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NIES Annual Report 2004

AE - 10 - 2004

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

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Foreword

This booklet is a report of the 2003 activities of NIES. However, first we must mention the sad loss of Prof. Tsuneyuki MORITA (Director of the Social and Environmental Systems Division), who passed away in August 2003 from liver failure. The most prominent contribution made by Prof. MORITA to environmental science in his short 53 years was the establishment of the Asian Pacific Integrated Model (AIM), which is now acknowledged as one of the most successful tools used for Greenhouse Gas analysis. His loss has been so great that it is hard to imagine that anyone will be able to fill the gap that he has left. His colleagues, however, are now striving to further develop AIM, and we greatly appreciate their efforts.

The construction of a new facility, the Environmental Specimen Time Capsule Building, was completed in March 2003. Various research projects are now being launched in the new facility, including the regeneration of extinct species. Construction of the long-awaited Nanoparticle Health Effect Research Laboratory (Nano HERL) will be complete in one more year.

Energy saving is a pressing issue at NIES, and our energy consumption is still increasing. Therefore, we plan to introduce a new facility, turborefrigerator, which will be very effective in improving our energy consumption.

The structure of the Institute—6 research divisions, 6 special priority research projects, 2 policy-response research centers, and 2 groups for the development of fundamental research techniques—has been maintained. However, the GOSAT research team has been added to enhance future monitoring activities by a satellite.

This fiscal year—in the middle of the 5-year mid-term research program—NIES was subjected to intermediate evaluation of its performance and was given an A grading. I appreciate the efforts put in by all of our NIES researchers to achieve this excellent result. I hope that this report will help you to become familiar with our achievements and activities during 2003.

Yohichi Gohshi
President of NIES

Contents

During the 1950s and 1960s, Japan experienced serious environmental pollution problems accompanying the rapid economic growth. In 1971, the Environment Agency was established within Japanese Govenment to develop countermeasures to serious environmental pollution problems such as Minamata disease caused by poisoning with organic mercury contained in the waste water of some factories and chronic bronchitis and asthma caused by sulfur oxides emitted from the factories of large industrial complexes. Since the promotion of basic research on environmental sciences was very necessary and could address public needs, the National Institute for Environmental Studies (NIES) was established in 1974 at Tsukuba Science City, about 50km north of Tokyo as a branch of the Environment Agency. NIES is the sole national institute for comprehensive research in the environmental sciences.

Researchers at NIES are of various specialties including physics, chemistry, biology, health sciences, engineering, agricultural & fisheries sciences, economics, etc. Interdisciplinary joint studies have been carried out, particularly in project research studies. There are various types of specially designed experimental facilities as well as remote research stations like the Lake Kasumigaura Research Station, the Okunikkou Field Monitoring Station and GHGs' Monitoring Station in Hateruma and Cape Ochi-ishi.

For these two decades, rapid, technological progress, structural changes in industries and changes in the styles of our daily lives have added new problems for environmental science to deal with. Moreover, global environmental problems, such as global warming, depletion of the stratospheric ozone layer, acid rain, destruction of tropical rain forests, desertification, etc., have recently given rise to deep concern worldwide. NIES underwent a major reorganization on July 1, 1990 to conduct more intensive research both on global environmental changes and their effects, and on conservation of the natural environment. The research functions of the new organization are conducted within two project research divisions, six fundamental research divisions and the Center for Global Environmental Research. The Principal Research Coordinator, the General Affair Division and the Environmental Information Center facilitate the research activities. The Environmental Information Center has the additional functions at preparing and providing access to both research publications and environment related data bases. On January 2001, in the context of re-organization of Japanese government, the Environment Agency was promoted to Ministry of the Environment, at the same time, NIES established Waste Management Research Division to conduct waste management research.

On 1 April 2001' the National Institute for Environmental Studies was reborn as an Independent Administrative Institution. The change from being a governmental institute to the new independent status allows us more flexibility in our operations, in order to provide better services to society.

NIES has prepared the medium-term plan that sets down our five-year work plans corresponding to the medium-term objectives directed by Ministry of the

Environment. NIES hopes to obtain the understanding and support of the public by articulating its research orientations and objectives, and will disseminate the results of its research widely. Since the change, new NIES has been very active to carry out new research projects with new research buildings and facilities.

As of the end of FY 2003, the total number of NIES regular permanent personnel was 272(6 foreigners included, Table 1). In FY 2003, NIES invited 318 scientists (7 foreigners included) to carry out the research programs as occasion demanded and also 308 researchers (68 foreigners included) joined NIES's research activities. The total budget of FY 2003 was 13,342 million yen (Table 2).

Table 1
Number of Permanent Personnel

Research	198	72.8%
Support & Management	52	19.1%
Env. Information Center	12	4.4%
Center for Global Env. Research	10	3.7%
Total	272	100%

(as of FY2003)

Table 2
Budget for Medium-Term Plan of NIES

	Category	2001-05 Budget(5years)		Fiscal 2003 Budget	
		million $	million ¥	million $	million ¥
Revenues	Grant for Operating Costs	444	48,849	85	9,401
	Subsidies for Facilities	28	3,093	19	2,110
	Loan Without Interest	17	1,850		
	Commissioned Work	160	17,576	32	3,508
	Total	649	71,368	137	15,019
Expenditures	Project Costs	290	31,873	56	6,197
	for Special Priority Research Projects	64	7,050	9	976
	for Policy-Response Research Areas	37	4,109	5	578
	for Environmental Information	19	2,132	3	358
	Facility improvements	34	3,709	19	2,110
	Expenses for Commissioned Work	160	17,576	32	3,508
	Personal	132	14,545	25	2,740
	Redemption Expenses	11	1,234		
	General Administrative Expenses	22	2,431	4	464
	Total	594	71,368	137	15,019

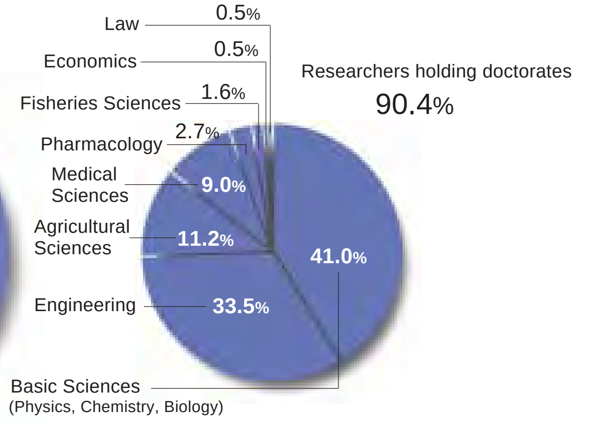
Note:The budget for each annual work plan will be requested and decided each fiscal year, based on the Medium-Term Plan.
$1=¥110

Budget

Number of Permanent Staff

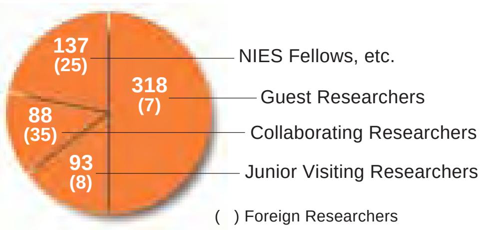
272

Fields of Expertise



Number of Visiting Researchers

636(75)



Organization

- Auditor
- President
  - Executive Director (Research)
  - Executive Director (Management)
- Adviser

- Principal Research Coordinator
  - Office of Research Coordination & Public Relations
  - Office of International Coordination
- Audit Section
- General Affairs Division
  - Global Affairs Section
  - Accounting Section
  - Facility Management Section
- Executive Investigator
  - Kosa Research Team
- Principal Investigator

[Research Divisions]

- Social and Environmental Systems Division
  - Environmental Economics Section
  - Resources Management Section
  - Environmental Planning Section
  - Information Processing and Analysis Section
  - Integrated Assessment Modeling Section
- Environmental Chemistry Division
  - Analytical Instrumentation and Methodology Section
  - Analytical Quality Assurance Section
  - Environmental Chemodynamics Section
  - Ecological Chemistry Section
- Environmental Health Sciences Division
  - Molecular and Cellular Toxicology Section
  - Environmental Biodefense Research Section
  - Biomarker and Health Indicator Section
  - Epidemiology and International Health Research Section
- Atmospheric Environment Division
  - Atmospheric Physics Section
  - Atmospheric Chemical Research Section
  - Atmospheric Remote Sensing Section
  - Atmospheric Measurement Section
  - Acid Deposition Research Team
- Water and Soil Environment Division
  - Water Quality Science Section
  - Soil Science Section
  - Geotechnical Engineering Section
  - Lake Environment Section
  - Marine Environment Section
- Environmental Biology Division
  - Ecosystem Function Study Section
  - Biotechnology and Phylogenetic Study Section
  - Tropical Ecology Section
  - Molecular Ecotoxicology Section

[Special Priority Research Projects]

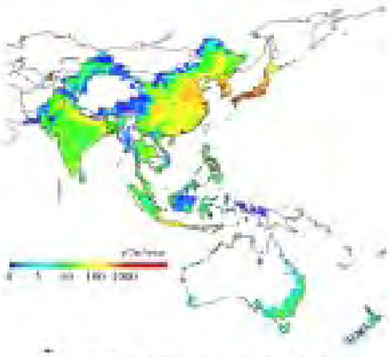
- Climate Change Research Project
  - Carbon Cycle Research Team
  - Carbon Sink Research Team
  - Socio-economic and Emission Modeling Team
  - Climate Modeling Research Team
  - Impact and Adaptation Modeling Team
- Ozone Layer Research Project
  - Satellite Remote Sensing Research Team
  - Ground-based Remote Sensing Research Team
  - Ozone Layer Modeling Research Team
- Endocrine Disrupters and Dioxin Research Project
  - Chemical, Bioassay and Dynamics Research Team
  - Biological Function Assessment Team
  - Pathophysiology Research Team
  - Health Effects Research Team
  - Ecological Effects Research Team
  - Counter Measurement and Engineering Team
  - Research Integration Team
- Biodiversity Conservation Research Project
  - Wildlife Population Research Team
  - Biological Invasion Research Team
  - Community Dynamics Research Team
  - Ecological Landscape Research Team
  - Biotechnology Risk Assessment Team
- Watershed Environments and Management Research Project
  - Watershed Environments Research Team
  - Coastal Environment Research Team
  - Remote Sensing Data Analysis Team
- PM2.5 & DEP Research Project
  - Research Group on Nanoparticles in the Environment
  - Traffic Pollution Control Research Team
  - Urban Air Quality Research Team
  - Aerosol Measurement Research Team
  - Epidemiology and Exposure Assessment Research Team
  - Inhalation Toxicology Team

[Policy-Response Research Centers]

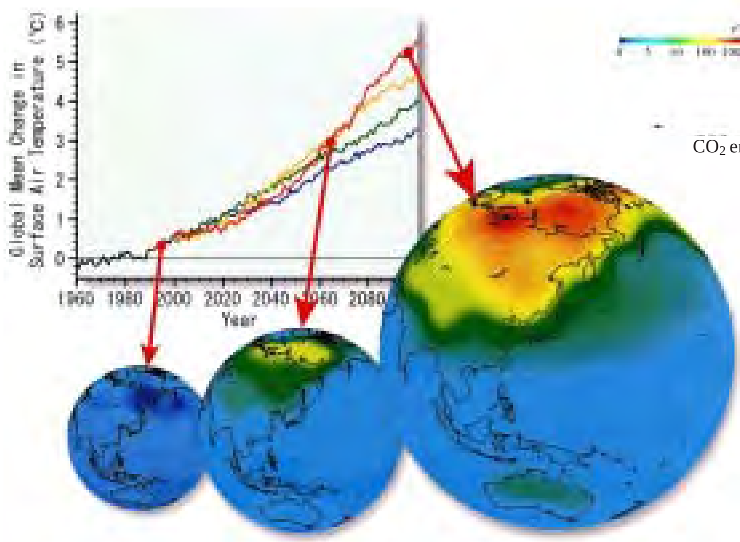
- Research Center for Material Cycles and Waste Management
  - Sustainable Material Cycles Management Section
  - Material Cycles Engineering Section
  - Waste Treatment Engineering Section
  - Final Disposal Engineering Section
  - Testing and Assessment Section
  - Hazardous Waste Management Section
  - Bio and Eco Engineering Section
- Research Center for Environmental Risk
  - Exposure Assessment Section
  - Health Risk Assessment Section
  - Ecological Risk Assessment Section

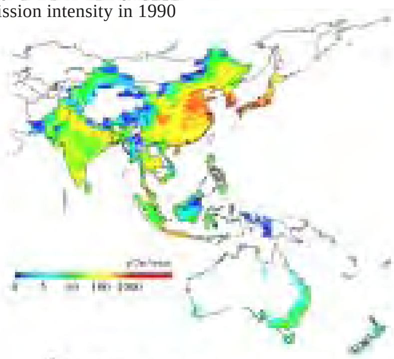
- Environmental Information Center
  - Information Planning Section
  - Information Management Section
  - Database Section
- Laboratory of Intellectual Fundamentals for Environmental Studies
  - Biological Resources and Informatics Section
  - Environmental Analytical Chemistry Section
- Center for Global Environmental Research
  - Research Program Manager
  - GHG Inventory Office
  - GCP Tsukuba Office
  - GOSAT Research Team

Climate Change Research Project



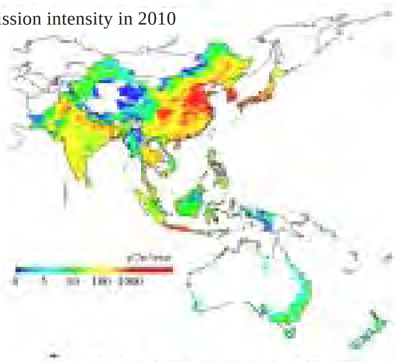
CO_2 emission intensity in 1990



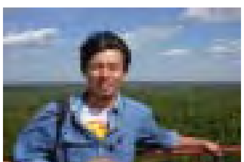


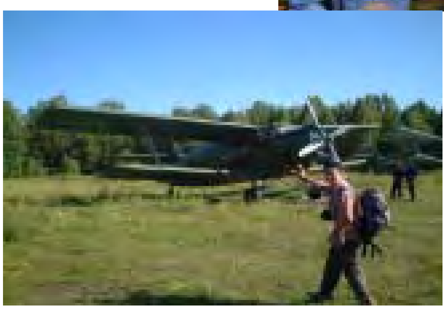
CO_2 emission intensity in 2010

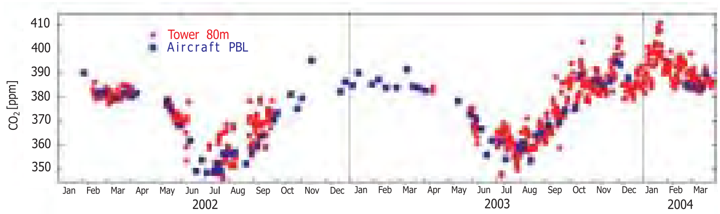
Global warming projections using the CCSR/NIES climate model



CO_2 emission intensity in 2030







Comparison between Aircraft observation (100-500m)
and Tower observation (80m)

Sub-project on carbon cycle research

This sub-project was initiated to determine the patterns and driving forces of the carbon cycle among anthropogenic sources and the pools of atmospheric, biospheric, and oceanic carbon. The two research teams involved in this sub-project are the **Carbon Cycle Research Team** and the **Carbon Sink Assessment Team**. This year we are reporting on ocean carbon sinks, an ecosystem model, and remote sensing of the biosphere.

Inter-annual change in the oceanic sink and sources of carbon dioxide in the Pacific

In the 1980s, the ocean was estimated as a sink for about 2 Gt/y anthropogenic CO_2, and its sink capacity is predicted to gradually increase during the 21st century along with the increasing atmospheric CO_2 concentration. As part of a global environmental monitoring program, we analyzed the inter-annual change in the North Pacific CO_2 sink from a surface pCO_2 data set obtained by CGER. We built a full 6-year dataset of surface ocean parameters, including pCO_2, sea surface temperature (SST), and sea surface salinity (SSS), for Internet access.

Initially, we gave the 6-year climatological surface pCO_2 data as annual means for each 4.5˚ latitude × 4.5˚ longitude grid cell where seasonal observation datasets covered more than 3 years. We mapped the distribution of these areas; they extended from east of Japan into the high latitudes of the North Pacific. We then calculated the annual average pCO_2 for grid cells where seasonal observation data (at least one observation for each season in a year) existed. The difference between the annual average and the climatology can be defined as the anomaly of each year's data. The largest anomaly for a grid cell was 29 μatm—a far smaller value than the seasonal variability in pCO_2 in the oceanic basin. In 1997, the North Pacific ΔpCO_2 (ocean pCO_2 minus atmospheric pCO_2) was lower than the climatology over the basin. In 2000, the Bering Sea ΔpCO_2 was higher than the climatology (Fig. 1). However, the anomaly distribution generally formed a mosaic, in which high and low anomalies had a complicate distribution. In contrast, SST and SSS anomalies had simple, wider distributions.

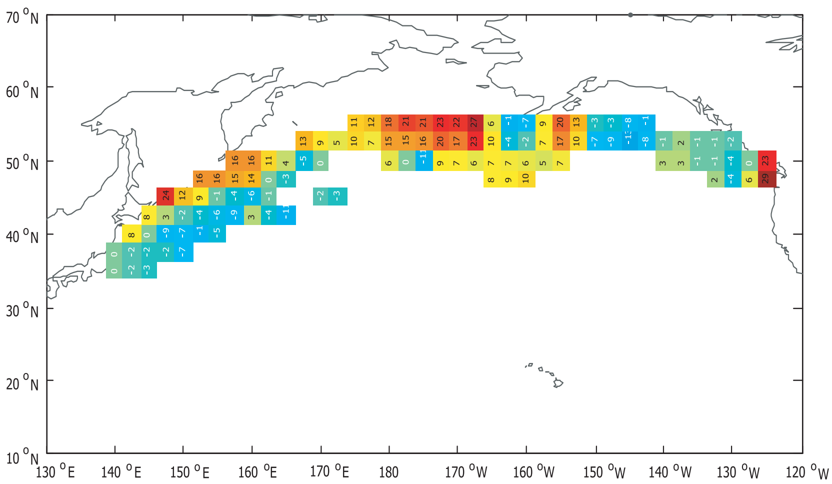


Fig. 1
Observed anomaly in 2000 annual mean pCO_2 from that of 1995-2001 climatology. Red indicates that the annual mean ocean pCO_2 was higher than the climatology and blue, lower. Numbers show pCO_2 anomalies in μatm.

No average inter-annual difference was detected in the western subarctic Pacific basin, and that in the eastern subarctic Pacific was 15 μatm in amplitude (Fig. 2, upper panel). In the Bering Sea, the inter-annual change was more significant. The low ΔpCO_2 in 1997 (Fig. 2, lower panel) corresponded to the relatively high SST in that year, and the high ΔpCO_2 in 2000 was associated with a low SST. A low ΔpCO_2 in a high SST year suggests summer shallowing of the surface mixed layer and enhanced biological productivity. A high ΔpCO_2 in a low SST year suggests extensive winter convection. These changes may be more important in relation to inter-annual variability in a smaller oceanic basin such as the Bering Sea than in the larger Pacific basins.

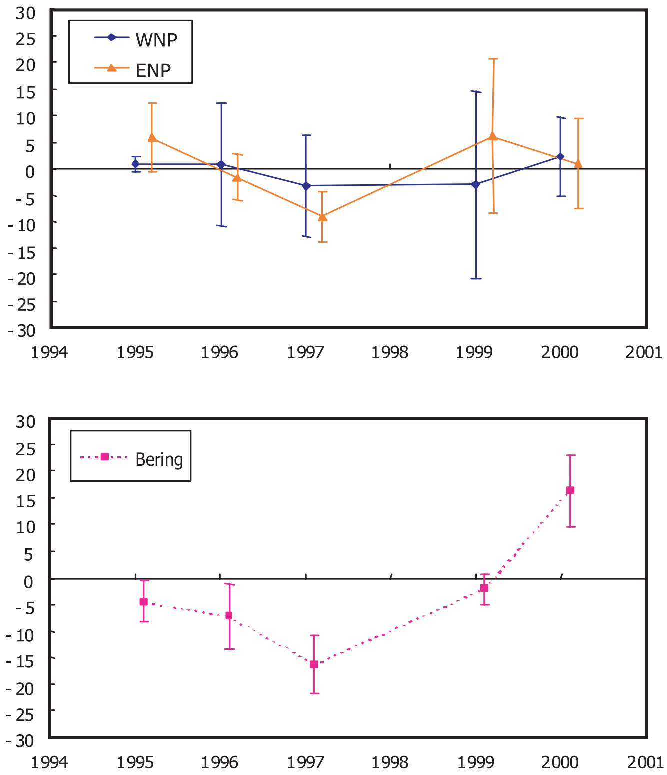


Fig. 2
Inter-annual variability in the annual average ocean surface ΔpCO_2 for the Western North Pacific (WNP), Eastern North Pacific (ENP), and the Bering Sea, analyzed from 1995-2001 observational data. Variations are expressed as differences from climatological annual means of ΔpCO_2 in μatm.

Our observations from 1995 to 2001 included an intensive El Niño event in 1997. However, its effect on the high latitude North Pacific pCO_2 was not apparent. This is completely different from the situation in the Eastern Equatorial Pacific, where the change in the equatorial upwelling in accordance with El Niño revealed a straightforward effect on surface pCO_2.

Ecosystem modeling approach

To improve our methodology of full carbon accounting, we calibrated our model by assimilating data from flux measurements. We used flux tower-based measurements of net CO_2 uptake by biomes on an annual basis for extrapolating and interpolating our ecosystem model in time and space. TsuBiMo (which our team has been developing since 1998) is one of the most suitable models for this purpose. Recalibration of the model with data from the flux site at Takayama, in central Japan, has made it possible to project seasonal and inter-annual changes in the flux from the cool-temperate broadleaf forest zone. Figure 3 shows the relationship between the measured and estimated fluxes: the model is capable of outstandingly close estimates of flux data.

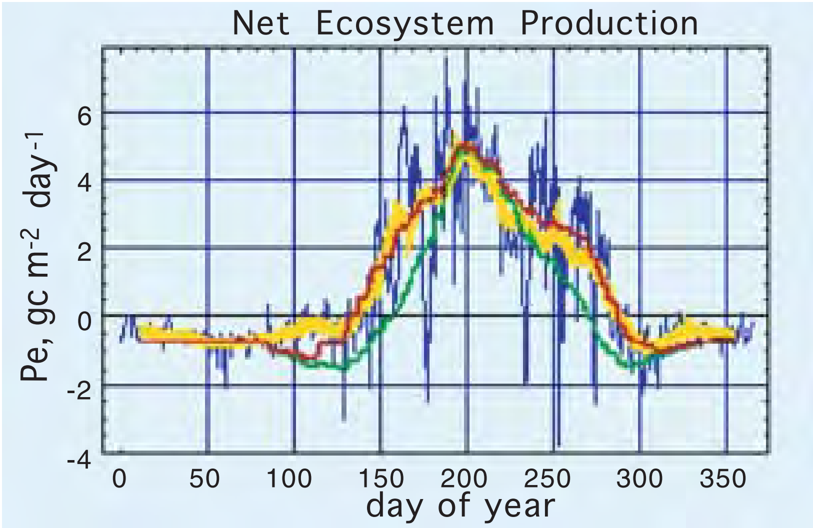


Fig. 3
Seasonal course of net ecosystem production (P_e) observed at the Takayama site (Japan) in 2001. Blue: daily values; yellow: simple 28-term moving average; green: TsuBiMo simulation.

Remote sensing approach

We investigated seasonal variations in the relationship between the daily photochemical reflectance index (PRI) and photosynthetic activity of larch trees to establish a remote-sensing monitoring technique for estimating CO_2 uptake in northern forest ecosystems. PRI was calculated using the canopy reflectance (R) at wavelengths of 531 nm and 570 nm by the following equation: PRI = (R531 - R570)/(R531 + R570).

The results suggest that the diurnal variation in light use efficiency (LUE), which is an important index for estimating the net photosynthetic rate of Japanese larch, can be estimated on the basis of the PRI obtained by remote sensing (Fig. 4). In addition, because the LUE-PRI correlation has been shown to vary depending on the season, we expect to be able to evaluate the annual photosynthetic activity by the PRI model, formulated in consideration of these seasonal variations.

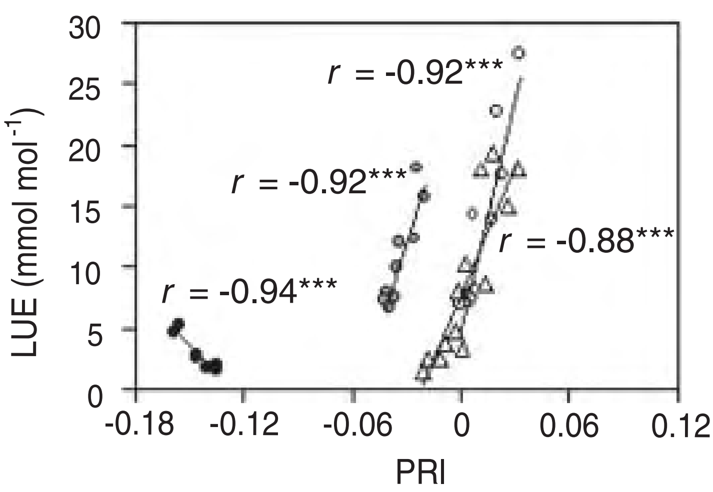


Fig. 4
Correlation between photochemical reflectance index (PRI) and photosynthetic light use efficiency (LUE).

Sub-project on climate change scenarios and comprehensive mitigation strategies based on integrated assessment models

This sub-project resulted from the outcomes of research over the past 10 years at NIES and aims to address new policy needs arising from the Kyoto Protocol, post-Kyoto negotiations, and long-term integration of climate and sustainable development policies. The target of the sub-project is to develop a set of models for integrated assessment of economic growth, climate change, and their impacts. These models will then be used to help estimate the effects of Kyoto and post-Kyoto interventions on global climate change and its regional impacts. The sub-project is also expected to identify the most effective future strategies for integrating sustainable development in Asia and climate change mitigation under alternative paths of future development.

The 3 research teams involved in this sub-project—the Socioeconomic and Emission Modeling Team, the Climate Model Research Team, and the Impact and Adaptation Modeling Team—achieved the following outcomes in FY 2003.

The **Socioeconomic and Emission Modeling Team** used emission models for greenhouse gases (GHGs) and air pollutants for scenario and policy analyses in major Asian countries such as Japan, China, India, Korea, Thailand, Malaysia, and Vietnam. The three Asia-Pacific Integrated Models (AIM/Enduse, AIM/Material and AIM/Top-down) simulate the effects of the carbon tax policy in Japan and they estimate our technological potential to reduce carbon emissions, the carbon tax rate that needs to be applied to achieve a certain result, and the resulting impacts on the national economy and international competitiveness (Fig. 5). The Emission Modeling Team also refined the economic model to estimate the effect of investment on the national recycling system, evaluate the values of ecosystems, set stabilization scenarios (including those for non-CO_2 gases), and analyze the impact of free trade agreements among Asian countries. We also developed the structure of a detailed database for innovative environmental options in selected Asian countries.

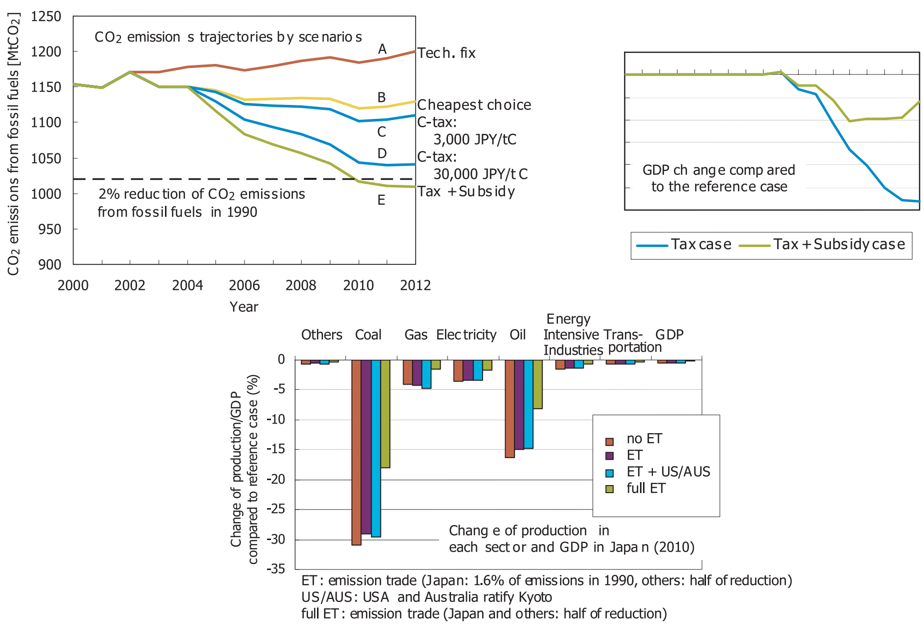


Fig. 5
Projected energy intensities of the steel, cement and paper, and pulp industries in China and India from 2000 to 2030, simulated by AIMs (Asia-Pacific Integrated Models).

The **Climate Modeling Team** introduced the various climatic impacts of natural (solar irradiance and volcanic aerosols in the stratosphere) and anthropogenic (well-mixed greenhouse gases, stratospheric and tropospheric ozone, sulfate and carbonaceous aerosols, and land-use change) forcings in their global climate model. We also prepared datasets of various climate forcings over the last 150 years to simulate historical climate change. Using a country-based historical inventory of fossil fuel combustion, domestic fuel wood consumption, agricultural waste burning, and forest fire, we constructed original datasets of grid emissions of black carbon aerosols (Fig. 6). The Climate Modeling Team is also setting up its coupled ocean-atmosphere global climate model to simulate transient climate change in the 20th and 21st centuries and beyond. The controll climate so far obtained is stable on a multi-century time scale, with no significant climate drift.

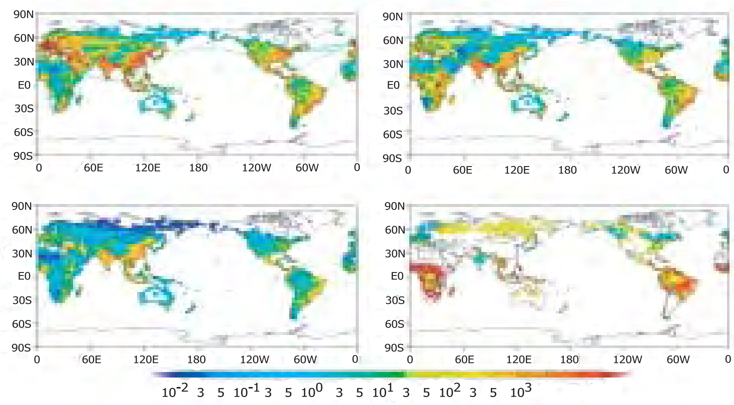


Fig. 6
Anthropogenic black carbon emissions in 2000 from
(a) fossil fuel combustion,
(b) domestic fuel wood consumption,
(c) agricultural waste burning, and
(d) forest fire.

The **Impact and Adaptation Modeling Team** developed a distribution package for impact models, tools, databases, and visualization modules, with an interface that enables these elements to be used in an integrated way. The package will be publicly distributed through the website. We expect that the package will enable researchers in developing countries to assess national-scale impacts independently. The Team also refined its agricultural model and found that future impacts of global warming will cause damage to agriculture, but adaptation will ease such damage (Fig. 7). The risk of crop damage will increase, especially in developing countries, as a result of population growth and rapid industrialization. The problems caused by water stress will be exacerbated by climate change in regions where precipitation is projected to decrease.

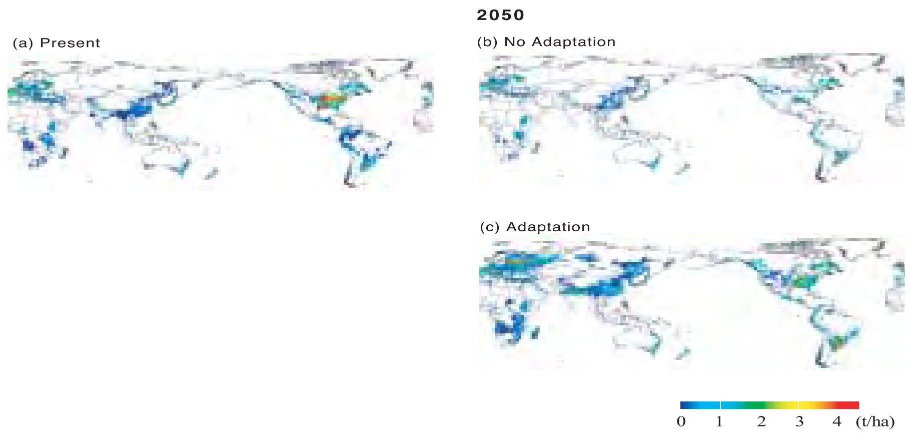
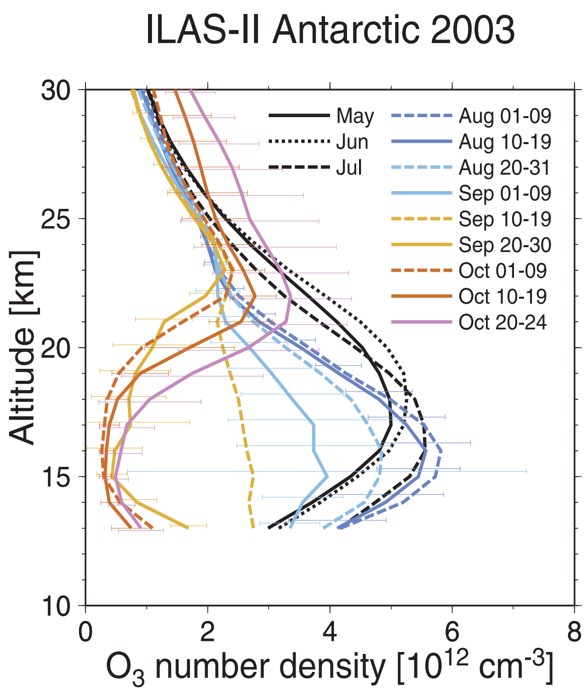
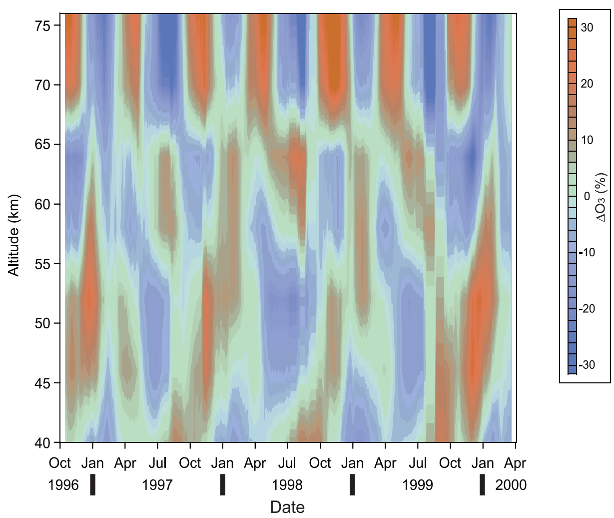


Fig. 7
Global warming impacts on winter wheat production.
(a) Present yield distribution.
(b) Future yield prediction (no adaptation).
(c) Future yield prediction (adaptation: e.g. selection of appropriate varieties, changes in timing of cultivation).

Ozone Layer Research Project



Vertical profiles of mean ozone measured by ILAS-II over the Antarctic.



Seasonal ozone variations over Tsukuba.

Background and Purpose

Specific chlorofluorocarbons, bromofluorocarbons, and other substances have been phased out to counter the problem of ozone depletion in accordance with the Vienna Convention for the Protection of the Ozone Layer, the Montreal Protocol on Substances that Deplete the Ozone Layer, and other relevant international agreements. As a result, the total content of organic chlorine and bromine compounds that are destroying the ozone layer has started to decrease, even in the stratosphere. Nevertheless, the Antarctic ozone hole still appears to be growing larger, even considering its great annual variation, and springtime ozone depletion over the Arctic is increasing. Therefore, it may not be appropriate to predict the scale of ozone depletion by chlorine content alone. Continuous monitoring of stratospheric ozone and species relevant to ozone depletion is required to explore how the ozone layer is changing in response to the decreasing halogen concentration in the stratosphere. We also need to accumulate scientific knowledge on the meteorological conditions and climate of the stratosphere, as well as on the physical and chemical processes that affect the depletion of the ozone layer. Together with the Ministry of the Environment (MOE), we have been monitoring the ozone layer by using a satellite-borne ozone sensor and ground-based remote-sensing equipment, analyzing the data obtained, and conducting research using numerical models.

The stratospheric ozone layer over both poles (high latitude regions) is strongly related to the occurrence of polar stratospheric cloud (PSC) particles and aerosols, as well as to the strength of the polar vortex. Polar ozone is influenced by these ozone-depleting factors through the direct and indirect effects of chlorine and bromine compounds and nitrogen oxides on ozone layer chemistry. To predict future changes in the polar ozone layer, we need to conduct detailed observations to gain an understanding of the detailed chemical and physical processes in the polar regions, including mechanisms of PSC formation. We monitored stratospheric ozone and species relevant to ozone layer destruction in the high-latitude regions by using satellite-borne sensors. The stratospheric ozone layer over the mid-latitudes is also susceptible to changes in transport processes and to *in situ* chemical ozone loss. Accordingly, we have been monitoring, and will continue to monitor, the ozone layer in the mid-latitudes by using ground-based remote-sensing equipment. We have gathered data both within and outside Japan to help monitor and identify mechanisms of change in the ozone layer. The project also conducts data analysis and numerical modeling to accumulate scientific knowledge on the mechanisms of change in the ozone layer, thus contributing to the prediction and validation of future ozone layer changes.

Objectives

The 5 main objectives of this project are: 1) provision of validated Improved Limb Atmospheric Spectrometer (ILAS) data products to the scientific community; 2) acquisition and processing of ILAS-II data; 3) continued ground-based ozone layer monitoring at Tsukuba (NIES) and Rikubetsu (Rikubetsu Integrated Stratospheric Observation Center, Hokkaido) for registration of obtained data in the Network for Detection of Stratospheric Change (NDSC) international database, and provision of the data to organizations both within and outside Japan; 4) identification of the role played in polar ozone layer changes by processes involving physically and chemically important elements, and identification of the mechanisms of these processes; and 5) validation of predicted future ozone layer changes as a basis for formulating measures to protect the ozone layer, and validation of the latest predicted ozone layer changes to provide expert knowledge for evaluating the effectiveness of these protection measures.

Achievements in Fiscal Year 2003

The following work is highlighted.

1. Data Processing and Validation of ILAS-II Observation

ILAS-II was launched aboard the Advanced Earth Observing Satellite (ADEOS)-II in December 2002 and was operational from 2 April 2003 until 24 October 2003, when ADEOS-II stopped functioning owing to solar-paddle failure. During this 7-month operational time, ILAS-II succeeded in making about 5700 solar-occultation measurements in high-latitude regions (54˚N-71˚N and 65˚S-88˚S). Vertical profiles of atmospheric constituents, such as ozone, nitric acid, nitrogen dioxide, methane, nitrous oxide, and water vapor were retrieved from the spectral data using ILAS-II data-processing algorithm (version 1.3). Aerosol extinction coefficients were observed at 780 nm and at wavelengths of four infrared window spectral elements. Temperature and pressure profiles were also observed.

(i) Ozone: ILAS-II version 1.3 ozone data were compared with ozone data measured by ozonesondes. For correlative and coincident ozonesonde measurements with ILAS-II, the time and space criteria used were ±12 h and 500 km. The ILAS-II data agreed with the ozonesonde data at altitudes between 15 and 30 km within ±10% and ±5% relative differences with 10%-30% and 20%-30% root mean square error in the Northern Hemisphere and in the Antarctic, respectively. Data for higher latitudes taken in the Antarctic also showed good agreement between the two.

(ii) Aerosol Extinction Coefficient: ILAS-II aerosol data at 780 nm were validated by comparison with the data from the coincident POAM III, SAGE II, and SAGE III measurements. For background conditions below 25 km, ILAS-II aerosol extinction coefficient data agreed with the SAGE II and SAGE III data (in the Northern Hemisphere) within 10% and with POAM III and SAGE II data (in the Southern Hemisphere) within 20%. After 20 May 2003, ILAS-II observed larger extinction coefficients than the background extinction level; this could be attributed to extinction by PSC. The vertical PSC profiles observed by ILAS-II occasionally showed vertically layered structures similar to those observed by POAM III.

(iii) Nitric Acid: ILAS-II nitric acid data (version 1.4) were compared with data measured by MIPAS-B (a balloon-borne version of the Michelson Interferometer for Passive Atmospheric Sounding), because radiance spectra were observed by MIPAS-B at a location ILAS-II had measured about 5.5 h before MIPAS-B. The agreement between ILAS-II and MIPAS-B was nearly perfect, and no systematic errors were found between 10 and 30 km.

2. Observation of Antarctic Ozone Depletion in 2003 by ILAS-II

ILAS-II observed the stratospheric constituents during the whole period when Antarctic ozone holes were present in 2003. Figure 1 shows the mean vertical profiles of ozone over the Antarctic in 2003, as measured by ILAS-II. Profiles were averaged over 1-monthly periods from May to July, and over 10-day periods from August to October. Ozone concentrations between 13 and 20 km started to decrease in late August 2003. The rate of ozone decrease peaked in September, and ozone between 14 and 18 km was almost totally absent until early October. We considered this to be caused by chemical ozone destruction, followed by the activation of reactive chlorine species owing to heterogeneous reactions on the surfaces of polar stratospheric clouds.

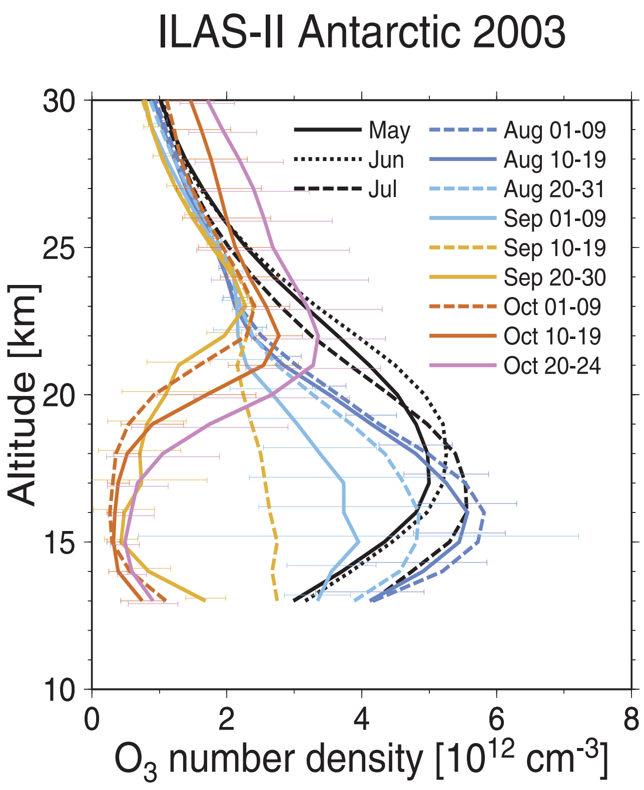


Fig.1
Mean ozone vertical profiles from May to October 2003 over the Antarctic, as measured by ILAS-II. Thick lines represent mean values. Horizontal thin bars represent one-sigma standard deviation. All of the ILAS-II measurements were used to calculate the average.

Significant reductions in the concentrations of nitrogen species, such as HNO_3 and NO_2, were also observed by ILAS-II. Such denitrification was first observed in late May when the stratospheric temperature over the Antarctic dropped below the nitric acid trihydrate saturation temperature, and was almost completed by the end of July, whereas the ozone depletion started in July. We subtracted the effect of dynamics on ozone concentration by using CH_4 and N_2O as tracers, and we determined the mean chemical ozone loss rate to be 0.10 ppmv/day at altitudes between 15 and 20 km (N_2O value of 60±20 ppbv) in September 2003.

3. Measurement of Vertical Ozone Profiles over Tsukuba with Millimeter-Wave Radiometer

Since October 1996 we have made continuous observations of the vertical ozone profiles over Tsukuba with a ground-based millimeter-wave radiometer. Ozone spectra at a frequency of 110.836 GHz are obtained every 5 min with a radiometer equipped with a superconductor-insulator-superconductor (SIS) mixer receiver and an acousto-optical spectrometer (AOS), and vertical profiles of ozone between altitudes of 38 and 76 km are retrieved with a resolution of 14 km. The SIS mixer receiver provides an extremely low-noise temperature of 50 K in single-sideband mode, which enables us to detect weak emissions from the mesospheric ozone. The AOS has a high frequency resolution of 40 kHz, permitting measurement of the narrow-line-width emissions of mesospheric ozone.

Temporal variations in stratospheric and mesospheric ozone were analyzed and are shown in Fig. 2. In these plots, seasonal variations in mesospheric ozone concentration are clearly seen, but the periods, phases, and amplitudes of the variations appear to differ at three altitudes. The most remarkable feature is a semiannual variation at 60 km, a variation whose details are revealed for the first time in the present measurements, as well as a variation at 76 km. The amplitude of the semiannual variation at 60 km was estimated to be 13% of the annual average, which is about half the value of 28% observed at 76 km.

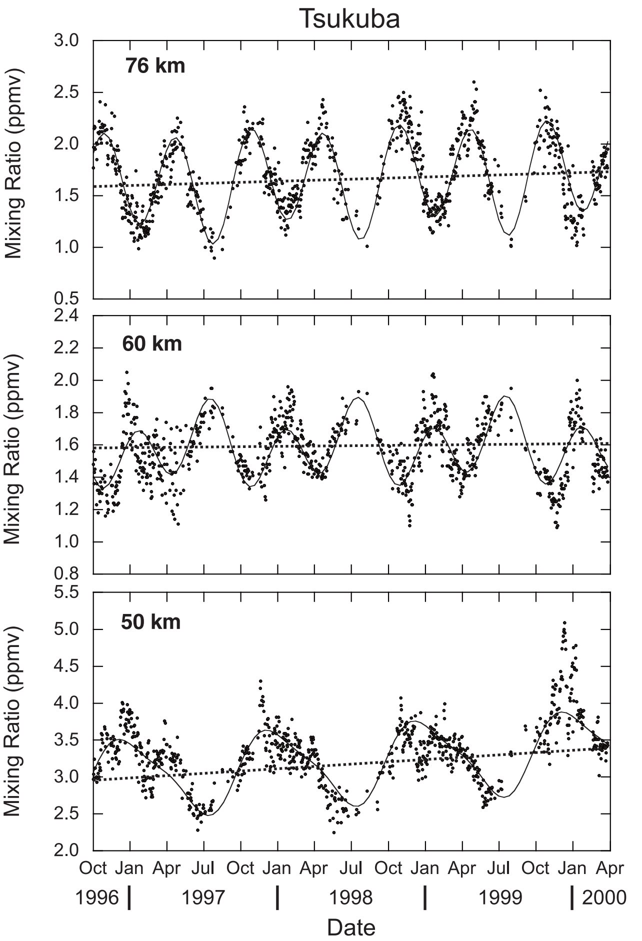


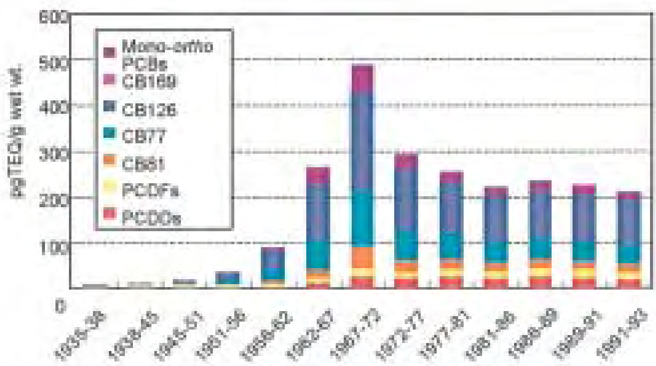
Fig.2
Time series of ozone mixing ratios at 50, 60, and 76 km over Tsukuba from October 1996 to March 2000. Thin lines are the fitted curves for all data at each altitude. Dotted lines are the trend components.

4. Model Simulation of Year-to-Year Ozone Variation over the Subtropical Western Pacific Region

Low ozone values were observed in winter over the subtropical western Pacific, especially for total column ozone, which was unusually low in the winters of 1996-1997, 1998-1999, and 2001-2002. Regression analyses of Earth Probe Total Ozone Mapping Spectrometer ozone data show that dynamic signals, such as quasi-biennial oscillation (QBO), play an important role in determining total ozone variation. We used the CCSR/NIES nudging chemical transport model (CTM) to simulate the year-to-year ozone variation and explain the mechanism for producing ozone lows in a three-dimensional distribution of ozone. The year-to-year variation was well simulated by the model, despite the inclusion or exclusion of heterogeneous chemical processes over the bands from lat 45˚S to lat 45˚N. The year-to-year variation in total ozone was closely related to the position of the ozone minimum, which is largely controlled by the QBO cycle. This suggests that year-to-year ozone variation is controlled mainly by dynamic transport processes.

Endocrine Disrupters and Dioxin Research Project

Great Cormorant
Phalacrocorax carbo



Trend of TEQ in the egg of great cormorant from Tokyo.

Trends in TEQ concentration in the eggs of great cormorants from the Tokyo region.

The work of the Endocrine Disrupters and Dioxins Research Project, which utilizes NIES's new Endocrine Disrupter Research Facility and Specific Research Facility for Dioxins, has covered the following 4 themes: 1) development of methods for measurement and bioassay of these substances; 2) evaluation of the current status of environmental pollution; 3) hazard and effects assessments; and 4) development of countermeasures and integrated information technologies. In FY 2003, we made major advancements in the following areas.

1) **Measurement of chemicals in environmental samples** was improved through the use of GC-NCI-MS and LC-ECD for non-volatile and thermally unstable compounds, and by the use of a GC-HRMS method to measure very low amounts of volatile compounds. We developed an LC-MS-MS method for the analysis of estrogens and their conjugates in sediment and water samples. We applied this improved method to water samples and surface sediments taken from Tokyo Bay to investigate the distribution of estrogens and their conjugates in the environment.

We also improved our ability to detect dioxins and related compounds by fine-tuning of our high-resolution mass spectrometer and by using high-volume injection for gas chromatography; this enabled us to assess human blood samples as small as 10 mL for dioxins and to demonstrate the presence of brominated dioxins and dibenzofurans (Fig. 1).

Residue Level of PBDD in Human Adipose Tissue

	1970 (n=10)		2000 (n=10)		
Compound	Median	Range	Median	Range	p^b
2,3,7,8-TeBDD	1.7	<0.8-4.2	0.51[a]	0.1-2.0[a]	<0.005
1,2,3,7,8-PeBDD	<1.3	<1.3	<1.3	<1.3	
2,3,7,8-TeBDF	3.3	1.6-4.3	2.8	1.7-4.2	>0.2
2,3,4,7,8-PeBDF	0.31[a]	0.28-0.60[a]	0.99	<0.8-1.9	0.07
PBDD/Fs	5.1	3.4-8.3	3.4	1.9-5.3	0.02

Chromatogram of TeBDD in Human Adipose Tissue

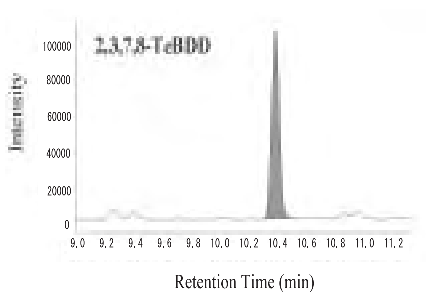


Fig. 1
Brominated dioxins in human adipose tissue.

2) ***In vivo* and *in vitro* bioassays** are important methods of screening chemicals for their endocrine disrupting properties. We developed 7 *in vitro* assays, including yeast two-hybrid reporter-gene assays to assess estrogen, androgen and thyroid hormone activity, as well as an ELISA-based assay for human estrogen receptor (ER) binding and for cell proliferation using neuronal cell lines. We showed that the receptors of different species have different affinities to chemicals: for example, the estrogen receptor-α of medaka fish had higher sensitivity to the alkylphenols tested than did the human estrogen receptor-α or -β. We tested environmental samples and samples of industrial effluent by using a medaka ER system, and we found that many samples showed estrogenic activity by the medaka system but not by the human ER system.

We used *in vivo* assays in medaka to detect vitellogenin synthesis and to examine partial and/or full life cycle tests. The small crustacean *Daphnia magna* is also used in our laboratory as a test animal to investigate the effects of endocrine disrupting chemicals on invertebrates. We found that offspring sex ratio was skewed dramatically toward males by exposure of mature adults to juvenile hormones and their analogues (pesticides) (Fig. 2).

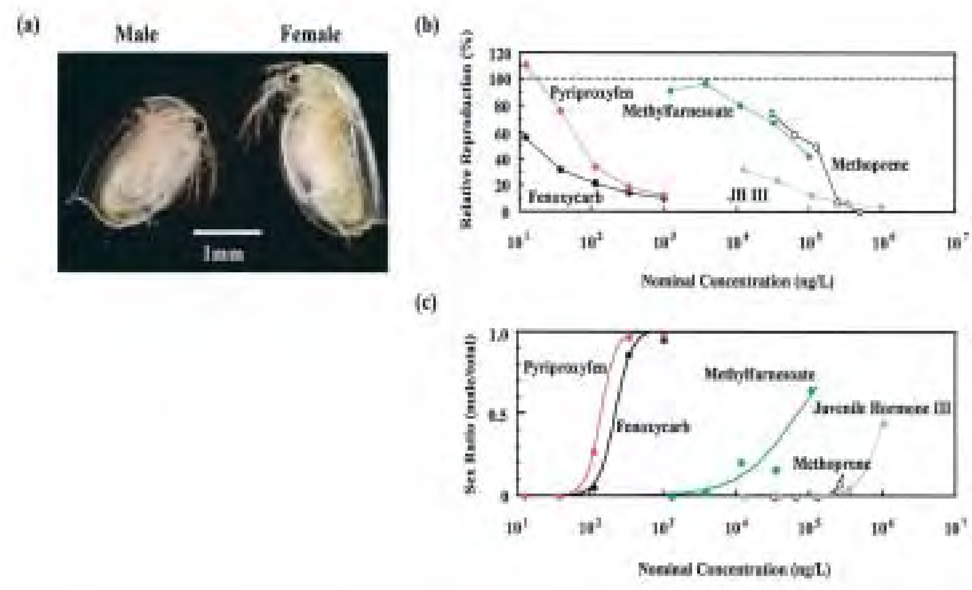


Fig. 2
(a) The small crustacean *Daphnia magna*, used as a test animal to investigate the effects of endocrine disrupting chemicals on invertebrates.
(b) Reduction in reproduction of *D. magna* exposed to juvenile hormones and their analogs.
(c) Changes in sex ratio of offspring of parents exposed to juvenile hormones and their analogs.

We also use *in vivo* testing of a frog (*Xenopus*) and reproduction and developmental toxicity tests in freshwater shrimp, chickens, freshwater mud snails, mice, and rats. The use of both *in vitro* and *in vivo* assays has enabled us to find several new compounds with estrogenic activity.

We use the Japanese quail (*Coturnix japonica*) to standardize our method of assessing the ecological risks of endocrine disrupting chemicals (EDCs) in avian species, in accordance with OECD guidelines.

3) We are also studying the **effects of EDCs on the central nervous system**. A high-field (4.7 T) magnetic resonance imaging spectrometer (MRI) for humans was set up for volunteer studies. We optimized a method of obtaining 3-dimensional anatomical images of the human brain to exhibit maximum contrast between the grey and white matters, and we used this method for routine collection of images of volunteer subjects. Figure 3 shows orthogonal views of the pituitary gland. We also developed a method of observing neuronal metabolites such as *N*-acetylaspartate (NAA), glutamate (Glu), and adenosine-triphosphate (ATP) in a localized area of the human brain in a single measurement. These metabolites could give us clues to neurovascular events in the brain.

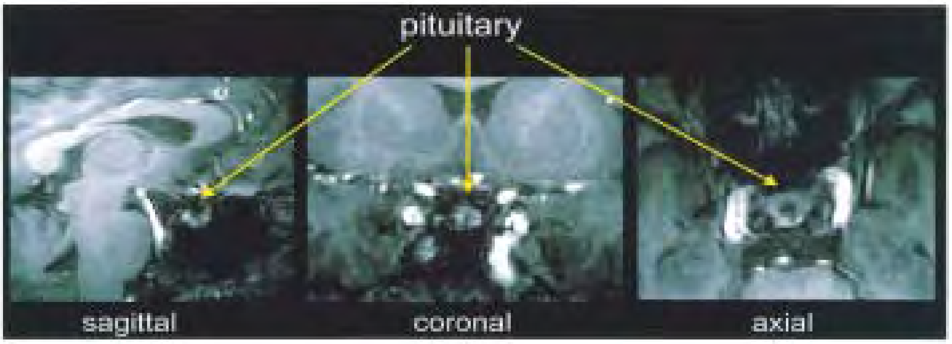


Fig. 3
Orthogonal (sagittal, axial, and coronal) views of the human pituitary gland, obtained by 3-dimensional imaging of the brain at 4.7 T. The very bright parts on both sides of the pituitary in the axial image are the carotid arteries. The surrounding very dark area is the sphenoid sinus. Grey matter appears dark grey, and white matter is a brighter grey.

To assess the effect of EDCs on the nervous system and on behavior, we observed the effects of bisphenol-A (an endocrine disrupter), ethylenethiourea, and other positive controls on experimental animals. Treatment with trimethyltin (TMT) induced reactive astrocytosis in the rat hippocampus, as evidenced by the results of vimentin immunohistochemistry; the effects were profoundly exacerbated by adrenalectomy. Prolonged administration of dexamethasone (a type II glucocorticoid receptor agonist) not only attenuated the exacerbating effects of adrenalectomy but also partly reversed the TMT-induced neuronal loss and reactive astrocytosis. Intracisternal administration of bisphenol-A (20 μg) into 5-day-old Wistar rats caused hyperactivity at 4 or 5 weeks of age, concomitantly with the impairment of mesencephalic tyrosine hydroxylase imunoreactivity.

We used transthyretin (TTR)-null mice to investigate the mechanisms involved in the thyroid-hormone- and retinoid-disrupting effects of 2 coplanar PCBs (PCB114 and PCB118) and a non-coplanar PCB (PCB153). Our results suggested that PCB114 exerts its thyroid-hormone- and retinoid-disrupting effects mainly via Ah receptor (AhR)-dependent mechanisms, whereas PCB118 could exert its effects via AhR-independent, and possibly TTR-dependent, mechanisms. It was suggested that PCB153 exerts its effects on thyroid hormones and retinoids via unknown AhR-independent and TTR-independent mechanisms.

In a search for a useful biomarker of dioxin exposure, we analyzed the expression of CYP1A1 mRNA in the cells of breast milk collected from mothers within 1 week of childbearing. Milk cells expressed CYP1A1 mRNA at much higher levels than those found in peripheral lymphocytes. Levels of CYP1A1 mRNA in milk cells were correlated with dioxin levels among non-smoking mothers, indicating that milk cells could be useful biomarkers of dioxin exposure.

4) To determine the **effects of EDCs on wildlife**, we observed sea snails and bivalves along the Japanese coast. To clarify the mode of action of organotin compounds such as tributyltin (TBT) and triphenyltin (TPT) on the development of imposex, we studied the basic biology of these gastropods. Four hypotheses have thus far been

presented on the mechanism of induction of gastropod imposex (Fig. 4), but the actual physiological or biochemical mechanism remains unclear. Interestingly, we discovered that the retinoid X receptor (RXR) plays an important role in inducing or promoting the development of imposex in gastropods, and we presented the RXR involvement hypothesis.

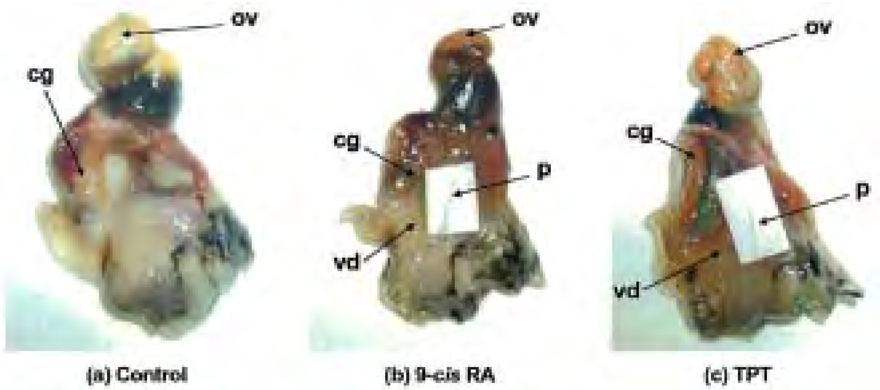


Fig. 4
Substantial penis growth observed in female rock shells after a month of 9-*cis* retinoic acid **(RA)** injections. cg: capsule gland, ov: ovary, p: penis, vd: vas deferens
(a) Neither penis nor vas deferens is apparent in the control female (after shell removal).
(b) Substantial penis growth as well as vas deferens development is observed in this female, which received 9-*cis* RA injections (after shell removal; penis length: 6.06 mm).
(c) Substantial penis growth as well as vas deferens development are also apparent in this positive control female, which received TPT injection (after shell removal; penis length: 6.50 mm). Imposex symptoms, as indicated by penis length and vas deferens sequence (VDS) index, were clearly promoted in females that received 9-*cis* RA injections, as in females receiving TPT injections.

The results of field studies (from January 1998 to March 1999) of endocrine disruption in giant abalone, *Haliotis madaka*, from an organotin-contaminated site (Site B) showed that disturbed reproductive cycles as well as ovarian spermatogenesis (19%) were still being observed in abalone from Site B, compared with the period from 1995 to 1997, whereas neither of these disorders occurred in the giant abalone from a reference site (Site A). Tissue concentrations of organotins were still higher in abalone specimens from Site B than in those from Site A. We investigated the contribution of organotin-induced endocrine disruption in abalone to population decline on the basis of a reproduction test using the parent abalone from Site B, 48-h tests of exposure of fertilized eggs and larvae of abalone to TBT and TPT; and a scuba survey of the distribution of juvenile abalone at Site B.

An extensive field study to search for endocrine disruption in marine fish has been carried out in Tokyo Bay since October 2002.

We also examined fish and freshwater snails in Lake Kasumigaura, and we sampled seabirds for thyroid dysfunction.

5) To **reduce the emission of dioxins and prevent secondary emission to the environment**, we studied a method of monitoring and decomposing dioxins. We have developed a simple sampling method that uses a special adsorbent filter for flue gas from municipal waste incinerators, and we are looking at applying the filter to real-time monitoring. Further, a fungal strain isolated from the soil that was able to utilize many kinds of cyclic ethers such as 1,4-dioxane as its sole source of carbon was identified from its 18S rDNA sequence as *Cordyceps sinensis*. Highly chlorinated

dioxins were successfully degraded by a 1,4-dioxane-degrading microorganism. We also studied the biological decomposition of EDCs, especially bis(2-ethylhexyl) phthalate (DEHP), in polyvinyl chloride by a soil bacterium isolated from the gardens at our institute. The bacterial strain was identified from a database as *Mycobacterium* sp. from its 16S rDNA sequencing homology. The primary degradation products of DEHP were 2-ethylhexanol and phthalic acid, suggesting that the biological reaction occurring might be hydrolysis. In another study we successfully used plants to biologically inactivate EDCs.

6) We developed **integrated risk assessment and management of endocrine disrupting chemicals and other contaminants** by comprehensive integration of information and methodologies into an assessment scheme. This formed a framework for a “Virtual World” geographic information system (GIS) (Fig. 5).

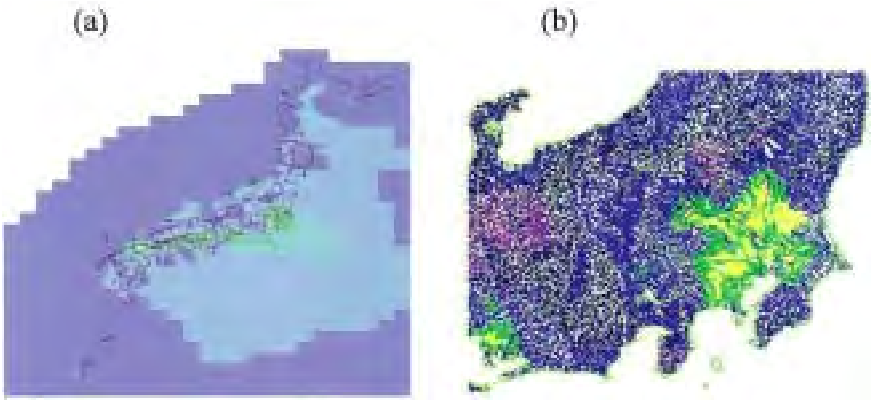


Fig. 5
Multimedia calculation of dioxin concentrations by the grid-catchment integrated modeling system (G-CIEMS).
(a) Atmosphere
(b) Rivers

The FY 2003 study continued our efforts from FY 2002, including the development of an environmental-fate modeling methodology, system and databases; development of emission inventory modeling methodologies; and statistical and geographic analysis of monitoring data. We developed a grid-catchment integrated modeling system (G-CIEMS)—a multimedia fate model for geo-referenced and spatially resolved fate simulation on a GIS system—for the entire Japanese land environment and the surrounding ocean. Comparative case studies of the G-CIEMS model output, generic multimedia model output, and monitoring-based output were performed for dioxins and several VOCs. The G-CIEMS model can predict averaged environmental concentrations to within a factor of 2 or 3, a result that is a great improvement on existing generic multimedia fate-modeling techniques. Although the G-CIEMS model and generic multimedia model give comparable outputs, the G-CIEMS model can provide distribution information in addition to the point information provided by generic models.

We also prepared a database of EDCs; it is available through the web.

Biodiversity Conservation Research Project

River-dwelling dragonflies require running water and riverside vegetation as part of their habitat.

The recent rapid expansion of human activity worldwide has resulted in continuing degradation of wildlife habitats and loss of biological diversity. In addition, ecological disruption by the incursion of invasive species and the production and release of genetically modified organisms has become a new problem. In the Biodiversity Conservation Research Project, which is composed of the 5 research teams described below, we are developing methodologies to assess changes in biodiversity on a variety of spatial scales, and are researching the ecological disruption caused by invasive species and genetically modified organisms.

Wildlife Population Research Team

As the need to prevent the extinction of wild species is increasing, the Wildlife Population Research Team has been researching the mechanisms of population colonization and extinction, which comprise the process of species persistence. In this fiscal year, we developed microsatellite DNA markers of the topmouth gudgeon *Pseudorasbora parva* to monitor the viability of wild populations of this fish in several habitat ponds. Furthermore, we promoted analysis of habitat suitability for bird species in landscapes. GIS was used to survey the distribution of the great reed warbler along the main channel of the Arakawa River in the breeding season and to determine the factors determining the bird's distribution. The warbler was scarce up to 20 km upstream from the river mouth, because reed beds were scarce in this area. It was abundant between 45 to 70 km upstream from the river mouth, where reed beds were distributed in many oxbow ponds and abandoned rice paddies. The upstream limit was 100 km from the river mouth, in the area of the town of Yorii, where the reed species began to change. A logistic regression analysis revealed that the warbler preferred large and clumped reed beds situated at altitudes lower than 50 m above sea level. This altitudinal limitation of habitat suitability also holds for the area around Lake Kasumigaura where the preceding research was made, suggesting that altitude is a common limiting factor of the warbler's habitat.

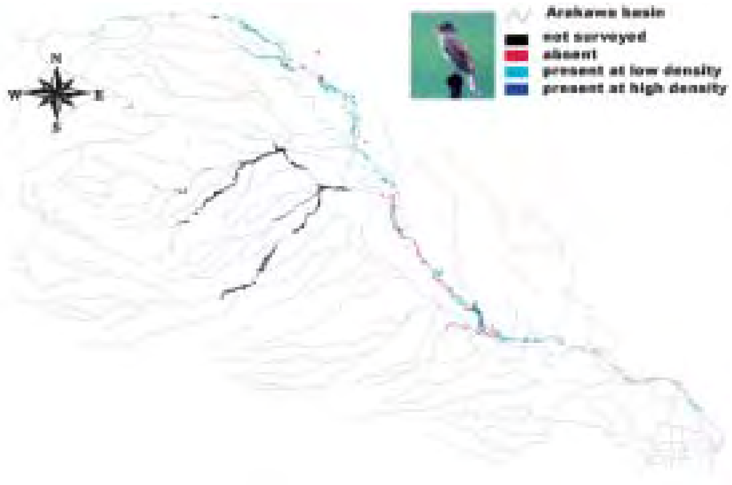


Fig. 1
Distribution of reed beds and occurrence of the great reed warbler in the Arakawa River basin.

Biological Invasion Research Team

Biological invasion is a serious cause of decreasing biodiversity. We investigated the ecological impact caused by the commercial stag beetle industry. In recent years, breeding of stag beetles has boomed in Japan, and many native and exotic species are now in circulation throughout Japan as pets.

Many ecologists fear that this boom will threaten the biodiversity of stag beetles in Japan. Stag beetle commercialization could have serious ecological impacts, including overhunting of natural populations, competition between native and exotic species, genetic disturbance as a consequence of hybridization between native and exotic species, and alien parasite invasion. In this study we focused on genetic disturbance and parasite invasion.

We investigated the status of hybridization between native and introduced species by using genetic markers at various sites in Japan. To assess the hybridization risk, we performed crossing experiments between introduced and native species. We also checked for parasite infestation in introduced individuals, using molecular genetic markers.

The phylogenetic analysis and crossing experiments indicated that there was little reproductive isolation between genetically and geographically far-isolated strains. The Indonesian and Japanese *Dorcus titanus* strains, considered to have been isolated from each other for 5 million years, could copulate and produce many offspring (Fig. 2), as could their F2 hybrids. In contrast, crosses between genetically and geographically closer strains revealed a high degree of reproductive isolation (Fig. 3). This suggests that genetic and geographic distance between species is not always correlated with the degree of reproductive isolation; this would be a complicated aspect of any genetic problems that might be caused by invasive alien species. In fact, we found hybrid individuals in the field, suggesting that genetic introgression has already occurred.

Many parasitic mites were detected in stag beetles from southeast Asia. Molecular genetic analysis suggested a close co-evolutionary relationship between stag beetles and mites. Disruption of this relationship caused by artificial transportation may have unexpected ecological impacts.

Fig. 2
An adult male F1 hybrid from a cross between an Indonesian female stag beetle, *Dorcus titanus titanus*, and a Japanese male Hirata stage beetle, *D. titanus castanicolor*. At 85 mm its body is much larger than that of its father (50 mm).

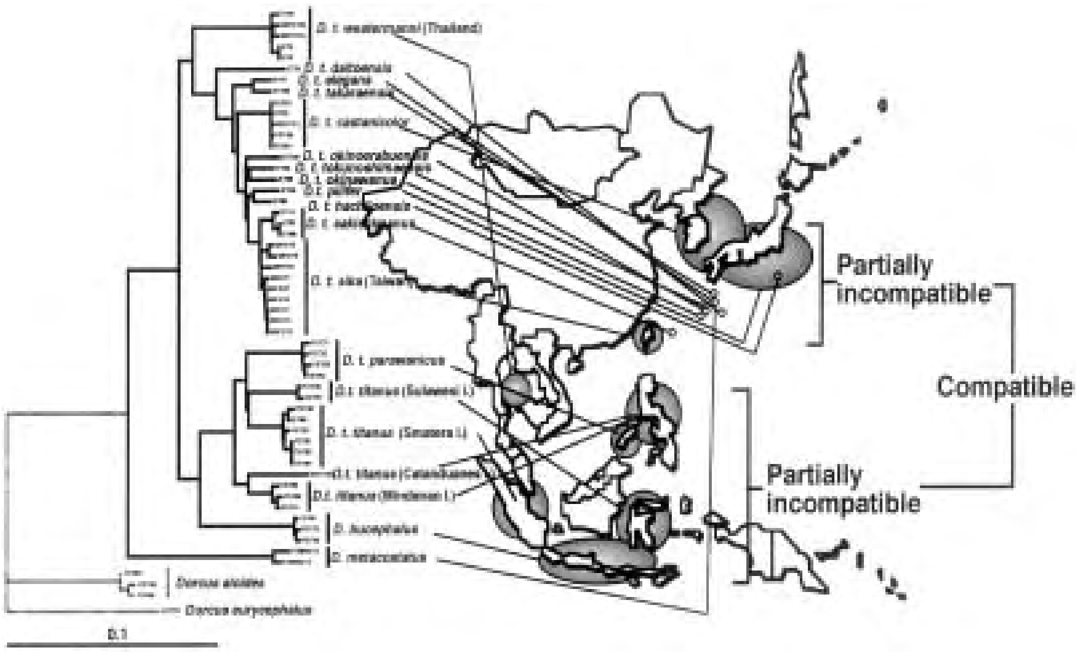


Fig. 3
Phylogenetic tree of the Hirata stag beetle *Dorcus titanus* species group, and the genetic compatibility between strains.

Ecological Landscape Research Team

Dams pose serious threats to aquatic organisms and biodiversity by fragmenting streams and rivers into small habitats and acting as barriers to passage between these habitats. We assessed the effects of damming on the three metrics of freshwater fish assemblage structure—fish abundance, diversity, and distribution—in Hokkaido, Japan. A series of regression models were fitted to fish abundance data collected at 125 sites in southern Hokkaido, and to both species richness and individual fish occurrence data collected over the last 50 years during 6674 fish surveys conducted throughout Hokkaido.

The abundance of four of the eight dominant diadromous fishes sampled in Hidaka, southern Hokkaido, was significantly and negatively affected by damming. Of these four fish, two relatively large salmonids were affected only by dams without fishways, whereas the other two species, which were smaller, were affected regardless of fishway existence, suggesting the limited efficacy of fishways as mitigation devices. Throughout Hokkaido, fish species richness was also significantly influenced by damming after the effects of altitude, sampling year, and other environmental factors were accounted for by the models. The predicted loss of species richness due to damming increased with decreasing elevation, reaching a maximum loss of nine species at river mouths. Areas throughout Hokkaido where fish species richness had potentially decreased were predicted and mapped (Fig. 4); the loss of species richness was predicted to be on average 12.9%. Of 43 fish species individually examined in this study, 26 were found to be influenced by damming, and 10 of these were directly and negatively affected. This study provides a comprehensive look at the effects of damming on freshwater fish, through the examination of numerous species with various life histories on a large spatial scale, covering an area of approximately 78 500 km^2.

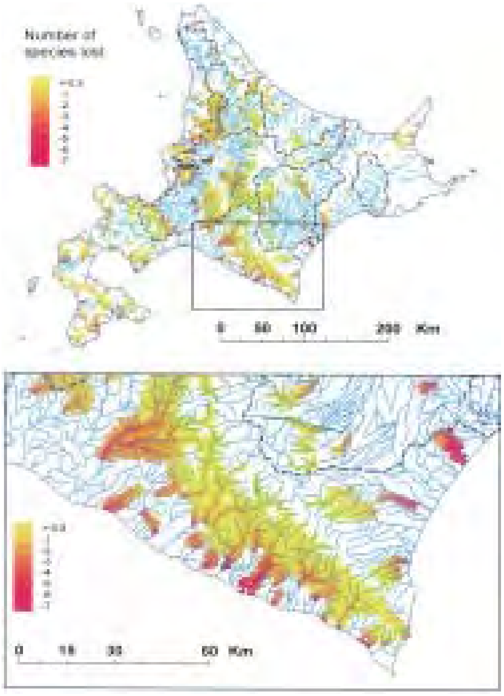


Fig. 4
Predicted loss of fish species richness in Hokkaido. The loss is defined as the difference between the predictions by the regression model taking into account the actual damming status and that with the hypothetical status of no dams. The inset magnifies the Hidaka region of Hokkaido.

Community Dynamics Research Team

Numerous hypotheses on the mechanisms of tree species' coexistence within a forest have been proposed. One of them is the temporal fluctuation of reproduction; that is, the concept that species coexistence of sessile organisms competing for space is promoted if each organism produces offspring more than once in its life, and this reproduction is synchronous within each species but asynchronous among species. A minority species may recover its population size when it produces offspring and the other species may not. In 2002, we demonstrated the validity of this hypothesis as a mechanism for promoting species coexistence in a forest by using a spatially explicit, tree-based simulation model of forest dynamics. In 2003, we studied how tree species with different competitive abilities coexist under fluctuating reproduction. We found that: 1) species that produce more seeds and have a longer seed dispersal distance and less temporal variation of reproduction are more competitive; 2) less competitive species can coexist with more competitive ones when reproduction varies temporally; and 3) less competitive species are consistently less abundant.

We conducted a simulation study on the dynamics of species diversity within an ecosystem, taking into account the evolution of species. The development of the structure of a food web within the system was also considered. In this food web model, each species had a specific feeding preference. When we assumed that a predator species should have a larger body size than its prey, the body size of species increased rapidly, especially when there was intra-clade predation (predation among species that had evolved from a common ancestor). High species diversity was developed within such clades. When intra-clade predation was not allowed, evolution toward large body size was not observed. This suggests that intra-clade predation is one of the key factors in body size evolution and diversification of a clade.

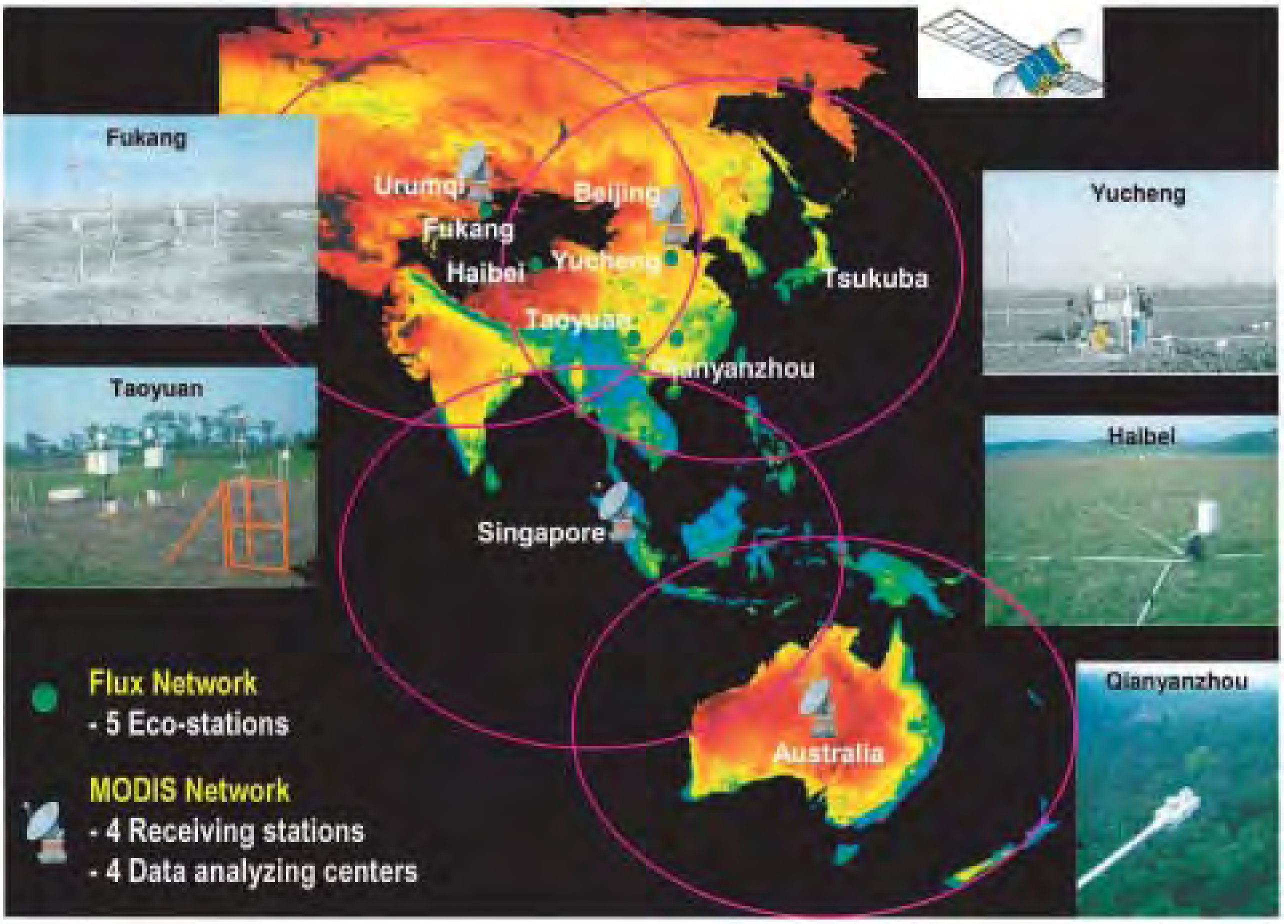
Biotechnology Risk Assessment Team

Genetically modified or "transgenic" organisms have been generated and utilized for a variety of purposes, and there is public concern over their potential effects on the natural environment. A satisfactory method of evaluating and monitoring these effects needs to be established. For this purpose, we modified a gene-encoded Green Fluorescent Protein (GFP) under the control of the cauliflower mosaic virus 35S promoter to visualize the movement of the transgene (Fig. 5). Transgenic *Arabidopsis* plants expressing GFP (*AtGFP*) that exhibited fluorescence were easily distinguished from wild-type plants. The phenotype was inherited by the F1 hybrid and behaved as a dominant trait. The crossing rate between the wild type and *AtGFP* was 0.24% when plants were propagated in a growth chamber.

In another study, to monitor the fate of genetically engineered microorganisms introduced into the environment, we developed a method based on real-time PCR for the specific and rapid enumeration of the trichloroethylene-degrading bacterium, *Methylocystis* sp. M, in groundwater. Real-time PCR reliably quantified this strain over at least 5 orders of magnitude. Five cells or fewer were detectable when the cells were suspended in distilled water. This quantification procedure was completed within 3 h, including the preparation time of the environmental sample.

Fig. 5
Wild-type (left) and *AtGFP* (right) *Arabidopsis*. The *AtGFP* plant exhibits yellow fluorescence under blue-light irradiation. The wild-type plant described the nature of self-fluorescence generated from chloroplasts, resulting in the *AtGFP* plant, which is easily distinguishable from the wild type.

Watershed Environments and Management Research Project



Integrated monitoring system under the collaborations with NIES in Japan, the IGSNRR in China, NUS in Singapore and CSIRO in Australia

Objectives

Environmental conditions are deteriorating in the Asia-Pacific region, home to about 60% of the world's population and currently experiencing rapid population and economic growth. The fact that many countries in the region are at different stages of economic development creates a complex set of problems that seriously constrain balanced and sustainable economic development. Examples are the health impacts of industrial pollution, degradation of natural resources through industrial development, increased pollution associated with greater use of motor vehicles and the concentration of populations in cities, and increased greenhouse gas emissions. In the context of the major economic growth in Asia in the twenty-first century, we must give thought to sustainable methods of managing the environment that take into account the ecosystem functions that govern the cycle of nature. Our research has focused on the circulation of water and materials in East Asia; we are working to scientifically observe and understand the ecosystem functions of major river basins in China, the heart of the region. In addition to developing methods to forecast the degradation and recovery of ecosystem functions through models that manage the river basin environment on the basis of ecosystem function, we will propose sustainable environmental management plans that cover the application of environmental recovery technologies, the re-evaluation of development plans, and the reduction of environmental loadings.

Integrated monitoring of environmental degradation in the Asia-Pacific Region

If we are to take effective countermeasures against environmental depletion and degradation we will need to examine the present environmental conditions and changes in natural resources. As one step toward solving these problems, an Integrated Environmental Monitoring (IEM) network system, consisting of 4 Terra-MODIS satellite data receiving stations and 5 ground-monitoring stations, was developed by the National Institute for Environmental Studies (NIES) in Japan and the Institute for Geographical Sciences and Natural Resources Research (IGSNRR) of the Chinese Academy of Science, the National University of Singapore (NUS), and the Commonwealth Scientific & Industrial Research Organization (CSIRO) in Australia. Although numerous satellite-derived indices in the Asia-Pacific region have already been produced by other projects and organizations, most have yet to be calibrated or validated by ground-truth data and they might contain significant uncertainties. We have established 5 validation sites in a variety of ecosystems in China (grassland, crop land, paddy field, forest, and semi-arid area) at which ground-truth data—including information related to radiation, meteorology, soil, and vegetation—are continuously measured. Using these consistent and quality-assured datasets, we can produce accurate and reliable information specific to the region. Figure 1 shows a comparison between LAI (Leaf Area Index) produced by IEM and that done by NASA in 2002. LAI produced by NASA was poorly correlated with the field observations. One of the reasons is that misclassification of land cover leads to errors in NASA products.

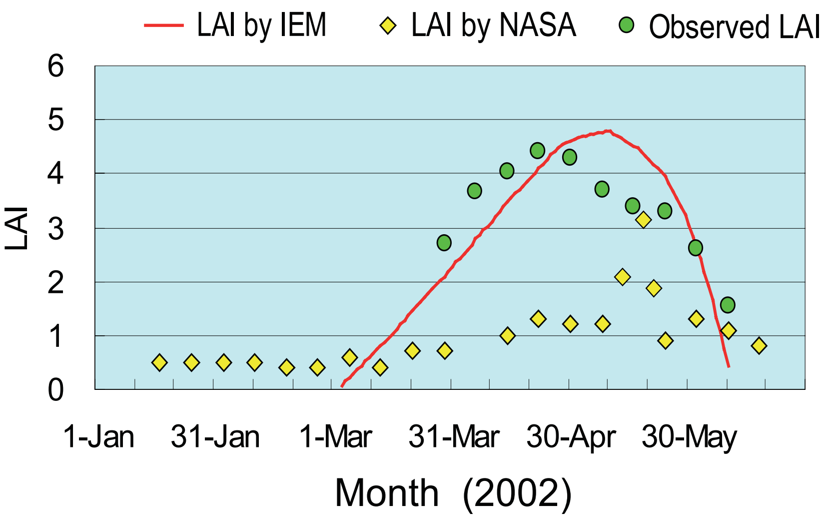


Fig. 1
Comparison between LAI produced by IEM and that done by NASA in 2002. (One of the reasons is that misclassification of land cover leads to errors in NASA products.

Our data can help create scenarios for realizing sustainable development. As some of the most important drivers of both ecological change and economic development, changes in land use and land cover have been monitored dynamically by our network system. Figure 2 shows land-use changes from 1990 to 2000 in China. The areas occupied by cropland, towns, rural residences, and water bodies increased in both eastern and western China; the area of farmland increased more in western China than in eastern China. Areas of woodland and forest decreased in both eastern and western China; the extent of decrease was higher in the east.

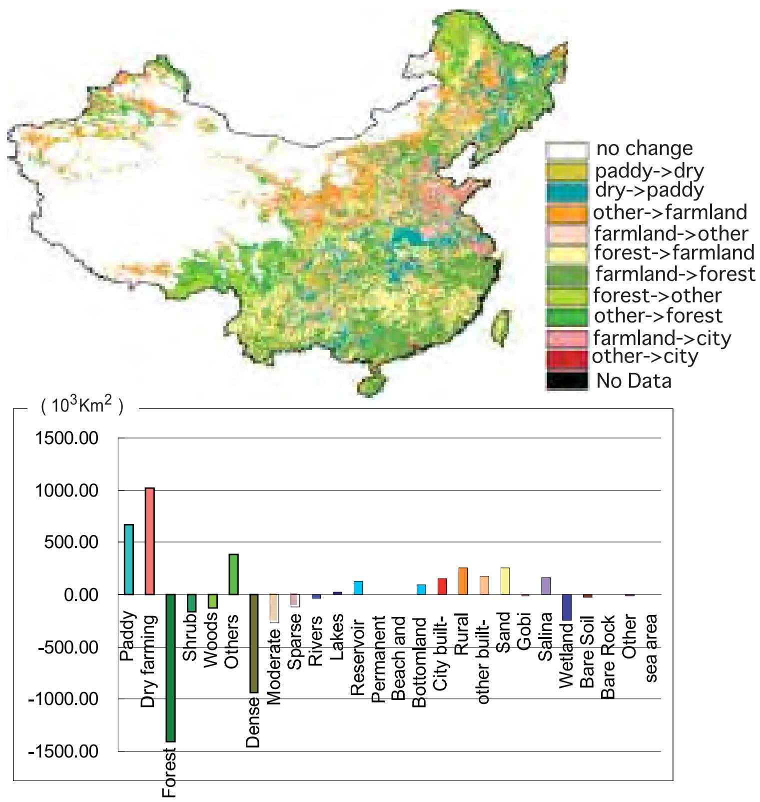


Fig. 2
Land-use changes from 1990 to 2000 in China.

Sediment routing model of upstream Changjiang River basin

The Three Gorges Dam will create a 600-km-long lake, into which 5 ×10^8 tons of sediment will flow each year. In 1987, the upper Changjiang (Yangtze River) tributaries delivered about 5.8 × 10^8 tons of sediment downstream, and the Three Gorges reach added 2.7 × 10^8 tons, totaling about 8.5 × 10^8 tons at the Yichang hydro-station. Approximately 20% of the sediment load came from the Jialingjiang watershed, one of the biggest sediment sources in the upper Changjiang River. The Jialingjiang, at 1120 km long and with a watershed area of 160 000 km^2, joins the main river at Chongqing, 600 km upstream of the Three Gorges Dam. For this reason, an understanding of the sediment runoff throughout the Jialingjiang watershed is indispensable to effective management of the sedimentation problems and water environment in the Three Gorges Dam reservoir.

To simulate the sediment runoff in the Jialingjiang watershed in 1987, we applied our proposed sediment-routing model to the watershed. The model consists of the following sub-systems: (1) model of rainfall runoff from watershed slopes; (2) model of sediment yield from watershed slopes due to rainfall runoff; (3) model of sediment erosion along the riverbank due to river flow; (4) model of flood-routing in the river network; (5) model of transport of bed material loads and wash load; and (6) bed-elevation variation model. We attempted to improve the sediment-routing model by adding the two effects of spatial distribution of sediment diameter and down-scaling of daily rainfall intensity.

We performed a simulation of sediment-routing in the Jialingjiang watershed in 1987, and compared the calculated sediment discharge with the observed one at Beibei, where the Jialingjiang enters the Changjiang River, and just upstream of Chongqin. Figure 3 compares the simulated sediment discharge and the observed one; the close agreement of the two demonstrated the applicability of our model.

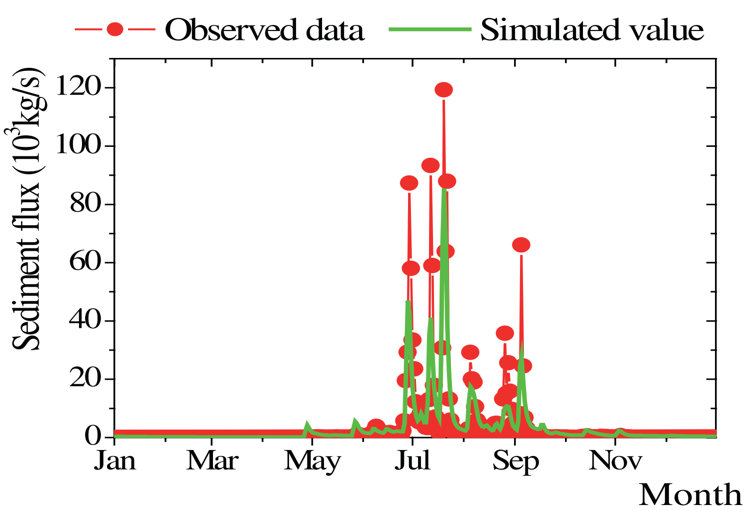


Fig. 3
Comparison between simulated sediment flux and observed flux.

Understanding the marine environment of the East China Sea

The East China Sea has high levels of primary production and biodiversity. The Changjiang River basin supplies this Sea with vast amounts of sediment, nutrients, and chemicals, and occurrences of red tides in the East China Sea increased about 4-fold between the 1980s and the 1990s. Over this time the type of plankton causing these red tides has changed from diatoms to dinoflagellates. One of the causes of this change is that the supply of silicates is low in these nutrient-rich environments. The Three Gorges Dam will further decrease the supply of silicate. Diatoms in the form of zooplankton generally play an important role as energy sources for fish. For this reason, any change in the dominant phytoplankton species will have a great influence on marine primary production. In light of this threat we have been conducting a field survey of the East China Sea and the mouth of the Changjiang River since 2001 (Fig. 4).

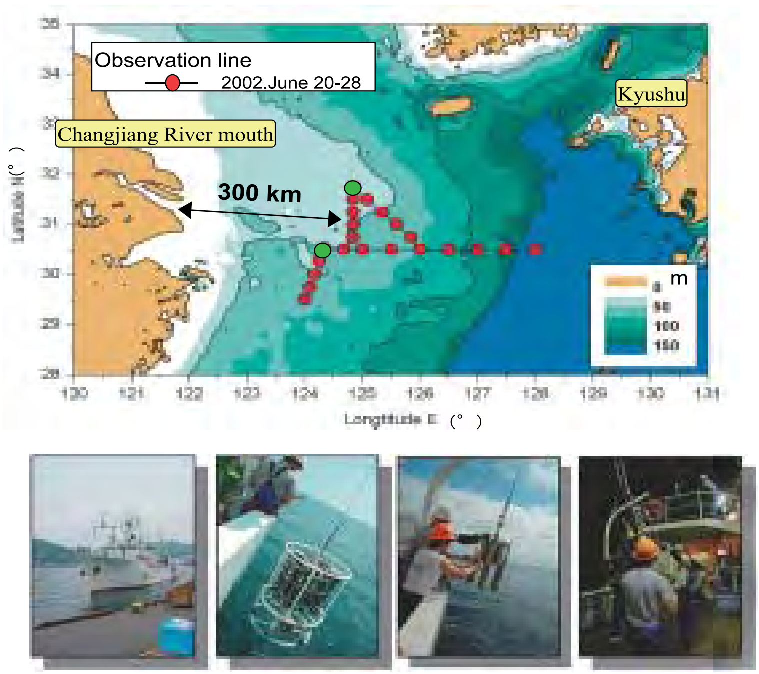


Fig. 4
Field survey in the East China Sea.

Conservation of the coastal environment

The ecological functions of the coastal environment have become cause for social concern, because shallow coastal areas of Japan have been reclaimed to make new land without appropriate consideration of coastal ecosystems. However, there are few scientific methods available for evaluating the importance and vulnerability of such ecosystems. As part of our research project on management of the watershed environment of Tokyo Bay, we have been conducting field surveys and model calculations. One of our objectives is to provide a scientific basis for evaluating the impact and effectiveness of the environmental recovery technologies currently in use, by exploring the relationship between aquatic ecosystems (important components of coastal ecosystems) and benthic ecosystems; the circulation of substances in benthic ecosystems; the biology of representative organisms; and population dynamics. To analyze the impact and effectiveness of recovery efforts we have been monitoring water quality and benthos survival on a constructed tidal flat in Tokyo Bay.

Another objective is to evaluate the effect of the pollutant load originating in the Tokyo Bay catchment on the coastal aquatic ecosystem and fishery resources. We are developing methods to estimate the pollutant load from the catchment. The methods include a model for compiling a water-pollutant load-production inventory, which is a reflection of social and economic activities in the catchment, and a numerical simulation model for estimating the pollutant load from the whole catchment. Two kinds of distributed hydrologic models are being tested as candidates for the simulation model: one is a pollutant load model that considers the runoff process from each of a number of land-use types in the upper and middle regions of the Tokyo Bay catchment, and the other is a model to estimate the pollutant load caused by combined sewer overflow. In the latter model, we are applying a Horton-Strahler stream-order concept to the original complicated sewer network system to simplify the sewer network system in the lower region of the catchment, which services the metropolitan area. By integrating these models we can simulate the daily inflow volumes of pollutants to Tokyo Bay during rain events.

To evaluate the effect of pollutant load on the Tokyo Bay environment, we conducted a field survey on 3 and 4 October 2002, just after heavy rain from a typhoon passing over the bay (Fig. 5). We found a stream of fresh water on the surface of Tokyo Bay, from the mouth of the Arakawa River (one of main rivers flowing into the bay) out to sea. The fresh water conveyed large amounts of nutrients from the land to the bay during the flood, including untreated sewage that had overflowed into stormwater drains. The total nutrient load flowing into Tokyo Bay is the target of government regulations to control the bay’s water quality. This load has been estimated in the past from the nutrient concentrations observed on calm days, but our data show that estimates should include nutrient loads observed during periods of flood.

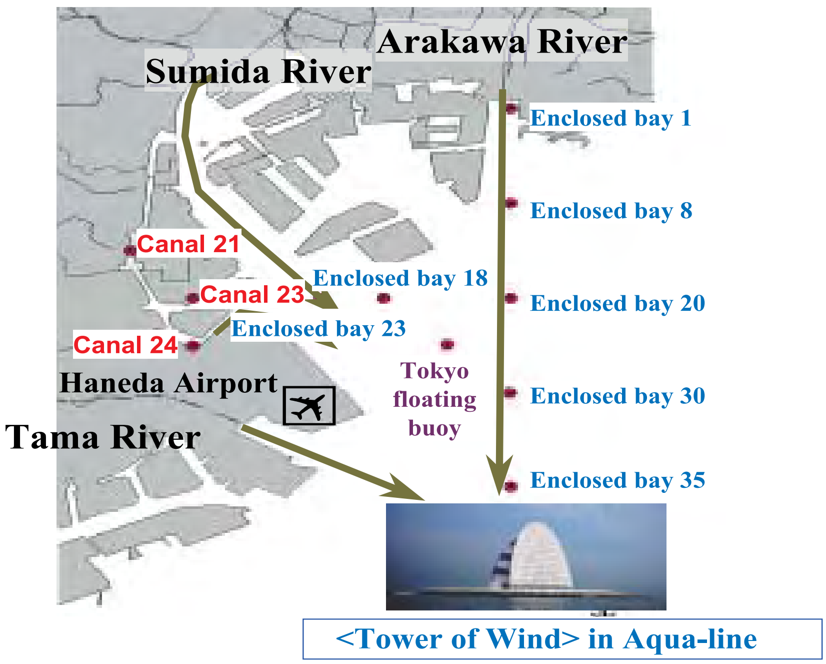


Fig. 5
Sampling points in Tokyo Bay.

PM2.5 & DEP Research Project

Sampling of particulate matter using low volume samplers, a high volume sampler, and a cascade impactor at an urban site. The aim of the study was to compare impaction and filtration samples in terms of correction for pyrolysis of organic carbon.

Environmental fate and risk assessment of fine particulates and diesel exhaust particles

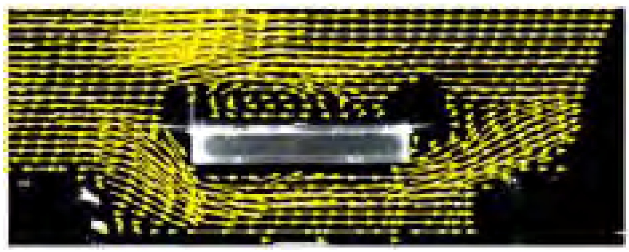
Air pollution from vehicle emissions remains a serious problem in urban areas. The PM2.5 & DEP Research Project Group is carrying out investigations to better understand the characteristics of pollution sources as well as the environmental fate of fine particulate matter ($PM_{2.5}$) and diesel exhaust particles (DEP) and their effects on human health.

Independent Senior Researcher

In FY 2002, an independent senior researcher began a 3-year inter-institutional project on approaches to reducing the air pollution caused mainly by diesel vehicles along heavily trafficked urban roads. Reduction strategies studied were: (1) enhancement of the diffusion of exhaust emissions around roads by changing the roadside environment, and (2) improvement of fuel to reduce the toxicity of diesel exhaust. NIES staff (most of whom are PM2.5 & DEP Project members) conducted wind tunnel experiments and field experiments in relation to strategy (1). Our progress in the second year of the project, FY 2003, was as follows.

In FY 2003 we performed wind tunnel experiments on a 1:100 scale model of a built-up area in Ikegami-Shinmachi, Kawasaki, where a heavily traffic roadway runs at ground level below an elevated parallel road. These followed the FY 2002 experiments, which used a 2-dimensional 1:300 scale model of the area. Our aims were to study more realistically the flow and distribution of air pollution around the roads and the effect of building a solid barrier below the elevated road along the center line in an effort to reduce localized high concentrations of air pollutants. We used PIV (particulate image velocimetry) to measure pollutant flow around the main road and found that the effect of the barrier in blocking air flow was alarmingly large (Fig. 1).

With fence



Without fence

Fig. 1
Cross-section of flow of air under and around an elevated road with and without a barrier installed under the center line, as measured by particulate image velocimetry.

In particular, the PIV images revealed that, with a barrier, the wind velocity in the lee of the barrier decreased, resulting in localized accumulation of high concentrations of pollutants. We also used a high-speed hydrocarbon meter to measure pollutant concentrations over a wide surrounding area and found that localized high concentrations of pollutants extended to areas near the main road. Under stable, stratified air conditions high pollutant concentrations extended widely over the surrounding area.

We also tested the use of an upward air stream from a linear horizontal nozzle aimed at shielding the sidewalk from vehicle exhaust. We measured particulate concentrations around the device, which we placed at the edge of the sidewalk in Kawasaki. Although we observed changes in pollutant concentrations due to the air stream, we need to test the effectiveness of the idea further in the context of promoting upward diffusion.

Traffic Pollution Control Research Team

The Traffic Pollution Control Research Team formulated emission inventories and reduction strategies for PM, DEP, and other environmental burdens imposed by motor vehicles. We measured automotive exhausts on a chassis dynamometer, performed field surveys near trunk roads, compiled emission inventories, reviewed technical and regulatory measures, and developed GIS-based tools for assessing traffic pollution. In FY 2003, we measured particulate and gaseous pollutants from diesel-engine vehicles on the chassis dynamometer as well as with on-board equipment to examine emission factors under various realistic driving conditions. We also measured the size distributions and chemical properties of ultra-fine particles with the chassis dynamometer and at roadside sites under various traffic conditions. We made progress in constructing a GIS-based integrated system for assessing the effectiveness of various policy measures: it consists of numerical sub-models of traffic flow, particulate emission and dispersion, and exposure assessment. We carried out a preliminary simulation of DEP concentrations in the greater Tokyo area to compare the geographic distribution of the population’s exposure to DEP before and after the implementation of the government’s most recent emission control policy.

Urban Air Quality Research Team

The Urban Air Quality Research Team has been investigating the relationships between changes in the relative importance of various air pollution sources and the spatial and temporal distribution of urban air pollution. To clarify the behavior of airborne particulatematters—such as $PM_{2.5}$ and DEP—and gaseous air pollutants, we have been conducting wind tunnel experiments, field observations, data analyses, and computer model simulations. In FY 2003, we performed a series of thermally stratified wind tunnel studies, focusing mainly on air pollution distribution around a heavily trafficked crossing in Kawasaki, to determine the dynamic behavior of air pollution near roads. Using three-dimensional field observations, monitoring of air pollution, and a computer simulation model, we continued our research into the mechanisms behind the observed increasing trend in ground-level ozone in urban and rural areas of Japan. Taking the regional scale air pollution into consideration, we continued our studies of urban air pollution in Tokyo and Osaka.

Aerosol Measurement Research Team

The Aerosol Measurement Research Team has been investigating new technologies for measuring particulates and gaseous pollutants. To do this, we have developed a monitoring system with high spatial and temporal resolution.

In FY 2003, we conducted multi-location measurements of NO_2 and PM concentrations in a city with heavy traffic. In addition, to examine the applicability of the β-ray absorption method to the measurement of $PM_{2.5}$, we continued our comparison studies with other commonly used methods, such as TEOM and the gravimetric filtration method.

To determine the concentrations of carbonaceous particles such as elemental and organic carbon (EC and OC), we use the thermal optical reflectance (TOR) and thermal optical transmittance (TOT) methods. Optical reflectance and transmittance are utilized to correct for pyrolysis of OC; however, it is necessary to examine the combination of sampling and correction methods and their applicability to various types of samples. We investigated these issues in different types of ambient particulate samples. In heavily loaded samples (those with more than about 50 $\mu g/cm^2$ EC) the level of transmittance was too low to detect pyrolysis, and estimates of pyrolyzed carbon levels based on reflectance were possibly too large. The relationship between reflectance and carbon concentration was therefore used as a calibration curve to estimate levels of pyrolyzed carbon. We applied this method successfully to correct for pyrolysis in most of the samples. Comparisons of filtration and impaction samples of the same size range, collected simultaneously, revealed that OC concentrations in the impaction samples may be overestimated because of the correction for pyrolysis. We also performed parallel measurement testing of four black carbon (BC) monitors at a rural site and a roadside site. Each monitor used a different monitoring technique: reflectance, transmittance, multi-angle detection, or thermal detection.

Epidemiology and Exposure Assessment Research Team

The Epidemiology and Exposure Assessment Research Team is investigating the extent of human exposure to $PM_{2.5}$ and DEP. Assessment of exposure is an integral, essential component of environmental epidemiology, risk assessment, and risk management. The methodologies used to assess exposure employ various direct and indirect techniques, such as personal monitoring and modeling. We are currently investigating an exposure modeling approach for airborne PM, based on microenvironmental concentrations and time-activity data. So far, in cooperation with the Traffic Pollution Control Research Team and the Urban Air Quality Research Team, we have conducted a basic study using a GIS to establish an exposure assessment system. We have completed the first-phase model, which can calculate the level of exposure in the population according to the pollution concentration (calculated from a diffusion model using concentrations of air pollution emitted from roads and other sources) superimposed on the population distribution. In FY 2003, the second-phase model is almost complete and we are constructing the final-phase model. Components of the second-phase model can include concentrations of PM in typical microenvironments (e.g. homes, roadsides, vehicles). The final-phase model consists of numerical models of traffic flow, particulate emission and dispersion, and exposure assessment. In particular, we examined the integration of a dynamic traffic flow simulation model into the system to assess the effectiveness of traffic demand management policies in terms of exposure.

We analyzed data on vital statistics in various regions, looking for statistical correlations between exposure levels and mortality rates. We conducted a data analysis on mortality in 13 large Japanese cities to investigate the short-term effects of particulate matter on mortality. These results suggest a positive relationship between PM concentrations and daily mortality in Japan, in agreement with many reports in the USA and Europe. We are now engaged in a prospective cohort chronic exposure study and short-term morbidity studies conducted by MOE.

Inhalation Toxicology Research Team

The Inhalation Toxicology Research Team has designed toxicological studies to clarify the effects of DEP—the major component of particulate pollutants— and $PM_{2.5}$ on cardiac, respiratory and immunological function in animals.

Cardiac function: The effect of diesel exhaust (DE) on the cardiovascular system has not been fully elucidated. We obtained electrocardiograms of rats exposed to DE (containing 3.0 mg/m^3 of particles), DE gases (DEG), or clean air (control) for 12 h a day, 7 days a week for 4 months to elucidate the effects of DE inhalation on cardiac function. The frequency of arrhythmias in rats exposed to DE was significantly higher than that in the controls. No significant difference was observed between rats exposed to DEG and those exposed to clean air. Heart rates of rats exposed to DE decreased dose-dependently (controls > DEG > DE). Our results suggest that inhalation of the particulates included in DE enhances the provocation of arrhythmias and changes in cardiac function. We also determined which chemicals in DEP were affecting cardiovascular function and estrogenic activity. We isolated and identified the compounds in DEP responsible for vasodilatation of the rat thoracic artery by the Magnus method (Fig. 2). They were 3-phenylphenol-4-nitrophenol and 3-nitrophenol, from a benzene extract of DEP. Further, we showed clearly that 3-methyl-4-nitrophenol and 3-phenyl phenol-4-nitrophenol had estrogenic activity.

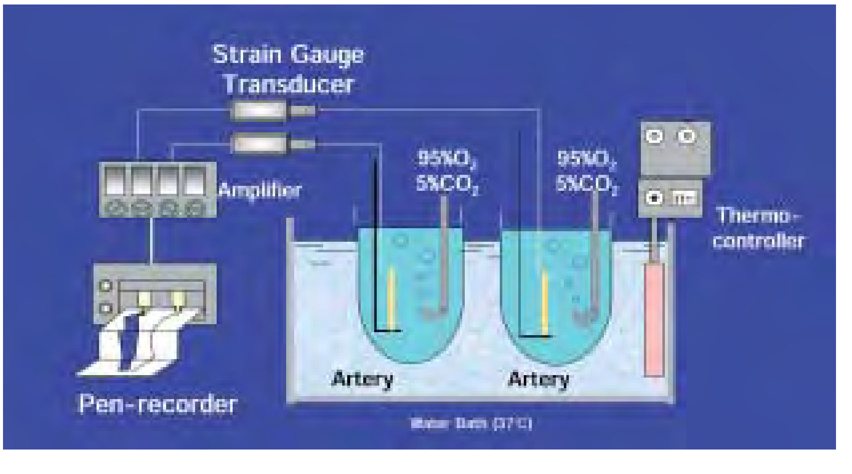


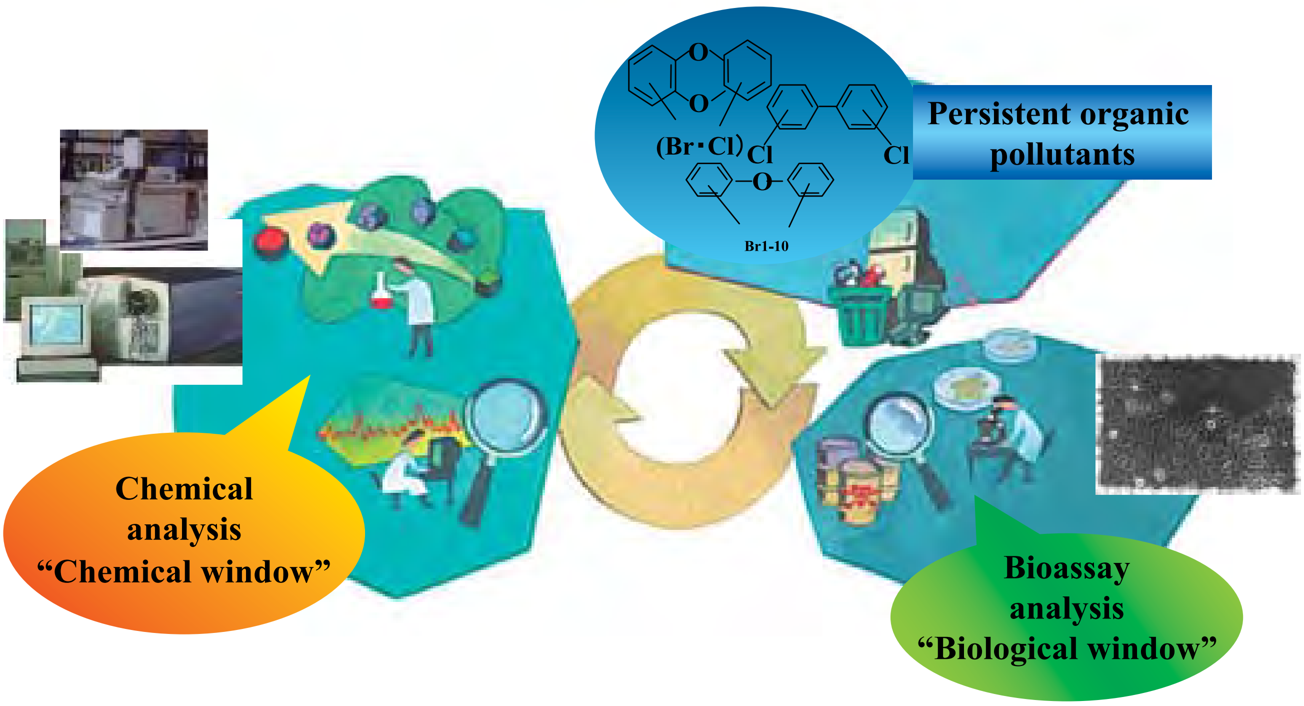
Fig. 2
Apparatus used in the Magnus method. Rat thoracic arteries are hung in Magnus tubes filled with Krebs solution. Graded compounds extracted from diesel are added cumulatively to the Magnus tubes, and the movements resulting from constriction of the arteries are recorded by the pen recorder.

To elucidate the effects of PM or DEP on the cardiovascular system, we examined the effects of organic extracts of $PM_{2.5}$ or DEP on myocardial infarction risk in rat heart microvessel endothelial cells. The risk indicators studied were the production of heme oxygenase-1 (HO-1), which works cytoprotectively in the cardiovascular system, and the production of plasminogen activator inhibitor-1 (PAI-1), an antifibrinolytic factor. Exposure to organic extracts of $PM_{2.5}$ or DEP induced HO-1 production and decreased PAI-1 production. These results suggest that the direct effect of organic extracts of $PM_{2.5}$ or DEP on the thrombotic function of endothelial cells is weak.

Respiratory and immunological function: We have previously shown that DEP aggravates the acute lung injury caused by bacterial toxins in mice. Residual carbonaceous nuclei ('washed DEP') derived from DEP, rather than organic chemicals (DEP-OC), are the predominant contributors to this aggravation of lung injury. The effects of the DEP components were concomitant with the increased lung expression of inflammatory molecules, such as intercellular adhesion molecule-1, interleukin-1β, macrophage chemoattractant protein-1, keratinocyte chemoattractant, and, in particular, macrophage inflammatory protein-1α, which is known to predominate after exposure to whole DEP and bacterial toxins. DEP also enhances the manifestation of allergic asthma, although the components in DEP that are responsible have not yet been determined. In our study, DEP-OC and whole DEP enhanced the infiltration of eosinophils into bronchoalveolar lavage fluid in the presence of an allergen, whereas washed DEP did not. This enhancement was concomitant with the increased lung expression of interleukin-5 and eotaxin. The aggravating effects of whole DEP on allergen-related changes were more prominent than those of DEP-OC. These results suggest that the extracted organic chemicals, rather than the residual carbonaceous nuclei of DEP, are the principal contributors to the aggravation of allergic inflammation, although coexistent organic chemicals and carbonaceous nuclei have the greatest effect.

Antigen presentation is also a factor contributing to the allergic reaction. We investigated the effects of DEP on the expression of cell surface molecules associated with antigen presentation (Ia, B7.1, B7.2) on rat alveolar macrophages (AM) as representative mature antigen-presenting cells and on peripheral blood monocytes (PBM) as representative immature cells. Cells were exposed to whole DEP, DEP-OC, or washed DEP. Whole DEP or DEP-OC significantly increased the expression of Ia and B7 molecules in a concentration-dependent manner in PBM but not in AM. Washed DEP had no effect. DEP-OC also increased antigen-presenting activity in PBM. These results suggest that DEP may aggravate the allergic reaction in the lung by enhancing antigen-presenting activity. The aggravating effect of DEP is attributable to the organic compounds rather than to the residual carbonaceous particles.

Research Center for Material Cycles and Waste Management



Combined bioassay and chemical analysis evaluation of recycling materials and wastes

Introduction

Under the current economic and social system—one of mass production, mass consumption, and mass disposal—we are developing into an economy and society oriented toward material cycling. However, a precise map and compass for where the world is going in terms of material cycling and how it should arrive there is not yet available. Under these uncertain circumstances, in April 2001, the Research Center for Material Cycles and Waste Management was established at NIES, and energetically set out to promote appropriate research. This research center intends to keep an eye on progress toward the realization of a material cycle society by developing innovative technologies, monitoring techniques, and methods for processing and analyzing a wide range of information. The tools we intend to use in our research and policy development include system analysis, technological development, and comprehensive risk control.

Many waste-related issues—from waste prevention to the recycling, treatment, and disposal of wastes—are the targets of our research, which will range from studies of waste characterization, hazard characterization and risk management, to practical studies of technological control methods and system development and assessment. We will tackle 4 main topics: 1) methods for assessing sustainability and the basic organization of a material cycling society; 2) technologies for material recycling, treatment, and disposal; 3) comprehensive risk control methods related to material cycles; and 4) remediation technologies for polluted environments. We are currently focusing on developing methods for assessing sustainability and the preparation of basic systems for supporting the transformation to a material cycle society.

(1) Material Systems Research

As a basis for supporting the transformation to a sound material-cycle society, it is essential that we synthesize various statistical data related to flows of materials such as resources, products, and wastes, and develop tools to analyze these data. We have made progress in preparing data on waste generation, treatment, and disposal by industrial sector and by waste type for several time periods, so that changes over time can be analyzed. On the basis of this information, we conducted a preliminary study of the impact of long-term use of products on the environment and economy. Our study also included a review of the problems that can occur in the application of indicators representing sound material cycles to local administrations.

To promote sound material cycles, it is important that we assess the contribution of each individual measure to the overall reduction in environmental load. Our studies include the development of methodologies such as life-cycle assessment (LCA) and LCA case studies of technologies for recycling “other plastics” under the Container and Packaging Recycling Law as feedstock. When conducting LCA to promote material cycling measures, changes in the human activities indirectly related to material cycling need to be carefully taken into account: the systems compared must have the same functions to meet the objectives of the assessment. For example, Figure 1 shows the quantitative results of the effects of recycling plastics as feedstock, based on a detailed examination of the systems compared: incineration with power generation, recycling as raw materials (in place of coking coal) for coke ovens, or recycling as raw materials (in place of coke or powdered coal) for blast furnaces. Recycling in blast furnaces as a substitute for coke has the advantages of reduced CO_2 emissions and coal consumption, whereas recycling in coke ovens gives a large reduction in oil consumption.

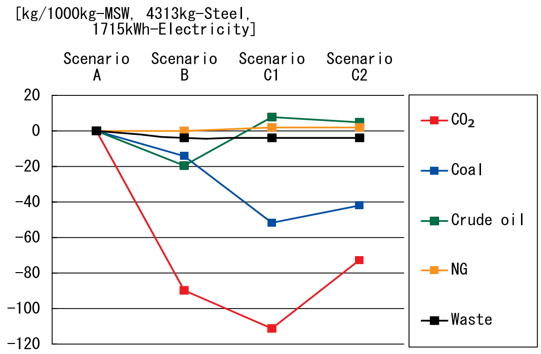


Fig. 1
Effects of recycling feedstock. Scenario A: incineration with power generation; Scenario B: recycling as raw materials for coke oven (in place of coking coal); Scenario C1: recycling as raw materials for blast furnace (in place of coke); Scenario C2: recycling as raw materials for blast furnace (in place of powdered coal).

Progress was also made in the development of a methodology for assessing regional material cycle systems. Information about the generation and transfer of wastes and recyclable materials in the targeted region was registered in a Geographic Information System, and factors affecting the transfer of wastes inside and outside the region were analyzed. Using a model of the physical distribution of wastes, we also analyzed geographical discrepancies between waste generation and treatment capacity, and estimated changes in flows in the case of enhanced waste treatment capacity.

In addition, to assess the safety and effective use of recycled products, we investigated the conditions under which products recycled from municipal solid waste, such as melt slag, were used. We also conducted basic studies of analytical methods and materials bioassay methods to assess the safety of recycled products used in the home environment: in particular, we developed a method for analyzing chemicals used to termite-proof wood and investigated the mutagenicity and tumor-promoting activity of these chemicals. Moreover, we discovered that mutagens were generated during the production of a carbide board to decrease VOCs in indoor air.

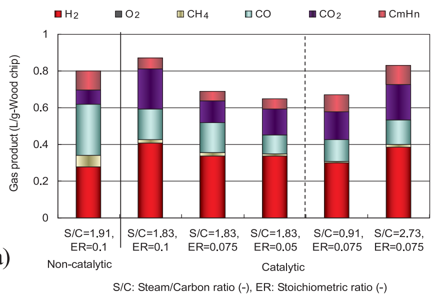
(2) Material Cycle Technologies

We have been seeking the technical solutions required to build an environmentally sound material cycling society. We have studied methods of effectively reducing the environmental load imposed by primary pollutants from thermal and hydrological processes and have developed both thermal and applied biological technologies for recovering resources.

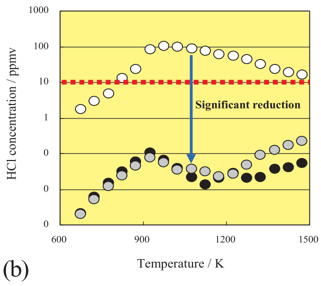
Ash samples collected from gasification-melting systems were heated experimentally to investigate the potential for dioxins to form. Although the carbon contents of the samples were extremely low, high rates of dioxin formation were observed, and a useful linear relationship on a logarithmic scale was found between the carbon content and the amount of dioxins generated. A survey was also conducted to investigate and assess the present status of gasification-melting plants with regard to facility performance and reduction of pollutant emissions. We will continue to collect extensive data on incineration plants on the basis of the survey results.

A promising means of recovering resources from biomass and wastes is pyrolysis-gasification and gas reforming and fermentation technologies to produce hydrogen gas, which will be related to the fuel cell system. Fig. 2(a) shows the composition and amount of gas generated from waste wood in an experimental gasification/gas reforming apparatus. The steam to carbon ratio and the stoichiometric ratio during operation affected hydrogen production, and that the employment of a catalyst improved the recovery of hydrogen. Because the system needs to be operated at a lower temperature in view of practical issues such as cost, we are hoping to use a catalyst. Emission of pollutants from this system could be minimized by blending different biomasses on the basis of a predictive calculation, as shown in Fig. 2(b). We will continue these studies in more detail.

(a)



(b)



Symbols
solid circle: HCl from cacao shells
open circle: HCl from demolition wood
gray circle: HCl from their 1:1 blend
Red dotted line: HCl tolerance concentration for molten carbonate fuel cells

Fig. 2(a)
Composition of hydrogen and other components under various conditions in an experimental gasification using waste wood (Temperature: 750˚C).

Fig. 2(b)
Reduction of HCl emission by blending two different biomass fuels (blending ratio of cacao shells and demolition wood = 1:1).

A database of organic wastes in a prefecture was made on the basis of data on unit discharge rates for each industrial category. Progress was also made in developing database characterization and methods for evaluating each organic waste as a recycling resource. In a study of the recovery of resources by using biological processes, the generation of hydrogen gas in acid fermentation of garbage was maintained for as long as 2 months. Control of pH in the system was found to be the most important factor for maintaining stable, high production of hydrogen. We also determined the manganese concentration required for rapid lactic acid fermentation from food waste by *Lactobacillus manihotivorans*, and showed that the yield of lactic acid was affected by the initial concentration of sugars in the fermentation broth. Seasonal changes in levels of contaminating lactic acid bacteria (LAB) in food waste were monitored, and we found it necessary to control the level of contaminating LAB in the fermenter below 1.3 $\times 10^8$ cfu by pasteurization, to keep the optical purity of the product at 98%.

Nitrogen and phosphorus in liquid wastes are major substances that we aim to control by biological processes (‘bio-eco engineering’). For the removal of phosphorus, zirconium ferrite carriers that showed adsorption saturation were collected from absorption-dephosphorization equipment currently installed in private households, and a system for phosphorus desorption, reproduction, and crystallization was developed. The reproduction carrier was found to have maintained its adsorption ability, and an effluent total phosphorus concentration of less than 1 mg/L was attained. A technology that can obtain a crystal purity of 95% or more has been developed by reducing the reaction temperature to less than 50˚C, applying a low-temperature vacuum-condensing method with a rotation function to evaporate moisture, and condensing the alkalinity concentration to about 20%. For nitrogen removal, by introducing techniques of molecular biology such as real-time PCR, we have clarified the relationships between the number of nitrifying bacteria and conditions such as inflow load and amount of water circulation. We have determined the optimum number of nitrifying bacteria to maintain nitrification ability and we recognize the importance of having a system that can maintain numbers of nitrifying bacteria at this level.

Hydrogen sulfide gas generated in high amounts is an important issue for inert waste landfills. We identified the causes and mechanisms of strong hydrogen sulfide gas production through bench-scale lysimeter and vial experiments. One cause is the existence of the 1% to 2% starch paste contained in gypsum board, and others are wastes such as litter and wood chips that have been disposed of illegally. We have proposed a technology for preventing the generation of high concentrations of hydrogen sulfide gas in both existing landfills and new landfills. Field-scale tests were conducted to investigate the acceleration of landfill stabilization, and results indicated that aerobic landfill bioreactor operation is an effective and promising technology for accelerating the stabilization of landfilled wastes for both organic matter and nitrogen.

(3) Material Cycles and Risk Management

Integrated approach using both bioassay and chemical analysis

We are promoting research to develop methods of monitoring and controlling the risks posed by chemical substances that remain in, or are formed in the process of, material cycles and waste management. The first part of this effort focuses on the development of analytical detection methods to systematically identify chemicals and on the development of bioassay methods to comprehensively grasp and manage the risk of chemicals (see the illustration at the front of this section). By using these methods, our second aim is to promote research on the behavior and control of persistent organic pollutants (POPs) and especially on the development of methods for destroying POPs, such as chlorinated organic compounds, in wastes.

Bioassay monitoring of dechlorination treatment of dioxins in fly ash

To detect chemical substances included in recycling materials and wastes, we have both upgraded our chemical analysis methods and applied bioassay methods. For example, a study employing a cell-based Ah receptor binding assay (CALUX) was successfully conducted for routine dioxin monitoring in incineration fly ash samples from municipal solid waste (MSW); this assay enables detection at a pg-TEQ (toxicity equivalent) level. Dioxins in fly ash were monitored by both CALUX and chemical analysis at full-scale plants adopting a low-temperature (below 400˚C), low-oxygen dechlorination process. The results of continual monitoring over 1 month during this process are shown in Figure 3. The TEQ values measured by CALUX were in good agreement with the results of the chemical TEQ analysis. The treatment reduced

TEQs of dioxins by 99%, from 1 to 10 ng-TEQ/g in untreated fly ash samples to less than 0.01 ng-TEQ/g in treated samples. Only 4 days were required for all the procedures of sample clean-up and CALUX, and CALUX was confirmed to have performed well.

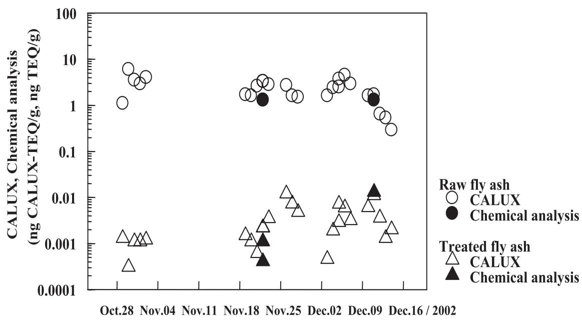


Fig. 3
Results of dioxin monitoring by CALUX (a cell-based Ah receptor binding assay) and by chemical analysis during the dechlorination process.

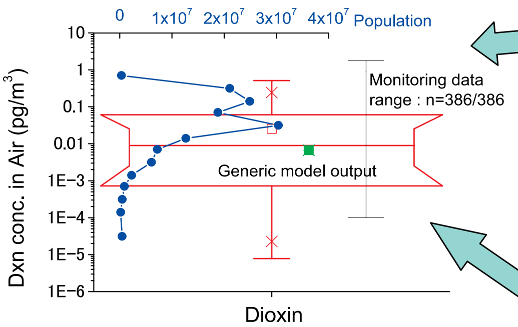
PCB destruction by sodium dispersion

Last year, photochemical dechlorination (PCD) and catalytic hydro-dechlorination over a palladium-carbon catalyst (CHD) were studied experimentally as destruction technologies for waste PCBs. To confirm the effectiveness of PCB destruction systems, it is important not only to find low levels of PCBs but also to understand the degradation mechanism and to check that there are no byproducts of other harmful substances in the degradation processes. In this way, we can explain differences in the reaction mechanisms of 2 methods, such as easy ortho-dechlorination by PCD as against CHD. We decomposed the same congeners by the sodium dispersion (SD) method and analyzed the differences in the pathways and the reactivity of the chlorines among the three methods. The SD process proceeded via an irreversible stepwise pattern, but its dechlorination pathway was quite different from that of PCD or CHD. The pathways seemed to be dependent on the numbers of chlorine atoms and on the positions of the substituted chlorine atoms.

Comparative study of PCB destruction with long-term storage

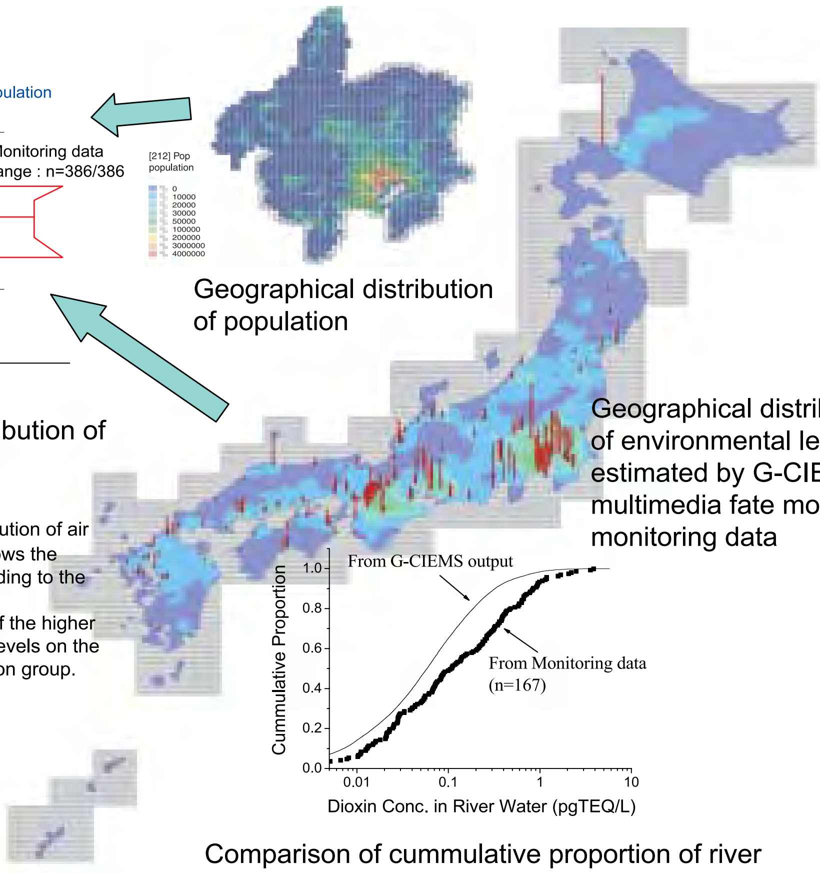
We performed a comparative risk assessment of the storage and destruction of PCB waste. Intakes of coplanar PCBs (co-PCBs) at the local (within 10 km from the destruction plant), national (Japan) and foreign (Northern Hemisphere, excluding Japan) levels were considered. On the basis of a comparison between estimated and measured PCB concentrations in air and water, we estimated the PCB emission caused by loss under storage of PCB wastes. There was good agreement between the estimated and measured values. Under the storage scenario, estimated individual exposure (EIE) to co-PCBs was in the order of several pg-TEQ/person/day in Japan. Under the destruction scenario, the EIE for the local area was in the range of 0.1 to 0.7 pg-TEQ/person/day, which was lower than that for the national area storage scenario. In terms of the estimated total exposure (ETE), which is defined as the product of EIE and the total population, we calculated that the foreign area made a large contribution, whereas the local area made only a small contribution. The difference in spatial distributions of EIEs and ETEs revealed that it was important to consider both local and global effects in PCB risk management.

Research Center for Environmental Risk



Estimated geographical distribution of exposure levels to dioxins.

Box-whisker plot (red) shows the distribution of air concentration. The circle plots (blue) shows the population living at the region corresponding to the environmental levels.
The figure suggests substantial impact of the higher end of the distribution of environmental levels on the chemical exposure to the major population group.



Geographical distribution of population

Geographical distribution of environmental levels estimated by G-CIEMS multimedia fate model and monitoring data

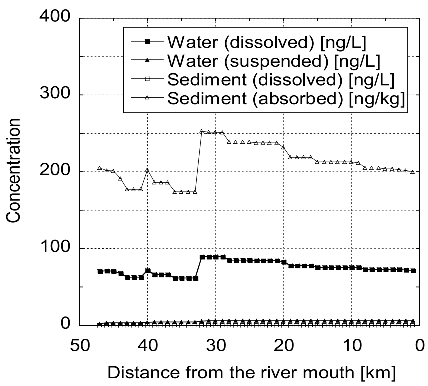
Comparison of cummulative proportion of river water concentration by model and monitoring data

This Center promotes research projects on environmental risk assessment. Currently, there are 7 project themes, covering the development of methodologies for 1) assessment of exposure to environmental risk in light of variability; 2) exposure assessment on the basis of limited information; 3) assessment of health risk in light of individual variations in susceptibility to chemical substances; 4) bioassay systems for environmental monitoring; 5) assessment of health risk from concurrent exposure to a number of chemical substances; 6) assessment of ecological risk of chemicals on the basis of their toxicity to individual organisms; and 7) communication of environmental risks.

Below are brief descriptions of some of the important results of these projects for 2003.

Development of a methodology to assess exposure on the basis of limited information

As part of this sub-theme, we built numerical models that could predict the concentration of a chemical in the environment from limited information. We developed a 1-dimensional, unsteady flow river model using an unsteady flow/ advection-diffusion calculation solved by the cubic interpolated pseudoparticle method, and a transfer/degradation calculation solved by the Runge-Kutta method. From a sensitivity analysis, we identified water depth, sediment porosity, and concentration and organic content of suspended solids as parameters that had a marked influence on the predicted concentration of chemicals. This model was modified to adopt a steady flow system with a branched river structure. The computer code was transformed into a spreadsheet (MS Excel); characteristics of the Tama and Tsurumi rivers, such as water flow, branch structure, length, and river width, are given as an example (Fig. 1). In the spreadsheet, the model lists the chemical properties of chemicals designated under the Japanese chemical substance control act, and users can select these properties by simply assigning a CAS (Chemical Abstract Service) number.



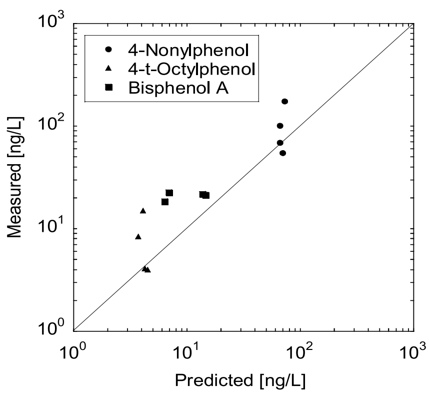


Fig. 1
Spreadsheet of the steady-state-flow river - chemical fate model, in this case a simulation of the concentration of nonylphenol in the Tama River 3 months (90 days) after measurement of outflow began.

We also continued to modify our coupled 3-dimensional hydrodynamic and ecotoxicological model. Processes such as sedimentation of suspended particulates and intake of chemicals by zooplankton and fish were added to the model. We used this model to simulate the behavior of DAS1 (4,4'-bis[(4-anilino-6-morpholino-1,3,5-triazin-2-yl)amino]stilbene-2,2'-disulfonate in Tokyo Bay (Fig. 2). The model was calibrated with monitoring data from the study area. The simulated results for dissolved bisphenol-A were well correlated with the observed values (r = 0.7807). The results of a sensitivity analysis showed that photodegradation rate was the most important parameter determining the concentrations of dissolved DAS1 and bisphenol-A in phytoplankton cells. Biodegradation rate and partition coefficient were both important determinants of the bisphenol-A concentration in particulate organic carbon.

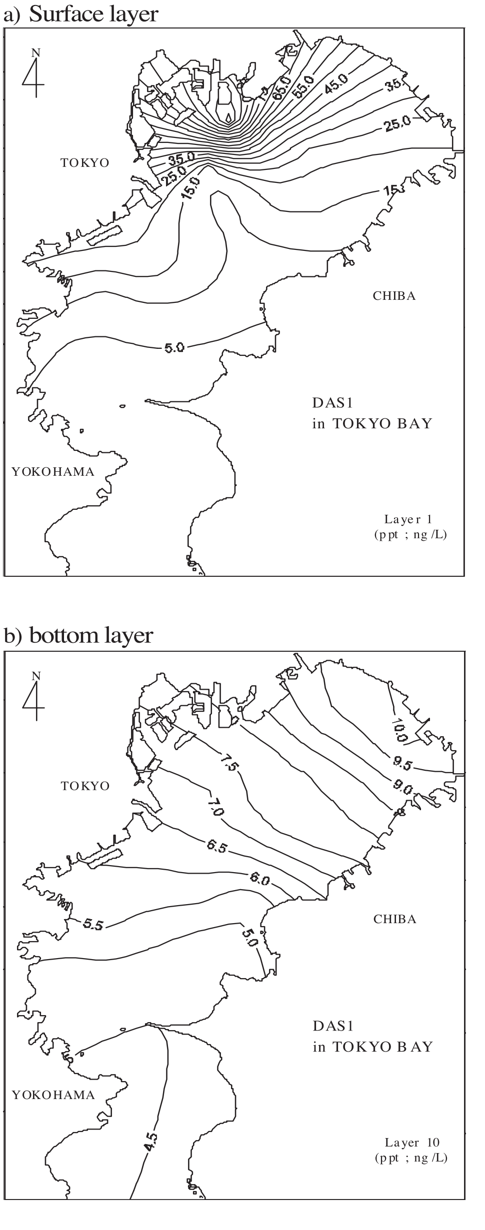


Fig. 2
Simulated distribution of dissolved DAS1 in a Tokyo Bay model.
a) Surface layer
b) bottom layer

Development of a methodology to assess health risks in light of individual variations in susceptibility to chemicals

People living in areas where arsenism is endemic are likely to have been exposed to inorganic arsenicals such as arsenate and arsenite. These inorganic arsenicals are methylated in the liver, and major metabolites of inorganic arsenicals in the urine are monomethylarsonic acid (MMA) and dimethylarsinic acid (DMA). Methylation of arsenic varies among individuals, suggesting that there may be polymorphism in arsenic methyltransferase. We studied single nucleotide polymorphisms (SNPs) of the arsenic methyltransferase Cyt19 in about 600 human DNA samples. However, there was no difference in the sequences we measured by Pyrosequencer. We generated human recombinant Cyt19 and investigated the metabolism of inorganic arsenicals *in vitro*. Inorganic arsenicals appeared to be first converted to arsenic triglutathione, which was then methylated by Cyt19. Cyt19 mediated the reactions from inorganic arsenicals to MMA and from MMA to DMA only in the presence of glutathione. These results indicate that metabolism of inorganic arsenicals depends on hepatic glutathione levels, and that glutathione may be implicated in the health effects of arsenic.

Development of bioassay systems for environmental monitoring

Bioassay methods are believed to be useful for identifying the hazardous effects of complex mixtures of chemical substances in the environment. To build bioassay systems than could estimate the total impact of exposure to a number of chemicals in the environment, we investigated the quantitative relationship between bioassay data and the adverse effects of air pollutants.

We compared the Ames test, a standard *in vitro* test for detecting mutagens, with an *in vivo* mutagenicity test in a transgenic mouse called the gpt delta mouse, established by Dr. Nohmi. To estimate the mutagenicity of diesel exhaust (DE), which is a major source of mutagens in ambient air, gpt delta mice were expose to diesel exhaust.

The frequency of mutations in the lungs of DE-exposed mice increased depending on the duration of exposure at a dose of 3mg SPM/m^3. The mutation rate was estimated to be an orde of 10^{-7}(celláday)$^{-}$. This value appears to be an informative parameter for describing the relationship between bioassay data (mutation frequency) and the incidence of adverse effects (cancer).

New attempt to establish a quantitative structure-activity relationship for chemicals with aquatic toxicity

We gathered data on the ecological hazards of chemicals from several existing databases and references. The data were compiled and analyzed to examine intra- and interspecies variations in sensitivity to chemicals and to clarify the relationship between aquatic toxicity and chemical structure.

The method used to predict aquatic toxicity comprises 2 modeling systems: 1) the clustering of chemical substances by using Kohonen self-organizing maps (SOMs), and 2) the prediction of toxicity by using artificial neural networks trained by the back-propagation neural network (BNN) algorithm.

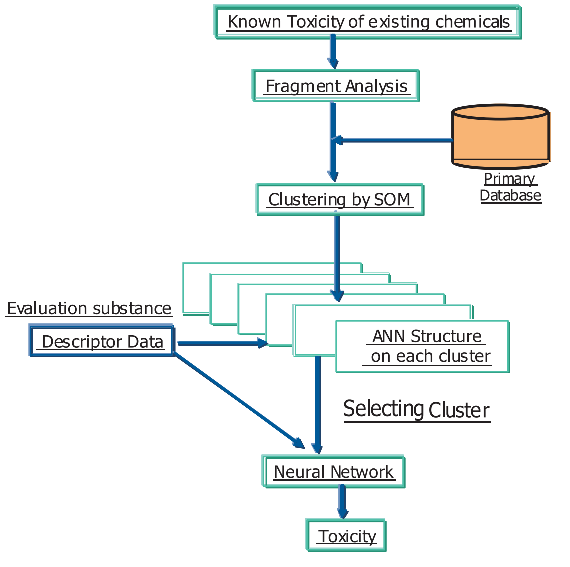


Fig. 3
Schematic representation of quantitative structure-activity relationship (QSAR) using a neural network.

The endpoint of toxicity comprised the 96-h LC_{50} values for 6 fish species (fathead minnow, zebra-fish, common carp, ricefish, guppy, and bluegill) as recommended by the OECD test guidelines. Measured acute toxicity values for 450 substances in fish were gathered from the AQUIRE database. Models were analyzed for sensitivity using this neural network approach by evaluating their effectiveness in predicting fish 96-h lethal concentration (as LC_{50}). The result showed that a robust quantitative structure-activity relationship (QSAR) model could be achieved using a hydrophobic descriptor (log K_{OW}), 2 steric descriptors (van der Waals volume, molecular weight), and 3 electronic descriptors (dipole moment, HOMO, LUMO). QSAR models were established on each cluster by using an artificial neural network (BNN) with 3 neurons in 3 layers. The result of the calibration showed that the r^2 value of the leave-one-out cross-validation (Q2) was 0.90, whereas the r^2 value of the ecological structure-activity relationship (ECOSAR) model was 0.62, indicating that the QSAR established by this approach was both internally consistent and highly predictive.

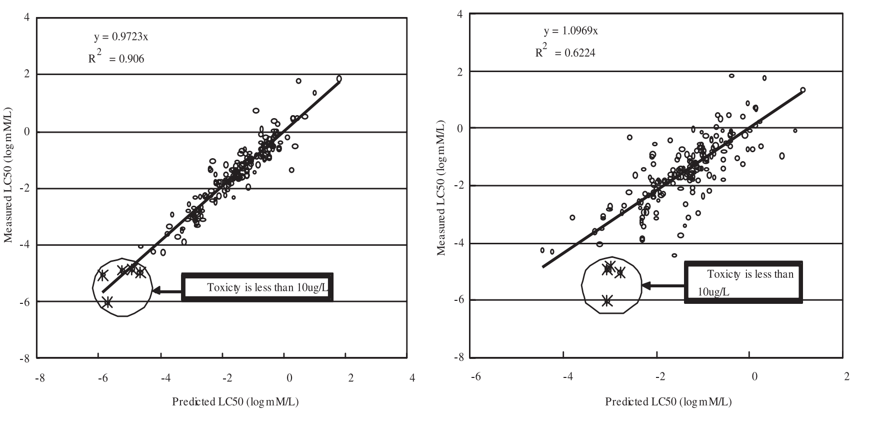


Fig. 4
Model-calculated values versus measured values for toxicities of various substances to fish. At left is the neural network model developed in our study. At right is the Ecological Structure—Activity Relationship (ECOSAR) model. Circled crosses represent substances with high toxicity (at less than 10 μg/L).

Development of a methodology to assess ecological risk on the basis of chemical toxicity to individual organisms

We assessed a method for testing sediment toxicity in a non-biting midge (*Chironomus yoshimatsui*), a species endemic to Japan, to develop 2 new OECD test guidelines (drafts 218 and 219), endorsed by the 15th WNT in May 2003. The method tested involved assessment of the hazards of chemicals with a high log P_{OW} (greater than 5). After preliminary experiments we made a standard procedure for the test. We then performed definitive ring tests to check the validity of the method and to assess any inter-laboratory variation occurring under the same conditions and with the same materials. Pentachlorophenol (PCP) was selected as the test substance, and 4 other Japanese laboratories joined the study.

The results of testing by our team showed that the method was relevant, as the emergence rate of midges in the control group was over 80%, satisfying the test validity criteria described in the test guideline. Adverse effects were observed in terms of PCP concentration: an EC_{50} of 60 mg/kg on emergence rate and a NOEC of 14.2 mg/kg on development rate.

We also performed supplementary experiments to determine the optimum test conditions for factors such as the amount and quality of food given in the test period, the volume of air bubbled through the test tanks, and the procedure used to prepare the artificial sediment. To check the validity of the test method in the OECD draft test guideline TG218 for substances with relatively low log P_{OW} (less than 5), we performed another ring test in collaboration with 3 other Japanese laboratories. Pyrene was selected as the test substance, and the test was performed with the materials and protocol proposed by our team.

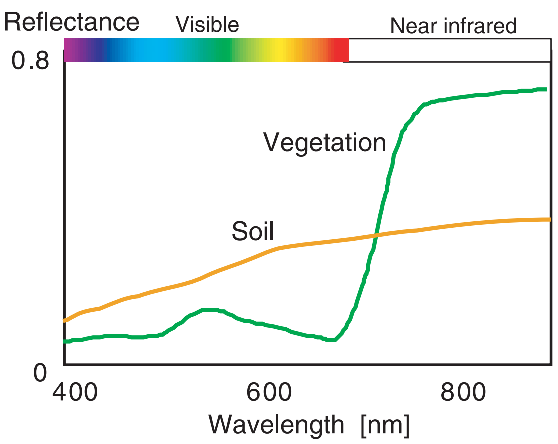
Our proposed method of eco-toxicological sediment testing using Chironomids has been adopted as an official method under Japan’s Chemical Substance Control Law.

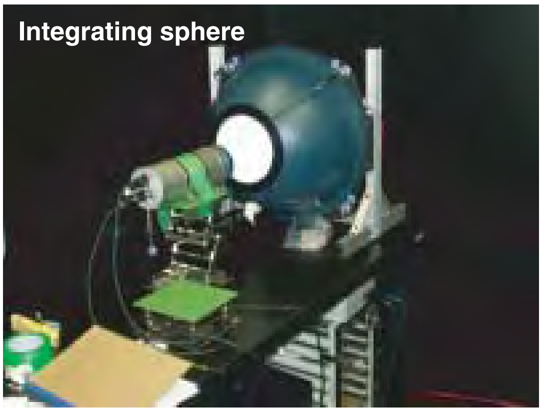
Chemicals database

Environmental monitoring data are essential for evaluation of exposure to chemicals and also for calibration of environmental numerical models. Various methods of analyzing environmental chemicals have not been reported in the scientific literature and may have appeared only in government manuals or in reports from the Ministry of the Environment. We developed the EnvMethod database to collect these widely scattered reports of analytical methods and to offer this information to researchers engaged in the development of analytical methods and to chemical laboratory technicians. EnvMethod is a web-based database that is searchable by features such as the name of the chemical substance, legal implications, references, title of the analytical method, and environmental medium. So far, we have collected environmental monitoring data from Ministry of the Environment reports published between 1991 and 2001.

These data will be linked with the WebKis-Plus chemical database by CAS (Chemical Abstract Service) number.

Social and Environmental Systems Division





Spectral reflectance of vegetation and soil (left) and system for calibration of remote sensing instruments (right). Satellite data are analyzed on the basis of these reflectance spectra, which are precisely measured by the calibrated instruments.

Environmental problems can be defined as those resulting from environmental changes that are consequences of various human activities. Whether these changes are pollution, physical degradation, or ecosystem destruction, they can threaten our daily lives, well-being, and socio-economic activities. Therefore, the human and societal dimensions of environmental change are of the utmost importance for environmental protection and conservation. In this context, the Social and Environmental Systems Division is concerned primarily with present and future interactions between social and environmental systems.

The Division consists of 5 research sections: Environmental Economics, Resources Management, Environmental Planning, Information Processing and Analysis, and Integrated Assessment Modeling. In addition, there is 1 Independent Senior Researcher. In FY 2003, the division conducted the following research.

Environmental Economics Section

(1) Comparative international study of sustainable consumption

We analyzed the results of both an international comparative survey and domestic surveys of the producer-retailer-consumer chain. We found that: (a) consumer trust in producers has an important influence on purchasing decisions; (b) the level of consumer trust in Japan is lower than that in Germany; and (c) a product's "health effects" are more important to consumers than its "environmentally friendly" attributes (Fig. 1).

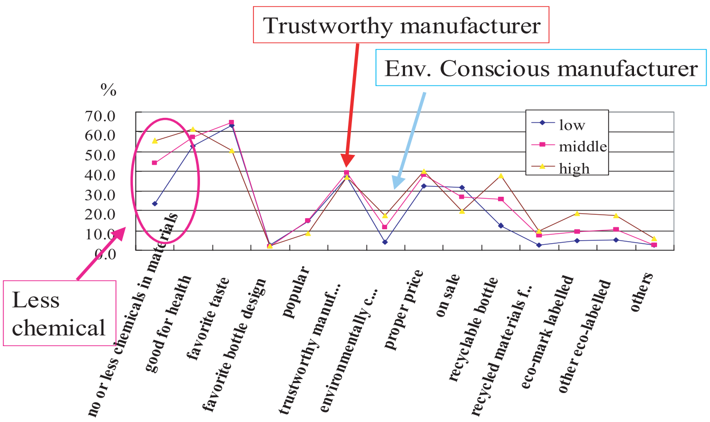


Fig. 1
Relative importance of various product attributes to consumers. These are the results of a survey of consumers in the Tokyo metropolitan area. The results clearly indicate that people place more value on "less chemicals" and "trustworthy manufacturer" than on environmental considerations.

(2) Study of firms' incentives to adopt ISO 14001 and their market value after its adoption

We explored incentives for Japanese manufacturing firms to adopt ISO 14001 and the impact of its adoption on the market value of firms. Our main findings were: (a) larger firms with higher profitability and larger exports had greater incentive; and (b) adoption of ISO 14001 increases a firm's market value.

(3) Study of the effect of international moves for sustainable development on Japanese domestic policy

We studied the impacts of international moves toward sustainable development on Japanese domestic policymaking on environmental issues. During the decade 1992-2002, Japanese environmental policymaking gradually began to involve many domestic stakeholders, such as the business community, environmental NGOs, and researchers. This change of process has affected the outcomes of policymaking.

Resources Management Section

The Resources Management Section studies methodologies for quantifying the environmental burdens and impacts associated with various socioeconomic activities. (1) Material flow accounting/analysis (MFA) is one of the key tools used for this purpose. Physical input-output tables (PIOT) are designed to describe the flows of natural resources, materials produced, and solid waste and recycled materials. (2) We analyzed the incentives for, and effects of, adoption of the ISO 14001 standard by firms in Japan and the USA. We applied models based on economic and political economic theory to help us understand what factors encourage firms to adopt ISO 14001 and how the environmental management systems of these firms work. (3) Another issue was the application of life cycle assessment to the use of underutilized energy sources to reduce carbon dioxide emissions. (4) We also applied other comprehensive environmental assessment methods, such as conjoint analysis and cost-benefit analysis, to transportation and waste management scenarios.

Environmental Planning Section

Our section studies techniques for planning and evaluating environmental conservation policies. Our research includes the setting of local environmental policy goals, as well as the prediction of global warming and assessment of its impacts. In 2003, we conducted the following research. (1) At the annual meeting of the Environmental Science Society, we organized a symposium on the Kyoto Protocol and regional environmental management. Regional management of mitigation options for global warming was discussed at the symposium. (2) Urban rehabilitation and reconstruction are inevitable if we are to make cities sustainable. We examined the concept of the compact city as an environmentally friendly city. To develop ways of improving the sustainability of the world’s large cities, we collected data and developed an urban database that can be used to compare a city against the compact city model. We then developed an ecological footprint as a comprehensive indicator of city sustainability (Fig. 2).

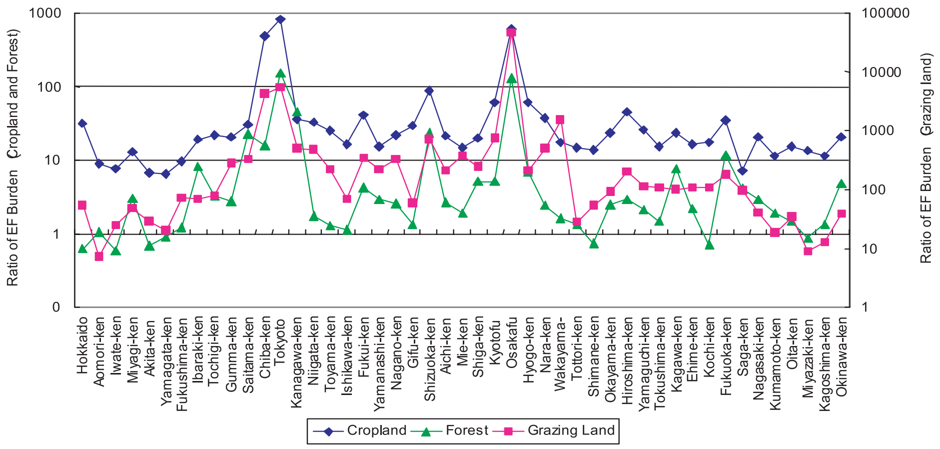


Fig. 2
Urban ecological footprint analysis used to evaluate sustainability in Japanese prefectures.
EF = ecological footprint

Information Processing and Analysis Section

Our section promotes comprehensive research on methods of environmental monitoring, numerical simulation analysis, and the processing of information from many kinds of observational data. Examples are the processing and analysis of remote-sensing satellite data on the atmosphere, land, and oceans; the non-destructive and sensitive discrimination of types of bird eggs; and the numerical simulation of diffusion of urban air pollution. We also process and analyze research data generated by the other sections of our Institute. In 2003, we processed information on several special priority research projects including the evaluation of grassland and coral reef environments by using hyper-spectral sensor data and the investigation of a new method to precisely estimate CO_2 column density from nadir-looking satellite sensor data.

Integrated Assessment Modeling Section

The "Integrated Assessment Model" has been developed to evaluate environmental conservation. This model covers a wide range of environmental problems, economic activities, land use change, lifestyle change, and recycling. It evaluates the impact of environmental conservation measures on the economy. If we are to conserve the future global environment it is essential that we cooperate with developing countries in the Asia Pacific region such as China, India, and Thailand. Presently, the priority of environmental conservation in developing countries is much lower than that in developed countries. However, it is essential that developing countries give importance to environment conservation and include it in their list of development priorities. The simulation examined suitable policies for sustainable development in India that included constraints on natural assets and potential countermeasures to these constraints. The simulation showed that recycling and technology innovation scenarios can be expected to mitigate the loss of GDP caused by policies that reduce production of industrial wastes. Also, they showed that early investment in land conservation measures could provide substantial national financial benefits.

Independent Senior Researcher

A type of landscape appreciation called the "Eight Scenes" was established in ancient China. It spread to surrounding areas and eventually influenced the appreciation of landscape throughout East Asia (Fig. 3). We investigated the popularity of the "Eight Scenes" in Japan from the Kamakura era to the present.

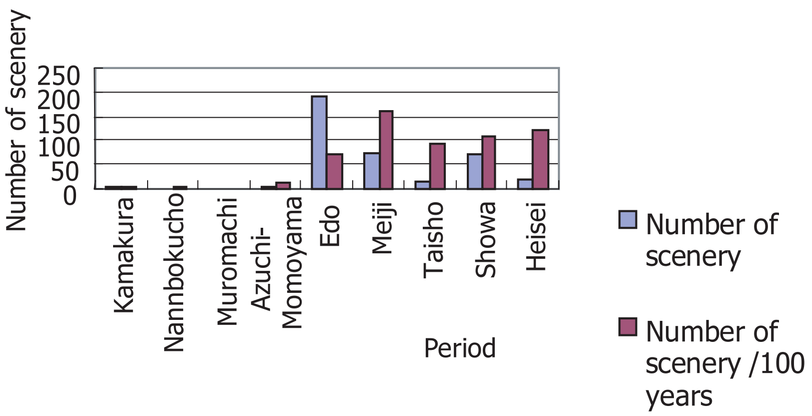
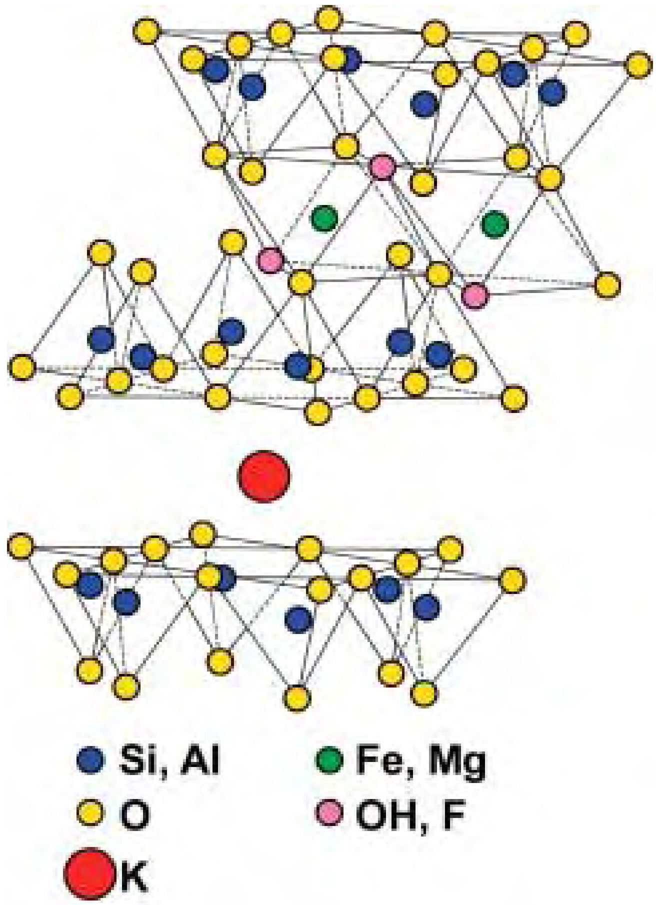


Fig. 3
Historical distribution of the "Eight Scenes" in Japan.

Environmental Chemistry Division



Structure of biotite

The Division, with its 4 research sections, develops analytical, bioanalytical, and geochemical methods for examining various chemical aspects of the environment.

The Analytical Instrumentation and Methodology Section has been developing new analytical methods and instrumentation. We developed lithium-drifted silicon (Si(Li)) detectors and TlBr detectors for charged particles and X- or gamma rays; diamond devices for ultraviolet light emission and detection; new carbon-based X-ray sources for environmental analysis; and new sensing materials for NO detection. We have initiated a new project in this fiscal year, aiming at producing hydrogen gas as an energy resource through development of a wind farm in the ocean on a large-scale floating platform navigating in the exclusive economic zone (EEZ) of Japan. Under the project, four major research themes were carried out: collection and analysis of wind conditions in the EEZ; design of a large-scale floating platform to support the system; improvement of the electrolysis system which produces hydrogen and oxygen gas directly from seawater; and the energy life-cycle assessment of the proposed system.

The Analytical Quality Assurance Section has been developing methods of analytical quality control by determining the most appropriate environmental analytical methods and preparing certified reference materials. We investigated methods of sample preparation and gas chromatography-high resolution mass spectrometry (GC-HRMS) analysis of polychlorinated-*p*-dibenzodioxins (PCDDs), polychlorinated-*p*-dibenzofurans (PCDFs), co-planar polychlorinated biphenyls (co-PCBs), and polybrominated dibenzodioxins/furans (PBDD/DFs) in various environmental samples. We successfully performed analytical quality assurance of environmental PCDD/PCDF monitoring by using certified environmental reference material NIES CRM-No. 21, “Soil”. We also studied methods of measuring fine particulates and volatile organic compounds (VOCs) in the atmosphere. Continuous monitoring of VOCs has been carried out at Tsukuba and Tokyo to establish quality assurance for the sophisticated automatic sampling GC-MS instruments and to characterize VOC pollution in metropolitan areas. VOC concentrations varied greatly from day to day at both monitoring sites, and the concentrations in Tokyo were several times higher than those in Tsukuba.

The Environmental Chemodynamics Section has been developing methods of chemical speciation by liquid chromatography-inductively coupled plasma mass spectrometry (LC-ICPMS) and LC-mass spectrometry (LC-MS); investigating the application of surface analytical methods such as secondary ion mass spectrometry (SIMS); determining stable isotopes by isotope ratio mass spectrometry (IRMS) and multi-Faraday-cup ICPMS; and performing radiocarbon analysis by accelerator mass spectrometry (AMS). We applied AMS radiocarbon analysis to the tasks of global carbon circulation determination, pollutant source apportionment, and reconstruction of historical environmental changes. We investigated the heat separation of black carbon from airborne particulate samples. Preliminary measurement of the ^{14}C age of airborne black carbon indicated that biogenic black carbon is dominant in Tsukuba and fossil carbon is dominant at Tokyo roadsides.

We used the surface analytical techniques of secondary ion mass spectrometry (SIMS) and X-ray photoelectron spectroscopy (XPS) to study the chemical weathering of rocks and minerals, which is essentially a surface process. Surface analysis of acid-treated biotite [$K(Fe,Mg)_3AlSi_3O_{10}(OH,F)_2$], a common rock-forming aluminosilicate mineral (Fig. 1), showed that Fe, Mg, K, and Al were selectively leached during acid dissolution, resulting in the formation of an altered surface layer rich in Si (hydrous silicon dioxide) and a cation-exchange zone (Fig. 2). In contrast, a thick, altered surface layer was not observed in the case of naturally weathered biotite. In biotite under natural weathering, unlike under acid treatment, Al was held in the surface layer. Because the mechanism of chemical weathering depends on the ambient solution reacting with the minerals, surface characterization of weathered minerals gives us useful information about weathering conditions.

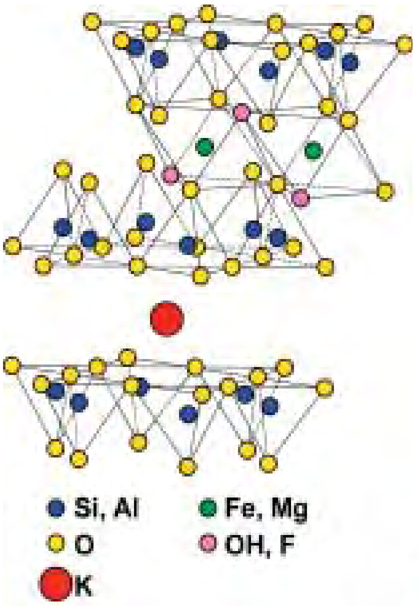


Fig. 1
Structure of biotite.

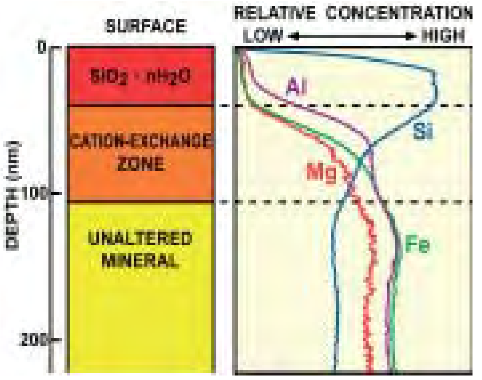


Fig. 2
Depth profile of biotite after acid dissolution (0.05 mol L^{-1} H_2SO_4) for 1 week.

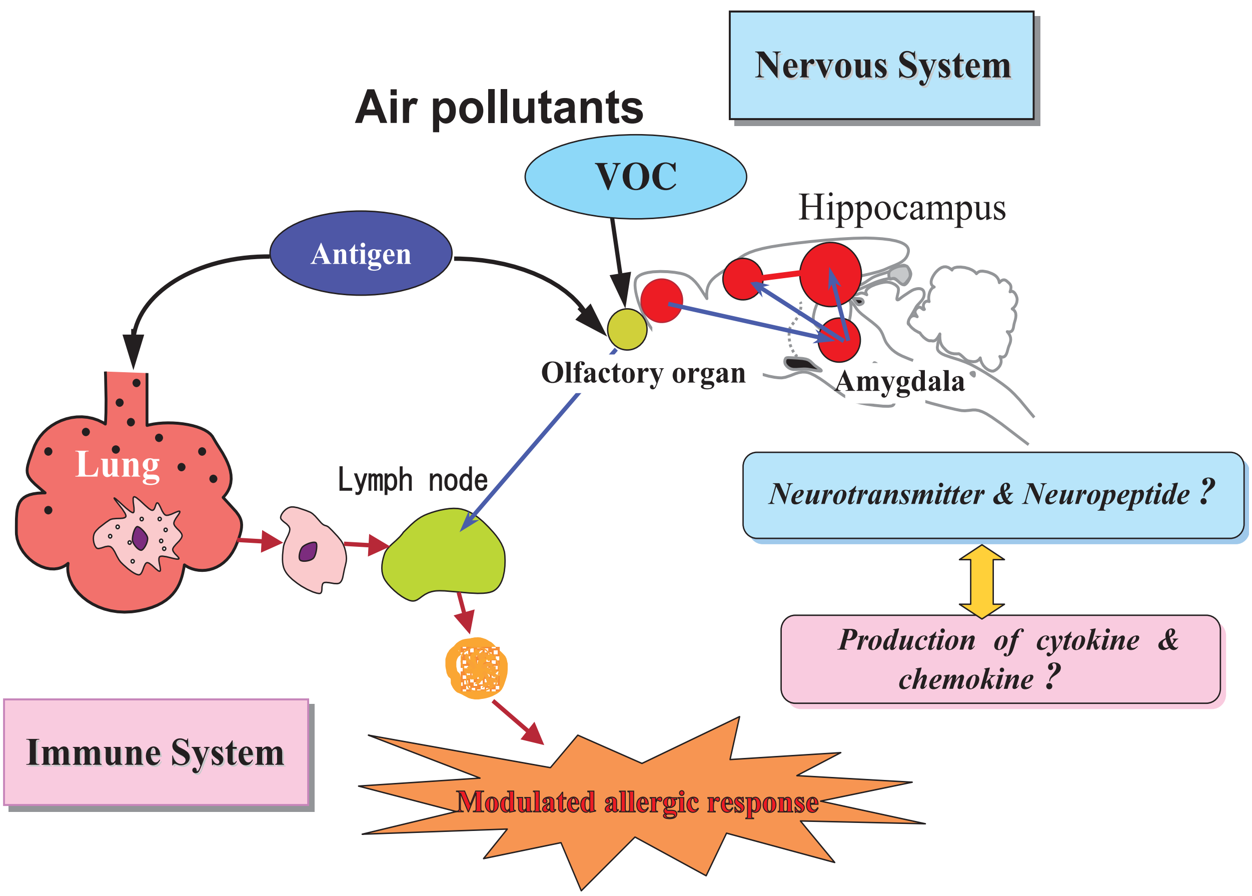
We developed our analytical methods and environmental monitoring strategies further to support the implementation of the Stockholm Convention on global elimination of persistent organic pollutants (POPs): for example, we established a system of marine pollution observation that uses international merchant vessels.

The Ecological Chemistry Section has been studying biochemical measurement and the biological effects of chemicals. Research on arsenic and on endocrine-disrupting chemicals has continued. We synthesized a series of organoarsenic compounds as part of our research on ground water organoarsenic pollution. We also conducted emergency research in response to an outbreak of carp herpesvirus infection at several locations in Japan, including Lake Kasumigaura. We continued research on the initial risk assessment of pharmaceuticals in the aquatic environment by developing both an LC-MS analytical method and a bioassay method.

Further, our senior research scientist conducted a research program on the fate of methyl halides and other VOCs on a global scale. We analyzed the methyl chloride concentrations in ice cores drilled in Antarctica to reconstruct historical patterns of change. The methyl chloride concentration in shallow cores was almost identical to the present level, whereas that in the Yamato ice core was higher than the present level, indicating that the methyl chloride concentration varied in the past.

In FY 2003, much effort was made to develop a method of analyzing an unusual organoarsenic compound, diphenylarsinic acid (DPAA), in various samples, including water, soil, and human tissue. DPAA is known to be an intermediate in the synthesis and decomposition of the old chemical weapons diphenylcyanoarsine and diphenylchloroarsine. In spring 2003, DPAA was found in ground water in the town of Kamisu in Ibaraki Prefecture, where it was affecting people's health. We developed a simple screening method, based on LC-ICPMS, for the identification and quantification of DPAA in various samples, and it was used to identify polluted wells and those people exposed to the chemical.

Environmental Health Sciences Division



The mission of the Environmental Health Sciences Division is to study the possible effects of harmful environmental chemicals (e.g. dioxins, environmental endocrine disrupters, heavy metals, air pollutants) and physical agents (e.g. ultraviolet radiation and electromagnetic fields) on human health. With this perspective, we aim to utilize the information obtained from these studies as a scientific basis for the risk assessment of these agents, alone or in combination. In this Division we perform both epidemiological and experimental studies. In the latter, we use laboratory animals as experimental models for humans. Although the use of these animals is essential in studying how environmental chemicals affect humans, the importance of alternative experimental models that replace laboratory animals has been recognized. Below, we highlight our progress in several study areas.

In the Molecular and Cellular Toxicology Section, this year's research was focused on the mechanisms of effects of dioxins, including 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) and polychlorinated biphenyls (PCBs). We examined how dioxins affect immune cells in animal studies and by using T cell lines. We also investigated the transcriptional activities of the aryl hydrocarbon receptor (AhR) (the transcription factor that mediates dioxin toxicity) in various animal species and strains, to gain insight into species- and strain-dependent sensitivity against TCDD. Factors or modifiers that affect sensitivity to TCDD were also studied. We used a toxicogenomic approach in many of our studies. In our study of the mechanism of the action of dioxins, we examined the effects of AhR activation on a T cell line by transiently expressing a constitutively active AhR (CA-AhR) mutant in AhR-deficient Jurkat T cells. CA-AhR expression markedly inhibited cell growth. This result was consistent with our previous observation that administration of TCDD to mice inhibits T cell expansion following antigen stimulation. Growth inhibition of the Jurkat T cells was accompanied by both an increase in the numbers of apoptotic cells and the accumulation of cells in the G_1 phase. Furthermore, CA-AhR induced changes in gene expression related to apoptosis and cell cycle arrest. These results suggest that AhR activation causes apoptosis and cell cycle arrest, especially through expression changes in apoptosis- and cell cycle arrest-related genes, and leads to the inhibition of T cell growth. This inhibitory effect of TCDD on T cells may be involved in TCDD-induced immune suppression.

In the Environmental Biodefense Research Section, we focused on changes in neuropeptides and growth factors of mice exposed to formaldehyde or toluene, in order to evaluate the effects of low-level volatile organic compounds on neuro-immuno interaction. Exposure to low-level formaldehyde modulates the expression of mRNAs of neuroreceptors, such as glutamate receptors and dopamine receptors in the hippocampus. The hippocampal NMDA receptors are the key molecules in neuronal memory formation. Immunization with ovalbumin (OVA) significantly enhanced the expression of hippocampal neuroreceptor mRNAs in mice exposed to formaldehyde. Exposure of immunized mice to toluene induced patterns of expression of neuroreceptor mRNAs different from those seen after formaldehyde exposure. Production of nerve growth factor (NGF) and expression of NGF mRNA in the hippocampi of immunized mice exposed to formaldehyde was significantly increased.

In bronchoalveolar lavage fluid, exposure to formaldehyde slightly increased the production of NGF (Fig. 1a). Although OVA immunization significantly increased the production of NGF, a combination of formaldehyde exposure and OVA immunization conversely decreased it (Fig. 1b). Exposure to toluene did not affect the production of NGF in immunized mice. Long-term exposure to low levels of formaldehyde, together with the allergic condition induced by OVA sensitization, may act on the olfactory system and the hypothalamo-pituitary-adrenal axis. These results suggest that exposure to low-level formaldehyde or toluene may disturb the neural and immune network.

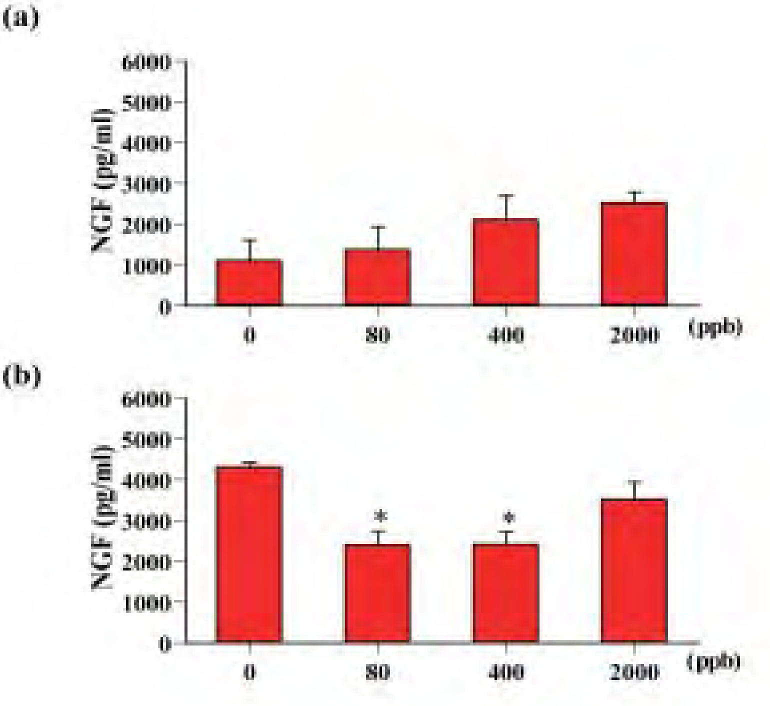


Fig. 1
Nerve growth factor (NGF) production in bronchoalveolar lavage (BAL) fluid.
(a) Production of in BAL fluid of nonimmunized mice exposed to low levels of formaldehyde was slightly increased.
(b) Exposure of mice immunized with ovalbumin to 80 or 400 ppb formaldehyde significantly decreased the production of NGF in BAL fluid compared with the control (0 ppb formaldehyde).
$^{*}P < 0.05$

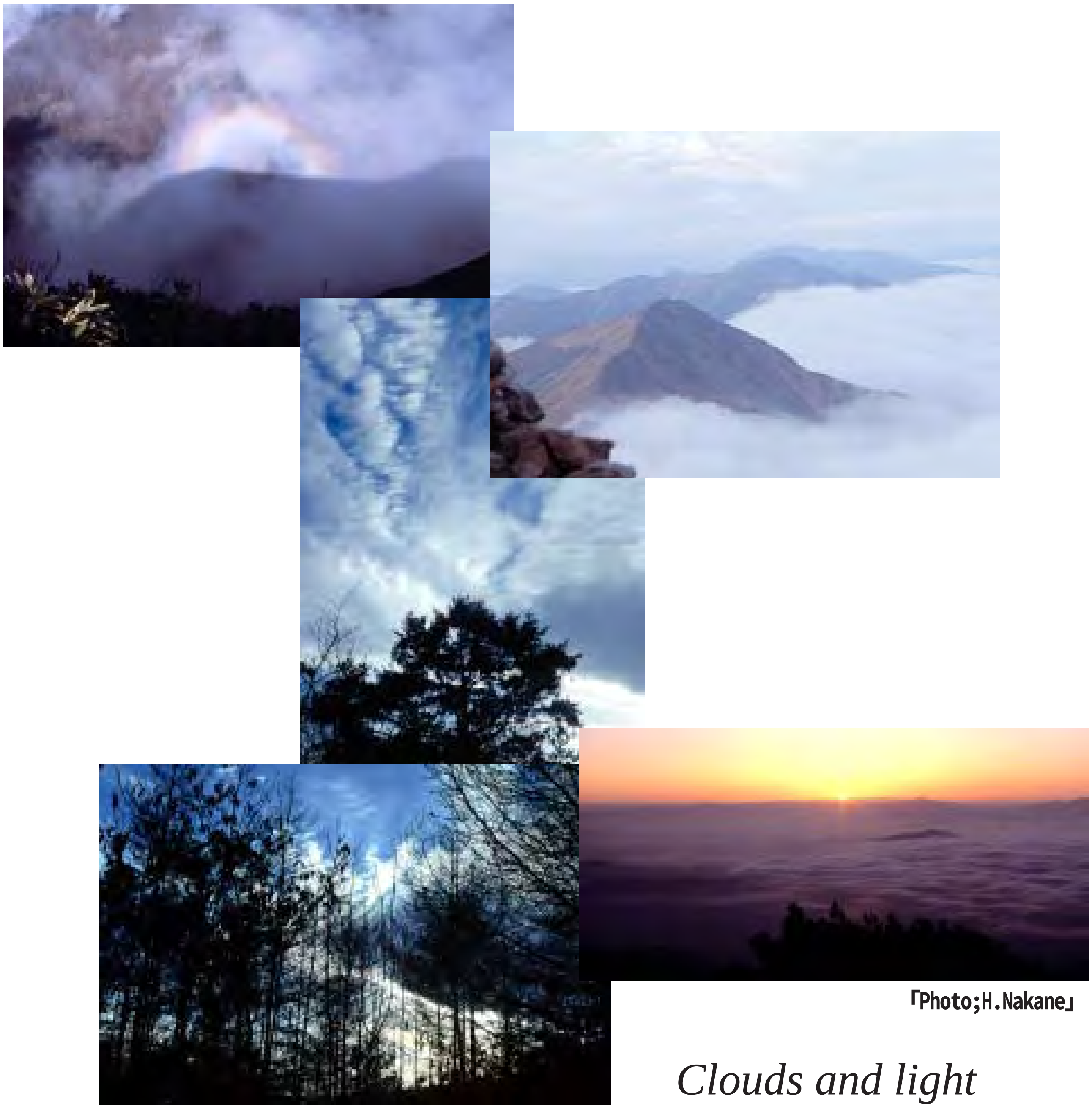
In the Biomarker and Health Indicator Section, we have been targeting the metabolic behavior and toxicity of arsenicals. Intake of inorganic arsenic is known to cause vascular diseases as well as skin lesions and cancer in humans. Inorganic arsenic has been reported to be metabolized in the liver, producing methylated arsenicals. We investigated the cytotoxicity and uptake rates of arsenicals and the gene expression of heme oxygenase-1 (HO-1) (a biomarker of arsenic exposure in many types of cells) in rat heart microvessel endothelial cells. Arsenite (iAs^{III}) was more cytotoxic than arsenate (iAs^{V}), and the LC_{50} values for iAs^{III} and iAs^{V} were calculated to be 36 and 220 μM, respectively. Monomethylarsonic acid (MMA^{V}, LC_{50} = 36.6 mM) and dimethylarsinic acid (DMA^{V}, LC_{50} = 2.54 mM) were less toxic than inorganic arsenicals. Trimethylarsine oxide (TMAO) was essentially not toxic. However, monomethylarsonous acid diglutathione ($MMA^{III}(GS)_2$) was highly toxic (LC_{50}= 4.1 μM). The mRNA level of HO-1 paralleled the cytotoxic effects of the arsenicals. Overall, the order of cellular arsenic accumulation of those 2 inorganic and 4 organic arsenic compounds was $MMA^{III}(GS)_2 > iAs^{III} > iAs^{V} > MMA^{V} > DMA^{V} >$ TMAO.

The cellular arsenic concentration was measured by inductively coupled plasma mass spectroscopy (ICP MS). $MMA^{III}(GS)_2$ was efficiently and rapidly taken up by the cells, and the uptake rate of arsenic seemed to determine the toxicity of these arsenicals. Buthionine sulfoximine (BSO), a cellular glutathione (GSH)-depleting agent, enhanced the cytotoxicity of MMA^V. However, BSO reduced, rather than enhanced, the cytotoxicity of DMA^V. These results suggest that intracellular GSH modulated the toxic effects of arsenic in opposite ways to MMA^V and DMA^V. The oxidation state of arsenic and the number of methyl groups in arsenic metabolites are important determinants of the health effects of arsenic.

The Epidemiology and International Health Research Section conducted some epidemiological research. One was a series of field studies in Japan and China and another was a statistical analysis of trends in various health phenomena, with special reference to environmental factors. With the financial support of the Ministry of the Environment, we conducted field research on the measurement of fine particulate matter ($PM_{2.5}$) using a personal $PM_{2.5}$ sampler, and we assessed residential exposure to $PM_{2.5}$ in 7 research areas. In each of the 7 cities we selected 20 households as participants, and we measured $PM_{2.5}$ concentrations inside and outside the participants' houses over 1 week in winter. As a field survey in the city of Tieling, in Liaoning Province in China, we conducted health investigations (pulmonary function testing of schoolchildren and a questionnaire survey of schoolchildren and their parents), environmental monitoring, and exposure assessment of air pollutants (in particular, SO_2 and $PM_{2.5}$). Results from the city of Shenyang, where the survey had been conducted the previous year, showed elevated levels of atmospheric pollutants from the combustion of fossil fuels both indoors and outdoors. Pulmonary function values among children were significantly depressed in April. This result suggests that, in winter, air pollution has subacute effects on pulmonary function.

We also performed a statistical analysis of the short-term effects of the daily average concentration of air pollutants on mortality in 13 major cities in Japan. The analysis was focused mainly on the effects of suspended particulate matter (SPM) on respiratory and cardiovascular diseases. We found that an increase of 10 $\mu g/m^3$ in SPM concentration increased the daily mortality rate by 0.7% from all causes other than accidents, by 1.1% from respiratory diseases, and by 0.8% from cardiovascular diseases.

Atmospheric Environment Division



「Photo;H.Nakane」

Clouds and light

This Division is conducting research with the aim of understanding and solving atmospheric environmental problems ranging from urban air pollution to global and trans-boundary atmosphere-related issues. The division consists of 4 sections and 1 team: the Atmospheric Physics Section, which conducts research on numerical modeling and data analysis of atmospheric dynamics and climate systems; the Atmospheric Chemical Reaction Section, which conducts research on chemical processes taking place in the atmosphere; the Atmospheric Remote Sensing Section, which conducts research on observations of the atmospheric environment using remote sensing techniques such as lidars (laser radars); the Atmospheric Measurement Section, which conducts field research on natural and anthropogenic trace species; and the Acid Deposition Research Team, which conducts research on trans-boundary air pollutants. Many of the members of this division also work for Special Priority Research Projects such as Climate Change Research, Ozone Layer Research, PM2.5 & DEP Research, and the Center for Global Environmental Research.

Following are brief accounts of some important results of our research in FY 2003.

Reproducing the 20th Century climate using GCM

Simulation of climate change in the 20th Century is important in ascertaining the performance of future climate projections using global climate models. It is also worthwhile in helping us to understand the mechanisms of climate change and to estimate the relative importance of natural and anthropogenic climate forcing. In this context, we are performing simulations of climate change in the 20th Century using a newer version of our coupled ocean-atmosphere GCM with both natural (solar variability and volcanic aerosols in the stratosphere) and anthropogenic (greenhouse gases, ozone, tropospheric aerosols, and land-use change) climate forcing. In an experiment with both natural and anthropogenic forcing, modeled changes in global annual mean surface air temperature showed very good agreement with the observed changes. In an experiment with natural forcing only, the simulated temperature change showed good agreement with observations made in the early part of the 20th Century, but it did not show the warming observed in the latter half of the century. In contrast, in the experiment with anthropogenic forcing only, there was no warming before the 1950s, but from then on the simulated warming pattern agreed with the observed pattern. This suggests that the warming observed in the latter half of the 20th Century resulted from anthropogenic climate forcing.

Aerial observation of atmospheric pollutants in China

In collaboration with Chinese researchers, aerial observations of aerosols and gaseous pollutants were carried out over central China along the Yangtze River (i.e., along the route from Shanghai to Wuhan to Chongqing) to better understand the atmospheric environment of East Asia and the Northwestern Pacific region. Experiments took place from 7 August 2003 to 13 September 2003 from a Yun-5, a Chinese single-engined biplane (Fig. 1). Changzhou (a small city near Shanghai) was chosen as a base for the observations. A total of 10 flights were made around Shanghai, Wuhan, and Chongqing. On board were an ozone analyzer, an SO_2 analyzer, and an NO_x analyzer to measure gaseous pollutants, and a particle sizer, a CNC, PM_{10} and $PM_{2.5}$ samplers, and an aerosol mass monitor for aerosol measurements. Good linear correlations between the concentrations of acidic species such as sulfate and nitrate and basic species such as ammonium and calcium were observed. The good correlations between nitrate and ammonium and between sulfate and calcium were in contrast to the results obtained from measurements over the East China Sea, where poor correlations were observed between those species. The results also revealed the presence of large emissions of ammonia and the ever-present soil dust in the air over this region of China.

Fig. 1
The Yun-5, a Chinese single-engine biplane used for air pollution measurements.

Continuous measurement of aerosol chemical composition on Fukue Island and Okinawa

The chemical compositions of aerosols were monitored continuously with an aerosol mass spectrometer (AMS) for more than 1 month on Fukue Island off western Kyushu (March-May 2003) and at Cape Hedo on Okinawa's main island (October 2003-March 2004) (Fig. 2). On Fukue Island, high concentrations of sulfate were observed when the air mass came from the direction of central eastern China, whereas high concentrations of organics were found when the air mass passed over the Korean Peninsula. The ratio of NH_4 to SO_4 was much smaller (about 0.5 to 1) at Cape Hedo than on Fukue Island (about 0.96 to 1). This result suggests that oxidation of SO_2 to sulfuric acid takes place during long-range transport of polluted air, and ammonia gas is removed by deposition.

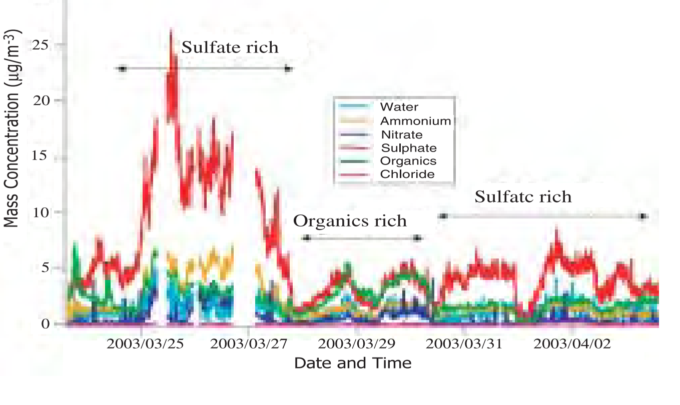


Fig. 2
Continuous measurement of aerosol chemical composition by aerosol mass spectrometer (AMS). Red: sulfate, green: organics, dark blue: nitrate, yellow: ammonium. Sulfate levels were very high from 25 to 27 March 2003, when the air mass was transported from central eastern China.

Modeling behaviour of nitrogen oxides in East Asia

We examined the annual concentration and deposition of nitrogen oxides in East Asia using a regional chemical transport model (HYPACT) coupled with a regional atmospheric modeling system (RAMS). The model domain covers an area of 4800 km (x) × 4400 km (y) in East Asia, with a horizontal grid spacing of 80 km. There are 60 grid points for longitude, 55 for latitude, and 23 for altitude, and the vertical limit is 20 km. So far we have conducted a numerical simulation for one year, 1995. HYPACT can reproduce annual amounts, seasonal variations, and spatial distributions of wet deposition of nitrogen oxides over Japan. However, the differences between the modeled and observed concentrations of particulate NO_3^- vary remarkably from site to site. Further, the modeled rate of conversion from gaseous HNO_3 to particulate NO_3^- is too low in winter.

Tower and aircraft observation of CO_2 in western Siberia

To analyze the exchange of CO_2 between the planetary boundary layer (PBL) and the free troposphere, we conduct frequent measurements of atmospheric CO_2 using a small aircraft and a tower in a forested area of western Siberia. A system of continuous CO_2 measurement was installed in the 90-m-high tower in the village of Berezorechka (56˚10´N, 84˚20´E) in October 2001. Observations are also performed 2 or 3 times a month from an Antonov-2 at altitudes between 2 km and 0.15 km over Berezorechka. The CO_2 mixing ratios observed at the tower show a clear diurnal variation, with lower values in the daytime and higher values at night. The amplitudes in diurnal variation are less than 15 ppm in winter and up to 120 ppm in summer. The peak-to-peak amplitude of the seasonal CO_2 variation within the PBL (35 ppm) is about twice as large as that observed in the free troposphere (19 ppm).

Ground-based measurement of CO_2 using FTIR

Recently, attention has been focused on the ground-based measurement of CO_2 using Fourier transform infrared (FTIR) spectrometers that use solar radiation as a light source. This method is the most appropriate for validating the satellite sensors planned for measuring CO_2 column concentration, such as those of the Orbital Carbon Observatory (OCO) in the USA and Japan's Greenhouse Gases Observing Satellite (GOSAT). We introduced solar radiation into FTIR spectrometers by using a solar tracking system and obtained short-wavelength infrared spectra with a wavenumber of 0.03 cm^{-1} in resolution. Figures 3 and 4 are examples of the CO_2 absorption spectra observed at around 1.58 μm (6330 cm^{-1}) and also show the residual spectrum after removal of absorption by the solar atmosphere. Column amount and vertical profiles of CO_2 concentration were calculated and used to simulate the observed spectrum. The simulated spectrum (blue line) and observed spectrum (red line) agree well. The systematic error of the calculated CO_2 column concentration was estimated to be less than 1%.

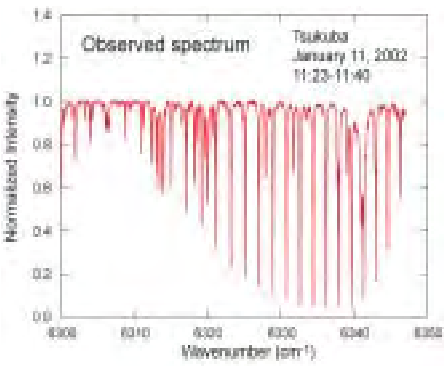


Fig. 3
Example of solar spectrum in the region of wavenumber 6300-6347 cm^{-1}.

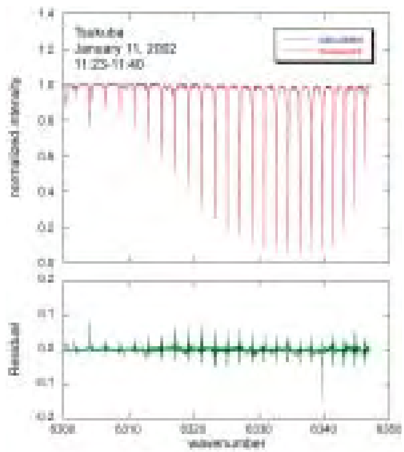


Fig. 4
CO_2 spectrum in the region of wavenumber 6300-6347 cm^{-1} after removal of absorption by the solar atmosphere (red). The simulated (blue) and residual (green) spectra are also shown.

Water and Soil Environment Division

The scene of monitoring at Lake Kasumigaura

Water—in precipitation, rivers, lakes, seas, and soil—is vital for our lives. Once the environment has been polluted, the time and cost needed for its restoration are enormous. Our Division undertakes research from a variety of approaches on the environmental pollution and ecological changes that occur via the media of water and soil.

Application of microbial ecology to environmental management

Microorganisms play a major part in various important biogeochemical transformations, such as mineralization of organic compounds and degradation of pollutants. In recent years, pollution-induced changes have been recognized in microbial community structures in various environments. For a more complete understanding of these processes we need a more complete accounting of the contributing microbial populations.

We are currently studying the contribution of microbial populations to the nitrogen cycle in aquatic ecosystems. Nitrification, the oxidation of ammonia to nitrates via nitrites, is central to the cycling of nitrogen in the environment and, when coupled with denitrification, alleviates the effects of eutrophication through removal of nitrogen to the atmosphere as nitrous oxide or dinitrogen gas. Many different types of microorganisms, contribute to this biogeochemical cycle in various aquatic environments.

We have also studied biological processes for preserving the aquatic environment. Anaerobic digestion (methane fermentation) is an economical process for treating organic wastes and wastewater (or liquid wastes). In comparison with aerobic processes it has many advantages, such as lower energy input, higher energy recovery (as methane gas), and less sludge production. Nevertheless, anaerobic processes have not been popular as treatment systems for diluted organic wastewater (with low organic concentrations under low temperature conditions), because it is difficult to maintain sufficient biomass retention time for the growth of methane-producing bacteria. Therefore, we need to develop a high-rate methane fermentation process for diluted wastewater. With this aim, we have been studying the mechanisms of biofilm formation under anaerobic conditions.

Leachability of constituent metals from Pb-free solders on exposure to precipitation

Recently, pollution from lead leaching out of solder in discarded electrical appliances has become an important environmental problem. Therefore, in the near future, Pb solder will be replaced by Pb-free solders containing other metals such as Ag, In, Sb, and Bi. However, information on the dissolution characteristics of Pb-free solders in the environment is extremely limited. We therefore investigated the leachability of constituent metals from Pb-free solders on exposure to precipitation, as follows: grains of Pb-free solders (0.8Ag-57Bi-Sn, 3Ag-2In-1Bi-Sn, 0.5Cu-3Ag-Sn, or 3Bi-8Zn-Sn) or Pb solder (37Pb-Sn) were placed in an exposure apparatus that we designed and were exposed to precipitation on bare land or in a forest. The metals leached by precipitation were analyzed by inductively coupled plasma (ICP)-atomic emission spectrometry and ICP-mass spectrometry. Although the Pb-free solders usually dissolved more rapidly in the forest than on bare land, the average annual leaching of metals, calculated on the basis of the weight of each metal, was as follows: Zn (19.1±5.7 mg/g-Zn) > Cu (4.7±2.2 mg/g-Cu) > Pb (1.5±1.3 mg/g-Pb)≫In (25±19 μg/g-In) Sn (23±19 μg/g-Sn) > Bi (7±16 μg/g-Bi) ≫Ag (0.8±0.9 μg/g-Ag). Divalent metals such as Zn, Cu, and Pb leached about 100 times as readily as rare metals. Therefore, replacement of Pb solder with Pb-free solders is expected to reduce the overall environmental risk, even if the toxicities of the rare metals are comparable to that of Pb.

Effects of coexisting surfactants and high-molecular-weight organic compounds on the aqueous solubility of trichloroethylene

Pollution of soil and groundwater by chlorinated organic solvents such as trichloroethylene (TCE) by transudation accidents has been increasing. Generally, these pollutants are hardly soluble in water, so they tend to be transported slowly in subsurface areas and are not likely to be removed from these areas. We considered that the direct injection of washing reagents, which are water-miscible and can solubilize such pollutants, into polluted subsurface areas would be very useful for the remediation of such sites. We therefore conducted a series of efficiency tests of this technique. We checked the dependence of the saturation solubility of TCE on 14 different additives (4 anionic surfactants, 5 non-ionic surfactants, 1 cationic surfactant, and 4 high-molecular-weight organic compounds). The solubility of TCE increased markedly when laurate, linear dodecylbenzenesulfonate, dodecylsulfate, cetyltrimethylammonium, Tween 20, Tween 60, Brij 35, or Brij 58 was applied. On the other hand, the solubility did not increase when Triton X-100, dodecanesulfonate, polyethyleneglycol 1000, polyethyleneglycol 6000, soluble starch, or β-cyclodextrin—each of which increases the solubility of other pollutants such as PAHs—was applied. These results indicate that it is very important to select an appropriate washing reagent for each target pollutant (Fig. 1).

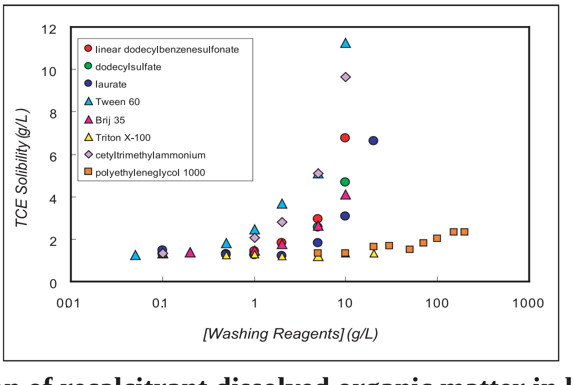


Fig. 1
Changes in saturation solubility of trichloroethylene in the presence of varying concentrations of several organic compounds.

Characterization of recalcitrant dissolved organic matter in lake water

A steady increase in recalcitrant dissolved organic matter (DOM) has been observed in several lakes in Japan, and this may be a new type of lake-water pollution. The accumulation of recalcitrant DOM in lake water—a phenomenon that has not been considered before—will clearly influence the way lakes are managed for environmental protection. It also presents a serious challenge for drinking-water management, because recalcitrant DOM could be a major precursor of the trihalomethane produced during chlorination in water treatment. Therefore, evaluation of the characteristics of DOM in lake waters is urgently needed.

To examine the characteristics and dynamics of DOM in lake water, we have developed a method by which DOM is separated into well-characterized macro-fractions. The DOM fractionation scheme consists of two experimental procedures: a long-term (100-day) degradation test, and a DOM resin-fractionation method. The long-term degradation test produces recalcitrant DOM. The DOM resin-adsorption fractionation method divides DOM into 5 fractions: aquatic humic substances (AHS), hydrophobic neutrals (HoN), hydrophilic acids (HiA), bases (BaS), and hydrophilic neutrals (HiN). Consequently, DOM is fractionated on the basis of biodegradable-recalcitrant, acidic-basic, and hydrophobic-hydrophilic breaks into 10 fractions: AHS, HoN, HiA, BaS, HiN, and their recalcitrant fractions.

We applied the DOM fractionation method to water samples from Lake Kasumigaura in Japan. We found that the majority of recalcitrant DOM in the lake water was composed of AHS and HiA. HiA predominated heavily over AHS in recalcitrant lake-water DOM. Furthermore, accumulation of recalcitrant DOM in the lake water was primarily caused by an increase in HiA during winter.

How does human activity affect aquatic and marine continua?

The Laboratory of Marine Environment is working with the relationship between anthropogenic loading of nutrients and the health of marine ecosystems. It is testing the "silica deficiency hypothesis", which explains the deterioration of the marine environment in terms of increased loadings of nitrogen (N) and phosphorus (P) and a decrease in the supply of silica from rivers. According to this hypothesis, freshwater diatoms take up DSi (dissolved silicate) and sink easily to the bottoms of the increasing number of reservoirs because the water is still, leading to a reduction in the amount of DSi flowing down to the sea. Increased anthropogenic loading of N and P and continuing construction of reservoirs and dams further enhance this tendency. Consequently, numbers of non-diatomaceous algal species (which are non-siliceous and potentially harmful) increase in place of diatoms (which are siliceous and mostly benign) in coastal areas, because diatoms cannot grow without Si. We comprehensively examined the biogeochemical trends in an aquatic continuum composed of Lake Biwa (an assumed reservoir), the Yodo River, and the Seto Inland Sea. DSi levels had decreased remarkably in Lake Biwa and suggested the importance of global silica decline (Fig. 2).

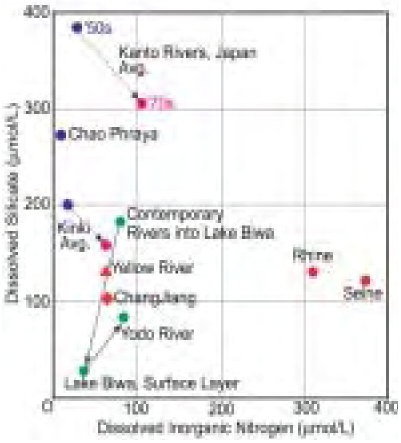
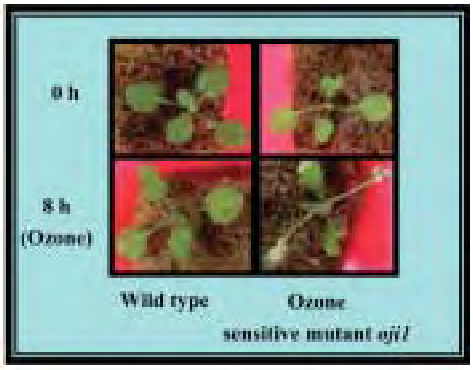


Fig. 2
Geographical variations and long-term shifts in dissolved inorganic nitrogen (DIN) and dissolved silicate (DSi) concentrations in river waters. For example, the river water loses its DSi after it enters Lake Biwa, a eutrophic fresh water body (●). In the rivers of the Kanto and Kinki regions of Japan, DIN increased and DSi decreased from the 1950s (●) to the 1970s (●), after the rapid economic growth of the 1960s (broken arrows). European rivers such as the Rhine or Seine are currently characterized by high DIN and low DSi (●). The water quality of the Changjiang (Yangtze River) (◆) in China will shift toward higher DIN and lower DSi after the construction of the Three-Gorges Dam. The "Duan-Liu" phenomenon —cessation of flow in the lower part of the Yellow River (▲)—may also reduce the supply of DSi to the sea and deteriorate the marine ecosystem.

Environmental Biology Division

Forest canopy observation at Pasoh Forest Reserve in Malaysia



Leaf damage by ozone in wild type and an ozone-sensitive mutant (oji1) of *Arabidopsis thaliana* isolated and characterized at this institute

Lichens harbor algal photobionts

Obitsu River delta, the largest natural wetland in Tokyo Bay

The Environmental Biology Division consists of 4 sections: Ecosystem Function Study, Biodiversity and Phylogenetic Study, Tropical Ecology, and Molecular Ecotoxicology. The Division performs basic and applied research on the effects of various environmental stresses, both chemical and physical, on organisms at various levels, from molecules and cells to individuals, species, populations, and ecosystems. The Division's work is also directed toward the conservation of genetic biodiversity, species, and ecosystems. In 2003, the Division performed 16 studies funded by NIES, 4 studies supported by the Global Environmental Research Fund (Ministry of the Environment), 2 studies funded by the Ministry of Education, Culture, Sports, Science and Technology, and 4 studies funded by other ministries.

Ecosystem Function Study Section

Succession of salt marsh vegetation in the largest delta in Tokyo Bay, Japan

We examined the relationships between the distributional pattern of each salt-marsh plant species and the micro-topographic characteristics of the Obitsu River delta, the largest natural wetland in Tokyo Bay. From examination of vegetation maps made in 1974, 1984, and 2001, we found that the area of the hinterland swamp expanded between 1974 and 2001. Examination of each landscape unit area in 1974, 1984, and 2001, revealed that salt-swamp plant communities in areas that flooded at high tide, such as the *Phragmites australis*, *Carex pumila*, and *Suaeda maritima* communities, had diminished in size, and plant communities in areas that did not flood at high tide, such as *Phacelurus latifolius*, had expanded. Sand dunes, grassland, and woody plant communities had decreased in size. Ruderal plant communities had expanded. Most of the area vegetated by *Suaeda maritima* became occupied by *Carex pumila* between 1980 and 2001.

Our examination of aerial photographs taken in 1974, 1984, and 2001 to investigate changes in the geographical features of the area revealed that the overall area covered by water decreased between 1974 and 2001. In the north, sand accumuluated and formed sandbars, and a natural waterway connected with the sea became partly closed. Moreover, in the south, although part of the *Pinus thunbergii* community had been eroded, a new geographical feature—a sandbar—projected toward the ocean.

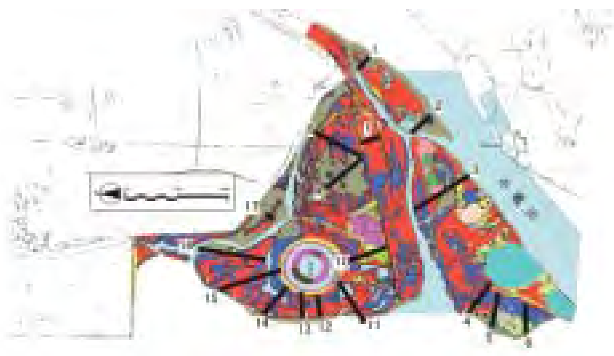


Fig. 1
Vegetation map of Obitsu River delta in 2001.
■: *Phragmites australis*
■: *Carex pumila*
■: *Suaeda maritima*
■: *Phacelurus latifolius*

From the transition of the vegetation, we concluded that the altitude of the whole delta has risen since 1984 and the distribution of terrestrial plants had therefore been extended.

Biodiversity and Phylogenetic Study Section

We conducted fundamental research to reveal the diversity of microorganisms and benthic animals and achieved the following results.

1) Three species (including 1 new one) of the haptophyte alga *Platychrysis*, detected by Transmisson Electron Microscopy observation, were isolated from Thailand. *Platychrysis pienaarii* showed strong toxicity and shared the same clade with *Prymnesium* (a toxic haptophyte) in the 18SrDNA tree, indicating their close relationship and the monophyly of toxic haptophytes.

2) Molecular markers to detect toxin genes were developed in 2 toxic cyanobacteria, *Microcystis aeruginosa* and *Planktothrix* sp. During the course of this investigation, we found that horizontal transfer and recombination among natural populations contributes to the genetic diversity of the toxin genes of *M. aeruginosa*.

3) We investigated exchanges of photobionts during vegetative reproduction in the lichen *Parmotrema tinctorum*, using molecular phylogenetic analyses and a DGGE technique. Photobiont exchange seems to be an ecological strategy of *P. tinctorum* in adapting to various environments (Fig. 2).

Fig. 2
Parmotrema tinctorum (arrow head) and various lichens growing on a tombstone (left), and cells of the algal photobiont *trebouxia corlicola* isolated from *P. tinctorum* (right).

4) The morphology of the larval mouthparts is a critical characteristic in the generic-level identification of chironomids. We found that, in *Fittkauimyia* sp., the shapes of the spine clusters on the mandibles changed conspicuously with growth, whereas no substantial changes were recognized in *Chironomus* species.

5) To apply HGM to a tidal flat area in Tokyo Bay, Japan, we determined the spatial and temporal variations of β-glucosidase and β-acetylglucosaminidase activity in sediments. The results showed that our methods were appropriate for taking spatially and temporally heterogeneous field samples as part of HGM assessment.

Tropical Ecology Section

With the aim of providing a new ecological assessment tool for viewing the current degradation status of forests and forecasting future environmental threats to forests from landscape changes, we conducted the following studies in a pilot study area of Peninsular Malaysia and China. 1) We gathered available information related to the ecological and socioeconomic functions and services of the rainforest. Our database was designed to establish linkages between individual ecological services. The ultimate aim was to determine the best way of optimizing ecological service values and goods and to give policy makers and local people better answers or guidelines for formulating landscape management plans. 2) On the basis of the ecological service database that we established, we then developed a risk assessment using GIS. With the aids of a computer and GIS software, we can quickly provide our clients information on the environmental risk of a proposed development (e.g. logging, forest clearing for plantation development, etc.). 3) To deepen our understanding of the problems faced by local communities in relation to deforestation, we studied the relationship between forest conservation systems and the aboriginal peoples of Peninsular Malaysia. Our results suggest that the forest certification program that has been conducted all over the world is quite useful for giving local forestry workers and inhabitants incentives for sustainable forest management.

To understand the contribution of grassland ecosystems to the terrestrial carbon budget, 3 years ago we began a project to examine CO_2, H_2O, and energy fluxes in alpine grasslands on the Qinghai-Tibetan Plateau. Major research activities are (1) estimation of the carbon budget of these alpine grassland ecosystems; (2) study of the ecological and biological mechanisms underlying the carbon cycle in alpine ecosystems; and (3) modeling of the relationship between global warming and ecological variables in the grassland ecosystems of the Qinghai-Tibetan Plateau.

Molecular Ecotoxicology Section

The Molecular Ecotoxicology Section aims to elucidate the effects of environmental stressors, such as air pollutants and ultraviolet light, on plants and the mechanisms of plant tolerance to conditions of stress. We are focusing on the genes involved in these protection mechanisms and are conducting molecular biological studies with various stress-related mutants of *Arabidopsis thaliana*.

We isolated a novel ozone-sensitive *Arabidopsis* mutant from T-DNA tagging lines. This mutant had severe foliar injury (shown in the picture at the front of this chapter) and higher ethylene emission than the wild type under 0.2-ppm ozone exposure. The ozone-induced injury and ethylene emission were suppressed by pretreatment with aminoethoxyvinyl glycine, an inhibitor of ethylene biosynthesis, in both this mutant and wild-type plants. Pretreatment with 10 μM methyl-jasmonate (MeJA), however, suppressed the ozone-induced foliar injury, shown as ion leakage (Fig. 3), and ethylene emission, only in the wild-type plants. This mutant was less sensitive to jasmonate than the wild type, as also shown by MeJA-induced inhibition of root elongation and ozone-induced expression of *AtVSP1*, a jasmonate-inducible gene. We therefore named this mutant *oji1 (ozone-sensitive and jasmonate-insensitive 1)*. These results suggest that the ozone sensitivity of *oji1* is caused by an increase in ozone-induced emission of ethylene as a result of low sensitivity to jasmonate, which plays a defensive role under stress conditions.

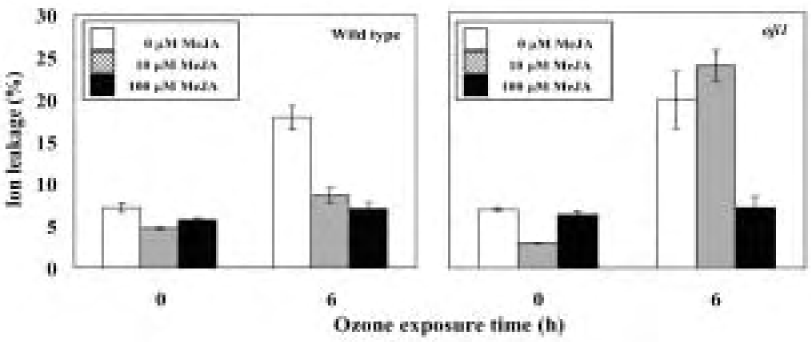


Fig. 3
Ion leakage from leaves (a quantitative index of injury) of MeJA-pretreated *Arabidopsis* seedlings exposed to 0.2 ppm ozone.

Environmental Information Center

The Environmental Information Center provides various kinds of environmental information for public through web sites.

The Environmental Information Center (1) provides information technology support for research and related activities at NIES, and (2) carries out public relations activities for NIES, including publication of NIES reports. In addition to these activities, the Center (3) performs various other activities, such as collecting and processing various kinds of environmental information and disseminating it to the general public, and performing tasks commissioned by the Ministry of the Environment. To implement these tasks more efficiently, the Center was reorganized in April 2003.

1. Information technology support for research and related activities at NIES

The activities of the Center in this field comprise: (a) management and operation of the computers and related systems at NIES; (b) improvement of work efficiency of NIES using information technology; and (c) running a library service.

a. Management and operation of computers and related systems

A new computer system started operation in March 2002. The system is an integration of a general-purpose computer system and a supercomputer system to meet the increasing demand for computing resources and a multiplicity of processing tasks. This UNIX-based computing environment consists of a supercomputer system and various subsystems, such as a scalar-computing server, a front-end server, storage devices, and application servers. Our vector-computing server (NEC SX-6/64M8), which employs an operating system equipped with a FORTRAN compiler with high-level debugging capability and high-efficiency optimization, executes the large-scale programs needed to handle global environmental problems.

A LAN called NIESNET was established at NIES in 1992. File transport in various computer systems, including the Gigabit Ethernet, was upgraded in March 2002. The network configuration was restructured, and large-scale file transport performance was improved at the same time. Registered users outside NIES can access the supercomputer system through the Tsukuba-WAN via the Science Information Network (SINET) connection to the Internet.

b. Improvement of work efficiency using information technology

The Center gives information technology support to the management sector of NIES, with the aim of increasing work efficiency. The Center also provides NIES researchers with relevant processed research data and helps them to disseminate their research data through the NIES homepage. In fiscal year 2003, the Center supported the following activities:

- construction of the research project database
- preparation of an automatic typesetting system, using XML, for issuing the NIES research program
- construction of a document management system for information disclosure
- preparation for the Intranet system to be managed by the General Affairs Division
- processing of various research data to be provided through the NIES homepage.

c. Library service

As of March 2004, the NIES library held 47,350 books, 462 technical and scientific serials, 8,501 maps, 116,531 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, MEDLINE, JOIS, DIALOG, STN-International, G-Search, and the British Library inside web.

Library facilities include separate reading rooms for books, journals, indexes and abstracts, reports, maps, and microfiche, as well as a database access room.

2. NIES public relations activities, including publication of NIES reports

The activities of the Center in this field comprise (a) management of the NIES World Wide Web (WWW) Internet site and (b) editing and publication of NIES reports such as the Annual Report and research reports.

a. Management of NIES WWW

NIES began to provide public information on its research activities and results via the Internet (www.nies.go.jp/index.html) in March 1996. The homepage was completely renewed and improved following the restructuring of NIES in April 2001 with a new status as an independent administrative institution. The design of our homepage was changed in April 2003 to improve accessibility to necessary information.

b. Editing and publication of NIES reports

Reports of 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

In addition to the activities mentioned above, the Center (a) collects, processes, and disseminates environmental information for the general public, (b) conducts tasks commissioned by the Ministry of the Environment, and (c) acts as the national focal point of UNEP-Infoterra.

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 (a-1) provides various kinds of environmental information for the public through web sites, (a-2) processes and manages environmental information databases, and (a-3) provides environmental information using GIS (geographic information systems).

(a-1) EIC Net and Environmental Technology Information Network

The "EIC Net" (Environmental Information & Communication Network, http://www.eic.or.jp/) provides various kinds of environmental information, such as news and topics on the environment, a chronology of environmental issues in Japan, and environmental education and training for children. In fiscal year 2003 we improved the homepage of the EIC Net and added more menus for ease of operation.

Further, the Center opened the Environmental Technology Information Network (http://e-tech.eic.or.jp/) in August 2003. It contains pages for environmental technology news on ministries and companies; research reports or coverage papers by environmental specialists; and seminar and event information on environmental technology.

At present, these homepages are available only in Japanese.

(a-2) 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 as monitored by local governments and reported to the Ministry of the Environment. These processed data can be accessed through the database on the NIES WWW, and duplication services and lending services are also available.

(a-3) Provision of environmental information using GIS

The Center, with the cooperation of the Ministry of the Environment, has been developing an environmental data provision system using a GIS. This system helps users easily understand the status of the environment, because it shows data on environmental quality together with 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

The Center performed the following 5 tasks commissioned by the Ministry of the Environment in fiscal year 2003.

(b-1) Development of an information system on total management of the aquatic environment

The purposes of the system are to help a wide range of people to understand the current state of Japan's aquatic environment and to support conservation activities and scientific investigations by providing relevant data and information through the Internet.

In this fiscal year, the Center developed an Internet system to register and display data from investigations of aquatic life. Relevant monitoring groups checked to registration of these observation data to examine the system and the Center held meetings of a study group, consisting of relevant researchers at NIES and local government officials in charge of preservation of the aquatic environment, to discuss how to improve the system.

(b-2) Management of display systems for wide-area air pollutant surveillance
The Center has developed an Internet system that displays real-time air pollution monitoring data from Japan. The system has been accessible to the public on the Internet since January 2002. This fiscal year, while operating and managing the system, the Center added a new system that collects pollen data from monitoring stations in both the Kanto and Kansai regions every hour and displays pollen counts on a map.

(b-3) Development of an information management system for noise, vibration, and offensive odor
This fiscal year, using “Environment GIS”, the Center developed a system for registering and displaying on the Internet data on the enforcement of noise, vibration, and offensive odor laws and on “100 Japanese Sites with Good Fragrance” and “100 Japanese Soundscapes”.

(b-4) Analysis of the results of a national survey of aquatic animals
This fiscal year, the Center has totaled, analyzed, and evaluated the results (collected by local governments) of a national survey of aquatic life, and has released a survey report. Moreover, the Center is considering making a homepage to deepen the public’s understanding of the survey and to widen the target audience.

(b-5) Collecting information on endocrine disrupters and constructing a database
This fiscal year, the Center added new data, collected and analyzed last year, to its database on endocrine disrupters, and a link to the database was added to the NIES homepage. The Center held a meeting of NIES and external specialists in this field to discuss this system.

c. National focal point of UNEP-Infoterra
UNEP-Infoterra is the global environmental information exchange network of the United Nations Environment Program. The network operates through a system of government-designated national focal points. The Center has been the designated national focal point of UNEP-Infoterra since 1975. These focal points provide a wide range of environmental information, including directories of information sources.

Laboratory of Intellectual Fundamentals for Environmental Studies

Time Capsule Building

The Laboratory of Intellectual Fundamentals for Environmental Studies (LIFES) consists of 2 research sections: the Environmental Analytical Chemistry Section and the Biological Resources and Informatics Section. They are responsible for organizing all of the intellectual research fundamentals accumulated since NIES began, and for developing basic research techniques that will be needed in future. These fundamentals and techniques are used for effective implementation of research and to form research networks.

LIFES functions as a reference laboratory for environmental research in Japan through: 1) improving methods of ensuring analytical quality control and cross-checking of analytical techniques; and 2) improving methods of classifying and culturing microalgae and other laboratory organisms, and preserving and supplying those organisms to provide standards for classification, standard strains for bioassay tests, and strains with special functions.

Preparation of environmental Certified Reference Materials

Environmental Certified Reference Materials (CRMs) are utilized for evaluation of new analytical methods and for the accuracy control of pretreatment and instrumental analyses. NIES has been preparing and distributing environmental and biological CRMs since 1980. Eleven kinds of CRM are now available for the quality control of an enormous amount of analytical data. Over 150 CRMs were distributed to researchers this fiscal year (Fig. 1).

Fig. 1
These Certified Reference Materials have been developed by LIFES.

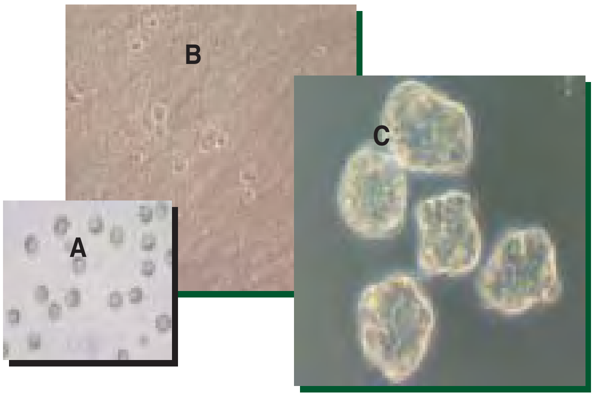
Long-term storage of environmental samples (environmental specimen bank)

We 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. The environmental specimen time capsule building, which was completed this March, is capable of accommodating various items of equipment for the low temperature preparation of environmental specimens for long-term storage, and to store such specimens for 50 years. The long-term cryogenic storage room is equipped with 14 ultra-low-temperature storage containers, where various specimens are stored in an atmosphere of liquid nitrogen vapor at about -150 ˚C (Fig. 2).

Fig. 2
Liquid nitrogen vapor tanks operated at about -150˚C for the long-term storage of environmental specimens.

Fundamental studies of germline stem cells using biotechnology

As a new development in the field of biotechnology, we are studying germline stem cells (primordial germ cells) in the Amniota (mainly in the Aves). We have made germline chimeras by transplantation of primordial germ cells, and by backcross analysis we have obtained offspring originating from the introduced primordial germ cells. 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 vertical infections via eggs and also in the recovery of populations from inbreeding depression by transplantation of primordial germ cells in the early embryonic stages (Fig. 3).



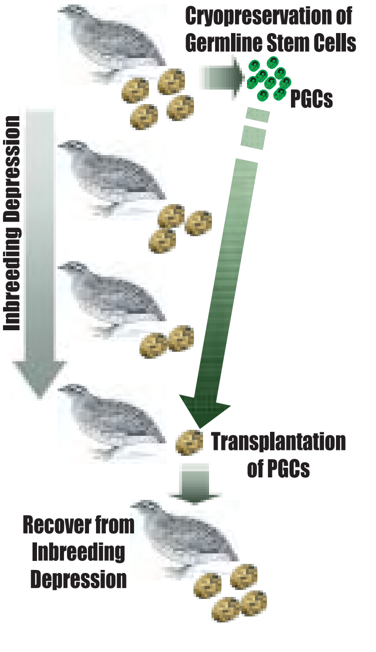


Fig. 3
Left: *In vitro* long-term culture of chick primordial germ cells (PGCs):
A: Isolated PGCs.
B: Initial phase of PGC culture on feeder cells.
C: Proliferated PGC colonies after 2 weeks' incubation.
Right: Use of frozen germline cells
Populations could be rescued from inbreeding depression by transplantation of stored primordial germ cells originating from young generation.

Preservation of cells and gene resources of threatened wildlife species

(1) Threatened wild animals

In the hope of future contributions to the conservation of threatened wild animals, we are cryopreserving their cells (including germline cells) and their tissues for genetic analysis, with the support of the National Time Capsule Program for the Environment and Threatened Wildlife. Samples (tissues, cultured cells, and sperm) cryopreserved between April 2002 and March 2003 included those from the Tsushima leopard cat (*Felis bengalensis euptilura*), Japanese crested ibis (*Nipponia nippon*) (Fig. 4), eagle owl (*Bubo bubo*), white-tailed eagle (*Haliaeetus albicilla albicilla*), Hodgson's hawk-eagle (*Spizaetus nipalensis orientalis*), Okinawa rail (*Gallirallus okinawae*), Steller's sea eagle (*Haliaeetus pelagicus pelagicus*), goshawk (*Accipiter gentiles fujiyamae*), ptarmigan (*Lagopus mutus japonicus*), Ryukyu ayu-fish (*Plecoglossus altivelis ryukyuensis*), deep-bodied bitterling (*Acheilognathus longipinnis*), Sakhalin taimen (*Hucho perryi*), and Ogasawara-yoshinobori (*Rhinogobius sp.*).

(2) Threatened algae

We have been surveying the status of threatened algal species in Japan since 1995. In the course of these surveys, we collect and culture strains of threatened algal species in our Biological Resource Collections. Now, 11 species of charophytes and 4 species of freshwater red algae are maintained in culture (Fig. 5). In particular, *Nitella furcata* var. *fallosa*, which was considered extinct, was isolated and cultured from the sediments of Lake Kasumigaura.

Fig. 4
The extinct Japanese crested ibis (*Nipponia nippon*).

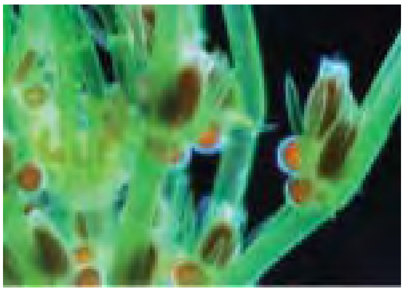


Fig. 5
A threatened charophyte, *Chara braunii*.

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

At the Microbial Culture Collection (MCC), we: 1) accepted 301 microalgal strains deposited by scientists within or outside NIES after evaluation by the Committee for

Evaluating Microbial Culture Strains; 2) made frozen samples of 76 strains of cyanobacteria, which are now entirely preserved in liquid nitrogen (we now have a total of 290 frozen strains); 3) distributed 645 algal strains; 4) renewed the MCC database system; and 5) published the 7th edition of the strain catalogue, which includes a list of 1221 strains and a list of 581 gene sequences data produced using NIES strains (Fig. 6). These activities are conducted in collaboration with 5 institutions as part of the National Bio-Resources Project.

Fig. 6
The NIES-Collection *List of Strains*, 7th Edition 2004, Microalgae and Protozoa.

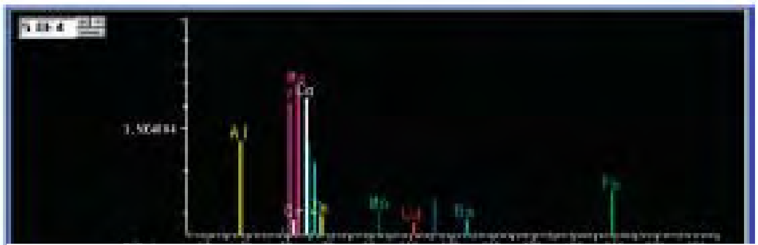
Development of a biodiversity information infrastructure for a wide range of bioresources

The laboratory has taken the lead in building its capacity for biological information sharing, both nationally and internationally. Under the UN Convention on Biological Diversity, a stuff of the laboratory serves as the Japanese Focal Point for the Global Taxonomy Initiative (GTI). As part of the GTI, we have developed databases on Japanese fauna and flora, disseminated biodiversity information, and supported the succession of knowledge in taxonomy. The GTI web site (Fig. 7) and the GTI Japan node of the Global Biodiversity Information Facility are milestones in the Japanese biodiversity information infrastructure. Accountable information on biodiversity underpins the sustainable management of bioresources and the free and appropriate sharing of research data.

Fig. 7
GTI web site homepage:
http://www.gti.nies.go.jp/

Management and operation of key analytical equipment

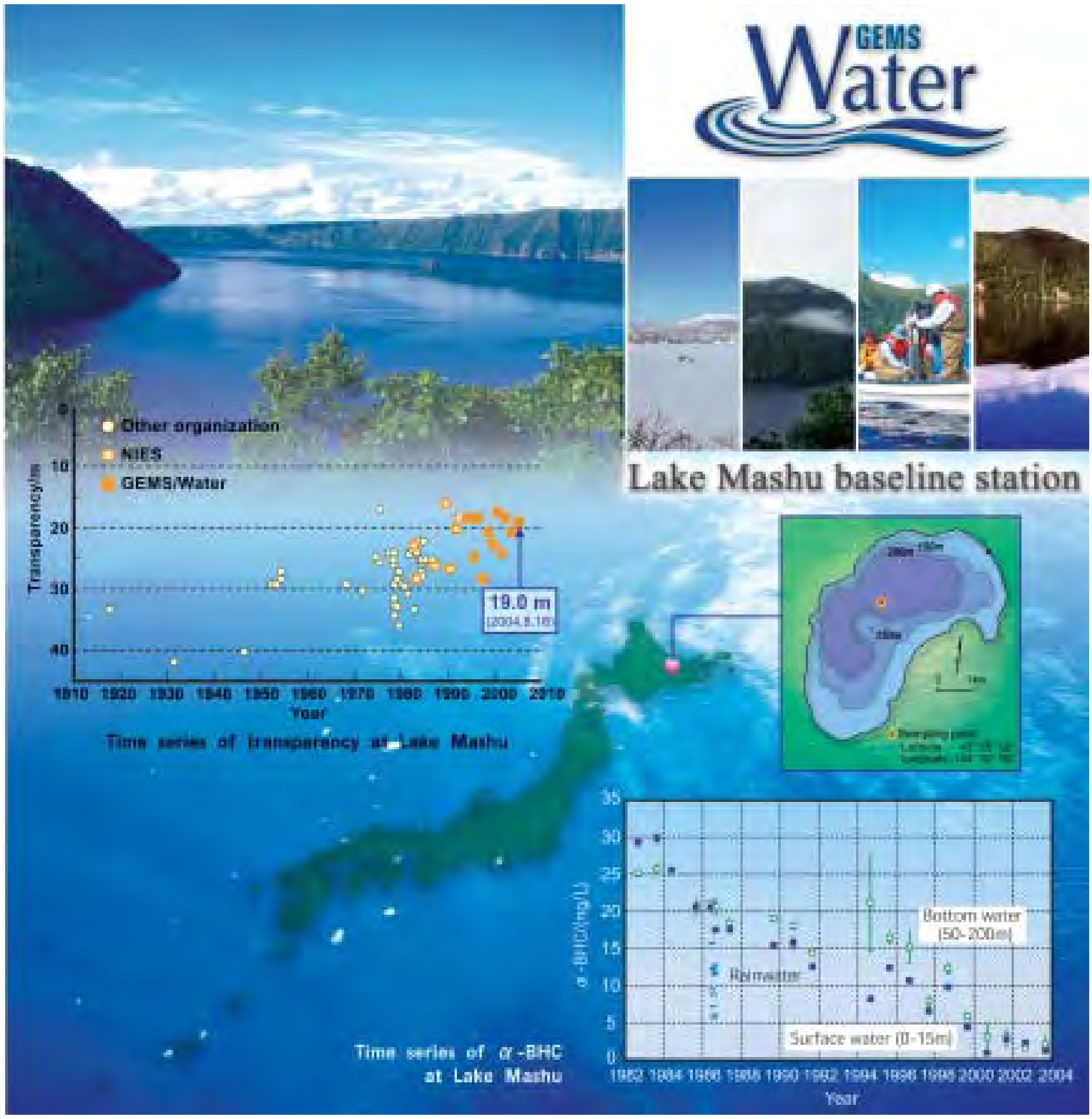
The laboratory has been working to improve the sensitivity and accuracy of analysis of environmental specimens at NIES and has been managing and operating commonly used key analytical equipment. An on-demand analysis service has been established and is operated by personnel technically trained in the use of 10 instruments. The analytical service was expanded when a new ICP/MS was installed this spring (Fig. 8). Requests for analyses on about 30 research themes were received from over 50 researchers, and we provided them with useful data derived under a high level of quality control.



Analytical result of a river water sample by an ICP/MS

Fig. 8
We have acquired a new ICP/MS instrument for trace analysis to the ppt (parts per trillion) level. The graph shows typical analytical raw data derived with the instrument.

Center for Global Environmental Research



The Center for Global Environmental Research (CGER) was established in 1990 to promote and support global environmental research from both national and international viewpoints to reduce the uncertainties of future prediction. CGER has 3 missions: monitoring of the global environment, support for global environmental research, and synthesis of global environmental studies.

1. Monitoring of the Global Environment

***In situ* monitoring of greenhouse gases (GHGs).** GHGs are monitored at 2 remote stations—Hateruma Island, over 1000 km southwest of the Japanese mainland, and Cape Ochi-ishi, in northeastern Hokkaido—together with related species (e.g., NO*x* and SO*x*), carbon isotope ratios, and oxygen concentrations, with the aim of furthering our understanding of atmospheric processes. Most species are measured automatically, but bottle sampling is also performed for some species. Over the latest 10 years, the average CO_2 concentration measured at both stations has increased from about 360 ppm to 380 ppm (Fig. 1)—a growth rate of about 2 ppm/year. This rate of increase is higher than that of the 1980s. The growth rate fluctuates each year with the climatic conditions. In particular, the occurrence of El Niño/Southern Oscillation (ENSO) events seem to significantly affect the growth rate. Large seasonal variation in CO_2 concentration due to photosynthesis by land plants was observed at both sites, whereas the daily variation was rather small. N_2O concentrations at both stations increased continuously between 1996 and 2003, but CH_4 concentrations have increased only very slightly over the last 7 years.

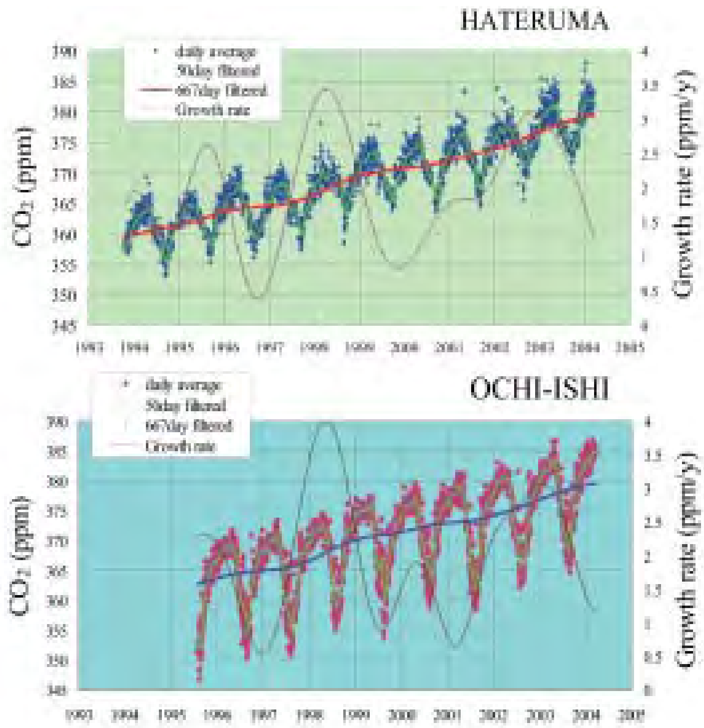


Fig. 1
CO_2 concentrations and trends at the Hateruma and Ochi-ishi greenhouse gas monitoring stations.

In addition, in the Pacific, 2 ships of opportunity were used to collect air samples along shipping routes between Japan and Australia and between Japan and the USA. The latitudinal distribution of GHGs was observed and isotopes were measured, and seasonal trends were plotted. Carbon isotope ratios showed that large variations in the CO_2 growth rate were associated with large variations in the land biota sink-source relationship.

In Siberia, the vertical distribution of CO_2 was measured over 3 sites every month. A larger seasonal variation in CO_2 concentration was observed at lower altitudes. Forests in Siberia seem to play an important role as sinks of CO_2 from the atmosphere, but Siberian wetlands appear to constitute a large source of CH_4.

Integrated carbon dioxide flux monitoring. The carbon exchange between the atmosphere and the terrestrial ecosystem, especially in larch forests, which are widely distributed throughout Asia, has been monitored at two remote stations, the Tomakomai FRS (Flux Research Site) at Tomakomai since 1999 and the Teshio CC-LaG (Carbon Cycle and Larch Growth experiment) site at Horonobe since 2001. To gain a better understanding of the mechanisms behind the CO_2 balance, we are making integrated observations using not only basic micrometeorological methods, but also physioecological methods. Moreover, to evaluate the spatial carbon balance from point data, we are developing a new remote-sensing technique for the quantitative detection of photosynthetic activity and biomass change.

Monitoring of stratospheric ozone. Vertical profiles of ozone are monitored at Tsukuba (lat 36˚02´N, long 140˚07´E) and at Rikubetsu in Hokkaido (lat 43˚30´N, long 142˚42´E) with millimeter-wave radiometers by measuring the emission spectra of ozone at 110.836 GHz. These radiometers are equipped with supercooled superconductor-insulator-superconductor (SIS) mixers, local oscillators, intermediate frequency processors and acousto-optical spectrometers (AOS). At Tsukuba, the bandwidth of the instrument was originally 60 MHz with 40 kHz frequency resolution, allowing measurements of vertical profiles of ozone from 38 km to 76 km in altitude. In FY 2003, we installed a newly developed single side-band mixer, which removed the need for a fine-tuning procedure to obtain single side-band operation. This modification resulted in higher stability in calibration and less noise. The variations in the ozone profile obtained at the Rikubetsu station were analyzed and correlated with variations in the synoptic-scale meteorological system.

In 2003, we also established a network to monitor harmful UV and performed inter-comparison to improve its accuracy.

Monitoring the ozone layer over the polar regions from space. The Improved Limb Atmospheric Spectrometer II (ILAS-II) aboard the ADEOS-II satellite observed the high latitudinal ozone layer from April to October 2003. On 25 October 2003, ILAS-II stopped performing measurements because of trouble with the satellite's power supply. The ILAS-II data handling facility (DHF), which is under the management of CGER, has been used to process, store, and distribute the ILAS-II data. Routine ILAS-II data processing began in April 2003 after several test measurements, and the data were processed and re-processed with revised processing algorithms. Distribution of Version 1.4x ILAS-II data products from the DHF to

ILAS-II registered researchers began in March 2004.

Water quality monitoring—GEMS/Water. CGER is participating in the Global Environmental Monitoring System Freshwater Quality Program (GEMS/Water), organized by UNEP and WHO for the collection and integration of monitoring data on terrestrial water bodies. Since 1994, monitoring data on river and lake water at 21 stations have been compiled.

- **Lake Mashu baseline monitoring:** Lake Mashu, in east Hokkaido, is one of the clearest lakes in the world. Since 1980, the water of Lake Mashu, as a representative of lakes least affected by pollution sources, has been sampled in late summer, when thermal stratification develops. Extremely precise analyses are performed on the samples, which are taken from the surface to the deepest point (212 m).
- **Lake Kasumigaura trend monitoring:** Since 1976, we have been conducting continuous field studies at every month Lake Kasumigaura, northeast of Tokyo, a representative Japanese eutrophic lake.

2. Support for Global Environmental Research

Standard gas system. We have developed a standard gas system for baseline monitoring of greenhouse gases (GHGs; e.g., CO_2, CH_4, N_2O, O_3) and other gases (e.g., NO, CO, H_2). Scales of standard gases for GHGs were compared with standard gases of NOAA/WMO, laboratories in the EU and the CSIRO in Australia to study differences in analytical data.

Global environment databases. CGER is creating original databases for researchers and policymakers. They include: 1) a greenhouse gas emission scenario database; 2) an emission inventory of air pollutants in Asia; 3) material flow; 4) a terrestrial ecosystem database for the tropics; and 5) potential (post) Kyoto carbon sink activities. This year, as part of our potential carbon sink assessment, we created an Afforestation and Reforestation (AR) activity dataset by remote sensing (Fig. 2).

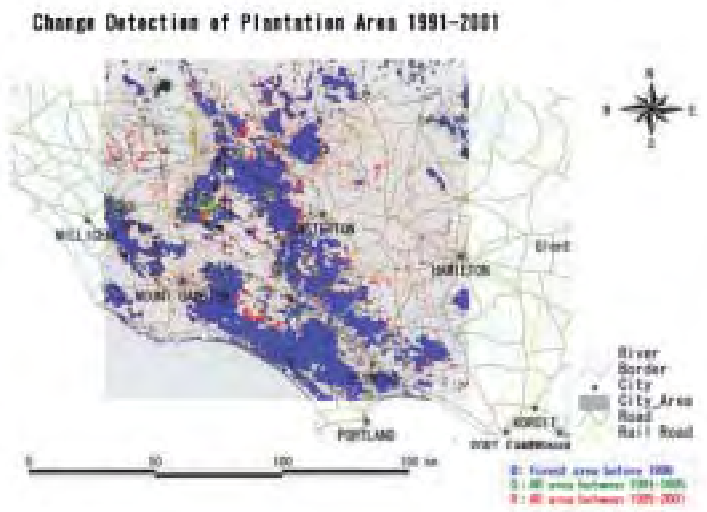


Fig. 2
Afforestation and Reforestation (AR) are considered emission reduction activities under the Kyoto Protocol. This historical AR activities dataset was created to show changes in the area covered by intensive forest plantation in southern Australia.

Greenhouse Gas Inventory Office of Japan. The Greenhouse Gas Inventory Office of Japan (GIO) was established in 2002. Its primary mission is to prepare and develop national inventories on emission and removal of GHGs, to be submitted to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC). GIO has been integrating diverse information relevant to GHG inventories and providing it to the public to promote GHG mitigation strategies and measures against global warming. Its main activities are:

- **Preparation of national GHG inventories.** GIO estimated emissions and removals of GHGs for the period 1990-2002, then compiled and submitted them as national inventories, including Common Reporting Format (CRF) tables, to the Secretariat of the UNFCCC on 24 May 2004. These inventories show that the total emissions in 2002 were 7.6% higher than those in the base year of the Kyoto Protocol (CO_2, CH_4, N_2O: 1990; HFCs, PFCs, SF6: 1995).
- **Conducting trend analyses of GHG inventories.** GIO conducted trend analyses of GHGs from 1990 to 2002; for example, it identified comprehensive emission trends of GHGs, analyzing the causes of decreases and increases (Table 1, Fig. 3).

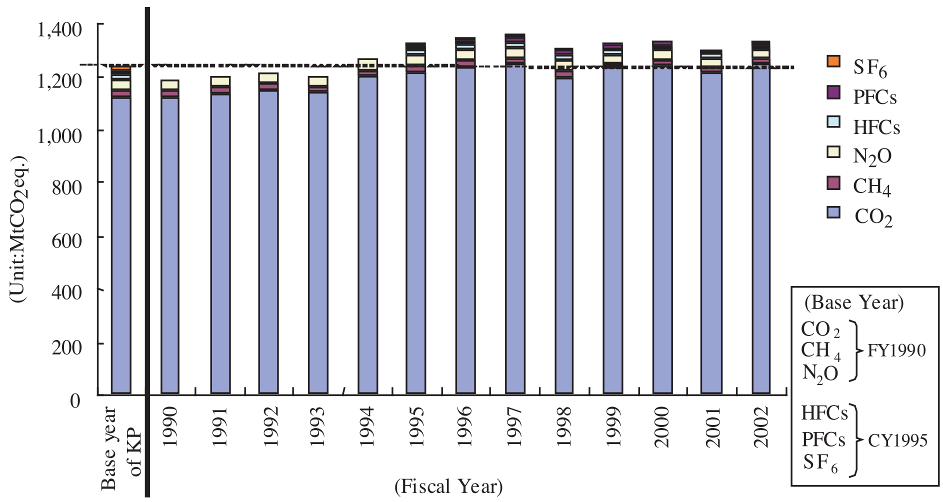


Fig. 3
Trends in emission of greenhouse gases in Japan.

Table 1 Trends in emission of greenhouse gases in Japan

[Mt CO_2 eq.]

	GWP	Base year of KP	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CO_2Emissions	1	1,122.3	1,122.3	1,131.4	1,148.9	1,138.7	1,198.2	1,213.1	1,234.8	1,242.0	1,195.2	1,228.4	1,239.0	1,213.8	1,247.6
CH_4	21	24.7	24.7	24.6	24.5	24.4	24.0	23.3	22.9	22.1	21.5	21.1	20.7	20.2	19.5
N_2O	310	40.2	40.2	39.7	39.9	39.7	40.6	40.8	41.7	42.2	40.8	35.1	37.8	35.1	35.4
HFCs	HFC-134a : 1,300 etc.	20.2						20.2	19.9	19.8	19.3	19.8	18.6	15.9	13.3
PFCs	PFC-14 : 6,500 etc.	12.6						12.6	15.2	16.9	16.5	14.9	13.9	11.7	9.6
SF_6	23,900	16.9						16.9	17.5	14.8	13.4	9.1	6.8	5.7	5.3
Gross Total		1,236.9	1,187.2	1,195.7	1,213.3	1,202.8	1,262.7	1,326.9	1,352.0	1,357.8	1,306.7	1,328.4	1,336.7	1,302.3	1,330.8

- **Performing various tasks relevant to GHG inventories.** GIO has developed a website and provides Japan's GHG emissions data to the public, thus facilitating the in-country-visit review of Japan's national GHG inventories submitted in 2003 to the UNFCCC. It has also participated in the development of the IPCC Emission Factors Data Base (EFDB), individual review of the GHG inventories under the UNFCCC, and GHG inventories review-training under the UNFCCC. GIO has assisted in international negotiations such as the Conference of Parties to the UNFCCC.
- **International cooperation.** To encourage countries in the Asia region and Russia to enhance their capacities for developing their own GHG inventories, GIO conducted some workshops and research activities.

Coordinating supercomputer-aided research programs. To predict climate change on a 100-year timescale, several groups of scientists around the world have conducted model calculation experiments based on emission scenarios proposed by the socioeconomic research group. A new supercomputer system, an NEC SX-6/64 M8 (64 CPU = 8 CPU/node × 8 nodes, 512 GFlops, 512 GB memory) was introduced in 2003. CGER published 2 annual reports in 2003: the *CGER Supercomputer Activity Report*, vol. 11, and the *CGER Monograph Report*, vol. 9.

3. Synthesis of Global Environmental Studies

International Research Cooperation—AsiaFlux. The AsiaFlux network was established in 1999 to promote cooperation and exchange of information on carbon flux observations in Asia. The executive office is now in CGER and issues a quarterly newsletter in both English and Japanese.

Enhancement of communication among scientists and citizens. *CGER NEWS* is published monthly to inform the Japanese public of recent progress in global environment research activities and to enhance communication among scientists in this field of research. More than 3500 copies are sent by mail, and it can also be accessed on our homepage.

JST/NIES Joint Symposium on Risk of EMF and its Governance

September 15, 2003
Hotel Heart-In Nogizaka
Kenpo Kaikan
Nogizaka, Tokyo

Health risks due to exposures to EMF in our daily lives have been a serious social concern internationally. The WHO international EMF project has been trying to promote health risk assessment and also partially risk governance since 1996. In a series of examinations in the space project, IARC evaluated cancer risk of ELF-EMF as “possible carcinogen” so that it became urgent to what and how we should do manage the suggested risk. In the symposium, epidemiologic findings on childhood leukemia, which have been studied most intensively so far with showing a positive risk generally, have been summarized and a brief result of pooled analysis was described by Anders Ahlbom, Kalorinska Institute. Leeka Kheifets introduced “precautionary framework” or a basic concept of WHO for every type of health risk issues to which WHO has been faced to. The results of our Japanese epidemiological study on childhood cancers, or childhood leukemia and brain tumors, conducted by NIES have also been introduced as a scientific basis for risk assessment. Some special comments from U.S. NIEHS and other related specialists gathered were also presented. The audience to this open symposium reached 300 or the maximum capacity of the conference room prepared.

Workshop on Greenhouse Gas Inventories in Asia Region

November 13-14, 2003
J. W. Marriott Phuket
Resort and SPA
Phuket, Thailand

Shared experiences and information on the current status of each participating country concerning institutional arrangements and technical aspects for developing GHG inventories in Asia region. The governmental officials and scientists from 11 countries and representatives of two international organizations attended this workshop.

The Second Workshop on Material Cycles and Waste Management in Asia

December 2-3, 2003
NIES
Tsukuba, Ibaraki

The objectives of this workshop were to understand the international material flow of end-of-life products and waste in Asia and to review the statistical and legislative information of waste management system in each Asian country/region. Asian experts from 10 countries/regions and Japanese participants discussed the current status and future challenges for material cycles in Asia.

Workshop on the Development of Research Proposal for Long-term Monitoring of Mekong River and its Biodiversity

December 15-17, 2003
Kasetsart University
Bangkok, Thailand

The first workshop was held (1) to develop a research proposal on long term monitoring of the Mekong River water quality and biodiversity, (2) to strengthen collaboration among the researchers from PR China, Lao PDR, Thailand, Cambodia, Vietnam and Japan, and (3) to prepare a declaration on sustainable research and development of the Mekong River regarding its water quality and biodiversity.

International Workshop on Global Change and Coral Reefs

January 13, 2004
University of Tokyo
Bunkyo, Tokyo

The aim of this workshop was to discuss and make a synthesis of the status of coral reefs and their response to glocal-scale environmental changes. Speakers were scientists from Japan and abroad engaged in global changes and coral reefs in various fields including biology, ecology, geology and physical oceanography. Various Japanese and foreign researchers and managers fully participated in this full-day open workshop and discussion.

Workshop on Ocean Surface pCO_2, Data Integration and Database Development

January 14-17, 2004
Tsukuba International
Congress Center
Tsukuba, Ibaraki

The goals for this workshop were to understand potential sources of error and differences in ocean pCO_2 systems, to develop guidelines for improving the systems and measurement practices, to reach agreements on data and metadata formats and data exchange practices, and to discuss ways in which we could begin to connect existing activities into a coordinated global network capable of producing high-quality, global data sets of pCO_2 and air-sea flux of CO_2. The need to go beyond simply connecting existing activities through common practices and to develop an international implementation strategy for a global network of observations was addressed.

International Symposium on Nanoparticles, 2004

January 20, 2004
NIES
Tsukuba, Ibaraki

The symposium aims to comprehensively overview nanoparticle emission, physical and chemical characterization of nanoparticles, and health effects of nanoparticles and to find out the direction of future research in nanoparticle sciences.

Workshop on GHG Stabilization Scenarios

January 22-23, 2004
NIES
Tsukuba, Japan

The aim of the workshop is to discuss key issues in the design of stabilization scenarios of climate change. About 55 experts including 17 climate modelers from abroad discussed key issues such as stabilization targets, what and when to stabilize, policy options to include and what burden sharing assumptions to make in the two-day workshop. The modelers agreed that the lessons from IPCC SRES scenarios are before us and the modelers could update these results with better knowledge/ information that is now at hand.

International Symposium/Workshop on the Kyoto Mechanism and the Conservation of Tropical Forest Ecosystems

January 29-30,2004
Waseda University
Shinjuku,Tokyo

The objective of this symposium/workshop was to assess the need for a new guideline to harmonize CDM (Clean Development Mechanism under the Kyoto Protocol) and ecosystem conservation associated with sustainable forest management, determine if criteria and indicators might provide a possible solution, and identify gaps and scientific requirements. In this symposium, the necessity of inter-linkages between the different sectors were discussed from various angles: (a) CDM as an incentive for private sectors and/or communities to practice voluntary SFM (sustainable forest management); (b) potential impacts of CDM on local communities, the economy and ecosystems; and, (c) A/R-CDM as a catalyst for restoration of forests and degraded lands.

International Symposium: Evaluation and Monitoring of Desertification Synthetic Activities for the Contribution to UNCCD

February 2, 2004
NIES
Tsukuba, Ibaraki

The Conference of the Parties (COP) of the United Nations Convention to Combat Desertification (UNCCD) required the establishment of the scientific methods on Evaluation/Monitoring of Desertification, and the "Thematic Program Network 1 (TPN1)" in Asia under UNCCD is concentrating to examine this matter. The purposes of this symposium were to synthesize the individual research activities conducted in each desertificated regions in Asia, to develop the systematic methods for evaluation/monitoring of desertification and also to examine the direction of necessary desertification researches to be advanced in near future. About 80 researchers from abroad and Japan participated, and 17 oral- and 24 poster-topics were presented in this symposium.

IPCC Emission Factor Database (EFDB) 2nd Meeting of the Editorial Board / Meeting of the Steering Group

February 18-20, 2004
NIES
Tsukuba, Ibraki

Evaluated the proposed additions to the database since the 1st Session of the Editorial Board Meeting, discussed sector specific issues, cooperation with other organizations, and further improvement of the Emission Factor Database. Poster session was also conducted by the researchers from NIES and relevant organizations. The members of the IPCC EFDB Editorial Board, the Steering Group of the IPCC project on Establishment of a Database on Greenhouse Gas Emission Factors, and Experts from relevant organizations attended the meeting.

Symposium on water resource and its variability in Asia in the 21st century

March 1-2, 2004
Epochal Tsukuba
Tsukuba, Ibaraki

The symposium was dedicated to present the major scientific results of assessing the change of water supply/demand situation in Asia during the 21st century, by considering future changes in crops, land use, and water resources due to climate change. Many scientists from abroad as well as from Japan made presentation and fully participated in the open discussion.

International Workshop on Time Capsule for Environment and Endangered Wildlife

March 22, 2004
NIES
Tsukuba, Ibaraki

This workshop was held to discuss on some scientific strategies of the time capsule project and for its application research in future, and to introduce a new building for the time capsule project in NIES. Over 50 researches including 6 invited speakers participated and discussed actively in the workshop.

COUNTRY
No.Title
Collaborating Institution
NIES Partner (As of Latest Review Meeting)

AUSTRALIA
1. Cooperative research on global environmental monitoring
CSIRO
Atmospheric Environment Div.
2. A comprehensive database of microbial diversity:cyanobacteria
University of NSW
Environmental Biology Div.
3. Trace characterization of organic/inorganic carbon in marine environment
WA. Marine Res. Labs
Regional Environment Div.

CANADA
1. Arctic atmosphere under polar sunrise
Atmospheric Environment Service
Environmental Chemistry Div.
2. Elucidation of the cycling and transformation of chemical substances in the North Pacific Ocean
Dept. Chemistry, Univ. British Columbia
Environmental Chemistry Div.
3. Monitoring of the atmosphere-ocean carbon dioxide exchange rate
Center for Ocean Climate Chemistry, Institute of Ocean Sciences
Global Environment Div.
4. Development of new methodologies to assess physiological effects by environmental pollutants
University of Western Ontario
Environmental Health Sciences Div.

CHINA
1. Advanced wastewater treatment processes for China
Research Institute for Environmental Engineering/Dept. Environmental Engineering, Tsinghua Univ.
Research Center for Material Cycles and Waste Management
2. 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
3. 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
4. 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
5. Dioxins analysis and survey of dioxins sources in China
China-Japan friendship Center for Environmental Protection Center
Environmental Chemistry Div.
6. Development of eco-engineering technologies for the control of eutrophication in the drainage area Honfeg Lake and Baihua Lake in China Guizhou
Guizhou Provincial Environmental Protection Bureau
Research Center for Material Cycles and Waste Management
7. Study on transport mechanism of kosa aerosol to Japan by way of Beijing
Sino-Japan Friendship Environmental Protection Center
Environmental Chemistry Div.
8. 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
9. Satellite Monitoring of Environmental Resources Asia by means of EOS-MODIS data
Institution of Geografica Sciences and Natural Resources, Chinese Academy of Sciences
Water and Soil Environment Div.
10. Molecular Epidemiological studies on the health effect of arsenic
Institution of Environmental Health and Engineering, Chinese Academy of Preventive Medicine
Environmental Health Sciences Div.
11. Research on VOCs &Ammonia emission in China
Chinese Research Academy of Environmental Science
Environmental Health Sciences Div.

CZECH
1. Biogeochemical studies on the acidic deposition and pollutions
Institute of Landscape Ecology, Czech Academy of Sciences
Atmospheric Environment Div.
2. Perception of Landscape: from Landscape Appreciation to Landscape Planning
Institute of Landscape Ecology, Czech Academy of Sciences
Social and Environmental Systems Div.

FRANCE
1. Ozone layer observation from satellite
Lab. Physique Moleculaire et Applications, CNRS/Univ. Pierre et Marie Curie
Global Environment Div.
2. Assessment of lung injury by air pollutants
Unite de Biologie Moleculaire, Hospital Armand Trousseau
Regional Environment Div.
3. Chemotaxonomy and molecular phylogeny of cyanobacteria
Institute Pastuer
Environmental Biology Div.
4. A molecular biological study for mechanisms of environmental adaptation plants
University of Picardie
Environmental Biology Div.
5. Studies on intermediary species in atmosphere and flames
Lab. of University Pierre et Marie Curie
Environmental Chemistry Div.
6. Biodiversity of microalgae obtained from the Atlantic and the Pacific Ocean
University of Caen
Environmental Biology Div.
7. Hormonal regulation of the toxicity of environmental pollutants
INSELM U469
Regional Environment Div.

GERMANY

1. Comparative study on total material flow balance between Japan and Germany
   Wuppertal Institute for Climate, Environment and Energy
   Research Center for Material Cycles and Waste Management
2. Studies on eutrophication and related problems in closed water bodies
   Nuclear Research Center, Karlsruhe
   Office of International Coordination (for Water and Soil Environment Div.)
3. Testing method of endocrine disrupting chemicals
   University Stuttgart, Institute for Sanitary Engineering
   Environmental Chemistry Div. /Endocrin Disrupters & Dioxin Research Project
4. Workshop on solid waste management
   Federal Environmental Agency
   Research Center for Material Cycles and Waste Management
5. Ground-based and satellite-borne studies of stratospheric ozone and trace gases (ADEOS-II project)
   Alfred-Wegener-Institute
   Ozone Layer Research Project

KOREA

1. Aircraft and ground-based observations of acidic and/or oxidative pollution in East Asia
   Environment Research Center, Korean Institute of Scienceand Technology
   Atmospheric Environment Div.
2. Cross-cultural comparison of landscape evaluation between Japanese and Korean
   KyungPook University
   Social and Environmental Systems Div.
3. 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
4. Study on the monitoring of long range transported air pollutants and acid deposition in the northeast Asia region
   Department of Air Pollution, National Institute of Environmental Research
   Atmospheric Environment Div.
5. Study on the marine pollution using ship-of-opportunity
   Korea Ocean Research and Development Institute
   Water and Soil Environment Division
6. Research on the prevention and management of Environmental Disease
   National Institute of Environmental Research (NIER)
   Environmental Health Sciences Div.

NORWAY

1. Studies on analyses of observed data of the stratospheric ozone layer
   Norwegian Institute for Air Research
   Global Environment Div.
2. Global environmental database
   GRID-Arendal
   Center for Global Environmental Research

POLAND

1. Molecular mechanisms of plant adaptation to atmospheric stresses
   Plant Breeding and Acclimatization Institute
   Biodiversity Conservation Research Project
2. Establishment of methodology of health risk assessment on air pollutants
   Institute of Occupational and Environmental Health
   Environmental Health Science Div.

RUSSIA

1. Research programs under the Baikal International Center for Ecological Research (BICER)
   Limnological Institute, Russian Academy of Sciences
   Office of International Coordination (for Environmental Chemistry Div.)
2. Airborne measurement of greenhouse gases over Siberia
   Central Aerological Observatory
   Center for Global Environmental Research
3. Modeling of methane emission rates from natural wetlands
   Institute of Microbiology
   Center for Global Environmental Research
4. Measurement of methane emission rates from permafrost areas
   Permafrost Institute
   Center for Global Environmental Research
5. Environmental change and its effects on the global warming in Siberian permafrost region
   Yakut Institute of Biology, Permafrost Institute, Pacific Oceanological Institute
   Center for Global Environmental Research
6. Vertical profile measurement of greenhouse gases over Siberia
   Institute of Atmospheric Optics
   Center for Global Environmental Research
7. Study of measurements of atmospheric trace species using FTIR and other methods in Siberia area
   Institute of Sollar-Terrestrial Physics (ISTP), Siberian Dep. Russian Academy of Science
   Atmospheric Environment Div.
8. Greenhouse Gases Budget of Land Ecosystems in Siberia
   Institute of Microbiology RAS
   Center for Global Environmental Research
9. Greenhouse gas monitoring to estimate the sink and source distribution in West Siberia
   Institute of Atmospheric Optics
   Center for Global Environmental Research

SPAIN

1. Development of new methodologies to assess physiological effects by environmental pollutants
   Dept. Cellular Biology, Autonomous Univ. Barcelona
   Environmental Health Sciences Div.

SWEDEN

1. Underway measurement of pCO_2 in the surface water of the Arctic Ocean
   Goteborg University
   Climate Change Research Project
2. Health risk assessment of heavy metal exposure: Effects of increase in human activity
   Kalolinska Institute
   Environmental Health Sciences Div.

U. K.

1. *In vivo* NMR spectroscopy method and its application to the field of environmental health
   Dept. Biochemistry, Univ. Cambridge
   Endocrine Disrupters & Dioxin Research Project
2. Effects of environmental pollution on the metabolism of trace elements in man
   Rowett Research Institute
   Environmental Health Sciences Div.
3. Algae and Protozoa
   CCAP, Institute of Freshwater Ecology
   Environmental Biology Div.
4. Cooperation on the development and application of Coupled Chromatography-Accelerator Mass Spectrometry Techniques
   University of Oxford
   Environmental Chemistry Div.
5. Mechanisms of phagocytic activities in alveolar macrophages
   University of Oxford
   Environmental Health Sciences Div.

U. S. A.

1. Development of bioremediation technologies for cleanup of contaminated soil
   Center for Environmental Biotechnology, Univ. Tennessee
   Water and Soil Environment Div.
2. Precise measurement of the greenhouse gases in the global baseline atmosphere
   Climate Monitoring and Diagnostic Lab, NOAA
   Center for Global Environmental Research
3. Health impacts of climate change and environmental degradation of human morbidity in regional societies
   National Institute of Environmental Health Sciences
   Regional Environment Div.
4. Effects of logging on lakes ecosystems
   University of Alaska Fairbanks
   Regional Environment Div.
5. Human impacts on biodiversity and nutrient cycling in mire wetland
   Smithsonian Institute
   Environmental Biology Div.
6. Establishment of phytotron research network
   Duke University
   Environmental Biology Div.
7. Studies on standardization of measurement and health effect of particulates
   USEPA, National Center of Environmental Assessment
   Environmental Health Sciences Div.
8. Studies on the feasibility of the FTIR network for vertical profiling atmospheric trace species
   University of Denver
   Atmospheric Environment Div.
9. Development of an advanced regional climate change prediction model as part of emission-climate-impact integrated models
   Goddard Space Flight Center, NASA
   Atmospheric Environment Div.
10. 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
11. 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 (DOE)
    Center for Global Environmental Research
12. 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

CANADA Agreement between National Institute for Environmental Studies and Institute of Ocean Sciences (1995).

CHINA Agreement for Collaborative Research to develop a Chinese Greenhouse Gas Emission Model. Energy Research Institute of China (1994).

Agreement on cooperative research projects between the National Institute for Environmental Studies, Environment Agency of Japan and the Institute of Hydrobiology, Chinese Academy of Sciences (1995).

Memorandum of understanding between Institute of Hydrobiology, Chinese Academy of Sciences, People's Republic of China (IHBCAS) and National Institute for Environmental Studies, Japan (NIES) for collaborative research on microalgal toxicology, systematics and culture collection operations (1995).

Memorandum of Understanding between Institute of Remote Sensing Applications, Chinese Academy of Science, People's Republic of China (IRSACAS) and National Institute for Environmental Studies, Japan (NIES) for Collaborative Research on Development of Remote Sensing and GIS Systems for Modeling Erosion in the Changjiang River Catchment (1996).

Memorandum of Understanding between Changjiang Water Resources Commission, Ministry of Water Resources, People's Republic of China and National Institute for Environmental Studies, Japan for Collaborative Research on Developments of Monitoring Systems and Mathematical Management Model for Environments in River Catchment (1997).

Memorandum of Understanding between National Institute for Environmental Studies, Japan (NIES) and Chinese Research Academy of Environmental Sciences, People's Republic of China (CRAES) for Collaborative Research on Advanced Treatment of Domestic Wastewater (1997).

Memorandum of Understanding between National Institute for Environmental Studies and School of Environmental Science and Engineering Shanghai Jiao Tong University for Collaborating Research on Eutrophicated lake and marsh water improvement using Bio-ecoengineering Technology (2000).

Memorandum of Understanding between Northwest Plateau Institute of Biology, the Chinese Academy of Sciences, P. R. China (NPIB) and National Institute for Environmental Studies, Japan (NIES) for Collaborative in Alpine Grassland Ecosystem (2001).

INDIA Memorandum of Understanding between the Indian Council of Agricultural Research and the National Institute for Environmental Studies for Collaborative Research on Desertification (1993).

INDONESIA Memorandum of Understanding between Research and Development Center for Biology, Indonesian Institute of Sciences (RDCP-LIPI), Bogor-Indonesia and National Institute for Environmental Studies, Tsukuba-Japan concerning Scientific and Technical Cooperation on the Biodiversity and Forest Fire (2001).

KOREA Agreement for Collaborative Research to develop a Korean Greenhouse Gas Emmisson Model. Korean Energy Economics Institute (1994).

Implementing Arrangement between the National Institute for Environmental Studies of Japan and the National Institute of Environmental Research of the Republic of Korea to establish a cooperative framework regarding environmental protection technologies (1988, and revised in 1994).

Implementing Agreement between the National Institute for Environmental Studies of Japan and National Institute of Environmental Research of the Republic of Korea to establish a cooperative framework regarding endocrine disrupting chemicals research (1999).

MALAYSIA Memorandum of Understanding between the Forest Research Institute Malaysia (FRIM), the University Pertanian Malaysia (UPM) and the National Institute for Environmental Studies, Japan (NIES) for Collaborative Research on Tropical Forests and Biodiversity (1991, and revised in 1995).

RUSSIA Agreement on a Joint Geochemical Research Program; Impact of Climatic Change on Siberian Permafrost Ecosystems between the Permafrost Institute Siberian Branch, Russian Academy of Sciences, Russia and the National Institute for Environmental Studies, Japan (1992).

	Agreement on a Cooperative Research Project between the Central Aerological Observatory, Committee for Hydrometeorology and Monitoring of Environment, Ministry of Ecology and Natural Resources, Russian Federation and the National Institute for Environmental Studies, Japan (1992).
	Agreement on a Cooperative Research Projects between National Institute for Environmental Studies, Environment Agency of Japan and Institute of Atmospheric Optics, Russian Academy of Sciences (1997).
	Agreement on Cooperative Research Project between Institute of Solar-Terrestrial Physics (ISTP), Siberian Branch, Russian Academy of Science and National Institute for Environmental Studies, Environment Agency of Japan.
THAILAND	Memorandum of Understanding between Kasetsart Unversity, Bangkok, Thailand and National Institute for Environmental Studies, Japan (NIES) for Global Taxonomy Initiative, Toxic, Cyanobacteria and Algal Diversity (2002).
UN	Memorandum of Understanding referring to the establishment and operation of a GRID-compatible Center in Japan (1991).
CHINA & KOREA	Tripartite Presidents Meeting among CRAES, NIES and NIER Joint Communique (2004).

<Host Division>
Researcher, COUNTRY, Research Period
Research Subject (Host Researcher)

<Office of International Coordination>

An, Ping, CHINA, 2002. 4. 1~2004. 3. 31
Studies on monitoring and assessment of desertification (Shimizu, H.)
Yu, Yi, CHINA, 2003. 4. 1~2004. 3. 31
Evaluation of vegetation indicators for the monitoring and assessment of desertification (Shimizu, H.)
Yu, Yunjiang, CHINA, 2002. 10. 2~
Researches on the mechanism of influence of aeolian sand flow on the ecophysiology of plants and adaptability of these plants to aeolian sand flow (Shimizu, H.)
Zheng, Yuanrun, CHINA, 2001. 7. 27~2004. 3. 31
Evaluation of countermeasures to rehabilitate desertificated lands (Shimizu, H.)

<Social and Environmental Systems Division>

Brandenburg, Christiane Gerda, AUSTRIA, 2004. 2. 29~2004. 3. 31
Comparison of mesurement of open space use between Japan and Austria (Aoki, Y.)
Cudlinova, Eva, CZECH REPUBLIC, 2003.11.12~2003.11.28
Comparison of landscape appreciation between Japan and Czech (Aoki, Y.)
Lange, Eckart, SWITZERLAND, 2004. 3. 29~2004. 3. 31
Comparison of landscape appreciation between Switzerland and Japan (Aoki, Y.)
Miloslav, Lapka, CZECH REPUBLIC, 2003.11.12~2003.11.28
Comparison of landscape appreciation between Czech and Japan (Aoki, Y.)
Nair, Rajesh, INDIA, 2003. 7. 12~2004. 3. 31
International collaborative studies for developing integrated assessment model in India (Kainuma, M.)

<Environmental Chemistry Division>

Aung, Nyein Nyein, MYANMAR, 2003. 4. 1~2004. 3. 31
Environmental exposure pathways assessment of lead among the children residing in Tokyo metropolis (Tanaka, A.)
Treuner, Anke Britt, GERMANY, 2002. 11. 29~
A study on factors for decreasing abalone stocks:an attempt to assess them with the methods of abalone larvae bioassays and organ culture experiments (Horiguchi, T.)

<Environmental Health Sciences Division>

Munidasa, Dulee, SLI LANKA, 2002. 8. 1~2004. 3. 31
Effect of TiO_2 particles on antigen-presenting activity and the mechanisms in lungs of rats (Kobayashi, T.)

<Atmospheric Environment Division>

Bellis, David John, U. K, 2003. 4. 1~2004. 2. 29
Development and application of biogeochemical methods on acid deposition research (Satake, K.)
Li, Hong, CHINA, 2003. 10. 1~2004. 3. 31
Studies on chemical components of organic aerosols transported from East Asia (Hatakeyama, S.)
Qi, Bin, CHINA, 2002. 1. 17~2004. 1. 16
Studies on the formation process of peroxides in photochemical reactions of hydrocarbons (Hatakeyama, S.)
Tatarov, Boyan, BULGARIA, 2003. 7. 1~2004. 3. 31
Study for determining climatology of the lidar ratio using a high-spectral resolution lidar (Sugimoto, N.)
Zhao, Shu-Li, CHINA, 2003. 8. 1~2004. 3. 31
Study of Asian dust phenomena in Beijing using lidar data and a chemical transport model (Sugimoto, N.)

<Water and Soil Environment Division>

Hou, Hong, CHINA, 2003. 4. 1~2004. 3. 31
Study on the behavior of Bc in soil (Takamatsu, T.)
Liu, Chen, CHINA, 2003. 4. 1~2004. 3. 31
Current Food Style and Food Circulation Structure and the Future Trend in China (Otsubo, K.)
Xiang, Bao, CHINA, 2003. 4. 1~2004. 3. 31
International cooperative research on the development of method to estimate the pollutant loads from the Changjiang river basin including the effect of land use change (Hayashi, S.)
Zhang, Jiqun, CHINA, 2001. 4. 1~2004. 3. 31
Study on the estimation of the pollutant load from Changjiang River Basin (Watanabe, M.)

<Environmental Biology Division>

Bathula, Srinivas, INDIA, 2002. 2. 15~2004. 2. 14
Molecular cloning and characterization of ozone-tolerant genes using ozone-sensitive *Arabiodopsis* mutants (Kubo, A.)
Cui, Xiaoyong, CHINA, 2001. 7. 10~2004. 3. 31
Combined effects of temperature and UV-B on leaf carbon gain of alpine plants in Qinghai-Tibet grassland (Tang, Y.)
Gunatilleke, Nimal Illeperuma Arachchige Upali, SLI LANKA, 2003. 10. 1~2003. 11. 29
Development of scaling up technology on biodiversity indices in tropical rain forest (Okuda, T.)
Gu, Song, CHINA, 2001. 7. 9~2004. 3. 31
Characterization of temporal variations of biometerological environments in a grassland in Tibet-Oinghai Plateau (Tang, Y.)
Hashim, Mazlan, MALAYSIA, 2004. 1. 4~2004. 3. 31
Risk assessment on landscape development using GIS approaches (Okuda, T.)
Makarchenko, Eugenyi Anatolievich, RUSSIA, 2003. 11. 27~2003. 12. 25
Study of taxonomy and biodiversity of chironomids *Orthocladiinae* subfamily of the Far East (Ueno, R.)

Noel, Mary-Helene, FRANCE, 2003. 4. 1~2004. 3. 31
Microalgae biodiversity and environmental factors in mangrove ecosystem (Kasai, F.)

Shen, Hai Hua, CHINA, 2003. 4. 1~2004. 3. 31
Physiological acclimation response to different light environment in alpine Primula (Tang, Y.)

Yusop, Zulkifli, MALAYSIA, 2004. 1. 4~2004. 3. 31
Studies on evaluation of logging impacts on soil erosion and watershed ecosystem-preliminary results (Okuda, T.)

Wichien, Yongmanitchai, THAILAND, 2004. 3. 24~
Collaborative research on microalgal diversity in a tropical region and culture collection (Kasai, F.)

Zhou, Huakun, CHINA, 2004. 2. 4~2004. 2. 28
Grassland degradation and its ecological and environmental consequences (Tang, Y.)

<Climate Change Research Project>

Chierici, Melissa, SWEDEN, 2002. 9. 25~2004. 10. 31
Comparison of oceanic sink and source of carbon dioxide in the Pacific and Atlantic with date integration of observational data sets (Nojiri, Y.)

Fransson, Agneta Ingrid, SWEDEN, 2002. 9. 25~2004. 9. 24
Analysis of CO_2 source and sink in the North Pacific and the role of irons as a controlling factor (Nojiri, Y.)

<Ozone Layer Research Project>

Khosrawi, Farahnaz, GERMANY, 2002. 9. 30~2003. 9. 27
A study on polar ozone depletion using tracer gas data from satellites and chemical Lagrangian model (Nakajima, H.)

Oshchepkov, Sergey, BELARUS, 2002. 5. 16~2004. 3. 31
Study on simultaneous retrieval of gasses and aerosols components from satellite remote sensing data (Nakajima, H.)

Zhou, Libo, CHINA, 2002. 3. 19~2004. 3. 18
A study on ozone transport processes using a chemical transport model (Akiyoshi, H.)

<Endocrine Disrupters and Dioxin Research Project>

Sheikh, Julfikar Hossain, BANGLADESH, 2003. 9. 8~2003. 9. 25
Behavioral study on effects of fragrance components on central nervous system functions (Umezu, T.)

Xu, Xiaobin, CHINA, 2003. 4. 1~2004. 3. 31
The study on the effects of endocrine disrupters on central nervous system (Imai, H.)

<Watershed Environments and Management Research Project>

Kim, Daekyung, KOREA, 2003. 4. 1~
Molecular level analyses on the mechanism of toxic action found in the red tide phytoplankton (Kohata, K.)

<PM2.5 & DEP Research Project>

Li, Shun-mei, CHINA, 2003. 4. 1~2004. 3. 31
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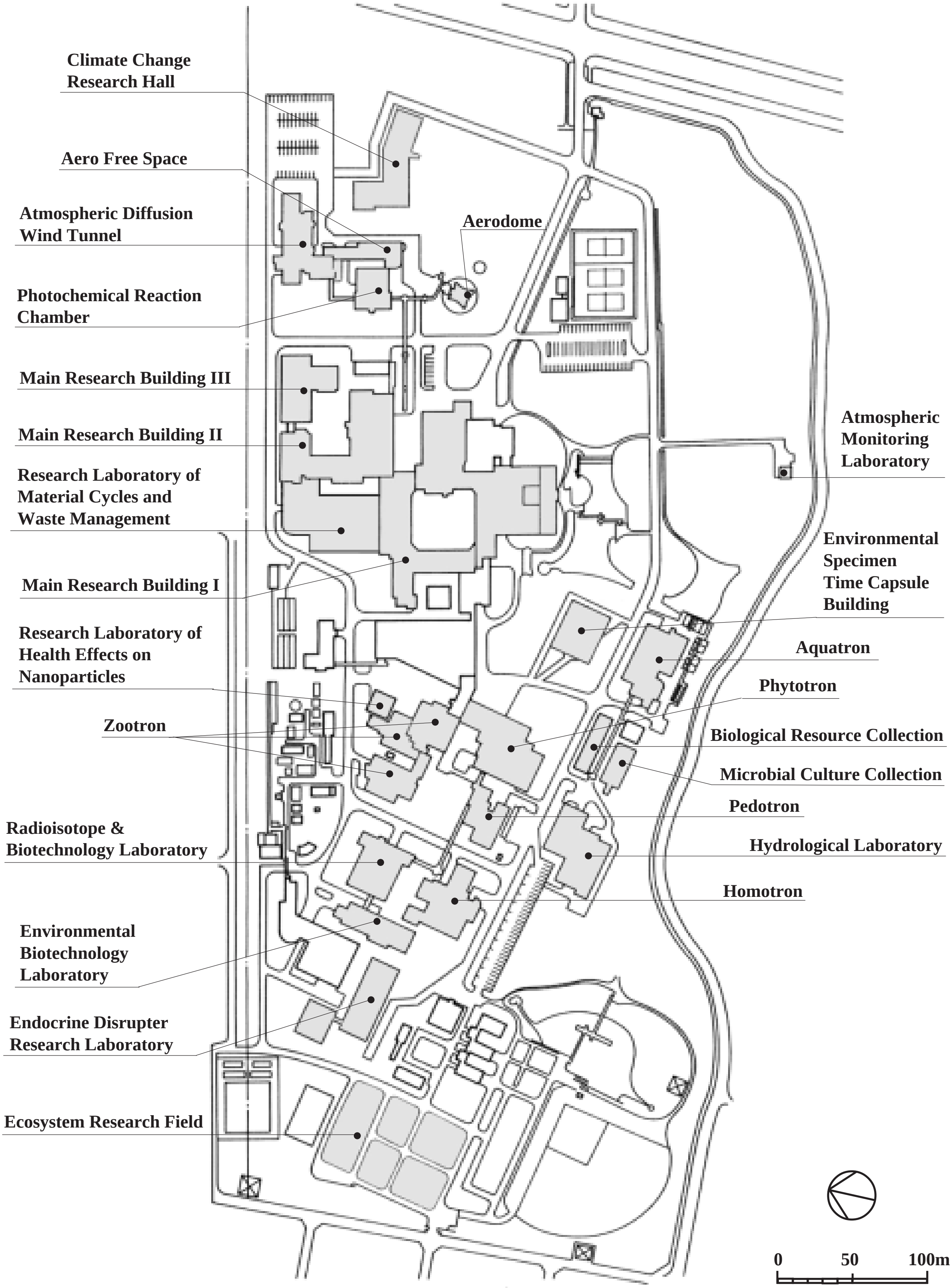
Climate Change
Research Hall
Aero Free Space
Atmospheric Diffusion
Wind Tunnel
Photochemical Reaction
Chamber
Main Research Building III
Main Research Building II
Research Laboratory of
Material Cycles and
Waste Management
Main Research Building I
Research Laboratory of
Health Effects on
Nanoparticles
Zootron
Radioisotope &
Biotechnology Laboratory
Environmental
Biotechnology
Laboratory
Endocrine Disrupter
Research Laboratory
Ecosystem Research Field
Aerodome
Atmospheric
Monitoring
Laboratory
Environmental
Specimen
Time Capsule
Building
Aquatron
Phytotron
Biological Resource Collection
Microbial Culture Collection
Pedotron
Hydrological Laboratory
Homotron
0
50
100m

Aerodome
The aerodome is a facility both for remote monitoring of pollutant particles in the atmosphere (via a large-scale laser radar) and for study of the formation of secondary particulates from gaseous primary pollutants. The laser radar can scan rapidly and sensitively, with computer-controlled pointing, both tropospheric and stratospheric aerosols at any angle above the horizon. The 4-m^3 aerosol chamber can be evacuated to 10^{-5} Torr.

Aero Free Space
The aero-free-space laboratory serves as the site for instrument calibration for both laboratory and field experiments. It is also available for atmospheric research that cannot be done in any of the other atmospheric research facilities.

The ozone laser radar is equipped with 3 lasers of different wavelengths and 56- and 200-cm caliber telescopes. Accurate ozone profiles up to an altitude of 45 km are being measured with this instrument.

Aquatron
This hydrobiological laboratory includes several related special facilities. The freshwater microcosm is particularly suitable for studies of the mechanisms of phytoplankton bloom formation and dynamics. The toxicity testing system is suitable for long-term exposure studies. Other associated facilities include temperature-controlled culture rooms, axenic culture rooms, large autoclaves and an outdoor experimental pond.

Atmospheric Diffusion Wind Tunnel
This wind tunnel is exceptional in that wind velocities (down to 0.2 m s^{-1}), air temperatures and floor temperatures can be independently controlled to create stratified flow fields. Temperature and wind velocity sensors are moved through the tunnel on a computer controlled traverse system gathering 3-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 under a variety of atmospheric conditions.

Atmospheric Monitoring Laboratory
Automatic instruments to monitor the concentrations of 7 atmospheric constituents (NO_x, SO_2, O_3, CO_2, non-methane hydrocarbons, suspended particulate matter and gaseous Hg) are operated in this facility. Wind speed, precipitation, atmospheric pressure, visible and UV radiation, earth surface (soil and air) temperature and other atmospheric characteristics are also measured and the results made available to NIES researchers. The stability and accuracy of the automated measurements and factors that interfere with them are studied.

Biological Resource Collection
In order to enhance research relating to microbes that are important for environmental studies such as hazardous substance decomposing microbes, and to preserve experimental materials for conservation studies, a new building is being constructed as an annex of the Microbial Culture Collection Building at NIES. The new facilities consist of rooms for cryopreservation, identification and classification, evaluation of functions, genetic analysis, and databases of environmental microbes.

Climate Change Research Hall
Climate Change Research Hall (CCRH), built especially for global warming research, was completed in March 2001 with 3 floors and 4,900m^2 total area. The following major research programs are conducted in this new facility: (1) development and implementation of the climate change models based on various socio-economic and emissions scenarios, (2) monitoring of atmospheric constituents to evaluate the ocean and terrestrial carbon sinks, and (3) assessment of forest sinks by remote sensing, forest models and statistical data. In addition, the facility includes equipment to evaluate low emissions vehicles. CCRH was constructed various new energy saving. The effectiveness of energy saving is being monitored and analyzed.

Endocrine Disrupter Research Laboratory
The Endocrine Disrupter Research Laboratory was founded in March 2001 for studies on the analysis, bioassay, and experimental hazard/risk assessment of endocrine disrupting chemicals (EDCs), as well as for carrying out field surveys and assessing management technologies for these substances. The building is of 4 floors with a total area of 5,200m^2, and is equipped with several special instruments including a high-resolution nuclear magnetic resonance imaging (MRI) instrument (800MHz) for examining the activity of the living human brain, and liquid chromatography-tandem mass spectrometry (LC/MS/MS) for the qualitative and quantitative analysis of EDCs. The laboratory has all necessary basic laboratory functions for chemical and biological research on EDCs and is also intended to strengthen research collaboration with domestic and overseas researchers for the further development of research on endocrine disrupter.

Environmental Biotechnology Laboratory
The Environmental Biotechnology 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. This laboratory was completed in FY 1993. The specialized instruments of the laboratory, including a peptide sequencer and a DNA sequencer, are actively used.

Environmental Specimen Time Capsule Building
The 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 will construct this new building to provide central facilities for the preservation of environmental specimens. The facilities will be used for the long-term storage environmental specimens such as soil and air particles, as well as cells and genetic material of threatened species.

Ecosystem Research Field
The institute's experimental farm is 4 km west of the main grounds. The farm's facilities include a cultivated field, an experimental field, lysimeters, a greenhouse, a tool storage shed, an observation tower, a remnant natural forest and offices. This farm serves to test results obtained in the indoor controlled-environment biological laboratories of the Institute; to evaluate the environmental maintenance functions of plant and soil

ecosystems; and to supply plant material, particularly for use in bioassays and bioremediation, to researchers at the Institute.

Global Environmental Monitoring Stations (Hateruma and Cape Ochi-ishi)

These Monitoring stations were set up mainly to monitor the long-term changes in baseline level of global-warming gases at sites where the effect of urban air pollution is virtually negligible. Hateruma Station is located in Okinawa Prefecture, on the eastern edge of Hateruma Island, the nation's southernmost inhabited island. This site is suited for monitoring the baseline atmosphere over the subtropical Pacific Ocean. Cape Ochi-ishi Station is located in Hokkaido Prefecture, at the tip of Cape Ochi-ishi, which is located at the root of Nemuro Peninsula. This site is suited for monitoring the baseline atmosphere over the Pacific Ocean in summer and over Siberia in winter. These stations are automated systems for high-precision monitoring of global-warming gases and other atmospheric species; human attendance is not required.

Homotron

This laboratory includes a variety of facilities to evaluate pollution effects on community health. The Noise Effects Laboratory has one anechoic room and three sound-proof rooms for testing the psycho-physiological effects of noise on health. The Community Health Laboratory provides facilities for epidemiological studies on humans and experimental studies on animals to evaluate the effects of environmental pollutants.

Hydrological Laboratory

The facilities of this unit facilitate study of groundwater transport and coastal water quality. A large ocean microcosm is uniquely equipped to permit culture of marine algae and studies of CO_2 dynamics and elemental cycles.

Main Research Building I

This building houses analytical instrumentation and support facilities such as clean rooms. The instruments permit accurate, highly sensitive and selective detection of harmful substances in environmental samples. Stable isotope analysis facilitates research on global warming and the origins of pollutants. Among this building's instruments, listed below, are some that are used for research and development of new analytical methods.

Table of 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

1) Evaluation Laboratory of Man-Environmental Systems (ELMES) and Systems Analysis and Planning in Intelligent Environmental Information Systems (SAPIENS)

ELMES includes a medium-sized conference room that serves as a group laboratory, a multi-group laboratory for gaming simulations, and minicomputer control devices for experiments, all to facilitate the experimental evaluation of human attitudes toward the environment, the environmental planning process and the effect of environmental information on these. SAPIENS is comprised of an environmental database, an image processing and display system and a minicomputer for presenting environmental information in ELMES. SAPIENS is also used to develop and study local environmental information systems.

2) Preservation Laboratory

This facility includes –20˚C, 4˚C and 25˚C temperature-controlled rooms, a room for –100˚C and –80˚C freezers and a room for archives. Environmental specimens are stored here for long periods. Research on specimen preservation is also conducted.

Main Research Building III

1) Fourier-Transform Mass Spectrometer (FT-MS)

FT-MS has very high mass resolution, more than 10^6 at m/z = 131, with a superconducting magnet rated at 3 Tesla. Cluster ions with high mass numbers, isotopes/isobars, and reactions of radicals and ions can be measured with very high mass resolution.

2) Tandem Mass Spectrometer (Tandem-MS)

Two double-focus type mass spectrometers, each with a resolution of 6.5×10^4, are connected serially (in tandem). The ions selected by the first mass spectrometer are modified by electron impacts and other reactions in the interface area and the resulting ions are analyzed by the second mass spectrometer. The chemical structures of complex molecules can be analyzed with this technique.

3) Accelerator Mass Spectrometer (AMS)

An electrostatic tandem accelerator of 5 million V (max.) terminal voltage is interfaced with two ion sources and an analytical mass spectrometer system. Isobaric atomic ions can be distinguished by the electric charges of their nuclei. The AMS is a very sensitive and selective method for atomic ion detection and it is used for measurements of long-lived radioisotopes such as ^{14}C and ^{36}Cl. These radioisotopes are used as tracers and time-markers (dating agents) in environmental research.

4) Hazardous Chemicals Area

Highly toxic substances, such as dioxins (chlorinated dibenzodioxins), polychlorinated biphenyls (PCBs) and polychlorinated dibenzofurans, are used in this area. The air pressure inside the area is maintained below atmospheric pressure, which prevents toxic fumes from leaking out. Exhaust air is treated by high-performance filters (HEPA) and charcoal filters; discharge water is also treated with a charcoal filter system. These filters and other wastes are destroyed by appropriate incineration facilities installed within the area. The Hazardous Chemicals Area contains a gas chromatograph/mass spectrometer (GC/MS) and a microcosm, as well as facilities for microorganism-related research, animal exposure experiments and measurements of the physical and chemical properties of substances.

5) Data Handling Facility (DHF) for the Limb Atmospheric Spectrometer II (ILAS-II)

ILAS-II is a satellite-borne sensor to measure atmospheric constituents such as ozone, nitric acid, and water vapor in the polar stratosphere. It was developed by the Ministry of the Environment of Japan. ILAS-II is aboard Advanced Earth Observing Satellite II (ADEOS-II named Midori II), which was launched on December 14, 2002. ADEOS-II is in routine operations from April 10, 2003. The ILAS-II measurement data are transferred from NASDA/EOC to ILAS-II DHF, and are processed, archived, and distributed at ILAS-II DHF. The ILAS-II data products are used for atmospheric research works at NIES and by other registered researchers.

6) Millimeter-wave Spectrometer System for Observation of Atmospheric Ozone

The millimeter-wave spectrometer is widely and extensively used in astronomical measurements of gaseous molecules in space. Ozone molecules in the stratosphere and mesosphere radiate millimeter-range radio waves. The spectrometer system was completed in October 1995, and since then has continuously monitored the vertical distribution of ozone (35~75 km altitude), except on rainy or heavily overcast days.

7) Eco-Office

This is an office area for evaluating energy-saving/solar-energy-utilizing equipment such as wall insulation, solar cells and a solar hot water supply system. Several types of solar cells, such as single-crystal, multi-crystal and amorphous types, are being compared under identical conditions. The hot water generated is used as the source for a heat-pump type air conditioner as well as for hot water faucets.

8) Reception and Processing Facility for NOAA Satellite Data

The Advanced Very High Resolution Radiometer (AVHRR) orbits the earth on a National Oceanic and Atmospheric Administration (NOAA, USA) satellite. This instrument monitors 5 electromagnetic radiation wavelength bands from the visible to the infrared region with high temporal resolution and a relatively medium spatial resolution (ca. 1 × 1 km). The NIES AVHRR facilities consist of 2 receiving stations—one at NIES, Tsukuba, and the other on the island of Kuroshima, Okinawa—and a data processing center at NIES.

9) Information Processing Center for GRID-Tsukuba

GRID-Tsukuba is a part of the Center for Global Environmental Research (CGER). The GRID information processing system was introduced at NIES in 1994. This system, which consists of a remote-sensing image processing system and a geographic information system, is operated by NIES researchers to process GRID data and to produce original data sets. The work stations of this system are connected to a supercomputer, super-minicomputer and personal computers through a LAN. Several software packages, including ERDAS/IMAGINE, ARC/INFO and GRASS, are installed on these workstations. Image processing is done with IDRISI on an IBM/PC.

Microbial Culture Collection
This facility collects, characterizes, cultures and distributes strains of microorganisms. Many of the strains in the collection are important for the study of red tides and other phytoplankton blooms (including toxic algae), bioremediation, pollution bioassays and carbon cycling.

Oku-Nikko Field Research Station
The field station in Oku-Nikko, Tochigi Prefecture, consists of an observatory and a control building. These facilities are used to both monitor background forest pollution levels and study the effects of pollution on the forest.

Pedotron
This is the soil laboratory, which contains large lysimeters, special growth chambers for studies of pesticide and heavy-metal effects, and soil-temperature-controlled chambers. Growth effects of pollutants and reclamation of contaminated soil are also studied.

Photochemical Reaction Chamber
This is a 6-m^3 stainless steel chamber that permits studies of atmospheric photochemistry at pressures as low as 10^{-7} Torr. This facility is essential to our research on the photochemistry of urban smog, stratospheric ozone depletion, and other important atmospheric phenomena.

Phytotron
The botanical laboratory complex consists of two major facilities to evaluate the effects of various detailed environmental scenarios on plants and soils. Both facilities include experimental chambers

in which light, temperature and humidity can be precisely controlled. Facility I also facilitates exposure of the experimental plants and soils to pollutant gases under these controlled conditions. Facility II has 2 simulators that permit the creation of micro-environments stratified from the soil up through the overlying atmosphere.

Radioisotope & Biotechnology Laboratory
In this laboratory, radioisotopes are used to facilitate studies of the transport, accumulation, chemical conversion and toxicity of environmental pollutants in plants, animals, soil, water and the atmosphere. The use of 36 β and γ emitting isotopes is permitted, but the use of a emitters is forbidden.

Research Laboratory of Material Cycles and Wast Management
In April 2001 NIES established the Research Center for Material Cycles and Waste Management, as an expansion of the Waste Research Division that had been create in January in connection with national governmentís administrative reforms. Research Laboratory of Material Cycles and Waste Management supports research on resource circulation and waste management, resource recovery and recycling, and technologies for environmental risk reduction and restoration after pollution, as well as testing, evaluation and monitoring.

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

This field station, located on the shore of Lake Kasumigaura, is used as a common facility by many NIES researchers. The station's location allows *in situ* studies of pollution, water quality recovery, lake ecosystem dynamics and material cycles in this heavily eutrophied and polluted lake.

2)Bio/Eco-Engineering Research Laboratory

Improving water quality in enclosed water bodies is an important environmental issue in many places around the world. If water-cleaning technologies are used, it is essential that they be properly suited to the local conditions. NIES constructed a new laboratory for research, development, and actual field testing of new types of innovative waste and wastewater treatment systems such as advanced Johkasou, aquatic plant-soil application processes that use Bio-and Eco-engineering technologies. The new laboratories will enhance research activities, including international cooperative research.

Research Laboratory of Health Effects on Nanoparticles
NIES conduct this new building to provide new knowledge about health effects of nanoparticles, which were emitted form diesel powered engines. The Laboratory will be equipped with newest exposure facilities for animal experiment, etc.

Rikubetsu Stratospheric Monitoring Station
NIES has carried out the monitoring of the stratospheric ozone layer over Hokkaido in collaboration with Solar-Terrestrial Environment Laboratory (STEL) in Nagoya University. Also, the monitoring has been made in a room of the Rikubetsu Astronomical Observatory administered by Rikubetsu town. The center has taken various systems to monitor, including vertical distribution of stratospheric ozone measured by Millimeter-wave radiometer, observation of harmful ultraviolet rays monitored by Brewer spectrometer and vertical temperature distribution of stratospheric ozone monitored by laser radar. The aim is to reveal the ozone depletion in the stratosphere and the effects of “Arctic ozone hole”. Since parts of the polar vortex in the Arctic region sometimes arrive over Hokkaido in winter/spring, Rikubetsu is one of the sites to study the effects of the Arctic polar vortex.

Tomakomai Flux Research Site
The main research objectives are to develop and evaluate the observation systems for measurement of fluxes of CO_2 and energy in woodland ecosystem at Tomakomai National Forest in Hokkaido. The comprehensive research has carried out continuous monitoring in larch forest to elucidate carbon cycle function such as CO_2 flux. With the cooperation of universities, national research institutes, regional government and Hokkaido Regional Forest Office as a main site, the observation has been implemented.

Zootron
The animal laboratory has two facilities, in which environmental conditions are controlled. Facility I breeds conventional and specific pathogen-free laboratory animals and has complex gas exposure chambers. Facility II also has a conventional laboratory-animal breeding unit and is useful for studies of the effects of heavy metals and residual chemical exposure. The Nuclear Magnetic Resonance Imager (NMRI) for living organisms images living bodies and active metabolic functions of humans and animals.

Present Number of Personnel

President	1
Executive Director	2
Auditor	2
Research Coordinators	9
Audit Section	3
General Affairs Division	38
Executive Investigator	1
Principal Investigator	1
Social and Environmental Systems Division	20
Environmental Chemistry Division	15
Environmental Health Sciences Division	17
Atmospheric Environment Division	22
Water and Soil Environment Division	17
Environmental Biology Division	15
Climate Change Research Project	1
Ozone Layer Research Project	4
Endocrine Disrupters & Dioxin Research Project	15
Biodiversity Conservation Research Project	11
Watershed Environments and Management Research Project	9
PM2.5 & DEP Research Project	12
Research Center for Material Cycles and Waste Management	28
Research Center for Environmental Risk	8
Environmental Information Center	13
Laboratory of Intellectual Fundamentals for Environmental Studies	7
Center for Global Environmental Research	10
Total	281

Fields of Expertise

Basic Sciences	80
Engineering	61
Agricultural Sciences	21
Medical Science	17
Pharmacology	6
Fisheries Science	3
Economics	1
Jurisprudence	1
Total	190

Division / Section/Team	Position	Staff Member	Extension	E-mail (@nies.go.jp)
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	President	GOHSHI, Yohichi	2300	gohshi
	Executive Director (Research)	NISHIOKA, Shuzo	2301	snishiok
	Executive Director (Management)	IIJIMA, Takashi	2820	t-iijima
	Auditor	TOMIURA, Azusa	2822	tomiura
	Auditor	OTSUKA, Hiroshi	2823	hotsuka
Research Coordinators				
	Principal Research Coordinator	MATSUMURA, Takashi	2302	mtakashi
	Deputy Director	UEHIRO, Takashi	2220	uehiro
Office of Research Coordination & Public Relations				
	Chief	MATSUMOTO, Kimio	2453	k-matsu
	Research Coordinator	TANABE, Masashi	2303	mtanabe
	Research Coordinator	YAMAZAKI, Kunihiko	2659	yamahiko
	Research Coordinator	KINO, Nobuhiro	2304	kino
	Research Coordinator	SUGIYAMA, Kenichirou	2307	kensugi
	Research Coordinator	HIROKANE, Katsunori	2308	hirokane
	Research Coordinator (*)	MATSUNAGA, Tsuneo	2305	kikaku-5
	Research Coordinator (*)	IMOMATA, Satoshi	2306	kikaku-6
	Research Coordinator (*)	TANABE, Kiyoshi	2657	kikaku-7
	Research Coordinator (*)	OSAKO, Masahiro	2658	kikaku-8
Office of International Coordination				
	Chief (*)	UEHIRO, Takashi	2220	uehiro
	International Coordination Researcher	SHIMIZU, Hideyuki	2309	hshimizu
	International Research Coordinator (*)	HIROKANE, Katsunori	2308	hirokane
Audit Section				
	Chief	ITO, Kishio	2831	k-ito
General Affairs Division				
	Director	KASHIWAGI, Jyunji	2311	kashiwagi
General Affairs Section				
	Chief	OTSUKA, Tetsuya	2312	t-otsuka
Accounting Section				
	Chief	MORI, Yutaka	2319	yutaka_m
Facility Management Section				
	Chief	TAKEUCHI, Tadashi	2410	ttakeuti
Executive Investigator				
		MORITA, Masatoshi	2332	mmorita
Principal Investigator				
		KABUTO, Michinori	2333	kabuto
Social and Environmental Systems Division				
	Director			
	Deputy Director	HARASAWA, Hideo	2507	harasawa
	Independent Senior Researcher	AOKI, Yoji	2389	yojiaoki
Environmental Economics Section				
	Leader			
		AOYAGI, Midori	2392	aoyagi
		HIBIKI, Akira	2510	hibiki
		KAMEYAMA, Yasuko	2430	ykame
		KUBOTA, Izumi	2979	izumi
Resources Management Section				
	Leader	MORIGUCHI, Yuichi	2540	moriguti
		MORI, Yasufumi	2539	mori-y
		TERAZONO, Atsushi	2506	terazono
Environmental Planning Section				
	Leader (*)	HARASAWA, Hideo	2507	harasawa
		TAKAHASHI, Kiyoshi	2543	ktakaha
		HIJIOKA, Yasuaki	2961	hijioka
Information Processing and Analysis Section				
	Leader	YOKOTA, Tatsuya	2550	yoko

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	SUGA, Shinsuke	2456	sugas
	SHIMIZU, Akira	2452	ashimizu
	MATSUNAGA, Tsuneo	2838	matsunag
	YAMANO, Hiroya	2477	hyamano
Integrated Assessment Modeling Section			
Leader	KAINUMA, Mikiko	2422	mikiko
	MASUI, Toshihiko	2524	masui
	FUJINO, Junichi	2504	fuji
	HANAOKA, Tatsuya	2710	hanaoka
Environmental Chemistry Division			
Director	SHIBATA, Yasuyuki	2450	yshibata
Deputy Director	TANABE, Kiyoshi	2478	tanabe
Independent Senior Researcher	YOKOUCHI, Yoko	2549	yokouchi
Analytical Instrumentation and Methodology Section			
Leader (*)	UEHIRO, Takashi	2811	uehiro
	KUME, Hiroshi	2436	hkume
	ARAMAKI, Takafumi	2124	ara
	SHIRAI, Tomoko	2265	tshirai
Analytical Quality Assurance Section			
Leader (*)	TANABE, Kiyoshi	2478	tanabe
	ITO, Hiroyasu	2398	h-ito
Environmental Chemodynamics Section			
Leader (*)	SHIBATA, Yasuyuki	2450	yshibata
	KUNUGI, Masayuki	2434	kunugi
	SEYAMA, Haruhiko	2462	seyamah
	TANAKA, Atsushi	2476	tanako
	YONEDA, Minoru	2552	myoneda
Ecological Chemistry Section			
Leader (*)	MORITA, Masatoshi	2332	mmorita
	HORIGUCHI, Toshihiro	2522	thorigu
	EDMONDS, J. S.	2860	Edmonds.john.s
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	IWANE, Taizo	2251	iwane
Environmental Health Sciences Division			
Director	TOHYAMA, Chiharu	2336	ctohyama
Deputy Director	KOBAYASHI, Takahiro	2353	takakoba
Molecular and Cellular Toxicology Section			
Leader	NOHARA, Keiko	2500	keikon
	OHSAKO, Seiichiro	2519	ohsako
	ITO, Tomohiro	2500	itotomo
Environmental Biodefense Research Section			
Leader	FUJIMAKI, Hidekazu	2518	fujimaki
	KUROKAWA, Yoshika	2437	kurokawa
	MOCHITATE, Katsumi	2538	mochitat
	YAMAMOTO, Shoji	2548	snyamamo
	KAKEYAMA, Masaki	2767	kake
Biomarker and Health Indicator Section			
Leader (*)	HIRANO, Seishiro	2512	seishiro
	YAMAMOTO, Megumi	2031	megumiy
	XING, Cui	2892	xing.cui
Epidemiology and International Health Research Section			
Leader	ONO, Masaji	2421	onomasaj
	TAMURA, Kenji	2520	ktamura
	ARAGAKI, Tazusa	2916	tazusa
	MURAKAMI, Yoshitaka	2254	ymura
Atmospheric Environment Division			
Director	SASANO, Yasuhiro	2444	sasano
Deputy Director	NAKANE, Hideaki	2491	nakane
Atmospheric Physics Section			

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Leader (*)	NAKANE, Hideaki	2491	nakane
	EMORI, Seita	2724	emori
	SUGATA, Seiji	2457	sugatas
	NOZAWA, Toru	2530	nozawa
	HIGURASHI, Akiko	2423	hakiko
	OGURA, Tomoo	2484	ogura
	NAGASHIMA, Tatsuya	2898	nagashima.tatsuya
Atmospheric Chemical Reaction Section			
Leader	HATAKEYAMA, Shiro	2502	hatashir
	TAKAMI, Akinori	2509	takamia
	SATO, Kei	2414	kei
	INOMATA, Satoshi	2403	ino
	TANIMOTO, Hiroshi	2930	tanimoto
Atmospheric Remote Sensing Section			
Leader	SUGIMOTO, Nobuo	2459	nsugimot
	MATSUI, Ichiro	2526	i-matsui
	SHIMIZU, Atsushi	2489	shimizua
	MORINO, Isamu	2515	morino
Atmospheric Measurement Section			
Leader	TOHJIMA, Yasunori	2485	tohjima
	UTIIYAMA, Masahiro	2411	utiyama
	MACHIDA, Toshinobu	2525	tmachida
	TAKAHASHI, Yoshiyuki	2468	yoshiyu
Acid Deposition Research Team			
Leader	MURANO, Kentaro	2537	murano
(*)	TAKAMATSU, Takejirou	2469	takamatu
(*)	NOHARA, Seiichi	2501	snohara
(*)	HATAKEYAMA, Shiro	2502	hatashir
Water and Soil Environment Division			
Director	WATANABE, Masataka	2338	masawata
Deputy Director	OTSUBO, Kuninori	2417	kuninori
Water Quality Science Section			
Leader (*)	WATANABE, Masataka	2338	masawata
	TOMIOKA, Noriko	2487	tomioka
	SYUTSUBO, Kazuaki	2058	stubo
	URAKAWA, Hidetoshi	2119	urakawa
Soil Science Section			
Leader	TAKAMATSU,Takejirou	2469	takamatu
	MUKAI, Satoshi	2535	mukaisa
	HAYASHI, Seiji	2599	shayashi
	MURATA, Tomoyoshi	2413	tmurata
	KOSHIKAWA, Masami	2440	mkanao
Geotechnical Engineering Section			
Leader	INABA, Kazuho	2399	inabakz
	DOI, Taeko	2488	tdoi
Lake Environment Section			
Leader	IMAI, Akio	2405	aimai
	MATSUSHIGE, Kazuo	2527	matusige
	KOMATSU, Kazuhiro	2733	kkomatsu
Marine Environment Section			
Leader	HARASHIMA, Akira	2508	harashim
	NAKAMURA, Yasuo	2492	yasuo
Environmental Biology Division			
Director	WATANABE, Makoto	2555	mmw
Deputy Director (*)	TSUBAKI, Yoshitaka	2482	tsubaki
Ecosystem Function Study Section			
Leader	NOHARA, Seiichi	2501	snohara
	NATORI, Toshiki	2494	tnatori
	MIYASHITA, Mamoru	2534	miyasita
	SATAKE, Kiyoshi	2446	satanii

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	YABE, Tohru	2533	yabet
Biodiversity and Phylogenetic Study Section			
Leader	KASAI, Fumie	2424	kasaif
	HIROKI, Mikiya	2513	hiroki-m
	UENO, Ryuhei	2408	uenor
	KAWACHI, Masanobu	2345	kawachi
Tropical Ecology Section			
Leader	OKUDA, Toshinori	2426	okuda
	TANG, Yanhong	2481	tangyh
Molecular Ecotoxicology Section			
Leader	SAJI, Hikaru	2445	hsaji
	KUBO, Akihiro	2435	kub
	AONO, Mitsuko	2391	maono
Climate Change Research Project			
Director (*)	INOUE, Gen	2402	inouegen
Deputy Director (*)	KAINUMA, Mikiko	2422	mikiko
Carbon Cycle Research Team			
Leader	NOJIRI, Yukihiro	2499	nojiri
(*)	MUKAI, Hitoshi	2536	lnmukaih
(*)	TOHJIMA, Yasunori	2485	tohjima
(*)	MACHIDA, Toshinobu	2525	tmachida
(*)	TAKAHASHI, Yoshiyuki	2468	yoshiyu
(*)	ARAMAKI, Takafumi	2124	ara
Carbon Sink Research Team			
Leader (*)	YAMAGATA, Yoshiki	2545	yamagata
(*)	FUJINUMA, Yasumi	2517	fujinuma
(*)	OGUMA, Hiroyuki	2983	oguma
Socio-economic & Emission Modeling Team			
Leader (*)	KAINUMA, Mikiko	2422	mikiko
(*)	KAMEYAMA, Yasuko	2430	ykame
(*)	HIBIKI, Akira	2510	hibiki
(*)	MASUI, Toshihiko	2524	masui
(*)	FUJINO, Junichi	2504	fuji
(*)	HANAOKA, Tatsuya	2710	hanaoka
Climate Modeling Team			
Leader			
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(*)	HIGURASHI, Akiko	2423	hakiko
(*)	OGURA, Tomoo	2484	ogura
Impact & Adaptation Modeling Team			
Leader (*)	HARASAWA, Hideo	2507	harasawa
(*)	TAKAHASHI, Kiyoshi	2543	ktakaha
(*)	HIJIOKA, Yasuaki	2961	hijioka
Ozone Layer Research Project			
Director	IMAMURA, Takashi	2406	imamura
Satellite Remote Sensing Research Team			
Leader	NAKAJIMA, Hideaki	2800	hide
	SUGITA, Takafumi	2460	tsugita
(*)	YOKOTA, Tatsuya	2550	yoko
Ground-based Remote Sensing Research Team			
Leader (*)	NAKANE, Hideaki	2491	nakane
Ozone Layer Modeling Research Team			
Leader (*)	IMAMURA, Takashi	2406	imamura
	AKIYOSHI, Hideharu	2393	hakiyosi
Endocrine Disrupters & Dioxin Research Project			
Director (*)	MORITA, Masatoshi	2332	mmorita
Deputy Director	TAKANO, Hirohisa	2334	htakano
Chemical, Bioassay & Dynamics Research Team			
Leader (*)	MORITA, Masatoshi	2332	mmorita
	SHIRAISHI, Fujio	2454	fujios

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(*)	SHIBATA, Yasuyuki	2552	yshibata
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Biological Function Assessment Team			
Leader	MITSUMORI, Fumiyuki	2862	mitumori
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	WATANABE, Hidehiro	2138	hidewata
(*)	KUROKAWA, Yoshika	2437	kurokawa
Pathophysiology Research Team			
Leader (*)	TAKANO, Hirohisa	2334	htakano
	ISHIDO, Masami	2396	ishidou
	IMAI, Hideki	2404	imahide
Heath Effects Research Team			
Leader	YONEMOTO, Junzo	2553	yonemoto
	SONE, Hideko	2464	hsone
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Ecological Effect Research Team			
Leader (*)	MORITA, Masatoshi	2332	mmorita
	TAKAHASHI, Shinji	2467	stakahas
	TADA, Mitsuru	2475	mtada
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Counter Measurement & Engineering Team			
Leader (*)	YASUHARA, Akio	2544	yasuhara
	HASHIMOTO, Shunji	2531	shunji
(*)	ITO, Hiroyasu	2398	h-ito
Research Integration Team			
Leader	SUZUKI, Noriyuki	2331	nsuzuki
	SAKURAI, Takeo	2801	tsakurai
Biodiversity Conservation Research Project			
Director	TSUBAKI, Yoshitaka	2482	tsubaki
Wildlife Population Research Team			
Leader	TAKAMURA, Kenji	2470	takaken
	NAGATA, Hisashi	2493	hnagata
Biological Invasion Research Team			
Leader	GOKA, Koichi	2480	goka
(*)	TATSUTA, haruki	2650	htatsuta
Community Dynamics Research Team			
Leader	TAKENAKA, Akio	2474	takenaka
	YOSHIDA, Katsuhiko	2443	kyoshida
Ecological Landscape Research Team			
Leader	TAKAMURA, Noriko	2471	noriko-t
	FUKUSHIMA, Michio	2427	michio
Biotechnology Risk Assessment Team			
Leader	NAKAJIMA, Nobuyoshi	2490	naka-320
	IWASAKI, Kazuhiro	2407	kiwasaki
	TAMAOKI, Masanori	2466	mtamaoki
(*)	TOMIOKA, Noriko	2487	tomioka
Watershed Environments and Management Research Project			
Director	MURAKAMI, Shogo	2388	murakami
Watershed Environments Research Team			
Leader (*)	MURAKAMI, Shogo	2388	murakami
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	WANG, Qinxue	2919	wang.qinxue
	KAMEYAMA, Satoshi	2401	kame
	NAKAYAMA, Tadanobu	2564	nakat
	OKADERA, Tomohiro	2656	okadera
(*)	HAYASHI, Seiji	2599	shayashi

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Coastal Environment Research Team				
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		KOSHIKAWA, Hiroshi	2505	koshikaw
		MAKI, Hideaki	2394	hidemaki
Remote Sensing Data Analysis Team				
	Leader			
	(*)	YAMANO, Hiroya	2477	hyamano
	(*)	MATSUNAGA, Tsuneo	2838	matsunag
PM2.5 & DEP Research Project				
	Director	WAKAMATSU, Sinji	2890	wakamatu
	Deputy Director (*)	KOBAYASHI, Takahiro	2353	takakoba
	Independent Senior Researcher	MATSUMOTO, Yukio	2529	y-matsu
Traffic Pollution Control Research Team				
	Leader (*)	MORIGUCHI, Yuichi	2540	moriguti
		KONDO, Yoshinori	2441	kondos
		KOBAYASHI, Shinji	2973	kobayashi.shinji
		MATSUHASHI, Keisuke	2511	matuhasi
	(*)	TANABE, Kiyoshi	2478	tanabe
Urban Air Quality Research Team				
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		UEHARA, Kiyoshi	2409	kuehara
	(*)	SUGATA, Seiji	2457	sugatas
Aerosol Measurement Research Team				
	Leader			
	(*)	UTIYAMA, Masahiro	2411	utiyama
	(*)	NISHIKAWA, Masataka	2495	mnishi
Epidemiology and Exposure Assessment Research Team				
	Leader	NITTA, Hiroshi	2497	nitta
	(*)	ONO, Masaji	2421	onomasaj
	(*)	TAMURA, Kenji	2520	ktamura
Inhalation Toxicology Team				
	Leader (*)	TAKANO, Hirohisa	2334	htakano
		SUZUKI, Akira	2461	suzukiak
		FURUYAMA, Akiko	2521	kawagoe
		KOIKE, Eiko	2439	ekoike
		INOUE, Kenichiro	2542	inoue.kenichirou
Research Center for Material Cycles and Waste Management				
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	Research Coordinator (*)	KINO, Nobuhiro	2918	kino
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		FUJII, Minoru	2967	fujii
		NANSAI, Keisuke	2889	nansai.keisuke
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Material Cycles Engineering Section				
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		NAKAJIMA, Daisuke	2984	dnakaji
Waste Treatment Engineering Section				
	Leader	KAWAMOTO, Katsuya	2958	kawamoto
		NISHIMURA, Kazuyuki	2990	knishi
		KURAMOCHI, Hidetoshi	2841	kuramochi.hidetoshi
Final Disposal Engineering Section				
	Leader	INOUE, Yuzo	2836	yinoue
		YAMADA, Masato	2837	myamada
		INANC, Bulent	2691	binanc

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		ENDO, Kazuto	2228	k-endo
Testing and Assessment Section				
	Leader	YASUHARA, Akio	2544	yasuhara
		YAMAMOTO, Takashi	2547	tyama
		SUZUKI, Shigeru	2845	suzuki.shigeru
		NOMA, Yukio	2846	noma
		TAKAHASHI, Shin	2203	shint
	(*)	HASHIMOTO, Shunji	2531	shunji
Hazardous Waste Management Section				
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		OSAKO, Masahiro	2835	mosako
		KIDA, Akiko	2730	akida
		TAKIGAMI, Hidetaka	2866	takigami
	(*)	SUZUKI, Noriyuki	2331	nsuzuki
Bio - Eco Engineering Section				
	Leader	INAMORI, Yuhei	2400	inamori
		MIZUOCHI, Motoyuki	2496	mizuochi
		ITAYAMA, Tomoaki	2361	itayama
		IWAMI, Norio	2361	niwami
Research Center for Environmental Risk				
	Director	SHIRAISHI, Hiroaki	2455	hirosira
	Research Coordinator (*)	YAMAZAKI, Kunihiko	2278	yamahiko
	(*)	HIRANO, Seishiro	2512	seishiro
	(*)	KABUTO, Michinori	2333	kabuto
	(*)	SUZUKI, Noriyuki	2331	nsuzuki
	(*)	GOTO, Sumio	2834	sumiogoto
Exposure Assessment Section				
	Leader (*)	SHIRAISHI, Hiroaki	2455	hirosira
		IMAIZUMI, Yoshitaka	2689	imaizumi
Health Risk Assessment Section				
	Leader	AOKI, Yasunobu	2942	ybaoki
		MATSUMOTO, Michi	2528	michi
		MARUYAMA, Wakae	2695	maruw
Ecological Risk Assessment Section				
	Leader (*)	SHIRAISHI, Hiroaki	2455	hirosira
		SUGAYA, Yoshio	2458	sugaya
		TATSUTA, Haruki	2650	htatsuta
		KASHIWADA, Shosaku	2651	shosaku
Environmental Information Center				
	Director	IWATA, Motokazu	2340	m-iwata
Information Planning Section				
	Chief	TAKEUCHI, Hisanori	2341	takehisa
Information Management Section				
	Chief	SHIRAI, Kunihiko	2342	shiro
Database Section				
	Chief (*)	SHIRAI, Kunihiko	2337	shiro
Laboratory of Intellectual Fundamentals for Environmental Studies				
	Director	WATANABE, Makoto	2555	mmw
	(*)	KASAI, Fumie	2424	kasaif
	(*)	TAKEUCHI, Tadashi	2410	ttakeuti
Research Laboratory (Section) of Environmental Analytical Chemistry				
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		SANO, Motoharu	2449	sanotomo
		TAKAGI, Hiroo	2465	takakiho
	(*)	HORIGUCHI, Toshihiro	2522	thorigu
	(*)	ITO, Hiroyasu	2398	h-ito
Research Laboratory (Section) of Biological Resources and Informatics				
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		TOBE, Kazuo	2486	tobe
		KAWASHIMA, Takaharu	2174	kawataka
	(*)	KAWACHI, Masanobu	2345	kawachi
	(*)	SUGAYA, Yoshio	2458	sugaya
	(*)	TAKAHASHI, Shinji	2467	stakahas
	(*)	SHIMIZU, Akira	2452	ashimizu
Center for Global Environmental Research				
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	Director	INOUE, Gen	2402	inouegen
	Research Program Manager	FUJINUMA, Yasumi	2517	fujinuma
	Research Program Manager	YAMAGATA, Yoshiki	2545	yamagata
	Research Program Manager	MUKAI, Hitoshi	2536	lnmukaih
		ICHINOSE, Toshiaki	2598	toshiaki
		OGUMA, Hiroyuki	2983	oguma
	(*)	NAKANE, Hideaki	2491	nakane
	(*)	YOKOTA, Tatsuya	2550	yoko
	(*)	HARASAWA, Hideo	2507	harasawa
	(*)	MORIGUCHI, Yuichi	2540	moriguti
	(*)	KAINUMA, Mikiko	2422	mikiko
	(*)	YOKOUCHI, Yoko	2549	yokouchi
	(*)	TANAKA, Atsushi	2476	tanako
	(*)	ONO, Masashi	2421	onomasaj
	(*)	EMORI, Seita	2724	emori
	(*)	TOHJIMA, Yasunori	2485	tohjima
	(*)	MACHIDA, Toshinobu	2525	tmachida
	(*)	TANIMOTO, Hiroshi	2930	tanimoto
	(*)	MATSUSHIGE, Kazuo	2527	matusige
	(*)	OKUDA, Toshinori	2426	okuda
	(*)	NOJIRI, Yukihiro	2499	nojiri
	(*)	NAKAJIMA, Hideaki	2800	hide
	(*)	SHIRAI, Kunihiko	2337	shiro

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ADEOS-II	Advanced Earth Observing Satellite-II
AhR	Arylhydrocarbon Receptor
AHS	Aquatic Humic Substances
AIM	Asia Pacific Integrated Models
AMS	Accelerator Mass Spectrometry
BaS	Bases
BCF	Bioconcentration Factor
BNN	Back-propagation Neural Network
BSO	Buthionine Sulfoximine
CAS	Chemical Abstracts Service
CCSR	Center for Climate System Research, the University of Tokyo
CHD	Catalytic Hydro-Dechlorination
CMAQ	Community Multiscale Air Quality System
co-PCBs	Co-planar Polychlorinated Biphenyls
CRM	Certified Reference Material
CSIRO	Commonwealth Scientific & Industrial Resrarch Organization
DEP	Diesel Exhaust Particles
DGGE	Denaturing Gradient Gel Electrophoresis
DMA	Dimethylarsinic Acid
DOM	Dissolved Organic Matter
DPAA	Diphenylarsinic Acid
DSi	Dissolved Silicate
ECG	Electro Cardiogram
EID	Estimated Individual Exposure
ELISA	EnzymeLinked Immunosorbent Assay
ER	Estrogen Receptor
ETE	Estimated Total Exposure
GC-HRMS	Gas Chromatography-High Resolution Mass Spectrometry
GC-HRMS	Gas Chromatography-High Resolution Mass Spectorometry
G-CIEMS	Grid-Catchment Integrated Modeling System
GCM	Genaral Circulation Model
GC-NCI-MS	Gas Chromatography-Negative Chemical Ionization-Mass Spectrometry
GDP	Gross Domestic Products
GEMS/Water	Global Environmental Monitoring System Freshwater Quality Program
GHG	Greenhouse Gas
GIS	Geographical Information System
HF	High Frequency power spectrum
HGM	Hydrogeomorphic Assessment
HiA	Hydrophilic Acids
HiN	Hydrophilic Neutrals
HoN	Hydrophobic Neutrals
ICAM-1	Intercellular Adhesion Molecule-1
ICP	Inductively Coupled Plasma
IEM	Integrated Environmental Monitoring
IGSNRR	Institute for Geographical Sciences and Natural Resources Research
IL-1β	Interleukein-1β
ILAS	Improved Limb Atmospheric Spectrometer
ILAS-II	Improved Limb Atmospheric Spectrometer-II
IRMS	Isotope Ratio Mass Spectrometry
ISO	International Standard Organization
LAB	Lactic Acid Bacteria
LAI	Leaf Area Index
LAN	Local Area Network
LCA	Life-Cycle Assessment
LC-ECD	Liquid Chromatography-Electro Chemical Detector
LC-ICPMS	Liquid Chromatography-Inductively Coupled Plasma Mass Spectrometry
LC-MS	Liquid Chromatography-Mass Spectrometry
LC-MS-MS	Liquid Chromatography-Tandem Mass Spectrometry
LF	Low Frequency power spectrum
MFA	Material Flow Accounting/Analysis
MIPAS-B	Michelson Interferometer for Passive Atmospheric Sounding-Balloonborne Version
MMA	Monomethylarsonic Acid
MODIS	Moderate Resolution Imaging Spectroradiometer
MSW	Municipal Solid Waste
NDSC	Network for the Detection of Stratospheric Change
NGF	Nerve Growth Factor
NO	Nitrogen Oxide
NOEC	No Observed Effect Concentration
NUS	Nationa University of Singapore
OECD	Organization for Economic Co-operation and Development
OVA	Ovalbumin
PBDD/DFs	Polybrominated Dibenzodioxins/Furans
PCBs	Polychlorinated Biphenyls
PCD	Photochemical Dechlorination
PCDDs	Polychlorinated-*p*-Dibenzodioxins
PCDFs	Polychlorinated-*p*-Dibenzofurans
PEC/PNEC	Predicted Environmental Concentration/ Predicted No-Effect Concentration
PIOT	Physical Input-Output Tables
$PM_{2.5}$	Particulate Matter less than 2.5 microns
POAM III	Polar Ozone and Aerosol Measurement III
POPs	Persistant Organic Pollutants
PSC	Polar Stratospheric Cloud
QBO	Quasi-Biennial Oscillation
QSAR	Quantitative Structure-Activity Relationship
RXR	Retinoid X Receptor
SAGE II	Stratospheric Aerosol and Gas Experiment II
SAGE III	Stratospheric Aerosol and Gas Experiment III
SD	Sodium Dispersion
SH	Spontaneously Hypertensive
SIMS	Secondary Ion Mass Spectrometry
SNP	Single Nucleotide Polymorphism
SOM	Self-Organizing Map
SPM	Suspended Particulate Matter
TCDD	2,3,7,8-Tetrachlorodibenzo-*p*-dioxin
TCE	Trichloroethylene
TEOM	Tapered Element Oscillating Microbalance
TEQ	Toxic Equivalency Quantity
TG	Test Guideline
UNEP	United Nations Envrionment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VOCs	Volatile Organic Compounds
WAN	Wide Area Network
WHO	World Health Organization
WWW	World Wide Web
XPS	X-ray Photoelectron Spectroscopy

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