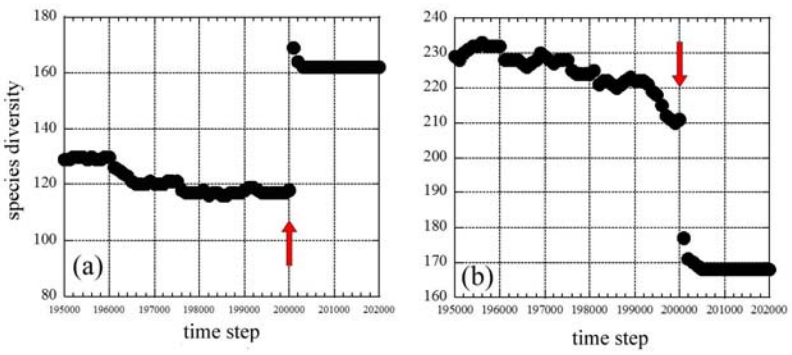


Fig. 7 Results of a computer simulation study showing the change in species diversity resulting from the fusion of two virtual ecosys-tems. (a) Species diversity in an individual ecosystem; (b) Global species diversity. Red arrowheads indicate the time pint at which the two ecosystems were merged.

Laboratory of Intellectual Fundamentals for Environmental Studies

Examples of experimental aquatic animals used in environmental risk evaluation

A: Damselfly (*Ischmura senegalensis*)
B: Daphnid (*Daphnia magna*)
C: Zebrafish (*Danio rerio*)

The Laboratory of Intellectual Fundamentals for Environmental Studies (LIFES) incorporates two research laboratories: the Environmental Analytical Chemistry Laboratory (ACLab) and the Biological Resource Laboratory (BRLab). The aim of LIFES is to promote environmental research, not only in NIES but all over the world, through the provision of environmental Certified Reference Materials, microbial cell strains, and experimental animals for environmental risk evaluation, and through the development of databases related to environmental biology. In addition to the major topics summarized below, both laboratories conduct research that has both fundamental and frontier themes.

ACLab has been evaluating the quality assurance and quality control (QA/QC) of environmental monitoring; developing new environmental analysis methods; and comparing methods for monitoring of atmospheric particles. Some of the results are being applied to the monitoring of Asian dust storms (*kosa*) in the north Asia monitoring network. The molecular extinction coefficient (ε) of cylindrospermopsin, a cyanobacterial toxic alkaloid, was determined to be 9800 (previously reported to be 5800 to 6250) at a wavelength of 262 nm by purification in an anion-exchange cartridge followed by normal-phase HPLC.

BRLab has been working on several biotechnologies. With the aim of developing new technologies in the field of bioscience, we are studying primordial germ cells (germline stem cells) in the Amniota (mainly in the Aves). We have made germline chimeras by transplanting primordial germ cells, and we have obtained offspring originating from these introduced primordial germ cells by backcrossing. We are now trying to put this method to practical use for the proliferation of threatened bird species. Our techniques should be useful in cleaning up infections transmitted via eggs and in the recovery of populations from inbreeding depression by the transplantation of primordial germ cells in the early embryonic stages (Fig. 1). After 2007, we conducted a short training course on bird cell culture for eight foreign researchers from Russia, Korea, China, and Thailand (Fig. 2) to disseminate information on techniques used in bird cell culture and the cryopreservation of living bird cells.

LIFES functions as a reference laboratory for environmental research in Japan by improving methods of ensuring analytical QC and cross-checking analytical techniques; improving methods of classifying and culturing microalgae and other laboratory organisms; and preserving and supplying organisms as standards for classification, standard strains for bioassay tests, and strains with special functions.

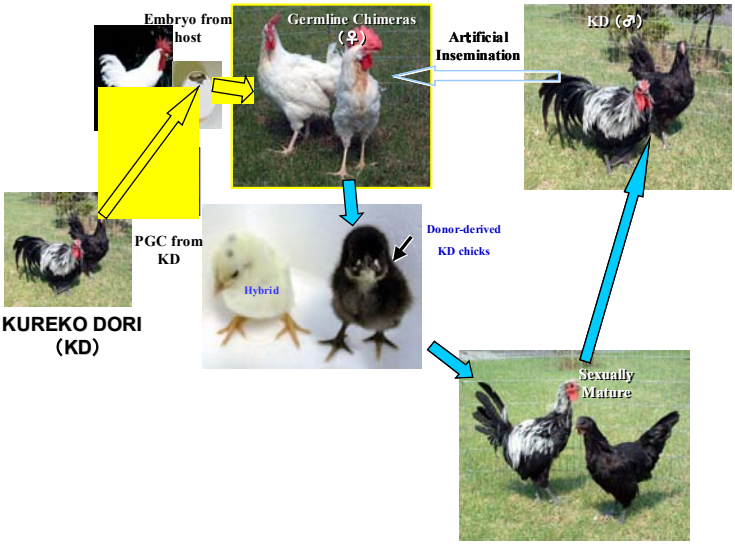


Fig. 1 The *Kureko Dori*, an endangered domestic fowl breed of the Kureko region of Kumamoto Prefecture in Kyushu, Japan. By strict screening criteria, the *Kureko Dori* was designated a prefectural natural treasure in 1965. Offspring of the *Kureko Dori* can be obtained from germline chimeras by using reproductive stem cells—the so-called primordial germ cells (PGCs).

Fig. 2 Russian participants in a training course on techniques in bird cell culture and cryopreservation of living cells.

Management and operation of key analytical equipment

ACLab has been working to improve the sensitivity and accuracy of analysis of environmental specimens at NIES through the use of key analytical equipment. An on-demand analysis service has been established and is operated by personnel technically trained in the use of 10 instruments. Our ICP-MS and SEM-EDX equipment was renewed so that it can be used appropriately for more varied research at NIES. Over 50 researchers made requests for analyses on about 30 research themes, and we provided them with useful data derived with a high level of QC.

Preparation of environmental Certified Reference Materials

Environmental Certified Reference Materials (CRMs) are used to evaluate new analytical methods and to control the accuracy of pretreatment and instrumental

analyses. We have been preparing and distributing environmental and biological CRMs since 1980. Over 180 CRMs were distributed to researchers worldwide this financial year (Fig. 3). We have begun to make a new CRM from water hyacinth, a biological plant material that we have been cultivating for half a year in an experimental pool in which the water quality is controlled.

Fig. 3 Environmental Certified Reference Materials (CRMs) produced at NIES. Information on NIES-CRMs can be found at <http://www.nies.go.jp/labo/crm-e/index.html>.

Long-term storage of environmental samples (environmental specimen bank)

We have continued to collect and prepare environmental samples for long-term, low-temperature storage as part of our expanded program to make samples available for retrospective analysis of pollutants. Our time-capsule facility accommodates various items of equipment for low-temperature preparation of environmental specimens for long-term storage. The facility can store specimens for 50 years under an atmosphere of liquid nitrogen vapor at about –150 °C. About 290 samples of bivalves and stingray livers have been added, and the total number of time-capsule samples under liquid nitrogen vapor is now about 1800. In addition to these, several thousand biological specimens and atmospheric samples have been stored in freezers (–80 °C) and freezing rooms (–60 °C) (Fig. 4).

Fig. 4 Environmental Specimen Bank: sting-ray liver *in situ* after excision; coarse and fine crushing; bottling; and cryopreservation in cold N_2 vapor (colder than –150 °C) over liquid N_2.

Preservation of cells and gene resources of threatened wildlife species

(1) Threatened wild animals

In the hope of making future contributions to the conservation of threatened wild animals, we cryopreserve the cells (including germline cells) and tissues of such animals for genetic analysis, with the support of the National Time Capsule Program for the Environment and Threatened Wildlife. As at March 2008, 1754 kinds of samples (tissues, cultured cells, and sperm) had been cryopreserved. From April 2008 to March 2009, we accepted another 222 individual threatened wild animals (22 mammals, 200 birds) from all over Japan. There were three newly cryopreserved species: common redshank (*Tringa tetanus*), Ryukyu rabbit (*Pentalagus furnessi*), and dugong (*Dugong dugon*). As at the end of March 2009, samples from 122 individuals of the Okinawa rail (*Gallirallus okinawae*) had been stocked at –160 °C. Fewer than 800 living Okinawa rail remain (Fig. 5).

Fig. 5 This young Okinawa rail on a road in the Yambaru area of Okinawa Island runs a high risk of being killed by a car.

In addition to threatened Japanese wildlife, we are starting to cryopreserve threatened Russian wildlife under a joint research project with the Bolonsky Nature Reserve in Russia. We collected samples (skin and blood) from 32 individuals, namely the oriental white stork (*Ciconia boyciana*, 18 individuals;

Fig. 6), red-crowned crane (*Grus japonensis*, 5 individuals), white-necked crane (*Grus monacha*, 7 individuals), and white-tailed eagle (*Haliaeetus albicilla*, 2 individuals). In total, in 2008 we cryopreserved 824 kinds of samples (tissues, DNA, and cultured cells) from 254 individuals of Japanese and Russian wildlife. Since 2004, 2578 kinds of samples have been cryopreserved by the National Time Capsule Program.

Fig. 6 Three oriental white stork nestlings in Russia, just before their first flight from the nest.

Infections of wild birds with highly pathogenic avian influenza virus (HPAIV, classified as an influenza virus type A) occurred in 2004, 2007, and 2008 in Japan, so NIES began to monitor the spread of this disease among our wild birds. Resident and migratory birds in Japan were monitored for influenza virus type A from 2 October 2008 to 31 March 2009 with the support of the Ministry of the Environment.

We collected 3236 samples and tested them for the presence of an influenza virus type A gene; 71 samples were positive. Further experiments revealed that low-pathogenic avian influenza virus was present in all positive samples.

2) Threatened algae

We have been surveying the status of threatened algal species in Japan. During FY 2008 we surveyed 52 potential habitats of Charales algae in Aomori and Kagawa prefectures. Members of the Charales grew at 30 of the sites. We carefully collected several thalli (plant bodies), without disturbing the populations, so that we could establish culture strains. During FY 2008, we newly established 8 species and 10 strains of Charales, and 3 species and 8 strains of freshwater red algae. We now maintain a total of 341 strains of endangered algae (22 species and 73 strains of Charales, and 10 species and 268 strains of freshwater red algae), among which 119 strains of freshwater red algae are preserved in liquid nitrogen only., whereas others are preserved by sub-culturing.

Recently, successful restoration of Charales algae has been reported from oospores buried in the bottom mud of eutrophic lakes such as Lake Kasumigaura, where at least four Charales algae were present until the 1960s but are now extinct. Because it was considered possible that the buried oospores would

degenerate within about 50 years, we collected the bottom mud containing the buried oospores from Lake Kasumigaura to examine ways of preserving the oospores in the long term.

Investigation, collection, and storage of microbes useful for environmental conservation and development of laboratory organisms

In FY 2008 at the Microbial Culture Collection (NIES-Collection), we:

- received 78 strains of microbes from scientists within and outside NIES
- distributed 869 algal strains for education, research, and development
- renewed the Microbial Culture Collection website and started an online ordering service (Fig. 7)
- published the NIES-Collection List of Strains, 8th Edition, which includes, among other things, strain information, a list of type specimens, and lists of media.

We now maintain a total of more than 2500 strains, of which 2148 are available as NIES strains. To minimize the risk of loss of culture strains in the event of a disaster, the NIES-Collection has duplicated some of the cryopreserved strains in the Kobe University Macroalgal Culture Collection. These activities are being conducted as part of the National Bio-Resource Project.

Fig. 7 Home page of the Microbial Culture Collection website, renewed in FY 2008. A strain information search and an online ordering service are now available

Provision of experimental aquatic animals for environmental risk evaluation

We supply 12 aquatic animals used mainly in eco-toxicity tests (Fig. 8): egg masses of two species of midge (*Chironomus tentans*, *C. yoshimatsui*), larvae of damselfly (*Ischnura senegalensis*), scud (*Hyalella azteca*), three species of daphnid (*Daphnia magna*, *Moina macrocopa*, *Ceriodaphnia dubia*), a shrimp (*Paratya compressa improvisa*), medaka (*Oryzias latipes*), zebrafish (*Danio rerio*), guppy (*Poecilia reticulata*), and fathead minnow (*Pimephales promelas*). In FY2008, there were 35 requests for 111 samples of 7 species.

Fig. 8 Aquaria for culturing experimental animals used to assess the environmental hazards of chemicals.

Environmental Information Center

The Environmental Information Center provides the public with various kinds of environmental information through websites.

The Environmental Information Center provides information technology (IT) support for research and related activities at NIES; carries out public relations activities for NIES, including the publication of NIES research reports; and performs miscellaneous other activities, including collecting and processing environmental information and disseminating it to the general public, performing tasks commissioned by the Ministry of the Environment, and acting as the national focal point for UNEP-Infoterra. These tasks are described in detail below.

1. IT support for research and related activities at NIES

The Center manages and operates the computers and related systems at NIES, uses IT to improve the work efficiency of NIES, and runs a library service.

a. Management and operation of computers and related systems

A new computer and network system started operation in March 2007. The UNIX-based computing environment consists of a supercomputer system and various subsystems, including a scalar-computing server, a front-end server, storage devices, and application servers. Our vector supercomputer (NEC SX-8R/128M16), which is equipped with a FORTRAN compiler with high-level debugging capability and high-efficiency optimization, executes the large-scale programs needed to model global environmental problems.

A local-area network called NIESNET was established at NIES in 1992. File transport was upgraded in March 2007. The network configuration was restructured, and large-scale file transport performance was improved at the same time. Registered users outside NIES can use the supercomputer system through the Tsukuba wide-area network via the Science Information Network (SINET) connection to the Internet.

b. Use of IT to improve work efficiency

The Center gives IT support to the management sector of NIES, with the aim of increasing work efficiency. It also provides NIES researchers with processed research data and helps them to disseminate their data through the NIES home page. In FY 2008, the Center supported:

- development of an electronic application and registration system at NIES
- operation of a thin-client PC management system for the administrative section
- development of the NIES research information database
- modification and operation of a database of basic information on each member of staff at the Institute
- a basic plan for a processing system to be used for budgeting and settlement of accounts
- operation and modification of the NIES eco-management system.

c. Library service

As of March 2009, the NIES library held 53,966 books, 398 technical and scientific serials, 9,688 maps, 121,710 microfiches, and various other reports and reference materials.

In addition to these materials, researchers at NIES can access documentary information through commercial databases such as Web of Science, Science Direct, JDreamII, STN, G-Search, and the British Library Inside Web.

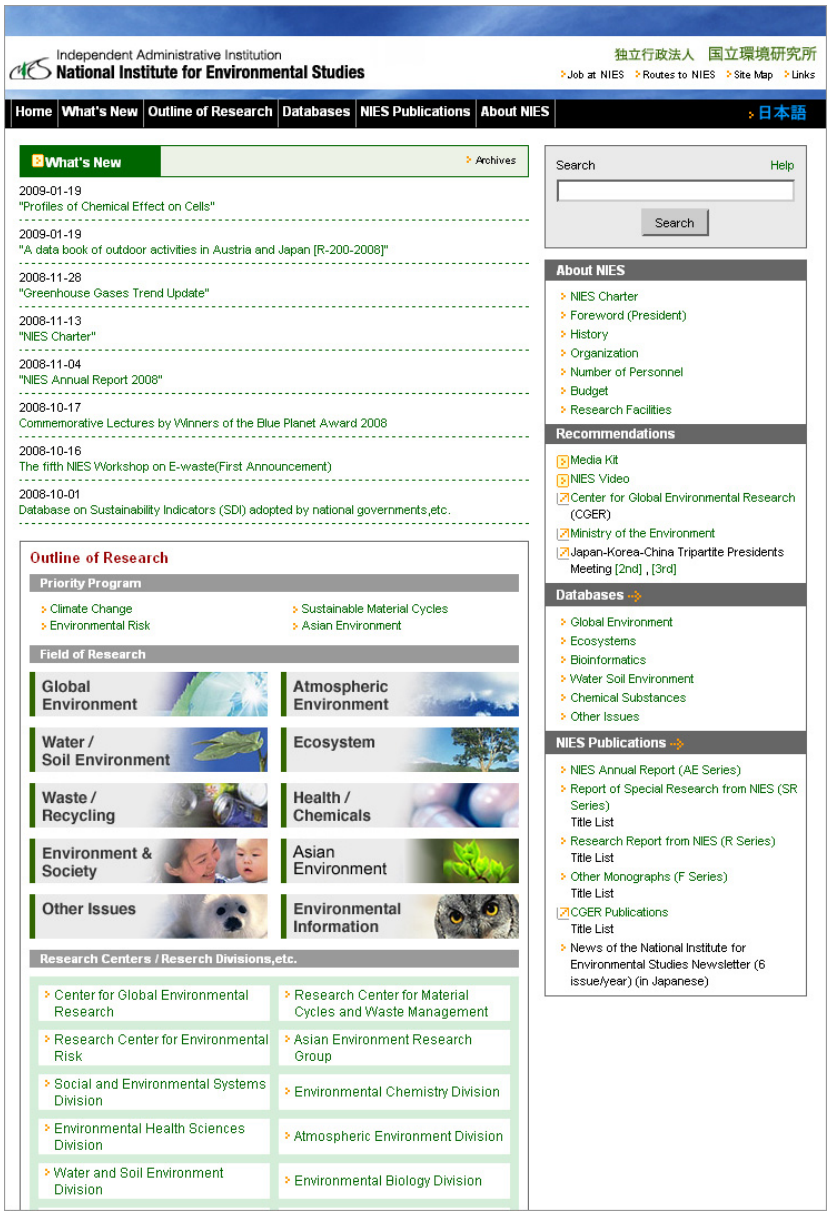
Library facilities include separate rooms for reading books, journals, indexes and abstracts, reports, maps, and microfiches.

2. NIES public relations activities

The Center manages the NIES website. It also edits and publishes NIES reports such as research reports and this *Annual Report*.

a. Management of NIES WWW

NIES began to provide public information on its research activities and results via the Internet (http://www.nies.go.jp/) in March 1996. The website was completely renewed and improved in accordance with the restructuring of NIES in April 2001 as an independent administrative institution. Because NIES started the second stage of its medium-term plan in April 2006, a newly designed website was prepared in accordance with the new organization and activities. The new site was designed to offer improved usability, including improved accessibility for people with disabilities.



b. Editing and publication of NIES reports

Reports on NIES research activities and results, such as the NIES *Annual Report* and research reports, official newsletters (*NIES News*, in Japanese), and NIES research booklets (*Kankyo-gi*, in Japanese) are edited, published, and distributed by the Center.

3. Other activities

a. Collection, processing, and dissemination of environmental information

NIES is required to carry out "the collection, processing, and dissemination of environmental information" as one of its major tasks. The Center provides various kinds of environmental information to the public through websites; processes and manages environmental information databases; and provides environmental information via GIS (geographic information system).

Environmental Research and Technology Portal

The Center opened the Environmental Research and Technology Portal (http://ecotech.nies.go.jp/) in October 2007. The portal provides a variety of content, such as news on environmental research and technology from domestic and foreign news resources, reports on key topics in environmental technology, and information on seminars and events in environmental research and technology. Additionally, new content for environmental learning was launched in January 2009. The site is currently available only in Japanese.

Processing and management of environmental information databases

Various environmental data are needed for research, policy decisions, and policy

enforcement. The Center compiles and processes air quality and water quality data collected by local government and reported to the Ministry of the Environment. These processed data can be accessed through the database on the NIES website. Duplication and lending services are also available.

Provision of environmental information via GIS

The Center, with the cooperation of the Ministry of the Environment, has been using GIS to develop an environmental data provision system. This system helps users to easily understand the status of the environment by showing data on environmental quality and other information on maps. The system has been publicly available through the Internet since September 2002.

b. Tasks commissioned by the Ministry of the Environment

In FY 2008, in tasks commissioned by the Ministry of the Environment, GIS was used to evaluate the following five datasets against quality standards:

- a nationwide car noise survey
- living environment data, covering noise, vibration, and offensive odors
- a national aquatic organisms survey
- a survey of the concentration distributions of hazardous air pollutants
- a dioxin monitoring survey.

c. National focal point of UNEP-Infoterra

UNEP-Infoterra is the Global Environmental Information Exchange Network of the United Nations Environment Programme. The network operates through a system of government-designated national focal points. The Center has been the designated Japanese national focal point since 1975. These focal points provide a wide range of environmental information, including directories of information sources.

International Expert Meeting on Bottom-up Based Analysis on Emission Reduction Potential

May 7, 2008
Novotel Paris Tour Eiffel
Paris, France

The meeting had four sessions. Session I focused on the analysis of mitigation potential by bottom-up modeling and discussed mitigation potential by using sectoral technology data. Session II focused on the latest information on sectoral mitigation potentials. Session III focused on modeling analysis of stabilization scenarios and included a discussion on how to use bottom-up data to develop these scenarios. The final session focused on the contribution of mitigation potential analysis to negotiations after 2012. The meeting provided a range of mitigation estimates as a basis for discussions to achieve an effective future framework and fair national emission reductions targets. It also enhanced international collaboration among researchers and research institutions in furthering meta-analyses of modeling assumptions, to enable policymakers to understand the diverse outcomes of various models.

International Workshop on Sustainable Regional Development Through a Circular Economy

May 19-21, 2008
Rose Hotel
Shenyang, China

International researchers and government officials from Japan and China discussed sustainable eco-industrial developments in Asian Pacific metropolises, focusing on comparative research and collaboration among Chinese and Japanese industrial cities such as Shenyang and Kawasaki. The workshop comprised three opening remarks, one special speech, four keynote speeches, and five research presentations, followed by the chairman's summary. Speeches and presentations were delivered by researchers and representatives from NIES, the Environmental Bureau of Kawasaki, the Shenyang Environmental Protection Bureau, and the Shenyang Research Academy of Science, with a special focus on innovative research methods and tools for urban symbiosis, catchment management, and the implementation of environmental technologies and policies. The workshop was held as one of a number of periodic international sessions aimed at establishing a collaborative knowledge platform and funded by the Ministry of the Environment (MOE), Japan. It was part of a national research project on "Strategic policy and technology scenario design and evaluation system based on integrative analysis among environmental fluxes for Asian metropolises".

6th Workshop on GHG Inventories in Asia (WGIA6)

July 16-18, 2008
National Institute for Environmental Studies
Tsukuba, Ibaraki, Japan

The MOE of Japan and NIES convened this workshop on "Capacity building support for developing countries on GHG inventories and data collection (measurability, reportability, and verifiability)" as part of the Kobe Initiative of the G8 Environment Ministers' Meeting. The workshop was attended by 64 participants from 13 WGIA-member countries in Asia and 10 participants and observers from Bangladesh, France, the USA, the United Nations Framework Convention on Climate Change (UNFCCC), the Intergovernmental Panel on Climate Change (IPCC), the United Nations Environment Programme (UNEP) and the Regional Capacity Building Project for Sustainable National Greenhouse Gas Inventory Management Systems in Southeast Asia (SEA Project). All the participants stressed the need for continued and enhanced information exchange and more targeted use of the WGIA online network. The participants expressed their interest in discussing GHG inventory issues in the energy and industrial processes sectors, updating or reviewing country- or region-specific emission factors, updating a roster of experts, and performing other ongoing WGIA-network activities at the next meeting. The need for continued support in training inventory compliers was recognized. The WGIA secretariat proposed to offer such opportunities again at future meetings; participants welcomed this proposal.

Workshop on Ecosystem Function and Conservation of Tropical Forests

August 12, 2008
National Institute for Environmental Studies
Tsukuba, Ibaraki, Japan

Participants attended from mainly Japan, the USA, Thailand, and Indonesia. The workshop addressed three overarching scientific questions: (1) What are the effects of climate variation at multiple time scales (e.g., ENSO [El Niño – Southern Oscillation index], Indian Ocean Dipole) on the carbon and water fluxes of agricultural and forest ecosystems in monsoon Asia? (2) What are the effects of land-use change and intensification on the carbon and water fluxes of terrestrial ecosystems in monsoon Asia? (3) What are the impacts of changes in land–climate interactions in the region on food and forest production and on ecosystem services? During the workshop, participants (notably those from the USA and Japan) proposed to develop an international research program with four tiers: (1) ecosystem-scale observations – long-term measurements at selected flux sites in monsoon Asia; (2) catchment-scale observations – measurements over areas of about 1000 km^2 at a cluster of flux sites and by remote sensing; (3) assimilation of data into models and ecological forecasting at multiple scales; and (4) data integration, analysis, and modeling across institutions. A potential education plan to enable students and junior researchers to perform advanced studies at foreign field sites and institutions was also discussed. The workshop was part of a strategy for a future project to advance international collaboration and enrich our capacity to enable young scientists to develop skills and networks across culturally diverse Southeast Asia.

IGES-NIES-ESCAP Policy Forum "Towards a Copenhagen Consensus: Opportunities and Challenges"

October 9-10, 2008
Hotel EL Inn
Kyoto, Japan

The forum discussed various aspects of the Bali Action Plan, especially from an Asia-Pacific regional perspective. There were many ideas for reconciling potentially competing perspectives on important provisions of the Bali Action Plan. For instance, many emission mitigation activities, such as improving energy efficiency or shifting to renewable energy, were considered to bring about co-benefits for other problems such as local air pollution. Adaptation strategies were also considered to be important in many Asian countries. Monitoring, technology transfer, and capacity-building were considered to be important elements of adaptation activities.

2nd International Expert Meeting on Bottom-up Based Analysis on Mitigation Potential

October 21, 2008
Novotel Paris Tour Eiffel
Paris, France

As a follow-up to the 1st workshop in May 2008, the 2nd International Expert Meeting was held to make progress in comparing bottom-up models and thus provide policymakers with reliable scientific information. The latest results of the application of various models to mitigation potentials were presented. The estimates of mitigation potentials for each major sector were compared among models and assessed. Participants discussed equal marginal abatement costs and total abatement cost as a percentage of GDP. The meeting provided information to enable policymakers to understand the diverse outcomes of various models.

Workshop on the Data Utilization of Greenhouse gases Observing SATellite(GOSAT) "IBUKI"

November 5, 2008
Toranomon Pastoral Hotel
Tokyo, Japan

The Japan Aerospace Exploration Agency (JAXA), the National Institute for Environmental Studies (NIES), and the MOE held a workshop on GOSAT data use and publicized it in anticipation of the satellite's launch in January 2009. The workshop was attended by 138 people from domestic and foreign research laboratories, universities, and enterprises.

GOSAT Research Announcement Principal Investigator Meeting

November 6-7, 2008
Toranomon Pastoral Hotel
Tokyo, Japan

Forty-five principal investigators and co-investigators attended the titled meeting organized by JAXA, NIES, and MOE. Presentations from a part of the adopted proposals were made. Abstracts of all the adopted proposals were distributed at the meeting.

NIES Commemorative Lectures by the Blue Planet Prize Winners

November 14, 2008
National Institute for Environmental Studies
Tsukuba, Ibaraki, Japan

Dr. Claude Lorius and Professor José Goldemberg, winners of the 17th Blue Planet Prize for outstanding achievements in providing solutions to global environmental problems, gave special lectures to NIES researchers and residents of Tsukuba.

5th NIES Workshop on E-waste

November 17-18, 2008
Mielparque Kyoto
Kyoto, Japan

Participants, including 13 experts from China, Germany, India, the Netherlands, the Philippines, and Japan, exchanged the latest information on electronic waste and discussed future research needs. There were three topics: "Material Flow Analysis of E-waste", "Toxicity and Evaluation of E-waste Recycling", and "Collection, Reuse and Recycling System of E-waste". Current material and substance flows and environmental pollution from inappropriate recycling were discussed. Participants also shared information on the need for recovery of materials by formal recyclers and related challenges in China.

5th Meeting of the Tripartite Presidents Meeting among NIES, NIER, and CRAES

November 25-27, 2008
Century Royal Hotel
Sapporo, Hokkaido, Japan

The Tripartite Presidents Meeting (TPM) among NIES, NIER, and CRAES has worked to expedite joint efforts in environmental research among Japan, Korea, and China, while seeking further cooperation on issues of common interest. At TPM5, the three presidents agreed to add solid waste management and climate change to the list of research areas in which to explore possibilities for joint projects. They shared the view that personnel exchange contributes to strengthening the ties among the three institutions and agreed to further promote this exchange where possible.

COP14/CMP4 Side Event: Sustainable Low-carbon Asia: How can it change the post-2012 climate negotiations?

December 8, 2008
Congress Centre Poznań International Fair
Poznań, Poland

The official side event during UNFCCC COP14/CMP4, "Sustainable Low-Carbon Asia: How can it change the post-2012 climate negotiations?", focused on how to achieve a sustainable low-carbon Asia; how to structure a framework, mechanism, and rules to realize this goal; and how to integrate a long-term strategy and short-term action into the post-2012 agreement. The panel presented visions and practical roadmaps for developing a low-carbon society in Asian countries, including Japan, China, and India, and examined potential solutions for strengthening participation by Asia in the post-Kyoto agreement. Over 100 people attended.

Asia-Pacific International Workshop on Industrial Ecology

December 8-9, 2008
Institute of Industrial Promotion, Kawasaki
Kawasaki, Kanagawa, Japan

The workshop included discussions on the development of theories and practices of industrial ecology (IE), focusing mainly on the Asia-Pacific region. The workshop was the first regional meeting organized for the International Society for Industrial Ecology and was attended by more than 100 international participants, including researchers, experts, and practitioners in both the public and private sectors. The panel discussion on the progress and challenges of IE in the Asia-Pacific region highlighted the importance of the region as an arena in which IE would play a central role in improving existing industrial and social systems. It also identified challenges such as financial instability, limited availability of information, and changes in regulations that could hamper IE applications. Participants looked forward to the development of a better informed society, networks, and the widespread adoption of IE.

Workshop on Monsoon Asia Tropical Forest Dynamics and Sustainability

January 8-11, 2009
University of Khon Kaen
Khon Kaen, Thailand

Japanese and Malaysian researchers in ecology, forestry, meteorology, and hydrology discussed biodiversity, sustainable use, and management of tropical rain forests. The latest findings and research activities of several research projects were presented, and protection of biodiversity for sustainable management of tropical lowland rain forest as an overall entity was discussed.

5th Asia-Pacific Eco-Business Forum

February 16-18, 2009
February 16: Kawasaki Industrial Promotion Center
February 17: Kawasaki Civic Museum
February 18: Kawasaki Todoroki Arena
Kawasaki, Kanagawa, Japan

To achieve a sustainable global environment, Kawasaki City, in conjunction with the United Nations Environment Programme (UNEP), has been fostering the global exchange of environmental technology and experience accumulated during the process of combating pollution. The 5th Asia-Pacific Eco-Business Forum aimed at creating opportunities for those interested in exchanging cutting-edge environmental technologies and strategies and sharing information on the outcomes of the UNEP Eco-Town project. The forum was held in conjunction with the Kawasaki International ECO-Tech Fair 2009 to share information acquired in Kawasaki by both government and industry. Topics included energy saving, recycling, waste management, and global warming. The event incorporated environmental technologies and products, guided tours, business discussions, and seminars to foster a deeper understanding of environmental issues in Kawasaki.

International Symposium on "Realizing Low Carbon Cities: Bridging Science and Policy"
International Workshop on "Towards Low Carbon Cities: Understanding and Analyzing Urban Energy and Carbon"

February 16, 2008
Hotel Mielparque Nagoya

February 17-18, 2008
Noyori Conference Hall, Nagoya University
Nagoya, Aichi, Japan

At the symposium, over 200 participants from government, business, academia, and the public, including key experts from institutions around the world, debated scientific policies supporting low-carbon cities. Participants highlighted key scientific challenges such as how to treat the cross-boundary functional elements of urban systems; how to integrate the elements into policymaking for carbon management; and the need for better knowledge of and support for policies for managing energy, materials, and urban infrastructure through technology, and for market and behavioral changes to create low-carbon cities. At the workshop, 80 key experts from around the world discussed the opportunities for and barriers to selected cities, models, modeling and analytical techniques, and various research and policy initiatives for low-carbon cities. The workshop consolidated and expanded the Urban Energy and Climate Modeling Forum, which was established in February 2008 at a similar workshop organized in Bangkok.

3rd Workshop on "Improvement of Solid Waste Management and Reduction of GHG Emissions in Asia"

February 18-20, 2009
Seiwa-Kan, Ohmiya Campus, Ryukoku University
Kyoto, Japan

Nine experts from seven Asian countries attended the workshop. The opening remarks looked back on the results and issues discussed at past workshops. In the first session, four experts presented information on the progress of research, including the reliability of Asian waste data, methods used to quantify landfill GHGs, mitigation technologies for landfill GHGs (semi-aerobic landfills and bio-covers), and collaboration with the WGIA. In the second session, seven experts demonstrated the status of upstream municipal solid waste (MSW) management in each country. Participants discussed this subject in the third session and agreed that schemes for separation at source (in homes) should take priority in upstream MSW management. They concluded that education, public awareness, economic incentives, and development of downstream systems (e.g. transportation and storage) are needed to promote separation-at-source schemes. They also pointed out that promotion measures should be specific for each region or country, and that the simultaneous development of education and imposition of penalties to encourage people to participate would be important. In the fourth session, three speakers presented information on the status of solid waste management systems and GHG emissions in China, Korea, and Japan. In the fifth session, participants discussed the sustainability of waste management. They concluded that zero emission should be a target for sustainable waste management, but that there are several barriers to upgrading waste management in each country or region. They also concluded that indicators of sustainability of waste management must be defined for Asian countries, and that the weak points in each country should be determined from these indicators. Participants reached the consensus that waste management could be included as part of a sustainable society. They agreed to compile further reports on these issues and to hold a seminar as an outcome of the three workshops.

Community Ecology and Adaptive Evolution

March 13, 2009
National Institute for Environmental Studies
Tsukuba, Ibaraki, Japan

The following three lectures were given on the latest developments in research into community ecology and trait evolution:

- "Spatial synchrony of predator–prey cycles" (Jeremy Fox, University of Calgary, Canada)
- "Food webs: Just a bunch of behavioral ecology?" (Owen Petchey, University of Sheffield, UK)
- "A trait-based framework for linking global change to ecosystem services: implications for management" (Jon Norberg, Stockholm University, Sweden)

Afterwards, about 20 audience members took part in a discussion on each of the lecture topics.

COUNTRY
No.Title
Collaborating institution
NIES partner (as of latest review meeting)

CANADA

1. Monitoring of the atmosphere-ocean carbon dioxide exchange rate
   Center for Ocean Climate Chemistry, Institute of Ocean Sciences
   Center for Global Environmental Research
2. Elucidation of the cycling and transformation of chemical substances in the North Pacific Ocean
   Department of Chemistry, University of British Columbia
   Environmental Chemistry Division

CHINA

1. Development of wastewater and water resources treatment processes applicable to China
   Chinese Research Academy of Environmental Sciences
   Research Center for Material Cycles and Waste Management
2. Advanced wastewater treatment processes for China
   Research Institute for Environmental Engineering & Department of Environmental Engineering, Tsinghua University
   Research Center for Material Cycles and Waste Management
3. Advanced sewage treatment processes by soil system applicable to China
   Institute of Applied Ecology, Chinese Academy of Sciences
   Research Center for Material Cycles and Waste Management
4. Studies on techniques to control emission of acid-Precursors in East Asia on evaluation of impact of their application on the environment
   State Environmental Protection Administration
   Atmospheric Environment Division
5. Research on the development of water pollution control techniques for the Taihu Lake in China by bio/ecoengineering
   Chinese Research Academy of Environmental Sciences
   Research Center for Material Cycles and Waste Management
6. Dioxins analysis and survey of dioxins sources in China
   Sino–Japan Friendship Center for Environmental Protection
   Environmental Chemistry Division
7. Development of eco-engineering technologies for the control of eutrophication in the drainage area Hongfeng Lake and Baihua Lake in China Guizhou
   Guizhou Provincial Environmental Protection Bureau
   Research Center for Material Cycles and Waste Management
8. Study on transport mechanism of *kosa* aerosol to Japan by way of Beijing
   Sino–Japan Friendship Center for Environmental Protection
   Environmental Chemistry Division
9. Molecular epidemiological studies on the health effects of arsenic
   Institution of Environmental Health and Engineering, Chinese Academy of Preventive Medicine
   Environmental Health Sciences Division
10. Research on development of suitable technologies to control greenhouse gas emissions during the treatment of domestic wastewater using bio-eco engineering system
    Shanghai Jiao Tong University
    Research Center for Material Cycles and Waste Management
11. Research on VOCs and ammonia emissions in China
    Chinese Research Academy of Environmental Sciences
    Atmospheric Environment Division
12. Environmental impact assessment of dams & floodgates and river ecosystem restoration in Huai River, China
    Key Laboratory of Water Cycle and Related Land Surface Processes, Institute of Geographical Science and Natural Resource Research, Chinese Academy of Sciences
    Asian Environment Research Group

CZECH REPUBLIC

1. Biogeochemical studies on the acidic deposition and pollutions
   Institute of Landscape Ecology, Czech Academy of Sciences
   Atmospheric Environment Division
2. Perception of landscape: from landscape appreciation to landscape planning
   Institute of Landscape Ecology, Czech Academy of Sciences
   Social and Environmental Systems Division

FRANCE

1. A molecular biological study for mechanisms of environmental adaptation plants
   University of Picardie
   Environmental Biology Division
2. Biodiversity of microalgae obtained from the Atlantic and the Pacific Ocean
   University of Caen
   Environmental Biology Division

KOREA

1. Study on the marine pollution using ship-of-opportunity
   Korea Ocean Research and Development Institute
   Water and Soil Environment Division
2. Aircraft- and ground-based observations of acidic and/or oxidative pollution in East Asia
   Environment Research Center, Korean Institute of Science and Technology
   Atmospheric Environment Division
3. Study on monitoring of long range transported air pollutants and acid deposition in the northeast Asia region
   National Institute of Environmental Research
   Asian Environment Research Group

4. Analysis of environmental changes by corals distributed around Japan and Korea
   Korea Ocean Research and Development Institute
   Center for Global Environmental Research
5. Korea–Japan information exchange and cooperative survey on invasive alien species in both countries
   National Institute of Environmental Research
   Research Center for Environmental Risk
6. Establishment of real-time data exchange system of Asian dust observations between Korea and Japan (Joint research on the monitoring of Asian dust using a LIDAR system)
   Korea Meteorological Administration
   Atmospheric Environment Division
7. Study on the monitoring of harmful algal bloom and effects of nitrogen and phosphorus
   National Institute of Environmental Research
   Research Center for Material Cycles and Waste Management
8. Research on the prevention and management of environmental disease
   National Institute of Environmental Research
   Environmental Health Sciences Division

POLAND

1. Molecular mechanisms of plant adaptation to atmospheric stresses
   Plant Breeding and Acclimatization Institute
   Biodiversity Conservation Research Project

RUSSIA

1. Measurement of methane emission rates from permafrost areas
   Permafrost Institute
   Center for Global Environmental Research
2. Modeling of methane emission rates from natural wetlands
   Institute of Microbiology
   Center for Global Environmental Research
3. Airborne measurement of greenhouse gases over Siberia
   Central Aerological Observatory
   Center for Global Environmental Research
4. Measurements of greenhouse gases affected by Siberian ecosystems
   Institute of Atmospheric Optics
   Center for Global Environmental Research
5. Vertical profile measurement of greenhouse gases over Siberia
   Institute of Atmospheric Optics
   Center for Global Environmental Research
6. Greenhouse gases budget of land ecosystems in Siberia
   Institute of Microbiology, Russian Academy of Sciences
   Center for Global Environmental Research
7. Conservation of genetic resources on wild animals in Khabarovsk region
   Bolonski State Natural Reserve Laboratory, Russian Federation Ministry of Natural Resources
   Laboratory of Intellectual Fundamentals for Environmental Studies

SWEDEN

1. Health risk assessment of heavy metal exposure: effects of increase in human activity
   Karolinska Institute
   Environmental Health Sciences Division
2. Underway measurement of pCO_2 in the surface water of the Arctic Ocean
   Göteborg University
   Climate Change Research Project

UK

1. Cooperation on the development and application of coupled chromatography – accelerator mass spectrometry techniques
   University of Oxford
   Environmental Chemistry Division

USA

1 Joint implementation of ocean-surface CO_2 observation in the Pacific Ocean to understand the oceanic sink of CO_2
   Pacific Marine Environmental Laboratory, NOAA
   Climate Change Research Project
2. Collaboration on greenhouse gas observation from space
   Jet Propulsion Laboratory, NASA
   Center for Global Environmental Research
3. Joint implementation of CO_2 flux observations for the identification of carbon-fixation ability of forests and the prediction of its fluctuation
   Department of Energy
   Center for Global Environmental Research
4. Comparative, standardized, and complementary measurement of atmospheric constituents for the evaluation of terrestrial/oceanic sources and sinks of carbon, other non-CO_2 greenhouse gases, and aerosols
   Climate Monitoring and Diagnostics Laboratory, NOAA
   Center for Global Environmental Research

Notes:

1. The number of projects is subject to change, as the adoption of certain projects is still under discussion.
2. Names of collaborating institutions are shown as they were at the time of approval of the joint research project.

AUSTRALIA	Consultancy Agreement between National Institute for Environmental Studies (NIES) and the University of Wollongong (2008)
CANADA	Agreement between NIES and the Institute of Ocean Sciences (1995)
CHINA	Memorandum of Understanding (MoU) between NIES and the Sino–Japan Friendship Center for Environmental Protection of the State Environmental Protection Administration of the People's Republic of China, on Cooperation in the Field of Environmental Protection (2006)
	MoU between NIES and Zhejiang Ocean University, China. Cooperative Research on Adaptive Management for the Marine Ecological Environment and Biological Resources of East China Sea (2007)
	MoU between Nanjing University of Information Science and Technology and NIES regarding Collaborative Research on "Urban Heat Balance and Biometeorology Modeling under Different Climatic Conditions" (2008)
	MoU on Joint Research on Integrated Assessment of the Water Environment in Liaohe Watershed (2008)
	Joint Research Agreement on the Observation and Modeling of Water and Biogeochemical Cycles in Subtropical Rice Paddy Ecosystems between the Asia Water Environment Research Group (NIES, Japan) and Taoyun Experimental Station for Agricultural Ecosystems (Institute of Subtropical Agriculture, Chinese Academy of Sciences) (2008)
	MoU on Joint Research implemented by NIES and the Sino–Japan Friendship Center for Environmental Protection, China, on the Characteristics of Aerosol Pollution in Northern China during the Dust and Sandstorm Season (2008)
	Implementation Plan for a Water Quality Automatic Monitoring System and Watershed Environmental Management Modeling in the Middle and Low Reaches of the Hanjiang River (2007)
	Implementation Agreement for "Establishment of an Early Observation Network for Global Warming Impacts", a Cooperative Project of the Sino–Japanese Science and Technology Joint Committee (2008)
	Agreement for Cooperative Study on Water Resources and Water Environment Management in Haihe River Basin (2006)
GERMANY	Contract for the research support between NIES and University of Bremen (2008)
INDIA	MoU between NIES and Anna University, Chennai, India. Collaborative Research on Atmospheric Science (2006)
KOREA	Implementing Agreement between NIES and National Institute of Environmental Research of the Republic of Korea to Establish Cooperative Framework regarding the Environmental Protection Technologies (1994)
MALAYSIA	Collaborative Research on Tropical Forest Ecology and Biodiversity (1991)
MONGOLIA	MoU between NIES and the National Agency for Meteorology, Hydrology and Environment Monitoring, Mongolia, for Joint Research on Quality Assurance / Quality Control (QA/QC) of the Dust and Sandstorm (DDS) Monitoring Network System in Mongolia and the Data Analysis for Early Warning Implemented (2007)
NEW ZEALAND	Independent contractor agreement between NIES and the National Institute of Water and Atmospheric Research Limited (2008)

RUSSIA	Agreement on Cooperative Research Projects between NIES, Environment Agency of Japan, and Institute of Atmospheric Optics, Russian Academy of Sciences (1997)
	Agreement on Cooperative Research Projects between the Central Aerological Observatory, Committee for Hydrometeorology and Monitoring of Environment, Ministry on Ecology and Natural Resources of the Russian Federation and NIES (1992)
	Agreement on Cooperative Research Projects between NIES and the Institute of Microbiology, Russian Academy of Sciences (1994)
SWEDEN	MoU for Joint Research on Product and Waste Oriented Environmental Management and Policy (2008)
UK	Collaboration Agreement "Towards constructing a consistent dataset of atmospheric CO_2 concentrations from the new generation of satellite instruments to improve estimates of carbon sources and sinks" (2008)
USA	Implementing Agreement Joint Research on Analyses of Marine Productivity and Oxygen Cycle in the Pacific and Tasman Sea, NIES and Princeton University, USA (2008)
	Technical Assistance Agreement between NIES and the California Institute of Technology at the Jet Propulsion Laboratory (2008)
	Technical Services Agreement between NIES and the California Institute of Technology (2008)
UNEP	MoU referring to the establishment and operation of a GRID-compatible Center in Japan (1991)
	MoU between NIES and UNEP Risø Centre on Energy, Climate and Sustainable Development, Denmark, for Joint Research on Global Energy – Economic Modeling (2007)

GOSAT-Research Announcement Joint Research Agreements

CANADA	Validation of GOSAT Measurements Using Ground-Based and Satellite Data (2008)
	Evaluation of Applicability of GOSAT Data for Monitoring of Green House Gases (GHG) Emissions from Tailing Ponds and Upgrader Operations in the Oil Sands Production Area, Alberta, Canada (2008)
	Chemical Data Assimilation and Inverse Modeling of Atmospheric CO_2 (2008)
CHINA	Analysis of Spatial and Temporal Relationship between Greenhouse Gases and Landuse/Landcover in China (2008)
FRANCE	Geophysical Parameters Derived from TANSO/FTS and CAI Data (2008)
	Correlative TIR, SWIR, and NIR Measurements for GOSAT (2008)
GERMANY	Cloud Remote Sensing using GOSAT Instruments (2008)
	Towards Consistent Long-term SCIAMACHY and GOSAT Greenhouse Gas Data Sets (CONSCIGO) (2008)
	Distributions of CO_2 and CH_4 over Eurasia between 30°N and 90°N (2008)
	Non-standard Cloud, Aerosol, and Albedo Products (2008)

	Quantification of the Carbon Cycle in Europe and Western Africa by the Top-down Method (2008)
	Validation of TANSO CH_4 Columns and Profiles by Ground-based Solar Absorption FTIR (2008)
NETHERLANDS	Retrieval of Methane, Carbon Dioxide, and Water Vapor from GOSAT Near-infrared Spectra (2008)
	Intercomparison of CO_2 Fluxes Estimated using Inverse Modeling of GOSAT and OCO Measurements (2008)
	Study of Aerosol and Cloud Properties by using Polarization of the O_2A band (2008)
NEW ZEALAND	Southern Hemisphere Validation of GOSAT XCO_2 and XCH_4 from TCCON Solar FTS Measurements in Australia and New Zealand (2008)
RUSSIA	Simulation of Cirrus Clouds and Humidity in UTLS by using a Coupled Cirrus/Trajectory Model, and Modification of the Transport Models used for the Purposes of Greenhouse Gas Inversion (2008)
	Development of Methods and Software for Retrieval of CO_2 and CH_4 Spatial Distributions from TANSO-FTS and TANSO-CAI Sensor Data, and Application of these Methods to Analysis of the Atmosphere over Western Siberia (2008)
	Development of Radiative Transfer Technique for Arbitrary 3D Geometry with Consideration of Polarization Effects (2008)
	Development of Column Amounts and Concentration Profiles for Retrieving Algorithms for CO_2 and CH_4 from Satellite Data using A Priori Information (Neural Network Approach) (2008)
UK	Application of GOSAT Data in a 4D-Var Data Assimilation System, in Combination with Other Greenhouse Gas Observations, to Better Estimate CO_2 and CH_4 Fluxes (2008)
	The UK Universities' Contribution to the Analysis of GOSAT L1 and L2 Data: Towards a Better Quantitative Understanding of Surface Carbon Fluxes (2008)
USA	Early Detection of Leakage from Siberian and Alaskan Gas Pipelines (2008)
	Infrared Validation and Mid-tropospheric CO_2 from the FTS GOSAT Sensor (2008)
	Trace Gas Remote Sensing using Near IR and Longwave IR (2008)
	Validation of a Lidar System for the Measurement of CO_2 (2008)
	Evaluation and Validation of GOSAT CAI Vegetation Index Products using MODIS, AVHRR, and In Situ Data over the Conterminous United States and Hawaii (2008)
	Assessment of GOSAT TIR FTS absolute calibration through validation (2008)

Host Division

Researcher, COUNTRY, Research Period
Research Subject (Host Researcher)

Center for Global Environmental Research

Valsala, Vinu Krishnapillai, INDIA, 2007.10.1–2009.9.30
A robust estimation of the ocean–atmosphere exchanges of carbon dioxide (CO_2) (Maksyutov, S.)

Schutgens, Nicolaas Alexander Johannes, NETHERLANDS, 2008.4.1–2009.3.31
A study of aerosol and cloud information retrievals from data observed by the Cloud & Aerosol Imager aboard GOSAT (Yokota, T.)

Wang, Quan, CHINA, 2008.5.13–2009.3.31
Study of the response of soil microbe respiration to global warming of Japanese forest systems (Liang, N.)

Kim, Heon-Sook, KOREA, 2008.10.24–2009.3.31
Application of atmospheric transport and inverse modeling in global methane flux estimation and GOSAT data product evaluation (Maksyutov, S.)

Research Center for Material Cycles and Waste Management

Kong, Hai-nan, CHINA, 2008.4.1–2009.3.31
Studies of advanced treatment and energy recovery from liquid wastes using bio-eco technology (Xu, K.)

Kim, So-Young, KOREA, 2008.10.1–2009.2.27
Analysis of material flow and management system of E-waste in Asia (Terazono, A.)

Research Center for Environmental Risk

Li, Chunmei, CHINA, 2007.4.5–2009.4.4
Effects of diesel exhaust with enrich-nanoparticles on reproductive and endocrine function (Suzuki, A.)

Puzyn, Tomasz, POLAND, 2007.9.12–2008.9.11
Development of linked SPRMM model for the assessment of POP-like characteristics of chemicals (Suzuki, N.)

Larson, Eric R., USA, 2008.6.24–2008.8.19
A home-and-away comparison of the effects of an invasive crayfish on aquatic food webs (Nishikawa, U.)

Adu-kumi, Sam, GHANA, 2008.9.16–2009.11.7
Exposure assessment of lindane in Ghana (Suzuki, N.)

Yang, Lin Qing, CHINA, 2008.9.16–2009.3.31
Study of molecular effects of nuclear receptor ligands on carcinogenesis and aging (Sone, H.)

Lee, Soyoung, KOREA, 2009.1.9–2009.2.19
Investigation of the impacts of chemicals on egg (embryo) development in Medaka (Tatarazako, N.)

Asian Environment Research Group

Tian, Hezhong, CHINA, 2007.9.19–2008.9.30
Development and verification of an emission inventory for air pollutants in East Asia (Ohara, T.)

Xu, Zhenzhu, CHINA, 2007.11.5–2009.11.4
Climate change impacts on dominant species in the severely deteriorated ecosystem of North China grassland (Shimizu, H.)

Tang, Changyuan, CHINA, 2008.4.1–2009.3.31
Degradation of ground water resources in river basin (Murakami, S.)

Qi, Yu, CHINA, 2008.4.1–2009.3.31
Design and evaluation system for industrial symbiosis technologies and policies in Asian metropolises (Fujita, T.)

Zou, Chunjing, CHINA, 2008.6.24–2010.3.31
Comparative analysis on eco-physiological characteristics among ecotypes grown in semi-arid regions (Shimizu, H.)

Sung, Kyoung-hee, KOREA, 2009.1.9–2009.2.19
The effects of objective analysis (OBSGRID) in WRF(Weather Research and Forecasting) on air quality modeling (Ohara, T.)

Koolkalya, Sontaya, THAILAND, 2009.3.16–2009.5.16
Effects of constructed barriers such as dams on freshwater fishes in the Mekong River and rivers in eastern Thailand (Fukushima, M.)

Social and Environmental Systems Division

Jing, Yuanshu, CHINA, 2008.4.1–2008.12.28
Urban energy heat balance and thermal sensation modeling of different urban climatic conditions (Ichinose, T.)

Pertova, Elena, RUSSIA, 2008.4.1–2009.3.31
Comparison of appreciation on natural landscapes between Russia and Japan (Aoki, Y.)

Yang, Yufang, CHINA, 2008.4.1–2009.3.31
Research on the effect of thermal environment mitigation by heat circulaion through Tokyo Bay (Ichinose, T.)

Matuschek, Olaf, GERMANY, 2008.4.29–2008.8.1
Applied climatology, with emphasis on thermal comfort in urban areas and recreation/tourism (Ichinose, T.)

Lee, Kee-cheol, KOREA, 2008.5.8–2008.5.27
Landscape appreciation and distribution of the Eight Views (Pal Kyung) in Japan (Aoki, Y.)

Zhang, Xiaoxi, CHINA, 2008.6.4–2009.3.31
Assessment of the impacts of water resource changes due to global warming on economic activities in China (Masui, T.)

Welch, Eric Wayne, USA, 2009.3.27–2009.5.24
Study on the effectiveness of the voluntary aproach (Hibiki, A.)

Environmental Health Sciences Division

Qin, Xianyang, CHINA, 2008.10.1–2009.3.31
Study of the association between AHR- and ESR1-responsive gene variations and susceptibility to endocrine-disrupting chemical exposure, and risk of male genital disrders (Yonemoto, J.)

Atmospheric Environment Division

Vaidyanathan, Venkatesan, INDIA, 2006.6.1–2008.5.31
Spectroscopic studies of secondary organic aerosol formation (Imamura, T.)

Zhou, Libo, CHINA, 2008.4.1–2009.3.31
An analytical study of interannual variations in the ozone layer (Akiyoshi, H.)

Xing, Jia-hua, CHINA, 2008.6.6–2009.3.31
Studies of variability in stratospheric processes and uncertainties in the prediction of future changes in stratospheric ozone (Imamura, T.)

Water and Soil Environment Division

Ayoub, Sameh Reyad, EGYPT, 2008.4.1–2009.3.31
Study of techniques for remediation of soil and groundwater pollution caused by hazardous chemicals (Inaba, K.)

Environmental Biology Division

Vaulot, Daniel, FRANCE, 2008.4.1–2008.6.30
Whole genome amplification of marine picoplankton from single cells sorted by flow cytometry (Kawachi, M.)

Saghar, Zarenezhad, IRAN, 2008.6.2–2009.3.31
Molecular phylogenetic study of the toxic cyanobacterium *Cylindrospermopsis raciborskii* (Kawachi, M.)

Akiyoshi H., Zhou L.B., Yamashita Y., Sakamoro K, Yoshiki M., Nagashima T., Takahashi M., Kurokawa J., Takigawa.M., Imamura T., 2009, A CCM simulation of the breakup of the Antarctic polar vortex in the years 1980-2004 under the CCMVal scenarios, J.Geophys.Res., 114, D03103.

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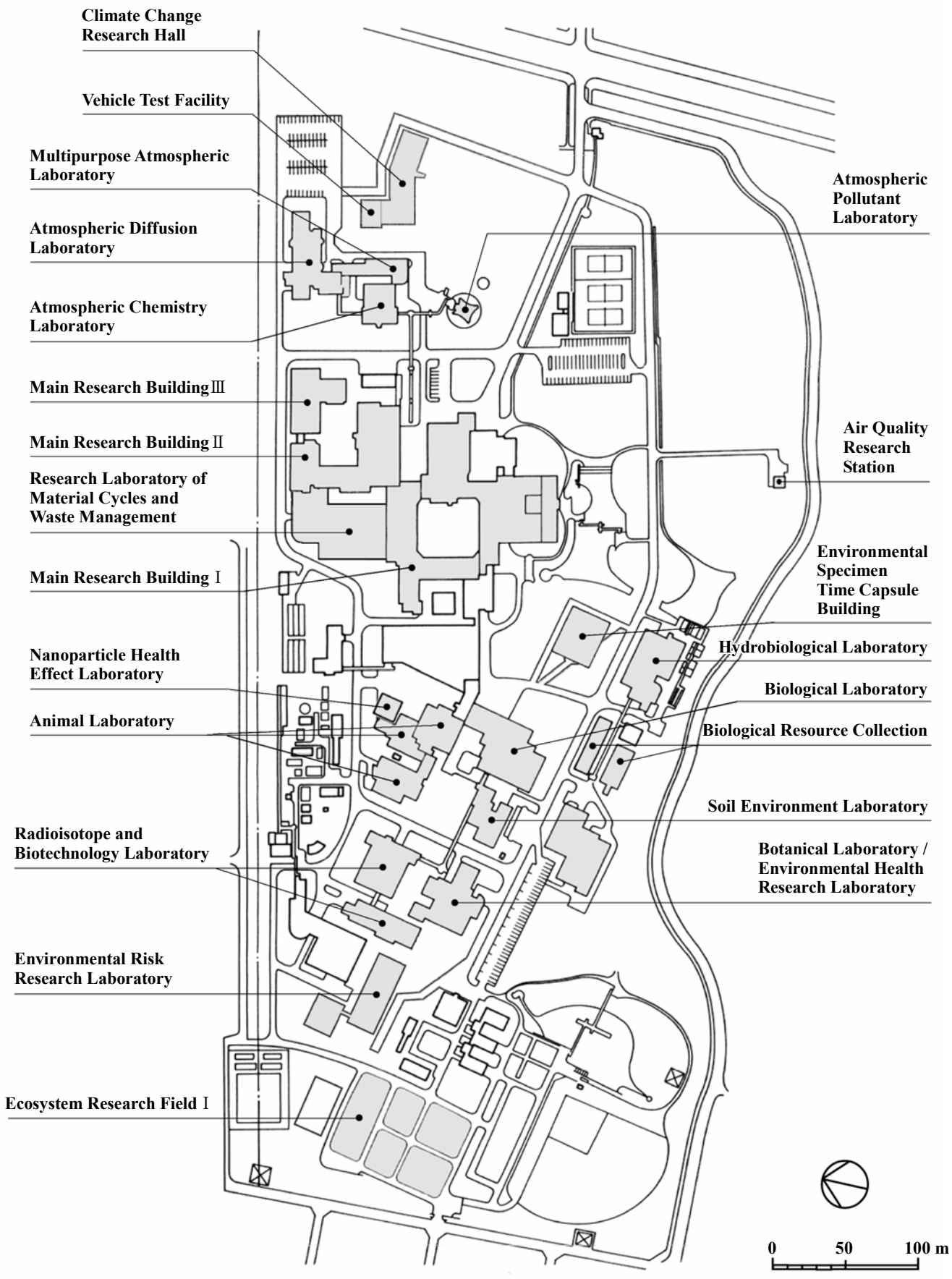
Climate Change Research Hall
Vehicle Test Facility
Multipurpose Atmospheric Laboratory
Atmospheric Diffusion Laboratory
Atmospheric Chemistry Laboratory
Main Research Building Ⅲ
Main Research Building Ⅱ
Research Laboratory of Material Cycles and Waste Management
Main Research Building Ⅰ
Nanoparticle Health Effect Laboratory
Animal Laboratory
Radioisotope and Biotechnology Laboratory
Environmental Risk Research Laboratory
Ecosystem Research Field Ⅰ
Atmospheric Pollutant Laboratory
Air Quality Research Station
Environmental Specimen Time Capsule Building
Hydrobiological Laboratory
Biological Laboratory
Biological Resource Collection
Soil Environment Laboratory
Botanical Laboratory / Environmental Health Research Laboratory
0 50 100 m

Air Quality Research Station

Automatic instruments for monitoring the concentrations of seven atmospheric constituents (NO_x, SO_2, O_3, methane and non-methane hydrocarbons, suspended particulate matter, and gaseous Hg) are operated at this station. Wind speed, precipitation, atmospheric pressure, visible and UV radiation, temperature, and other atmospheric characteristics are also measured, and the results are made available to NIES researchers as fundamental data for various studies. The stability and accuracy of the automated measurements and the factors that interfere with them are studied, and new instruments developed for atmospheric monitoring—such as $PM_{2.5}$ monitoring instruments—are evaluated.

Animal Laboratory

The animal laboratory has three controlled-environment facilities. Facility I has breeding rooms for specific-pathogen-free laboratory animals, and it has complex gas or diesel exhaust particle (DEP) exposure chambers for investigating the health effects of $PM_{2.5}$ and DEPs. Facility II has a conventional laboratory animal breeding unit and laboratories for studying the effects of chemicals, including dioxins and heavy metals. Facility III was built in 2004 as a nanoparticle health effects research facility; it has exposure chambers and two diesel engines for generating nanoparticles. Research on the health effects of nanoparticles on experimental animals began in FY 2005.

Atmospheric Chemistry Laboratory

This laboratory has a 6-m^3 evacuable chamber with an inner surface coated with Teflon. The chamber is used to study atmospheric chemical reactions. This facility is essential to our research on atmospheric pollution, including photochemical ozone formation, degradation of volatile organic compounds, secondary aerosol formation, and other important atmospheric phenomena.

Atmospheric Diffusion Laboratory

A wind tunnel is housed in this laboratory. Our wind tunnel is exceptional in that wind velocity (down to 0.2 m s^{-1}), air temperature, and floor temperature can be controlled independently to create various atmospheric conditions. Temperature and wind-velocity sensors on a computer-controlled gantry can be positioned at arbitrary locations to obtain three-dimensional data. These features, together with the use of models of buildings or mountains in the tunnel, allow accurate simulation of air flow and pollutant transport in a variety of real-world situations.

Biological Laboratory

This facility consists of controlled greenhouses and growth cabinets used to evaluate the effects of various detailed environmental scenarios on organisms. It includes experimental chambers in which light, temperature, and humidity can be precisely controlled. It facilitates the exposure of experimental plants to pollutant gases under these controlled conditions.

Biological Resource Collection

The collection is equipped with various standalone incubators (5 to 50 ºC), culture rooms (10 to 22 ºC), a programmable freezer, a liquid nitrogen supply system with sixteen 245-L tanks, a scanning electron microscope, various types of light microscopes, and molecular taxonomy equipment. Two projects are conducted in the collection. One is the Microbial Culture Collection (known as NIES-Collection) and the other is *ex situ* conservation of endangered algae. In these two projects, the collection maintains a total of about 2576 strains of microalgae, protozoa, and endangered macroalgae. Among them, 2148 strains are available to researchers inside and outside NIES. In FY 2008, researchers were supplied with 869 strains.

Climate Change Research Hall

The hall was completed in March 2001 and has three floors with a total area of 4900 m^2. Three major research programs are conducted in this facility: (1) development and implementation of climate change models based on various socioeconomic and emissions scenarios; (2) monitoring of atmospheric

constituents to evaluate ocean and terrestrial carbon sinks; and (3) assessment of forest sinks by remote sensing, forest modeling, and use of statistical data. The hall also contains equipment to evaluate low-emission vehicles.

Ecosystem Research Fields
Main Field I, on the NIES campus, and the Branch Field, 4 km to the west, include experimental fields for various types of plant-dominated ecosystems, lysimeters, greenhouses, observation towers, and laboratories. These fields are used to explore ecosystem processes under regulated outdoor conditions; to develop remote-sensing techniques from small-scale ground-truth data; and to supply plants, particularly for bioassays and mitigation studies.

Environmental Risk Research Laboratory
This laboratory is the core research facility of the Research Center for Environmental Risk. Its staff conduct extensive studies of ecological effects, human health effects, and environmental exposure, and they collect, analyze, and disseminate related information. The building is equipped with several special facilities, including freshwater and marine exposure systems for ecotoxicological research, a room for breeding laboratory animals, and instruments such as a liquid chromatograph – tandem mass spectrometer for qualitative and quantitative analysis of environmental chemicals and a confocal laser scanning microscope for cell biology.

Environmental Specimen Time Capsule Building
Strategic and systematic storage of environmental samples and biological specimens provides an important knowledge base and is essential for environmental research. For example, such samples and specimens are needed to study long-term trends in environmental pollutants and to verify past conditions when new types of pollution have been identified. NIES constructed this building to provide central facilities for the long-term storage of environmental specimens such as mussels and air particulates, as well as cells and the genetic material of threatened species.

Forest ecosystem sites for monitoring carbon sequestration
These monitoring facilities were established to study the carbon balance of terrestrial ecosystems and to evaluate the methods used to monitor this balance. All three sites are located in planted larch forests: one in Yamanashi Prefecture and two in Hokkaido, Japan's northernmost prefecture.

1) Fuji Hokuroku Flux Observation Site
This site was established in January 2006 in a forest composed mainly of planted larches in the foothills of Mt. Fuji in Yamanashi Prefecture. It is used to investigate the magnitude of the carbon sources and sinks in terrestrial ecosystems. It also serves as the principal monitoring site of the AsiaFlux network, an organization that promotes cooperation and the exchange of information on carbon flux observation in Asia.

2) Teshio Carbon Cycle and Larch Growth Experimental Site
This site, established in 2001, comprises one catchment in Hokkaido University's Teshio Experimental Forest in Horonobe, Hokkaido. At this site, we are focusing our research on the transition of carbon flow during tree growth periods. After the felling of a natural forest of coniferous and broad-leaved trees in February 2003, we planted larch saplings in October of the same year. We are now using standard forestry practices to manage these saplings and are monitoring the carbon flux.

3) Tomakomai Flux Research Site
This site was established in August 2000 in a planted larch forest in the foothills of Mt. Tarumae, near Tomakomai, in Hokkaido. Unfortunately, it was destroyed by a typhoon in September 2004. Since June 2005, we have been using the restored site to study the transition of the carbon balance in the devastated forest.

Global Environmental Monitoring Stations (Hateruma and Cape Ochi-ishi)
These monitoring stations were set up mainly to

monitor long-term changes in the baseline levels of greenhouse gases at remote sites in Japan. The island of Hateruma is located in Okinawa Prefecture and is the nation's southernmost inhabited island. The monitoring station was constructed on the eastern edge of the island. Cape Ochi-ishi Station is located in the eastern part of Hokkaido. These stations use automated systems for high-precision monitoring of greenhouse gases (e.g., CO_2, CH_4, N_2O, O_3) and other atmospheric species (NO_x, SO_2, suspended particulate matter). Long-term monitoring data are archived and distributed through the Center for Global Environmental Research home page and the World Data Centre for Greenhouse Gases.

Hydrobiological Laboratory

The Hydrobiological Laboratory was established to study organism-related environmental problems in water bodies. The toxicity testing system is suitable for long-term exposure studies. Other associated facilities include temperature- and light-controlled culture rooms, axenic culture rooms, large autoclaves, and an outdoor experimental pond. Some laboratories can be used for chemical and biological experiments on water and soil environment restoration and liquid waste treatment.

Main Research Building

The building houses analytical instruments and support facilities such as clean rooms. These instruments permit accurate, highly sensitive, and selective detection of harmful substances in environmental samples. Stable isotope analyses facilitate research on global warming and the origins of pollutants. Among the instruments (listed below) are some that are used for research and development of new analytical methods.

Analytical instrumentation in Main Research Building I

Standard instruments (free access to institute researchers)
Gas chromatograph – mass spectrometer
Gas chromatograph with atomic emission detector
Scanning electron microscope
Transmission electron microscope
Ultraviolet/visible microscope spectrophotometer
Inductively coupled plasma emission spectrometer
Atomic absorption spectrometer
X-ray fluorescence spectrometer
X-ray photoelectron spectrometer
Stable isotope mass spectrometer (for gas samples)
Fourier transform infrared spectrometer
Nuclear magnetic resonance spectrometer
Flow cytometer
High-speed amino acid analyzer
Special instruments (restricted access)
Gas chromatograph – mass spectrometer
High-performance liquid chromatograph – mass spectrometer
Inductively coupled plasma mass spectrometer
Secondary ion mass spectrometer
High-resolution mass spectrometer
High-precision stable isotope mass spectrometer (for gas samples)
Thermal (surface) ionization mass spectrometer (for stable isotopes)
Atmospheric pressure ionization mass spectrometer
Laser Raman spectrometer
X-ray diffractometer

Main Research Building II

Preservation Laboratory

This facility includes –20 ºC, 5 ºC, and 20 ºC temperature-controlled rooms where various environmental samples collected by field researchers are stored until they are put to practical use. The facility was previously used for environmental specimen banking; samples collected previously for long-term environmental monitoring have now been transferred to the Time Capsule Building.

Main Research Building III

1) Tandem mass spectrometer (MS/MS)

Two double-focus-type mass spectrometers are connected serially (in tandem). The resolution of the first is 6.5×10^4 and that of the second is 5×10^3. Ions selected by the first MS are passed through the collision cell, where they yield fragments that are analyzed by the second MS. The chemical structures of complex molecules can be determined with this instrument.

2) NIES-TERRA: accelerator mass spectrometer (AMS) facility

An electrostatic tandem accelerator of 5 MV (max.) terminal voltage is interfaced with two ion sources and an analytical mass spectrometer. Isobaric atomic ions can be distinguished by the electrical charges of their nuclei. The AMS is a very sensitive and selective tool for atomic ion detection and is used for measuring long-lived radioisotopes such as ^{14}C and ^{10}Be. These radioisotopes are used as tracers and time-markers (dating agents) in environmental research.

3) Hazardous Chemicals Area

Experiments using highly toxic substances such as dioxins (chlorinated dibenzodioxins), polychlorinated biphenyls, and polychlorinated dibenzofurans are conducted in this area. The air pressure inside the area is maintained below atmospheric pressure to prevent leakage of hazardous substances. Exhaust air is treated by high-efficiency particulate air (HEPA) filters and charcoal filters; discharge water is also treated with a charcoal filter system. The Hazardous Chemicals Area contains an analytical lab with a gas chromatograph – mass spectrometer and a microcosm, as well as facilities for microorganism-related research, animal exposure experiments, and measurements of the physical and chemical properties of substances.

4) GOSAT Data Handling Facility

The Greenhouse Gases Observing Satellite (GOSAT) Data Handling Facility (DHF) processes GOSAT data. The facility's tasks include data acquisition from JAXA (the Japan Aerospace Exploration Agency), processing, reprocessing, and storage; validation of the processed products; and data distribution. The major part of GOSAT DHF is located at NIES, but there are some external facilities that contribute to the overall function. The DHF started operating at the beginning of October 2008. The Operational Readiness Review of the GOSAT DHF was completed on 24 December 2008. GOSAT was successfully launched on 23 January 2009, and GOSAT DHF is ready to be tuned for data processing.

5) Millimeter-wave spectrometer for observation of atmospheric ozone

The millimeter-wave spectrometer measures the emission spectra from rotational transition of ozone molecules in the stratosphere and mesosphere with extremely high resolution. Vertical profiles of ozone from 14 to 76 km are retrieved by using the dependence of the width of the ozone emission spectra on altitude. The spectrometer was installed in 1995. Since then, ozone has been monitored continuously, except on rainy days and heavily humid days.

6) Facility for receiving and processing NOAA satellite data

Advanced Very High Resolution Radiometer (AVHRR) instruments orbit Earth on US National Oceanic and Atmospheric Administration (NOAA) satellites. They monitor five electromagnetic wavelength bands from the visible to the thermal infrared region with high temporal and moderate spatial resolution (about 1 km × 1 km). The AVHRR facil-

ity of NIES was able to receive these data up to March 2004. The data received up until that time are being processed and archived by the facility.

7) Global Resource Information Database (GRID)-Tsukuba information processing center
GRID-Tsukuba is a part of the CGER Global Environmental Database. The GRID information processing system was introduced at NIES in 1994. This remote-sensing image-processing system and geographic information system processes GRID data and produces original datasets. Several software packages, including ERDAS/IMAGINE, ARC/INFO, IDRISI, and GRASS, are installed on workstations and PCs.

Nanoparticle Health Effect Laboratory
This laboratory is equipped with experimental facilities to provide new information on the health effects, chemical and physical properties, behavior, and translocation of nanoparticles. There are four inhalation chambers that were designed for studies of the chronic health effects of environmental nanoparticles in laboratory animals.

Oku-Nikko Field Research Station
The field station at Oku-Nikko in Tochigi Prefecture consists of an observatory, a management building, and a research area.
This station was first constructed as an observation and monitoring facility for the long-term monitoring of forest ecosystem dynamics to obtain background values for atmospheric pollution. However, with the increasing variety of environmental issues, this facility is also used to monitor bioindicators of global warming.
In FY 2008, the station was used, for example, to check the performance of newly developed devices and systems for environmental measurement under field conditions; to clarify the influence of deer feeding on natural tree regeneration; and to monitor the succession of vegetation on rotten woods in relation to micro-environmental factors.
In March 2009, NIES released a plan to overhaul the use of large research facilities under the Independent Administrative Institution Consolidation and Rationalization Plan. As a result, as of 31 March 2009, this facility ceased to be used as a center for atmospheric monitoring.

Radioisotope and Biotechnology Laboratory
This laboratory is used to develop applications of recombinant DNA technology for environmental protection and to study the fate and effects of recombinant organisms in ecosystems. The laboratory's specialized instruments, including peptide and DNA sequencers, are available on the first floor. The second floor is a radioisotope-controlled area used for studies of the transport, accumulation, chemical conversion, and toxicity of environmental pollutants in plants, animals, soil, water, and the atmosphere.

Research Laboratory of Material Cycles and Waste Management
NIES established this laboratory in March 2002. The laboratory supports research on resource circulation and waste management, including resource recovery and recycling of waste. It also develops technologies for testing, evaluation, and monitoring to reduce environmental risk and to restore polluted sites.

Research Station for Preservation and Enhancement of the Water Environment
1) Lake Kasumigaura Water Research Laboratory
This field station, located on the shore of Lake Kasumigaura, is used as a common research facility by many NIES researchers. The station's location allows *in situ* studies of pollution, water quality recovery, lake ecosystem dynamics, and elemental cycles in this heavily eutrophicated lake.

2) Bio-Eco Engineering Research Laboratory
This laboratory studies, develops, and field-tests liquid waste treatment and resource recovery systems such as the *Johkasou* system, hydrogen–methane fermentation systems, phosphorus recovery systems, and aquatic plant–soil purification systems. Domestic wastewater samples are

used to develop and evaluate liquid waste treatment technologies. Air and wastewater temperatures are controlled to simulate the four seasons in Japan and the climates of Asian countries. Many people employed in research institutes, universities, government, and private companies visit the laboratory. The laboratory also plays an important role as a core facility for international cooperative research.

Rikubetsu Stratospheric Monitoring Station

NIES has been monitoring the stratospheric ozone over Hokkaido in collaboration with the Solar–Terrestrial Environment Laboratory (STEL) at Nagoya University. Monitoring is also performed in a room of Hokkaido's Rikubetsu Astronomical Observatory, which is run by the Rikubetsu town council. The observatory monitors harmful ultraviolet rays (by Brewer spectrometer) and the vertical distribution of stratospheric ozone (by millimeter-wave radiometer). The aim is to reveal ozone variations in the stratosphere and the effects of Arctic ozone depletion. Since parts of the polar vortex sometimes arrive over Hokkaido in winter or spring, Rikubetsu is one of the sites used to study the effects of ozone depletion in the Arctic.

Soil Environment Laboratory

The Soil Environment Laboratory contains unique large and small monolithic lysimeters in which the behavior of pollutants such as heavy metals, nitrates, and sulfates are investigated. The effects of pollutants on soil ecosystems (including the soil–organism–plant system) are also investigated.

Vehicle Test Facility

The Vehicle Test Facility is equipped with an environment simulation room, a chassis dynamometer, onboard fuel economy and emission measurement systems, conventional exhaust measurement systems, and devices developed by NIES, including an exhaust gas dispersion chamber and a dilution tunnel with high dilution ratio capacity, to measure and evaluate real-world vehicle exhaust and performance.

Number of personnel

President	1
Executive Director	2
Auditor	2
Planning Division	10
General Affairs Division	31
Audit Section	2
Center for Global Environmental Research	26
Research Center for Material Cycles and Waste Management	19
Research Center for Environmental Risk	24
Asian Environment Research Group	20
Social and Environmental Systems Division	12
Environmental Chemistry Division	15
Environmental Health Sciences Division	13
Atmospheric Environment Division	12
Water and Soil Environment Division	15
Environmental Biology Division	19
Laboratory of Intellectual Fundamentals for Environmental Studies	10
Environmental Information Center	10
Total	243

Fields of expertise

Basic Sciences	73
Engineering	57
Agricultural Sciences	22
Medical Sciences	15
Pharmaceutical Sciences	8
Economics	3
Fisheries Sciences	3
Law	1
Philosophy	1
Veterinary Sciences	1
Total	184

Division Section/Team	Position	Staff Member
Headquarters	President	OHGAKI, Shinichiro
	Executive Director (Research)	YASUOKA, Yoshifumi
	Executive Director (Management)	OHTA, Susumu
	Auditor	FUNABASHI, Motohisa
	Auditor	KOBAYASHI, Nobuyuki
Planning Division	Director	SAITO, Makoto
	Deputy Director	OSAKO, Masahiro
	Deputy Director	TAKIMURA, Akira
	Principal Research Coordinator (*)	UEHIRO, Takashi
	Principal Research Coordinator (*)	TANABE, Kiyoshi
Planning Office	Chief (*)	TAKIMURA, Akira
	Research Coordinator	YAMANE, Masanori
Research Coordination Office	Chief	MORI, Yasufumi
	Research Coordinator (*)	TASAKI, Tomohiro
	Research Coordinator (*)	OGURA, Tomoo
	Research Coordinator (*)	AONO, Mitsuko
Office of Public Relation and International Coordination	Chief	SATO, Kuniko
	Research Coordinator (*)	HIROKANE, Katsunori
	Research Coordinator	MURAKAMI, Masaharu
General Affairs Division	Director	SHIBAGAKI, Taisuke
General Affairs Section	Chief	KUWATA, Nobuo
Accounting Section	Chief	SUZUKI, Yoshimitsu
Facility Management Section	Chief	KUME, Hideyuki
Audit Section	Chief	HIRAO, Yoshinori
Center for Global Environmental Research	Director	SASANO, Yasuhiro
	Deputy Director	NOJIRI, Yukihiro
	Special Senior Researcher	Shamil Maksyutov
	Special Senior Researcher	YAMAGATA, Yoshiki
Global Carbon Cycle Research Section	Chief	MUKAI, Hitoshi LIANG, Naishen TAKAHASHI, Yoshiyuki
Satellite Remote Sensing Research Section	Chief	YOKOTA, Tatsuya MORINO, Isamu

(*) Multiple roles

		YAMANO, Hiroya
Climate Risk Assessment Research Section	Chief	EMORI, Seita TAKAHASHI, Kiyoshi OGURA, Tomoo ITO, Akihiko
Climate Policy Assessment Research Section	Chief	KAINUMA, Mikiko KAMEYAMA, Yasuko FUJINO, Junichi HANAOKA, Tatsuya
Office for Atmospheric and Oceanic Monitoring	Chief	MACHIDA, Toshinobu SHIRAI, Tomoko
Office for Terrestrial Monitoring	Chief	SAIGUSA, Nobuko OGUMA, Hiroyuki
Office for Global Environmental Database	Chief	MATSUNAGA, Tsuneo
	(*)	MORIGUCHI, Yuichi
	(*)	NAKANE, Hideaki
	(*)	YOKOUCHI, Yoko
	(*)	TOHJIMA, Yasunori
	(*)	IMAI, Akio
	(*)	TANIMOTO, Hiroshi
	(*)	ICHINOSE, Toshiaki
	(*)	TANAKA, Atsushi
	(*)	ARAMAKI, Takahumi
	(*)	KOMATSU, Kazuhiro
Research Center for Material Cycles and Waste Management	Director Deputy Director Research Coordinator (*)	MORIGUCHI, Yuichi NOMA, Yukio YAMANE, Masanori
Sustainable Material Cycles System Section	Chief (*)	MORIGUCHI, Yuichi HASHIMOTO, Seiji NANSAI, Keisuke
International Material Cycles Section	Chief	TERAZONO, Atsushi YOSHIDA, Aya
Material Cycles System Engineering Section	Chief(*)	OSAKO, Masahiro KURAMOCHI, Hidetoshi TASAKI, Tomohiro

(*) Multiple roles

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Planning Section	Chief	KIMURA, Kyoko
Database Section	Chief	SASAKI, Hirotoshi
Information Management Section	Chief	HIROKANE, Katsunori

(*) Multiple roles

ACLab	Environmental Analytical Chemistry Laboratory
4DVAR	Four-Dimensional Variational
AIM	Asia-Pacific Integrated Model
Al_o	oxalate-extractable Al
Al_p	pyrophosphate-extractable Al
AMeDAS	Automated Meteorological Data Acquisition System
AMS	accelerator mass spectrometry
APO	atmospheric potential oxygen
AR4	Fourth Assessment Report (IPCC)
As	arsenic
AVHRR	Advanced Very High Resolution Radiometer
BBM	bread-board model
BDF	biodiesel fuel
BEVs	battery electric vehicles
BM	basement membranes
BRLab	Biological Resource Laboratory
CAD	Computer Aided Design
CAI	Cloud and Aerosol Imager
CAS	Chinese Academy of Sciences
CC-LaG	Carbon Cycle and Larch Growth
CCM	chemistry climate model
CCMVal	chemistry climate model validation
CCSR	Center for Climate System Research, The University of Tokyo
CFD	computed fluid dynamics
CGER	Center for Global Environmental Research
CHAAMS	Cape Hedo Aerosol and Atmosphere Monitoring Station
CHASER	global chemical climate model
CMAQ	Community Multiscale Air Quality Modeling System
CONTLAIL	Comprehensive Observation Network for Trace gases by AIrLiner
COP	Conference of the Parties
CRM	Certified Reference Material
CRT	cathode ray tube
CSA	Carbon Sink Archives
CTMA	cetyltrimetylammonium bromide
CWRC	Changjiang Water Resources Commission
Da	Dalton
DC	dendritic cell
DCM	dichloromethane
DeBDethane	decabromodiphenyl ethane
DecaBDE	decabromodiphenyl ether
DEHP	di-(2-ethylhexyl) phthalate
DEP	diesel exhaust particles
DIN	dissolved inorganic nitrogen
DIP	dissolved inorganic phosphorus
DME	dimethyl ether
DMEM/F-12	Dulbecco's Modified Eagle's Medium/Nutrient Mixture F-12
DNA	deoxyribonucleic acid
DNMT1	DNA methyltransferase 1
DNPH	dinitrophenylhydrazine
DO	dissolved oxygen
DOC	dissolved organic carbon
DOM	dissolved organic matter
DPAA	diphenylarsenic acid
DSi	dissolved silicate
EEBB	Energy around Building Blocks
ER	estrogen receptor
EST	Environmentally sustainable transport
Fe_o	oxalate-extractable Fe
FOSE	perfluorooctane sulfonamide ethanole
FTIR	Fourier transform infrared
FTOH	fluorotelomer alcohol
FTS	Fourier transform spectroscopy
GAD	glutamate decarboxylase
GAM	generalized additive model
GC	gas chromatography
GC/MS	gas chromatography/mass spectrometry

GCP	Global Carbon Project
GC×GC	multidimensional gas chromatography
GD	gestational day
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Sytems
GERF	Global Environmental Research Foundation
GFAP	glial fibrillary acific protein
GHG	Greenhouse Gases
GIO	Greenhouse Gas Inventory Office
GIS	geographic information system
GLM	generalized linear model
GNS	graphene nanosheets
GOME	Global Ozone Monitoring Experiment
GOSAT	Greenhouse Gases Observing Satellite
GPP	gross primary production
GRID	Global Resource Information Database
HEVs	hybrid electric vehicles
HPAIV	highly pathogenic avian influenza virus
HPLC	high performance liquid chromatography
HR-MS	high-resolution mass spectrometry
HR-TOFMS	high-resolution time-of-flight mass spectrometry
HSRL	high-spectral-resolution lidar
HVAC	heating, ventilating, and air conditioning
IFN	interferon
IGES	Institute for Global Environmental Strategies
IL	interleukin
IPCC	Intergovernmental Panel on Climate Change
IT	information technology
JACCO	Japanese Alliance for Climate Change Observation
KGA	kidney-type glutaminase
LC	liquid chromatography
LCI	life cycle inventory
LDVs	light duty vehicles
lidar	Light Detection And Ranging
LIFES	Laboratory of Intellectual Fundamentals for Environmental Studies
LPS	lipopolysaccharide
MC-ICPMS	multi-collector inductively coupled plasma mass spectrometry
MDD	methyl-deficient diet
MeDIP-Seq	methylated DNA immunoprecipitation-sequencing
METEX	The Meteorological Data Explorer
MIROC	Model for Interdisciplinary Research on Climate
MODIS	Moderate Resolution Imaging Spectroradiometer
MOE	Ministry of the Environment
MRI	magnetic resonance imaging
mRNA	messenger RNA
MS-AP-PCR	methylation-sensitive arbitrarily primed PCR
MSD	methyl-sufficient diet
MSL	Mie-scattering lidar
MWCNT	multi-walled carbon nanotubes
NCAR	National Center for Atmospheric Research
NCEP	National Centers for Environmental Prediction
NC/Nga mouse	a murine mouse model of atopic dermatitis
NDVI	normalized difference vegetation index
NEDO	New Energy and Industrial Technology Development Organization
NEE	net ecosystem exchange
NGF	nerve growth factor
NICE-URBAN	NIES Integrated Catchment-based Ecohydrology for Urban
NIES	National Institute for Environmental Studies
NIPPON DATA	National Integrated Project for Prospective Observation of Non-communicable Disease And its Trends in the Aged
NOAA	National Oceanic and Atmospheric Administration
NPP	Net Primary Productivity
OCCCO	Office for Coordination of Climate Change Observation

OCO	Orbiting Carbon Observatory
ODA	official development assistance
OLR	organic loading rate
OVA	ovalbumin
Ox	photochemical oxidant
PAG	phosphate-activated glutaminase
PAH	polycyclic aromatic hydrocarbon
PBDE	polybrominated diphenyl ether
PBDF	polybrominated dibenzofuran
PBL	planetary boundary layer
PCM	phase-contrast microscopy
PCR	polymerase chain reaction
PGCs	primordial germ cells
PM2.5	fine particulate matter less than 2.5 μm in aerodynamic diameter
POP	persistent organic pollutant
PRTR	Pollution Release and Transfer Register
PTR-MS	proton transfer reaction mass spectrometry
QA/QC	quality assurance and quality control
QMS	quadrupole mass spectrometry
RCER	Research Center for Environmental Risk
RCPs	representative concentration pathways
REAS	Regional Emission Inventory in Asia
RNA	ribonucleic acid
SAM	S-adenosylmethionine
SBSE	stir bar sorptive extraction
SEC	size exclusion chromatography
SEM	scanning electron microscopy
SIMS	secondary ion mass spectrometry
SINET	the Science Information Network
SMC	sound material cycle
SMS	sound material-cycle society
SNWDP	South-to-North Water Diversion Project
SOC	soil organic carbon
SO-LAS	Surface Ocean – Lower Atmosphere Study
SORA	Study On Respiratory disease and Automobile exhaust
SPME	solid phase microextraction
SRES	Special Report on Emissions Scenarios
SVF	sky view factor
SWAT	Soil and Water Assessment Tool
SWCNT	single-walled carbon nanotubes
TANSO /FTS	Thermal And Near infrared Sensor for carbon Observation Fourier-Transform Spectrometer
TCCON	Total Carbon Observing Network
TCDD	2,3,7,8-tetrachlorodibenzo-*p*-dioxin
TEM	transmission electron microscopy
TERRA	tandem accelerator for environmental research and radiocarbon analysis
TD	thermal desorption
Th	helper T
TiO_2	titanium dioxide
TIR, SWIR, and NIR	Thermal Infrared, Short-Wave Infrared, Near Infrared
TLRs	toll-like receptors
TOC	total organic carbon
UNEP	United Nations Environmnent Programme
UNFCCC	United Nations Framework Convention on Climate Change
URCM	Urban and Regional Carbon Management
UTLS	Upper troposphere/lower troposphere
UV	ultraviolet
VOC	Volatile organic compounds
WDCGC	World Data Centre for Greenhouse Gases
WGIA	Workshop on GHG Inventories in Asia
W-Pass	Western Pacific Air-Sea Interaction Study
WWW	World Wide Web
XPS	X-ray photoelectron spectroscopy
XRF	X-ray fluorescence

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