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NIES Annual Report 1998

National Institute for Environmental Studies

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Foreword

With its history spanning a quarter of a century, the National Institute for Environmental Studies (NIES) is now ready to look at the next century. Recently, we have begun to recognize changes in the nature of environmental problems. These changes are expansion, diffusion and extension of environmental issues as follows:

1) Spatial expansion
We have observed the development of global-scale phenomena such as global warming and depletion of the stratospheric ozone layer. Another expansion is that of local pollution such as air pollution from automobile exhausts in mega-cities all over the world.

2) Diffusion of relationships between emitters and receivers of pollutants
In classical cases, the differentiation between polluters and those affected by pollution is very clear. However, in the case of pollution from non-point sources such as wastewater from households and exhaust gases from automobiles, both emitters and receivers of pollutants are the people in the street. The same person may be both an assailant and a victim. In such cases, the responsibility for pollution is apt to be very diffuse.

3) Temporal extension
It has become clear that it is up to our generation to leave a safe and sound environment for future generations. Some environmental problems such as global warming and endocrine-disrupters will affect not only our generation but also our descendants. For example, endocrine-disrupters in the environment affect the reproduction and existence of life on the Earth, which is a very severe problem that should be solved with urgency.

These changes in environmental problems make it more complicated and difficult to deal with them. Under these circumstances, NIES has been conducting researchs focused on the unprecedented problems occurring in our generation. Although there are various restrictions and/or limitations on our activities, NIES is now willing to expand its research fields from domestic to Asian regional, and to a global scale, and also to extend its scope from the environment of today to that of future generations.

Gen OHI, MD., D.Sci., M.P.H.
Director General

Contents

During the 1950s and 1960s, Japan experienced serious environmental pollution problems accompanying the rapid economic growth which followed World War II. Among these problems were 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. The Environment Agency of Japan was established in 1971 to develop countermeasures to serious environmental pollution problems such as these. 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 50 km north of Tokyo as a branch of the Environment Agency of Japan. NIES is the sole national institute for comprehensive research in the environmental sciences.

Since its establishment, NIES has conducted basic studies to reveal the nature of and to provide countermeasures to the so called seven common public nuisances; i.e. air pollution, water pollution, soil contamination, noise, vibration, offensive odor and ground subsidence. Researchers at NIES are of various specialties including physics, chemistry, biology, health sciences, engineering, 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 Water Research Station, the Okunikkou Field Monitoring Station and Monitoring Station-Hateruma, and Cape Ochi-ishi.

Recent, 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 (Fig. 1) on July 1, 1990 to elucidate the adverse effects of environmental pollution on human health, to search for countermeasures to these threats, 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 Senior 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. The Environmental Training Institute, located in Tokorozawa, enhances the capabilities of officials from all levels of government.

As of the end of FY 1997, the total number of NIES regular personnel was 270 (Table 1). In FY 1997, NIES invited 396 scientists to carry out the research programs as occasion demanded and also 165 researchers (62 foreigners included) joined NIES's research activities. The total budget of FY 1997 was 10,511 million yen (Table 2).

Table 1
Full Number of Personnel

Research	176	65.2%
Management	46	17.0%
Env. Information Center	19	7.0%
Center for Global Env. Research	10	3.7%
Env. Training Institute	19	7.0%
Total	270	100%

(as of the end of FY1997)

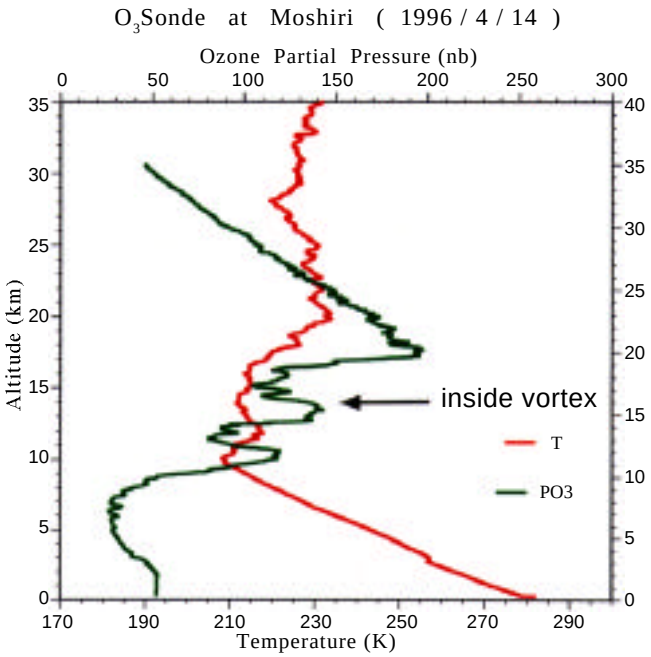
Table 2
Budget in Millions of Yen

Item	FY1995	FY1996	FY1997	
1. Primary budget				(% of total)
Personnel	2,199	2,267	2,348	(27.6%)
Research	1,637	694	848	(10.0%)
Facilities operations & maintenance	1,457	1,418	1,527	(18.0%)
Info. & related research	509	509	558	(6.6%)
Center for Global Env. Research	1,928	2,091	2,356	(27.7%)
Env. Training Institute	108	121	109	(1.3%)
Administration	354	356	490	(5.8%)
Facilities maintenance and repairs	2,005	463	256	(3.0%)
Total	10,197	7,919	8,492	(100%)
2. Additional resources from external research funds				
EA Research Funds	1,066	1,217	1,482	
STA Research Funds and etc.	588	683	537	
Total	1,654	1,900	2,019	

(EA=Environment Agency, STA=Science and Technology Agency)

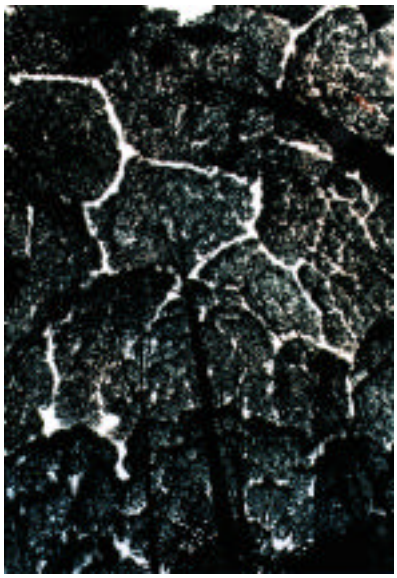
Fig. 1
Organization of the National Institute for Environmental Studies

Global Environment Division

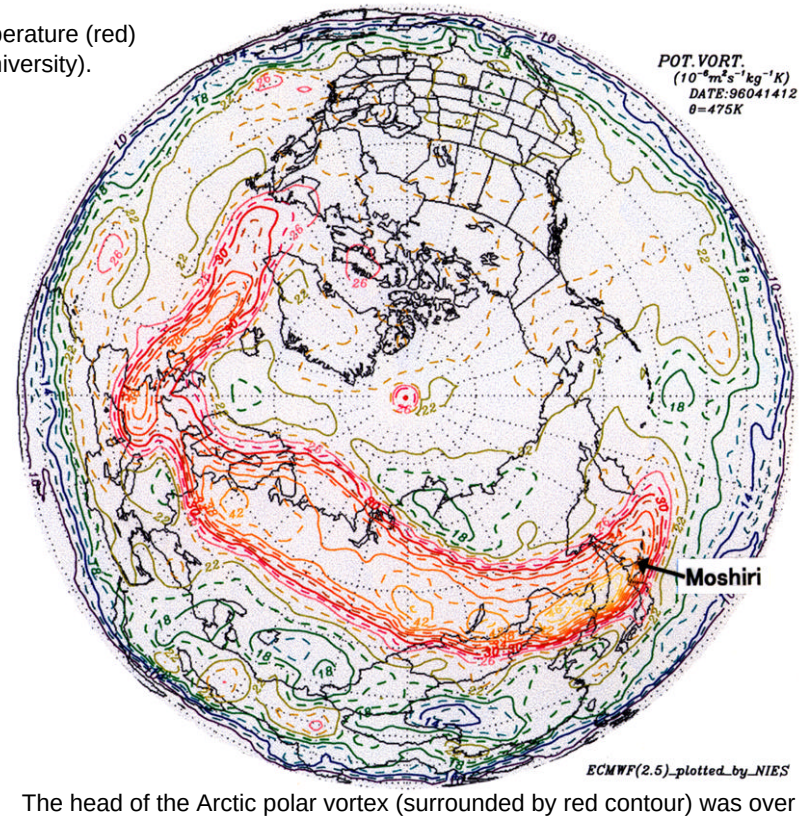


Vertical profiles of ozone (green) and temperature (red) at the Moshiri Station (STEL of Nagoya University).

Forest decline in northwestern Kanto Plain.



Canopy formed by *Dryobalanops aromatica* (Kapur) in the Forest Research Institute Malaysia (FRIM) arboretum.



The head of the Arctic polar vortex (surrounded by red contour) was over the Moshiri Station.

The mission of the Global Environment Research Division is to investigate contemporary global environmental issues with interdisciplinary and integrated approaches. These approaches are used to analyze, evaluate, and understand the issues. Based on the new insights so generated, we hope to propose technical and policy measures to solve the problems. In this section, the scope of activities of the 9 teams in the group is introduced and 3 major recent research topics are described in depth.

Global Warming Mechanism Research Team

This Team is measuring greenhouse gases in the troposphere and hydrosphere, using the NIES monitoring network with various platforms established by CGER/NIES, including ground-based stations, ships-of-opportunity and aircraft. A steady increase in atmospheric concentration of CO_2 at the two background air monitoring stations, located at Hateruma Island in Okinawa Prefecture, and Cape Ochiishi in Hokkaido Prefecture, has been observed since 1993 at Hateruma and since 1995 at Ochiishi. However, concentrations leveled off in 1997, which might be related with the recent El Nino episode. Latitudinal distributions of atmospheric CO_2, CH_4 and N_2O have been measured precisely since 1992 from a ship-of-opportunity that sails regularly between Japan and Australia. Bottles of marine air are collected automatically from lat 25°S to 35°N every 6 weeks. Additional sampling using another ship-of-opportunity sailing regularly between Canada and Japan started in 1995, collecting atmospheric samples from 54°N to 36°N to extend the latitudinal coverage.

Air sampling to measure vertical profiles of greenhouse gases has been carried out monthly since July 1993 over Surgut, western Siberia, using a chartered aircraft. Air samples have been collected at 8 different heights between 500 and 7000 m. The seasonal cycles of CO_2 concentration at the respective heights reached a maximum in late March or late April and a minimum in late July or late August. Similar sampling has begun over Yakutsk in eastern Siberia and at Tomsk in central Siberia.

The results of pCO_2 measurement in surface seawater from the Japan-Canada ship-of-opportunity were analyzed to estimate seasonality by ocean grid in the North Pacific. In the western North Pacific, winter deepening of surface mixing increases surface pCO_2 and summer production of phytoplankton decreases it. In the mid-latitudes of the Pacific, there is a small seasonal amplitude of pCO_2, mainly due to the sea surface temperature change. The high-latitude western North Pacific is a net source of CO_2, while the mid-latitude North Pacific is a net sink area of atmospheric CO_2.

Global Warming Response Research Team

This Team has been developing the Asian-Pacific Integrated Model (AIM) with Kyoto University and collaborating institutes in China, India, Korea and Indonesia. The model assesses policy options for stabilizing the global climate, particularly in the Asian-Pacific region, with the objectives of reducing greenhouse gas emissions and preventing impacts from climate change.

The AIM comprises three main models - a greenhouse gas emission model (AIM/emission), a global climate change model (AIM/climate), and a climate change impact model (AIM/impact). The AIM/emission model consists of Asian-Pacific country

models integrated into a regional and global model to provide estimates of energy consumption, land-use changes, etc., which ultimately provide predictions of greenhouse gas emissions. The AIM/climate model provides outputs for a variety of climate scenarios based on GCM experiments. The AIM/impact model estimates the impact on water supply, agriculture, forest products, vegetation and human health. It can also be used to make predictions of higher-order impacts on the regional economy.

The research program has made major contributions to policy deliberations at the national, regional, and global levels. The AIM model has been used to provide country-level greenhouse gas emissions in the Asia-Pacific region. Future Japanese CO_2 emissions have been estimated based on detailed future technologies and social structure changes. The modeling teams in various Asian regions have used the basic model structure to analyze climate change in their own regions. The AIM model has also been used to qualify new IPCC emission scenarios. An AIM training program has started and training workshops have been held in Beijing, China, and Ahmedabad, India, sponsored by the Asian-Pacific Network for Global Change Research.

Ozone Layer Research Team

Ozone depletion in the middle and high latitudes of the northern hemisphere during the winters of 1994/1995, 1995/1996, and 1996/1997 was extraordinarily large, especially inside the polar vortex. The Ozone Layer Research Team has been developing ground-based remote sensing instruments and balloon-borne instruments to measure trace species related to ozone depletion as well as participating in national and international research campaigns, such as Ozone Sounding as a tool for Detection of Ozone Change (OSDOC), in cooperation with national institutions, universities, and foreign institutions. The team is also in charge of the ozone layer monitoring effort supported by CGER. Ozone at altitudes of 15 to 45 km has been monitored for more than 9 years with a laser radar, as a component of the Network for the Detection of Stratospheric Change (NDSC). In September 1995, we installed a millimeter radiometer to measure vertical profiles of ozone continuously from 35 to 75 km to extend our ozone measurement capabilities in both time and space.

From January 1996, ozone sonde observations have been carried out to examine the influences of the polar vortex on ozone depletion at Moshiri Station (lat 44°N, long 14°E), operated by the Solar Terrestrial Environment Laboratory (STEL) of Nagoya University. These observations were complemented by visible spectrometer and Fourier transform-infrared spectrometer (FTIR) observations from STEL. In April 1996 and May 1997, the effects of ozone depletion in the polar vortex were observed by these methods.

Modeling of ozone depletion, laboratory experiments, and studies to evaluate the impacts of UV-B on human and plant health were carried out. The behavior of and measures for counteracting methyl bromide were also studied.

Satellite Remote Sensing Research Team

This Team has been taking a leading role in promoting the ILAS (Improved Limb Atmospheric Spectrometer) and ILAS-II projects for monitoring the stratospheric ozone layer from space. The ILAS instrument was in operation onboard the ADEOS

(Advanced Earth Observing Satellite) spacecraft from November 1996 to June 1997, when the ADEOS lost its functions due to solar battery failure. ILAS-II will be launched in 2000 and will have improved capabilities for characterization of stratospheric ozone layer chemistry and polar stratospheric clouds.

The Team has developed and modified the ILAS data processing software. The revised software reflects the results of algorithm studies and instrument function evaluation conducted in 1996 and 1997. The ILAS data obtained were processed to provide profiles of ozone and other trace gas species in the high-latitude stratosphere. These profiles were compared with truth data that had been obtained in the ILAS validation experiments.

The Team has been working with a group of researchers from Japanese and overseas universities and research institutes to conduct studies in and to provide scientific guidance for the ILAS project. The members have been working on revising algorithms for data processing, and on validation experiments and analysis for that project. Preliminary analyses indicate that the ILAS instrument worked normally without problems and produced valuable data on ozone layer chemistry and dynamics.

The team has started studies of algorithms and development of a data processing system for ILAS-II.

Acid Deposition Research Team

Acid deposition is one of the most interdisciplinary environmental problems that we are now facing. East Asia will soon become the largest source region for acidic pollutants in the world because of the increase in fossil fuel consumption in that region accompanying rapid population growth and industrial development of activity. The Acid Deposition Research Team is investigating the volume of emissions, and transport, deposition, and impact of acidic pollutants on life-environment systems in East Asia including China, Korea and Japan.

From data obtained by aircraft observations over the Sea of Japan, the East China Sea, and the Yellow Sea, air masses transported from the Asian continent to Japan in winter can be divided into 3 types: (A) air masses moving from northern China to Kyushu or west of Kyushu, which pass over the Yellow Sea; (B) air masses passing over the Korean Peninsula and reaching western Japan; and (C) air masses originating in northern Asia that move to eastern Japan, and do not pass over areas with large emissions of atmospheric pollutants.

A field survey at a remote island (Goto Island) in the East China Sea showed the existence of long-range transport of non-sea-salt sulfate and particulate ammonium from the Asian continent to Japan. Using the Sulfate Transport Eulerian Model (STEM), we simulated the typical temporal patterns of observed concentrations of both SO_4^{2-} and NO_3^- and found that wind pattern variations are extremely important in the transport of air pollutants.

An increase of NH_4^+ and NO_3^- in deposition, both as acids and essential nutrients for

plant growth, may change ecosystems, including interactions among organisms. The pH range of rainwater recorded at the island of Yakushima in Japan (a world natural heritage site) in 1994 to 1996 was 3.9 to 6.0, and that of snow was 4.8 to 5.2. During late autumn to early spring (November to March), the main wind direction is westerly. In winter, the concentrations of NH_4^+ and NO_3^- increase in rainwater as well as in snow; their concentrations are highly correlated, indicating the presence of ammonium nitrate, which is usually transported as sub-micron sized aerosols. The main uptake process of N compounds in the forest may be via the roots of trees such as *Cryptomeria japonica*. Although both NH_4^+ and NO_3^- are used by *C. japonica*, NO_3^- is used together with cations such as K^+ and Ca_2^+. Therefore, K^+ deficiency may influence the uptake of NH_4^+ and NO_3^-.

Marine Environment Research Team

Anthropogenic changes in the Asian marginal seas, ranging from discharges of hazardous chemicals to deterioration of ecosystems, are becoming significant and diverse. The objectives of the Marine Environmental Research Team are to detect these changes and reduce the uncertainties inherent in assessing their effects. In order to assess broadly the changes occurring in Asian marginal seas, a monitoring program using a ship-of-opportunity sailing between Japan and Malaysia is being carried out. A meeting to facilitate cooperative marine environmental monitoring was held, at which specialists from Asian countries were invited to promote this program efficiently. Among these marginal seas, the flux of materials in the Chang Jiang River estuary is of particular importance in view of the impact of anthropogenic perturbations of C, N, P, Si and other chemicals. An intensive NIES (Japan) - SOA (China) collaborative research program was conducted using field surveys and floating mesocosm experiments. A solid-phase extractor system was developed and deployed on a ferry to detect concentrations of hazardous trace chemicals in seawater.

A method to archive underwater stereo images was developed to analyze the growth, decline, and sustainability of the biodiversity of coral reef ecosystems.

Natural Vegetation Conservation Research Team

This Team has been studying the dynamics of the canopy and its effects on the forest floor vegetation in the Pasoh Forest Reserve, Peninsular Malaysia. The effects of canopy height on the regeneration and species composition of trees were studied using aerial photographs and tree demography data obtained in the reserve. Sapling density and tree diameter growth decreased with increase of the canopy height. However, local species diversity did not change distinctly as a function of canopy height. The distribution and size of the canopy gaps were found to have changed little between 1995 and 1997; the forest appears to have been stable during this period. Seedling survivorship of some dipterocarp species in canopy gaps and under closed canopies was compared; survivorship was not strictly dependent on the presence of canopy gaps. The phenolic content and leaf toughness of seedlings were measured to help understand the chemical and mechanical defense mechanisms of plants to herbivores and pathogens. Leaf toughness and phenolic content of seedlings were lower under the closed canopy than in the canopy gaps, while the rate of leaf damage by herbivores was not significantly different between the two habitats.

Wildlife Conservation Research Team

This Team has been developing techniques to evaluate the vulnerability of wildlife to population decrease and extinction. Populations may suffer significant genetic deterioration, that is, a decrease in genetic variability, which may lead to a corresponding decrease in fitness (survival and reproduction). We analyzed, for various species, their fluctuating asymmetry (FA: minor non-directional deviations from bilateral symmetry in morphological characters) and genetic variability, and the relationship between them. In several groups (butterflies, dragonflies, fruit flies, stickleback fish, and sylvid and emberizid birds), both terms can be calculated as measures of fitness. In addition to FA measurements, the team is analyzing the effects of decreased genetic variability on disease resistance in wildlife populations, using DNA analysis of major histocompatibility complex (MHC) polymorphisms and/or bioassays of the immune response of animals.

In the Japanese marsh warbler *Megalurus pryeri*, listed in the Japanese Red Data Book as an endangered species, we investigated the spatial and temporal distribution of breeding populations. This species forms a meta-population structure, characterized by three core populations with fairly stable numbers (Tone River and Aomori populations), and populations in several satellite areas (Akita and Miyagi populations). Populations in the satellite areas may become extinct, but a new population there may also be established by migrants from the core population when conditions become more favorable. Investigations so far carried out on a core population along the Tone River found no indication of increased FA or blood parasitism. We will compare characteristics of core and satellite populations in an extended study of populations in the satellite areas.

Populations of the freshwater threespine stickleback *Gasterosteus aculeate* in Japan are diminishing because of habitat destruction and/or fish culture. In a population of this species in central Japan, we counted the number of plate-like scales that form a row on each side of the body. FA in the number of scales increased after a decrease in population size, which suggests that the population is genetically stressed.

Human Dimensions Research Team

In light of the increasing importance of socio-economic elements in global change issues, the Human Dimensions Research Team started in FY 1995 to organize researchers whose interests were related to the Human Dimensions Program on Global Environmental Change (HDP). Those interests cover: 1) effects of land-use/cover change on global environmental change (Land Use for Global Environmental Conservation); 2) human activity and its impacts on the environment and socio-economic systems; and 3) quality of life and risk assessment. The research results obtained were presented at the 1997 Open Meeting of the Human Dimension of Global Environmental Change Research Community at IIASA in Laxenburg, Austria in June 1997. At this meeting, the HDP researchers from our institute had good opportunities to communicate with HDP researchers in other countries and to have future collaboration with them.

A new 3-part research project was initiated based on the research on urban life-style and its change toward sustainable development. The first part is Global Omnibus

Environmental Survey (GOES) related research, which will attempt, by a public opinion survey, to compare citizens' attitudes and behavior towards the global environment. The second is an Asian ecological awareness survey, which uses a focus-group survey to reveal Asian environmental consciousness. The third is a green consumer survey, which analyzes Japanese green consumers' environmental awareness and behavior and compares them with German green consumers.

Studies on the development of a comprehensive model of atmosphere-soil and an international cooperative field survey to clarify the budget of environment acidifying substances in East Asia

To understand the long-range transport of air pollutants from Asian continent to Japan, an extensive field survey was conducted on a remote island (Goto Island) in the East China Sea, chosen as a low pollution site. A modeling study to simulate the long-range transport of air pollutants was also carried out.

Data on the concentration variations of non-sea-salt sulfate and particulate ammonium at the Goto Island site, and backward trajectory analysis of the wind field in the East Asian region, showed the long-range transport of air pollutants to this site from the Asian continent.

The Sulfate Transport Eulerian Model (STEM) was applied. This model includes a detailed NH_3 - HNO_3 - NH_4NO_3 thermodynamic equilibrium mechanism and the heterogeneous reactions from SO_2 (gas) to aerosol sulfate. A numerical simulation with STEM was conducted from Feb. 4 to 28, 1992, and the numerical results were compared with detailed, high-temporal resolution (4- to 8-hr interval), aerosol monitoring data sets at Tsushima, Ogori and Seoul. Particulate sulfate distribution in the East Asian region is given in Fig. 1, which shows the transport of this sulfate to Japan at 13th Feb. The STEM model successfully simulated the typical temporal patterns of observed concentrations of both SO_4^{2-} and NO_3^-. We found that wind pattern variations associated with a synoptic-scale pressure system are extremely important for the transport of air pollutants. Sensitivity analysis showed that most of the observation data fell within the heterogeneous reaction rate 0.5 to 2.0% hr^{-1}. The model also predicted the large proportion of HNO_3 in Tsushima even in winter.

The East Asian Pacific Rim is presently one of the most economically dynamic regions in the world, and is characterized by high and rapidly growing anthropogenic emissions of NO_x, SO_2, hydrocarbons, and other air pollutants. The scientific objectives of the studies by this Team were: (1) to investigate the transport and chemical transformation of gaseous species over the East Asian Pacific Rim by measuring the spatial distribution and temporal variation of SO_2, ozone, NO_x, PAN, NMHC, etc.; and (2) to characterize and quantify aerosols transported in this area. Atmospheric pollutants over the seas between Japan and the Asian continent were monitored from aircraft from October 1991. Acidic compounds and their precursors were the main targets of these missions.

From data obtained by aircraft observations over the Sea of Japan, the East China Sea, and the Yellow Sea, we found that the air masses transported from the Asian continent to Japan in winter can be divided into 3 types: (A) air masses moving from

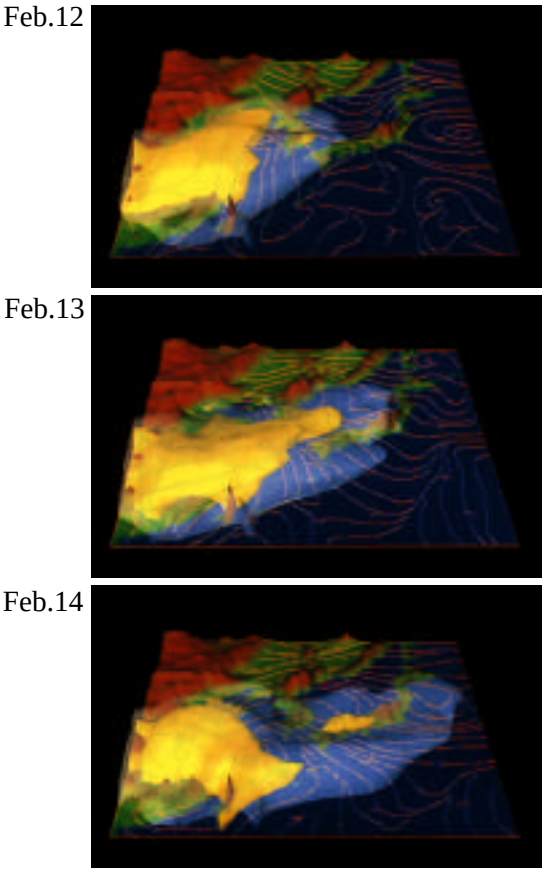


Fig. 1
Simulated sulfate isosurfaces for 6.5 μg m^{-3} (white area) and 13.0 μg m^{-3} (yellow area) from 12 to 14 Feb. 1992.

northern China to Kyushu or west of Kyushu, which pass over the Yellow Sea; (B) air masses passing over the Korean Peninsula and reaching western Japan; and (C) air masses originating in northern Asia that move to eastern Japan, and do not pass over areas with large emissions of atmospheric pollutants. These 3 types of air-mass trajectories are shown schematically in Fig. 2. The characteristics of these air masses are: (A) low SO_2, high SO_4^{2-}/SO_2 ratio; (B) high SO_2, low SO_4^{2-}/SO_2; and (C) low SO_2, low SO_4^{2-}.

Impact of acidic pollutants on ecosystems

An increase of NH_4^+ and NO_3^- in atmospheric deposition, both as acids and as essential nutrients for plant growth, may affect ecosystems, including the interactions among

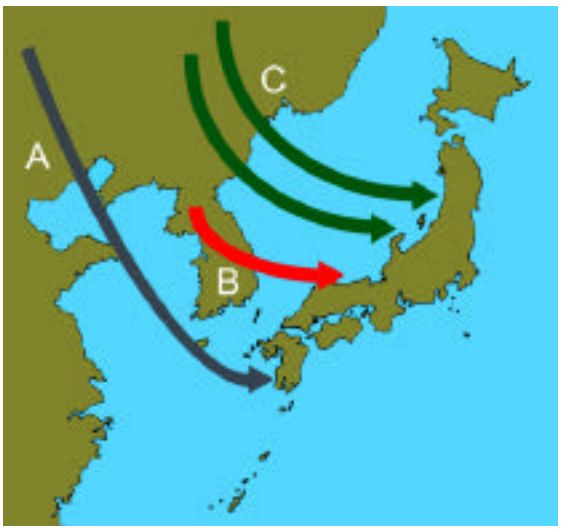


Fig. 2
The 3 types of air mass trajectories reaching Japan from the Asian continent.

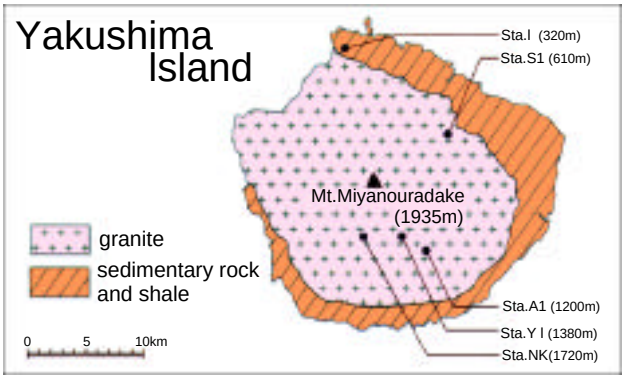


Fig. 3
Location of the island of Yakushima and sampling sites.

organisms. We set up a monitoring station on the island of Yakushima (Fig. 3), a world natural heritage site; it has untouched, dense ancient forests in the mountainous areas, ranging from broad-leaved forest along the coast to temperate coniferous forest at middle altitudes and cold-temperate bamboo grassland. Yakushima has an area of 503 km^2 and is about 800 km east of Shanghai in China, and about 140 km from Sakurajima (altitude 1060 m), an active volcano in southern Japan that produces sulfur dioxide.

The pH range of rainwater recorded at a station about 250 m above sea level was 3.9 to 6.0 in 1994 to1996, and that of snow was 4.8 to 5.2. The concentrations of NH_4^+, NO_3^- and other cations and anions in rainwater changed with the season, as did the rainfall itself.

During late spring to autumn (April to October), the main wind direction is easterly and supplies sea salt containing Na, K, Ca and Mg from the Pacific Ocean. During this season, the concentration of N-compounds such as NH_4^+ and NO_3^- is lower than that in the winter. However, during late autumn to early spring (November to March) the main wind direction is westerly which brings sea salt from the East China Sea and aerosols from continental Asia. During this season, the concentrations of NH_4^+ and NO_3^- increase in rainwater as well as in snow. Therefore wind direction and amount of rainfall may be important factors in bioelement supply to Yakushima. Furthermore, the concentrations of NH_4^+ and NO_3^- were highly correlated (Fig. 4). Such high correlation may indicate the presence of NH_4NO_3, which is usually present as sub-micron sized aerosols and can easily be transported long distances. The main acid in rain and snow is sulfuric acid. One notable event in spring is the long-range transport

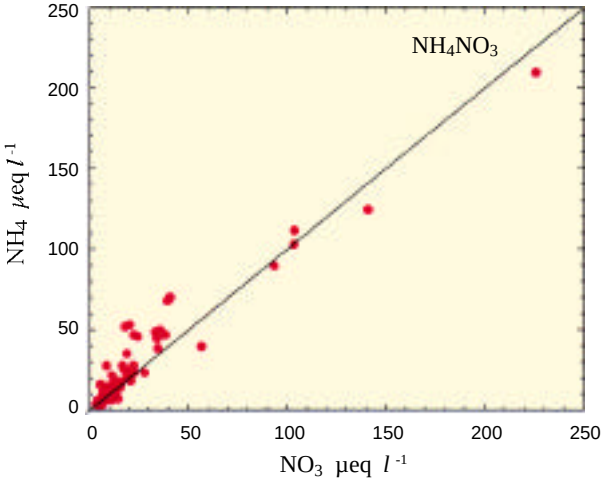


Fig. 4
Relationship between the concentrations of NH_4^+ and NO_3^- in rainwater collected during November to March (winter).

of Kosa aerosol from the desert of inland China. The high Ca content of rainwater at that time is believed to from Kosa aerosol.

The main process of N-compound uptake in the forest may be via the roots of trees such as *Cryptomeria japonica*. There are many trees in the high mountainous area growing directly on granite rocks. Heavy rain containing bioelements may support the growth of these trees. The C/N ratio of *C. japonica* leaves in high mountainous area is about 20-30. This ratio is a little higher than that in nutrient-rich areas, and the growth rate of the trees in the high mountainous area is very low, producing trunks with densely packed annual rings. One of the reasons for this seems to be the limited nutrient supply. Although both NH_4^+ and NO_3^- are used by *C. japonica*, NO_3^- is used together with cations such as K and Ca. Therefore, K deficiency may influence the uptake of NH_4^+ and NO_3^-. The pH range of the river water at a station located at 1200 m above sea level was 6.4 to 6.8 during Sept. 1995 to Apr. 1996. The concentrations of NH_4^+ and NO_3^- in river water were lower than those in rain and snow. There are many physical, chemical and biological processes that change the concentration of bioelements in rain (or snow) after deposition. The main processes are evaporation, sorption by soil, dissolution of elements from soil and rocks, uptake by terrestrial plants, release during decomposition, and change of chemical form by microbial activity. These processes, which are responsible for changing both the concentrations and ratio of ions originally present in rainwater to these prevailing in river water, reflect the characteristics of the terrestrial ecosystem. And the limited nutrient supply on the nutrient-poor granite bedrock in the high mountainous area of Yakushima may have been responsible for the characteristic, dense forest and may explain the difference in NH_4^+ and NO_3^- concentrations between atmospheric deposition and river water.

Detecting anthropogenic environmental changes in Asian marginal seas

Environmental stresses on Asian marginal seas, such as discharges of manmade hazardous chemicals, organic matter and nutrients, are causing deterioration of the ecosystems. Marine environmental issues involve far more uncertainty than their terrestrial counterparts, and also raise fundamental questions about the role of the ocean, particularly through the functioning of its ecosystems, in stabilizing the earth's environment. The main objective of the work of the Marine Environment Research Team is to reduce these inherent uncertainties in assessing environmental stresses, through a program composed of monitoring, modeling and process studies as follows.

In order to assess in detail the response of phytoplankton communities to land-based nutrient (N, P, and Si) discharges, we used a container ship sailing from Japan to Malaysia via the East China Sea, South China Sea, and Malacca Strait (Fig. 5). The data from the South China Sea in October 1997 showed a diverse phytoplankton community, including *Synechococcus spp.*, nitrogen-fixing Cyanophyceae (*Trichodesmium*), dinoflagellates, and other flagellates. This composition means that a new criterion to assess environmental change in these waters is needed, since the existing one based on the dinoflagellate/diatom ratio is based on temperate marine conditions. To interpret the monitoring data, a numerical simulation model for the South China Sea was constructed (Fig. 6). An international meeting to foster

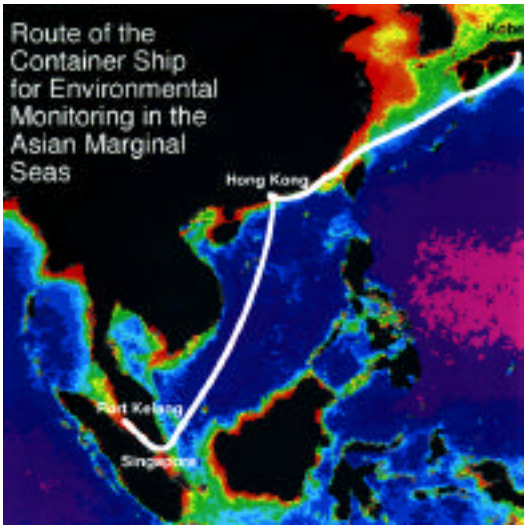


Fig. 5
Track of the container ship used for marine environmental monitoring. Background image is the yearly composite of phytoplankton chlorophyll distribution, processed from CZCS satellite data by NASA.

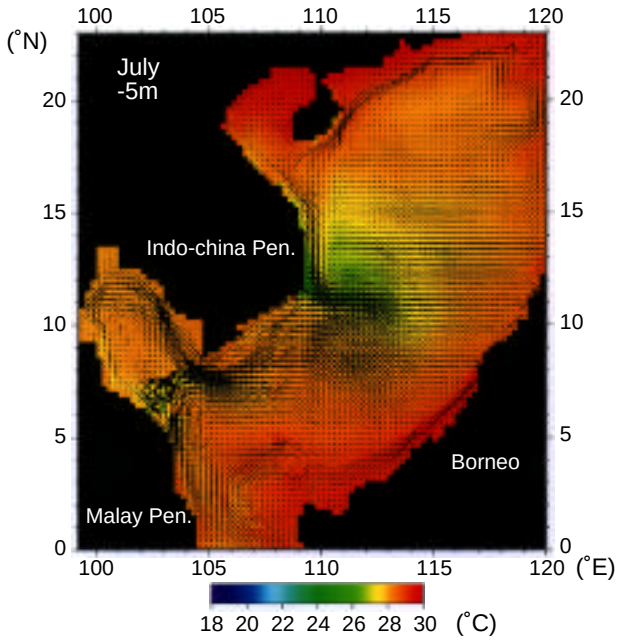


Fig. 6
Results of the simulated flow and sea surface temperature in the South China Sea in July.

Cooperative Marine Environmental Monitoring in the Asian Marginal Seas (CoMEMAMS Meeting) was held in Tokyo with invited specialists from China, Korea, Malaysia and Singapore. Based on discussions in the "CoMEMAMS Panel" by the participants, the Meeting concluded that the above-mentioned monitoring program should be put in place.

A continuous solid-phase concentrator was developed and deployed on a ferry from December 1996 to February 1998 (Fig. 7) to monitor POPs (persistent organic pollutants) such as chlordane, nonachlores, HCHs and DDTs in consideration of lowering their detection limit. The concentration of β-HCH was highest in the Seto Inland Sea, lower in the south of Japan and the lowest in the Kuroshio Current, suggesting spatial heterogeneity in the degree of anthropogenic effects. Other POPs species showed different behavior, implying in-water processes and occasional transport from remote sources by the variable wind system.

To study intensively the human impact in the Chang Jiang River estuarine processes, a Japan-China collaborative study has been established between NIES and the State

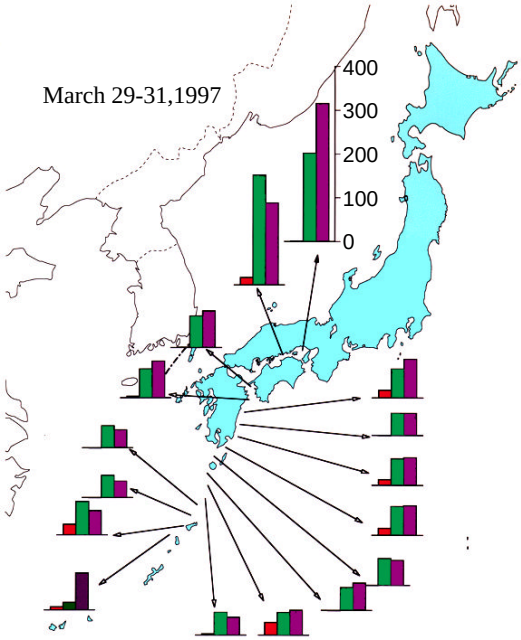


Fig. 7
Distribution of the 3 organo-halide species detected by the sampling system on the ferry between Osaka and Okinawa. Bars show the concentrations of tr-chlordane (red), α-HCH (green) and β-HCH (purple), respectively.

Oceanic Administration (SOA) of China with the participation of other Japanese and Chinese organizations. A field survey and floating mesocosm experiments have been conducted featuring a phosphate enrichment experiment and study of the carbon cycle via microbial food webs. The flux of particulate matter to the sediment was investigated using sediment-trapping technology and sediment core analysis.

Conservation of biodiversity in coral reefs, which are called the marine equivalent of tropical rain forests, is a globally urgent issue. The coral is a unique organism in that its growth creates a three-dimensional structure that generates secondary habitats and allows for great biodiversity. To analyze coral growth, we developed a method of archiving underwater stereo images and applied it to reefs in the Yaeyama Islands, Okinawa, Japan. The sample image (Fig. 8) shows that coral colonies tend to be recruited and grow on projections rather than in hollows to avoid siltation and to provide sufficient light for photosynthesis by the symbiotic algae.

Assessment of vulnerability to food shortage and water scarcity in Asia

The rapid growth of the population and economic activities in Asia has seriously degraded the environment. Deforestation is a typical and common problem in this region. Traditionally, natural resources such as water, forest/timber, etc. were wisely used for daily life by local residents and for primary industry. However, rapid economic development disrupted the traditional system, and as a result, human-induced

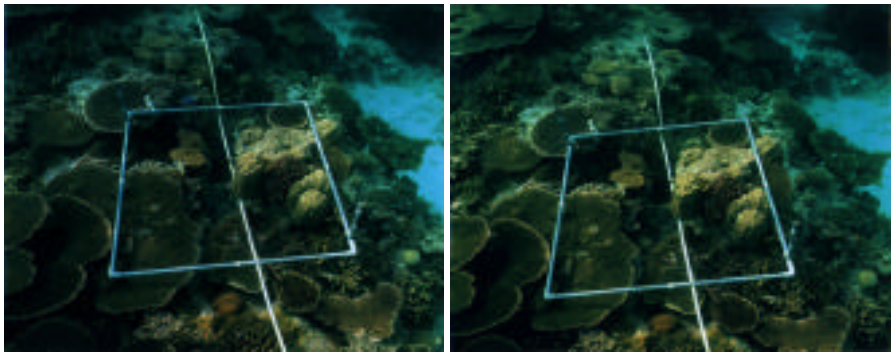


Fig. 8
A sample from the coral image archive being constructed. The reader can view the 3-dimensional structure in the coral reef ecosystem by paralleling eyes.

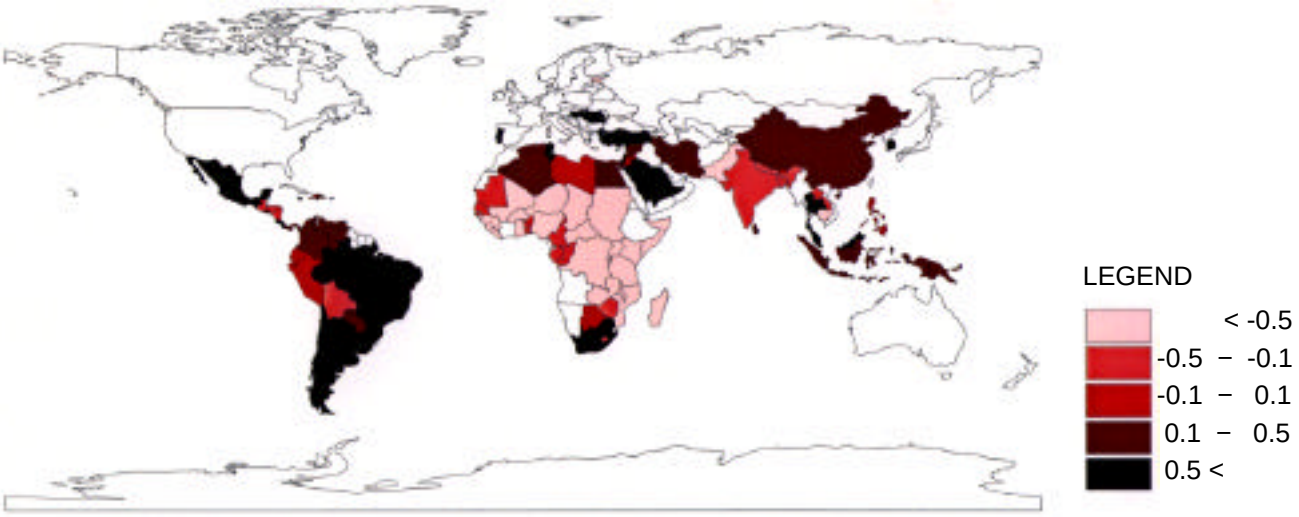


Fig. 9
Map of the modified food security index.

environment change has in turn significantly affected the socio-economic situation and daily life. This "vicious cycle" is considered to be the major cause of poverty in developing countries. The aim of our research is to identify the critical factors causing this vicious cycle based on past research and surveys, and then to develop a model explaining this cause-effect relationship. The model should allow predictions of future change assuming several socio-economic scenarios, and finally lead us to propose possible countermeasures to facilitate sustainable development in the Asian region. A brief outline of results obtained so far follows.

Food security is one of the most significant issues in Asia. To assess the food-security vulnerability of Asian countries, we developed an index, originally based on three indicators (national food shortage (food availability per capita in kcal d^{-1}), household food poverty (gross national product per capita), and individual food deprivation (Childhood (under 5) mortality per 1000)). In addition to those indicators, an indicator representing the demand for food due to growing population was incorporated to make a modified food security index. Population growth rate was used for this fourth indicator. Data for the four indicators in 1990 were drawn from World Bank and other sources for developing countries. The values of each indicator were normalized, and a composite food security index was calculated as the sum of the four indicator values. Figure 9 shows the distribution of values of this index in the Asian region. The vulnerability of the Indian sub-continent is low compared with that in tropical Asian countries. In contrast, food security is relatively high in China. Figure 10 shows the current crop yield in China reproduced using a crop-production model developed based on an FAO-AEZ model. Future climate conditions may cause more drought in western China. Future food security would thus become lower due to both climate change and growing population in this region.

In parallel, the human dimension team is also developing a water-resource model for assessing current and future water shortages in the Asian region. In development of the model, much information such as elevation, watershed size, and river flow data are necessary. Researchers in the Commission for Integrated Survey of Natural Resources (CISNAR) under the Chinese Academy of Science have been collaborating

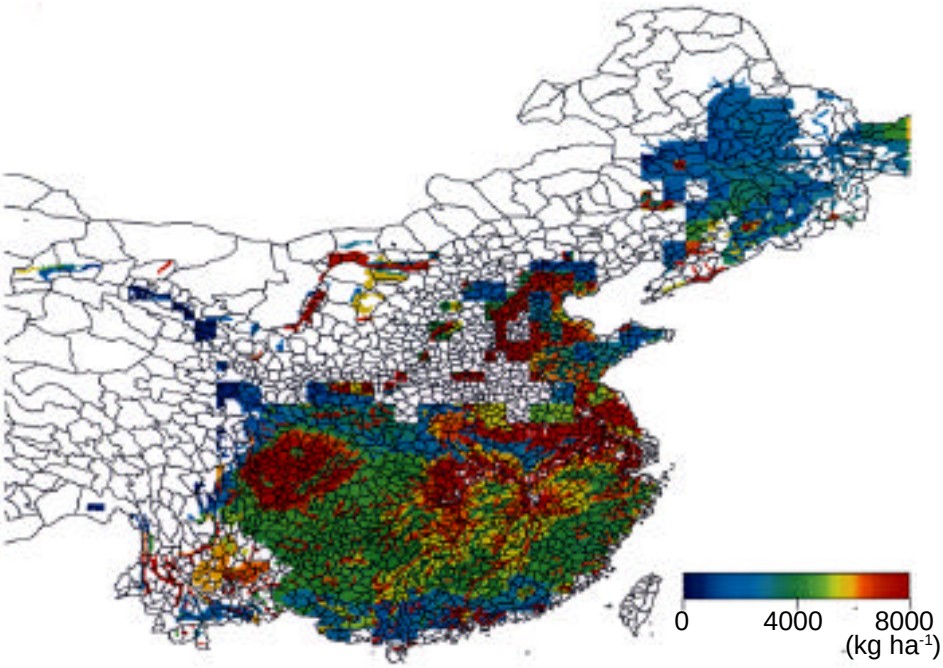


Fig. 10
Potential productivity calculated using a crop field model. (1987, China, kg ha^{-1})

with us in the effort. The information and data on watersheds as well as other information were stored in the computer using a Geographical Information System (GIS). Using the model and information gathered, the distribution of water resources available in China was calculated and plotted on a map (Fig. 11). A water supply-and-demand model is under development to assess the vulnerability of China to water shortage in the future.

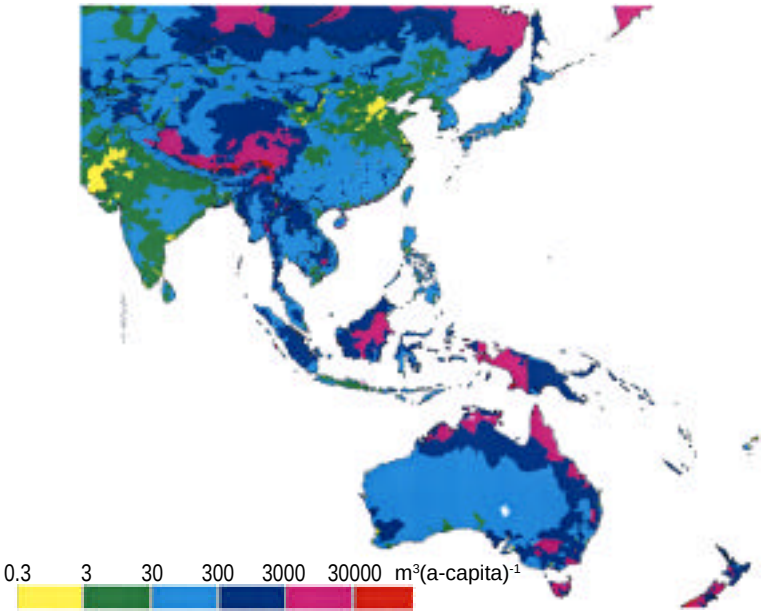


Fig. 11
Calculated water availability using a water resource model.

Regional Environment Division

Pollution by Chemicals and/or Acidification? Lethal Effects of Rainwater on Aquatic Organisms

Assessments of Pesticide Pollution on River Ecosystems (Kokai River)

Toxicity Tests of Chemicals Substance on Reproduction of Fish using Flow-through Aquaria

This Division is a research unit dealing with both national environmental issues and overseas environmental pollution problems. The unit is composed of 15 research teams. Our members have worked in cooperation with members of other NIES divisions and visiting scientists from both domestic and overseas institutions. Major target areas include environmental risk assessment, and pollution mechanisms and countermeasures. Since 1993, our international research terms have started activity to promote the transfer of environmental technology into developing countries. Following is a summary of the current studies of our respective teams. Not all the Regional Environment Division's research projects are included in the present report. Research reports from the respective teams have also been published separately and are available upon request.

Traffic Pollution Control Research Team

This team mainly studies: 1) methodology for environmental impact assessment of traffic systems, in particular motor vehicles; and 2) technology assessment of environmentally advanced transport systems, in particular electric vehicles.

Motor vehicles emit various organic compounds, which have been measured as total hydrocarbons and/or non-methane hydrocarbons, as well as NO_x, CO, etc. In recent years, some volatile organic compounds (VOCs) have been regulated as a result of their effects on health; thus, chemical analysis of organics emitted by vehicles is required. Studies have been initiated for detailed evaluation of traffic as an emission source of VOCs. Preliminary tunnel studies, which will provide on-road real emission factors including tail-pipe emission and fuel evaporation, and emission from new and old vehicles, indicated that on-road emission factors are higher than typical data from chassis dynamometers. GIS-based estimation of VOC emission distribution has been planned in order to evaluate traffic pollution by visualization, model simulation, etc. Link codes of the road traffic census have been matched to a digital road map for further analysis such as conversion to mesh data.

Development of a continuous monitoring method for VOCs has been initiated, which will provide detailed, accurate data on pollution by traffic. A hardware system consisting of a sampling system using canisters/adsorbent tubes, a standard gas generation system, sample concentration/introduction system and GC/MS has been constructed. Determination limits at ppt level and repeatability better than 10% have been obtained for about 40 hazardous air pollutants.

Studies on electric vehicles and future transportation systems have been carried out as a part of a project entitled "Studies on alternatives of urban transportation systems". Driving tests under different conditions on public roads and test courses have been carried out to evaluate the performance of a compact electric vehicle, the "Eco-Vehicle", developed in 1996. A questionnaire survey has been carried out to estimate social acceptance of this vehicle. Three-quarters of respondents expressed willingness to buy such a vehicle if its price were less than 1.5 million yen. For the selection of desirable future transportation systems in urban areas, various possible technologies have been evaluated from the viewpoint of life-cycle assessment.

Urban Air Quality Research Team

The major objectives of this research team are to investigate urban air pollution formation mechanisms to understand the relationship between changes in the relative importance of various air pollution sources and the spatial and temporal patterns of urban air pollution. The team's program includes:

(1) wind tunnel studies of the dynamic behavior of urban air pollution;
(2) 3-dimensional field studies of broad-area air pollution;
(3) air pollution trend analysis related to changes in pollutant loading from various sources;
(4) studies on an air pollution model and its application to urban areas.

Due to the rapid expansion of the Kanto and Kansai areas and changes in emission structure, widely distributed air pollution has become an environmental problem. To clarify the formation mechanisms of high concentrations of widely distributed air pollutants in and around the Tokyo metropolitan area, 3-dimensional observations covering the nearby sea and mountain regions are necessary. In August 1995, an intensive field survey using aircraft was conducted. High concentrations of photochemical ozone were observed above the southern sea area and the mountain region. Photochemical ozone observed over the Pacific Ocean is transported from the inner area due to the upper general wind. The processes by which photochemical ozone intrudes into the mountain region were also clarified. Secondary air pollutants, such as nitrogen oxides, photochemical ozone and aerosols in particular, are a serious problem. High concentrations of NO_2 are often observed in winter under stable atmospheric conditions, but in the Kansai area, NO_2 concentrations also increase in spring. Analysis based on a 3-dimensional simulation model revealed the importance of a photochemical reaction in spring.

Air pollution trend analysis suggested a change in the mechanism of O_3 formation in summer in both the Kanto and Kansai areas. Recently, regional O_3 maxima have been observed outside the central Kanto and Kansai areas. This trend of spreading of urban oxidant concentration maxima might be a reflection of increases in NO_x emissions and decreases in the ratio of the concentrations of VOCs to those of NO_x, indicating an increase in O_3 formation potential and a decrease in photochemical reactivity, respectively. Air pollution trend analysis showed that annual average concentrations of O_3 are increasing over a wide area of Japan. To understand these phenomena, a series of special research activities, mainly focusing on source characterization of VOCs, is being conducted from 1998 to 2000.

Coastal Environment Research Team

The coastal zone, especially in the enclosed-sea areas of Japan, is under pressure from the consequences of human activities such as eutrophication, pollution, and overcrowding, as well as under potential pressure from proposed developments. Shallow areas have been reclaimed without appropriate consideration of marine ecosystems. This team aims to prepare a precise scientific method to evaluate the vulnerability of the ecosystems of shallow areas through a special research project entitled "Studies on biogeochemical cycles and self-purification in shallow coastal areas for preservation of marine environment".

As a part of the project, we have conducted field surveys in a shallow area, Saban-se, in the head of Tokyo Bay, monitoring water quality, phytoplankton, and macro- and meiobenthos. Macrobenthic organisms were abundant in the shallow area in all seasons. Bivalves were the dominant animals, accounting for more than 98% of the total biomass. Respiration rates of bivalves were measured under various temperature conditions and shown to be faster in higher temperatures (Table 1). Bivalve filter-feeders can clear water columns in shallow areas. A system with high bivalve biomass, such as the Saban-se shallow area, clears large volumes of water faster than turnover rate of the water mass. The filtration rate of the bivalve *Mactra quadrangularis*, a dominant species in the area, was found by the static chamber method to be 4.1 $l g^{-1} hr^{-1}$ (bivalve mass in dry weight flesh) at 20°C. The clearance time of the system by bivalves, estimated by dividing water depth (2 m) by the product of observed filtration rate and biomass of the bivalves (105.7 gm^{-2}; flesh dry weight basis) observed in the shallow area, was 0.2 d, indicating the important role of bivalves in biogeochemical cycles in shallow areas.

Copepods have long been believed to consume most of the primary production in coastal areas. However, field observations and experiments in the Seto Inland Sea conducted in the first two years of our project indicated that a significant part of the primary production was channeled into small heterotrophic dinoflagellates (20 - 100 μm in length), appendicularians and doliolids. These organisms play important roles in carbon cycling. In FY 1998, we also assessed the ecological role of *Noctiluca scintillans*, a large heterotrophic dinoflagellate (0.5 mm), which is brightly bioluminescent and forms conspicuous red-tide streaks. *N. scintillans* blooms followed those of diatoms and this dinoflagellate was as productive as were the copepods. Knowledge of the ecological roles of these organisms is very important for understanding carbon flow and for protection of coastal ecosystems.

Table 1 Respiration rates of bivalves (O_2-mg g-flesh dry weight $^{-1}$ hr $^{-1}$)

Bivalves	15°C	20°C	25°C
Mactra chinensis	0.18	0.24	0.68
Mactra quadrangularis	0.18	0.80	1.16
Ruditapes philippinarum	0.39	1.07	1.41

Lake Conservation Research Team

A steady increase has been observed in recalcitrant dissolved organic carbon (DOC) in several lakes, such as Lake Biwa; this may be a new type of lake water pollution. The accumulation of recalcitrant DOC in lake water clearly influences the way that lake environment protection should be managed; this type of phenomenon is new and has not been given any previous consideration. It also presents a serious problem for drinking-water management. Recalcitrant DOC could be a major precursor of trihalomethanes produced during chlorination in water treatment. Therefore, evaluation of the characteristics of DOC in lake waters is urgently needed.

The objectives of our project were: to develop a method by which DOC is separated into well-characterized fractions, in order to examine the physicochemical

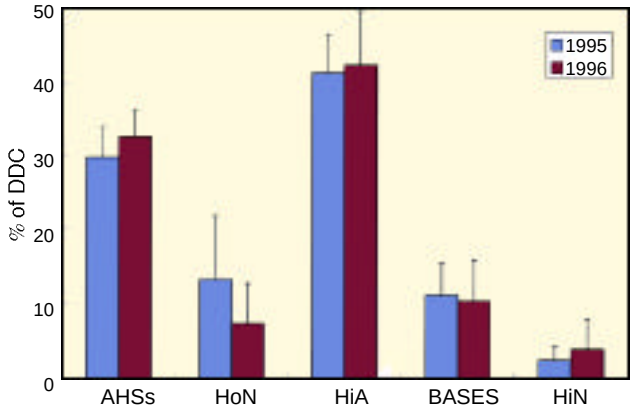


Fig. 1
Dissolved organic carbon (DOC) fractionation of water samples from the center of Lake Kasumigaura. DOC fractions are: aquatic humic substances (AHSs); hydrophobic neutrals (HoN); hydrophilic acids (HiA); bases (Bases); and hydrophilic neutrals (HiN). Error bars represent ±1 standard deviation of the mean of the monthly measurements.

characteristics and dynamics of DOC in Lake Kasumigaura, the second largest Lake in Japan; and to evaluate the effects of DOC on the growth of phytoplankton in the Lake and on lake water quality as a drinking-water source.

The major achievements in FY1997 were as follows: (1) a DOC fractionation method was established by which DOC was classified into five fractions: hydrophobic acids (aquatic humic substances, AHSs), hydrophobic neutrals, bases, hydrophilic acids, and hydrophilic neutrals; (2) AHSs and hydrophilic acids were found to predominate in the Lake's DOC, with the proportion of hydrophilic acids being greater than that of AHSs (Fig. 1); (3) AHSs exhibited significant inhibitory effects on the growth of the cyanobacterium *Microcystis aeruginosa* isolated from an algal bloom in the Lake.

Hazardous Waste Research Team

This team has been developing methodology to assess exposure to hazardous chemicals from waste landfills. Little is actually known about the environmental impacts of waste landfills in Japan. Our team, coordinated by the National Institute for Environmental Studies and including 14 local-government environmental research institutes, has been analyzing landfill exudates since 1994.

Measured items were general water quality variables such as pH, dissolved oxygen (DO), chemical oxygen demand (COD), biological oxygen demand (BOD), and suspended solids (SS); nutrients such as total phosphate, reactive phosphate, nitrate, nitrite and ammonium; inorganic elements including both metallic and non-metallic elements; and organic chemicals such as polychlorinated biphenyls (PCBs), polychlorinated naphthalenes (PCNs), pesticides, and herbicides; plastic-additives including phosphate and phthalate esters, polycyclic aromatic hydrocarbons (PAHs) and VOCs. Over 400 organic compounds were assayed, mainly by GC/MS. The results of leachate analyses indicate: 1) very low concentrations of highly hydrophobic compounds such as PCBs and some chlorine-containing pesticides; 2) high concentrations of compounds related to plastics, such as phthalate esters, phosphate esters, and bisphenol A in some samples; 3) high concentrations of boron in some samples; and 4) high concentrations of dioxane in some samples.

In FY 1997, VOCs in gases from several landfill sites and polychlorinated dibenzodioxins (PCDD) and furans (PCDF) in landfill gases and in landfill exudates were measured. Figure 2 shows an example of polychlorinated dibenzodioxin and furan concentrations in landfill gases and in landfill exudates. The results show that:

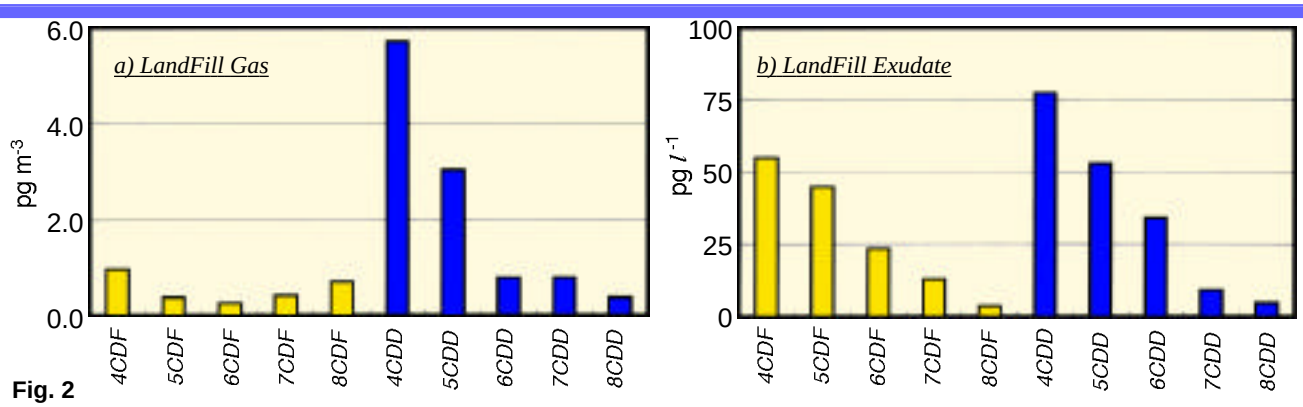


Fig. 2
The concentrations of PCDD and PCDF in landfill gases (a) and in landfill exudates (b).
(4C: tetrachloro; 5C: pentachloro; 6C: hexachloro; 7C: heptachloro; 8C: Octachloro; DD: dibenzodioxin; D: dibenzofuran)

1) the concentrations of VOCs exceeded 1 ppmv in some landfill gases; 2) higher-temperature landfill gases tended to show higher concentrations of VOCs; 3) the concentration of dioxins in landfill gas was lower than that in the surrounding ambient air; and 4) higher concentration of dioxins was observed in landfill exudates from domestic waste disposal sites, where incineration residues are dumped.

Interdisciplinary Impact Assessment Research Project

The Water Quality Renovation Technology Research Team previously studied soil and groundwater contamination from hazardous chemicals. Since FY 1996, the Team has filled the role of an ad hoc project team to manage a new interdisciplinary area entitled "Life cycle assessment (LCA) of environmental burdens and impacts originating from transportation and waste management systems". This study works toward the development of comprehensive environmental impact assessment methodology from the life-cycle point of view. The study consists of two areas of concern: fundamental methodologies for so-called life-cycle impact assessment (LCIA), and the application of such methodologies to case studies of transportation and waste management systems. The object of the assessments is a system including products, services and infrastructure, as well as institutional arrangements, rather than a single product or service unit; for example, a road transportation system rather than a motor vehicle as a product; a recycling system rather than cans and bottles as recyclable containers.

In the second year of this 3-year project, the second expert workshop of Comparative Risk Assessment (CRA) was organized for the purpose of listing endpoints of environmental impact and identifying problem areas and endpoints of high priority according to expert judgment. A computer system, which consists of an emission inventory model, a fate prediction model and an exposure assessment model, was developed, incorporating geographic information systems (GIS) software in order to assess the spatial distribution of health risks from conventional and hazardous air pollutants at the prefectural level. In addition to these methodological studies, practical case studies of life-cycle inventories (LCI) were carried out. By combining emission inventories of conventional air pollutants (SO_x and NO_x) and the Input-Output table, an LCI of air emissions was compiled for a conventional automobile and alternative transport media. A case study revealed that CO_2 and NO_x emissions per man-kilometer unit of transport by a tram system are less than half of those by automobiles. A case study on recycling automotive bumpers and another case study on recycling drink

containers are continuing, as LCA studies of waste-management systems.

Air Pollutants Health Effects Research Team

This team has experimentally studied the mechanism of pathogenesis of and evaluated the risk of chronic pulmonary diseases due to diesel exhaust particles (DEP) and diesel exhaust (DE).

Subthemes include: 1) clarification of mechanisms of asthma pathogenesis and examination of the dose-response relationship between diesel exhaust and asthma; 2) evaluation of the risk of pulmonary tumor formation due to diesel exhaust; 3) evaluation of suspended particulate matter (SPM) exposure levels from diesel exhaust and associated risk; and 4) evaluation of the overall risk posed by diesel exhaust to human health.

In FY 1997, we found evidence that diesel exhaust (DE) enhanced asthma like pathogenesis only under the challenge of ovalbumin (OA) as an allergen. The combination of DE exposure and OA challenge to mouse produced dose-dependent increase of goblet cells and eosinophil infiltration, an asthma-like pathogenesis, in addition to further increase of the typical changes induced by DE alone such as hyperplasia of airway epithelial cells. The relationship between the histological appearance in the airway and immunoglobulin production was also studied. OA treatment induced marked increase in OA-specific IgG1 and slight increase in OA-specific IgE production in plasma, but adjuvant effects of DE exposure on immunoglobulin production were not observed. From these results, we conclude that the combination of allergen and chronic exposure to DE produces increased eosinophilic inflammation in the airway, and that cell damage of epithelial cells related to asthma may be involved with IgG1 and IgE.

Human exposure levels to SPM including diesel exhaust particles (DEP) were surveyed in Osaka prefecture. In FY 1997, levels of personal exposure to SPM and NO_2 were measured in houses. The level of personal exposure to SPM of non-smoking individuals was strongly correlated with indoor SPM concentration (ID-SPM), and moderately correlated with outdoor SPM concentration (OD-SPM) when a strong correlation existed between ID-SPM and OD-SPM. In most cases, ID-SPM corresponded to about 50-70%. Therefore, we conclude that personal exposure level to SPM may correspond to 50-70% of OD-SPM. However, we found that indoor nitrogen dioxide did not correlate with individual human exposure levels outdoors.

Chemical Exposure and Health Effects Research Team

This team is in charge of the special research project “Reproductive and developmental effects of hormone-like chemicals in the environment”, which began in FY 1997. The purpose of this project is to obtain basal data for risk assessment of endocrine-disrupting chemicals on reproductive and developmental effects. Dioxin was selected as a model chemical since it is strongly toxic and the exposure level of the general population in Japan to dioxin is relatively high.

In FY 1997, the responsiveness of different rat strains to 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) was investigated in order to choose a sensitive rat strain for in-

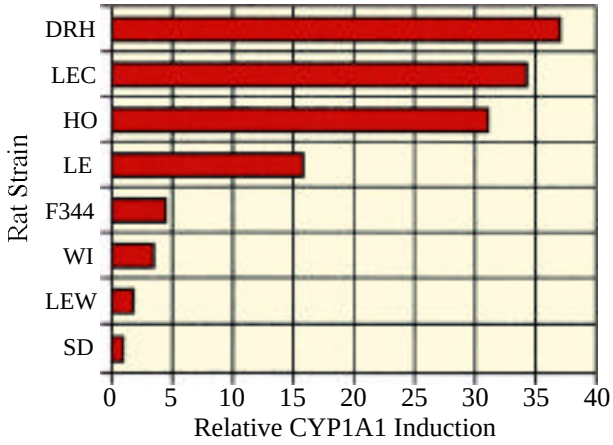


Fig. 3
Relative CYP1A1 mRNA expression in different strains of rat given a single oral dose of 2,3,7, 8-tetrachlorodibenzo-*p*-dioxin (40ng kg^{-1}).

utero exposure experiments. CYP1A1 mRNA expression in livers of 8 rat strains in response to TCDD was measured using competitive RT-PCR, since Ah receptor-mediated CYP1A1 gene expression is considered to be an early and sensitive biochemical response to TCDD. The relative induction of CYP1A1 mRNA at a dose of 40 ng kg^{-1} increased in the following strain order: SD, LEW, WI, F344, LE, HO, LEC and DRH.

There was more than 35-fold difference in CYP1A1 mRNA expression between the most sensitive (DRH) and the least sensitive (SD) rats (Fig. 3).

The mechanism involved in gender-specific response to TCDD was also investigated. Estrogen stimulated the induction of CYP1A1 protein in response to TCDD in the liver of ovariectomized female rats. This finding suggests that the toxicity of TCDD is modified by estrogenic condition.

Ecological Hazard Assessment Research Team

This team is studying the effects of chemical substances on aquatic ecosystems. This fiscal year was the last year of a project on “Development of useful biomonitoring methods for assessment of chemicals in aquatic ecosystems (1995 - 1997)”. We checked the usefulness of biomonitoring methods that we had developed over the previous two years at a biomonitoring station constructed beside the Sakura River. Several biomonitoring methods using new test organisms were also tested this year. Now we have several available biomonitoring methods that use different species of aquatic organisms selected according to ecosystem functions.

Biomonitoring methods using two species of duckweed floating in a flow-through aquarium carrying river water was an effective method for assessment of overall herbicide effects on aquatic plants. Its sensitivity was superior to that of *Selenastrum* in growth tests using river water samples. The mortality of freshwater shrimp in flow-through aquaria carrying Sakura River water revealed insecticide toxicity which was not detected in a (14-d) shrimp bioassay using water samples.

A biomonitoring method using a bivalve (*Anodonta woodiana japonica*) was developed and used for assessment of pesticide contamination of macrobenthos. The bivalves were individually settled in a cage (n = 32) in an indoor flow-through channel carrying Sakura River water, and growth was checked weekly. Figure 4 shows the

measured and the expected growth rates (adjusted based on the water temperature, and on food supply as chlorophyll a concentration in the water). The expected growth rates paralleled the measured growth rates except those estimated from June to August 1995, when river water was heavily contaminated with pesticides. The decreased growth rates in this period might be due to the overall pesticide contamination in the river water and/or suspended solids. Biomonitoring using the bivalve was useful for assessment of overall effects of toxic substances on benthic organisms, and the method could be applied with in situ experiments. A reproductive impairment occurred in male zebrafish (*Brachydanio rerio*) reared in an aquarium carrying Sakura River water: high mortality of embryos was observed in eggs produced from pairs in which the male was reared in the Sakura River water and the female, reared in well water, acted as a control. The cause may be toxic effects of some chemicals on the male reproductive system.

Biotechnology Products Assessment Research Team

This team studies the application of biotechnology to the preservation and restoration of environments and the risks entailed by this approach. Our approach is to produce genetically modified organisms useful for preservation or restoration of the environment and then to evaluate their impact.

Volatile aliphatic chlorinated compounds such as 1,1,1-trichloroethane (TCA), trichloroethylene, and tetrachloroethylene have been detected in groundwater throughout Japan. Various soil and groundwater cleaning technologies are now being developed. Bioremediation could be one of the most promising new technologies for cleaning up groundwater contamination, because of its low cost and the complete destruction of pollutants it facilitates. For these reasons, we isolated TCA-degrading bacteria and determined their fundamental characteristics for bioremediation.

Two strains of TCA-degrading bacteria, TA5 and TA27, were isolated. These strains, identified as *Mycobacterium*, can use ethane, ethanol, and various other carbon compounds as their energy source. Relative degradation of TCA by strains TA5 and TA27 was affected by TCA concentration. TA5 degraded 40% of TCA at an initial concentration of 50 mg l^{-1}, within 14 days. TA27 degraded more than 95% of TCA at an initial concentration of 1 mg l^{-1}, within 7 days; and degraded 10% of TCA at an initial concentration of 150 mg l^{-1}, within 14 days. Strain TA27 has higher degradation activity than does strain TA5.

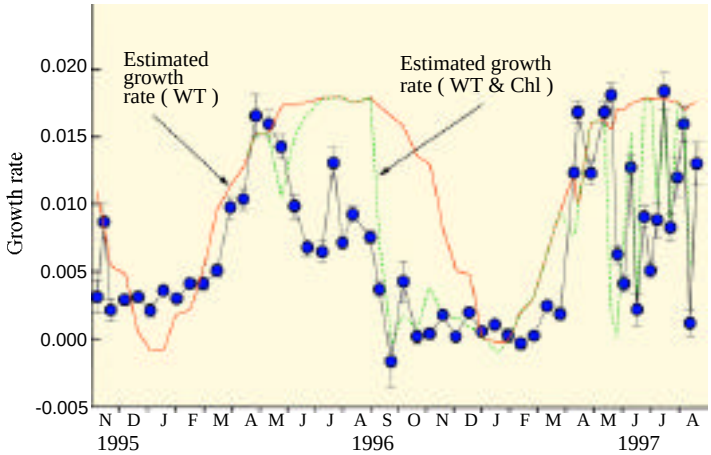


Fig. 4
Change in the growth rate (●) of a bivalve, *Anodonta woodiana japonica*, reared in a model stream carrying water from the Sakura River. Vertical bars indicate standard errors, and broken lines are the expected growth rate.

There are many mercury-contaminated areas in the world. We have developed microbial cleaning technologies for mercury-contaminated soils and sediments. Genetically engineered *Pseudomonas putida* PpY101/pSR134 was used in mercury removal experiments. Plasmid pSR134 was constructed by inserting 2 EcoRI DNA fragments encoding the mercury resistance gene from the NR1 plasmid into a broad-host-range vector pSUP104. *P. putida* PpY101/pSR134 was able to grow and remove 100 mg l^{-1} of $HgCl_2$. A bioreactor was constructed to examine the bacterial removal of $HgCl_2$ from aqueous solution. Mercury was completely removed from the bioreactor when there was less than 40 mg l^{-1} of $HgCl_2$.

Ozone is an air pollutant in many industrialized and developing countries. It is the main component of photochemical oxidants and damages many plant species at ambient concentrations. Ozone reportedly increases the rate of ethylene evolution from leaves, and this increased rate is linked to the extent of leaf damage caused by ozone. Ethylene is synthesized from S-adenosyl-L-methionine via aminocyclopropane-1-carboxilic acid (ACC) in higher plants. The formation of ACC catalyzed by ACC synthase (EC4.4.1.14) is often the rate-limiting step in this pathway. In higher plants, these ethylene biosynthesis enzymes are encoded in multigene families. Recent studies have shown that an increase in the activity of ACC synthase is one of the earliest biochemical responses observed in tomato plants during ozone exposure; it probably regulates the rate of evolution of ozone-induced ethylene. To further investigate the molecular mechanism of ethylene evolution by ozone, it is necessary to identify the gene encoding the ozone-inducible ACC synthase. It has been reported that ozone can induce tomato leaves to express a gene for wound-inducible ACC synthase. However, ethylene evolution began before the transcript of this gene accumulated; this suggests the presence of another isozyme whose transcript accumulates earlier.

Urban Environment and Health Research Team

This team has studied the human health effects of various urban environmental factors, such as traffic noise, air pollution, and electromagnetic fields (EMF).

Public concern regarding possible health risks from residential exposure to low-level, low-frequency electromagnetic fields produced by power lines has been increasing in recent years. A new project entitled “Health risk assessments of exposure to extremely low-frequency electromagnetic fields” began in FY 1997.

The EMF exposure facility (Fig. 5) was built in the Homotron (Community Health

Fig. 5
A facility for low-level EMF exposure to human volunteers.

and Noise Effects Laboratory). The exposure room (approximately 3 m × 3 m × 3 m) was designed to optimize field uniformity of EMF, as well as for controlling room temperature and humidity. The facility has a 4-coil system that was used for each of the 3 orthogonal axes, north-south, east-west, and vertical. It provides flexibility of operation at different magnitudes of magnetic flux density, frequencies and polarization, and has capabilities for true active-sham exposure conditions using twisted-pair wires. Using the facility, the effects of EMF exposure will be physiologically and endcrinologically evaluated.

We also conducted a field survey for exposure to extremely low-frequency EMF (ELF-EMF) among residents living in Tokyo, especially those living closed to power lines. The aim of the first phase of the survey is to estimate long-term variations between and/or within subjects. Based on the results, we are designing a second phase for evaluating exposure to ELF-EMF among residents living near power lines. We will show how much exposure to ELF-EMF depends on distance from power lines.

International Water Environment Renovation Research Team

The focus of this team is protecting the water environment and restoring eutrophic lakes, reservoirs and rivers through bioengineering and ecoengineering systems. Following are the main research activities conducted in the team.

Wastewater treatment facilities, soil and wetland systems are now considered to be important sources of greenhouse gases CO_2, CH_4 and N_2O that lead to global warming. For the development of adequate biological and ecological wastewater treatment technology, N_2O emission control is of great and worldwide importance. We have made a theoretic study, and technology development and field experiments are continuing. One of the main results is that an intermittent aeration process can be effective in controlling N_2O emission as well as improving nitrogen removal from wastewater.

Aquatic model ecosystems, such as microcosm systems are extensively studied by this team, to evaluate the behavior and effect of chemicals, microbial pesticides and genetically-engineered microorganisms in bioengineering and ecoengineering systems. Reproducibility and reflectivity to the natural ecosystem were proven to be very high in research on material cycles, energy flow, and the interaction of microorganisms in microcosm systems consisting of bacteria as decomposers, microanimals as predators, and algae as producers. Based on the above work, these approaches are being applied to predict the effects of chemical pollutants in natural ecosystems.

Our most important joint research activity concerns restoration of the aquatic environment in developing countries such as China and the Kingdom of Thailand, where the populations are increasing and industrial activity is growing. We are promoting the development of bioengineering and ecoengineering systems, such as aquatic plant purification processes and on-site domestic wastewater treatment processes (as shown in Fig. 6). Figure 7 shows our counterparts in the Environmental Research and Training Center (ERTC), Thailand. From our cooperative research, it

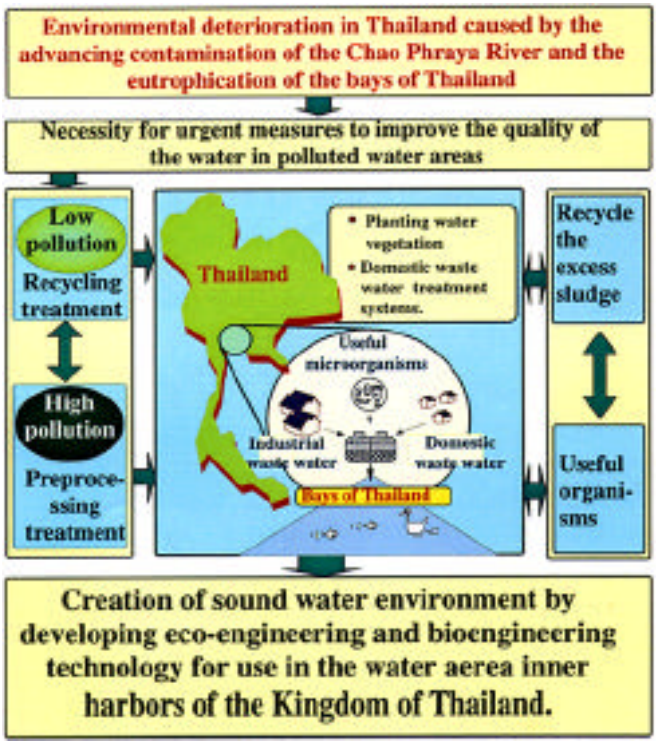


Fig. 6
Water environment restoration measures in Thailand.

Fig. 7
With Staffs of ERTC, Thailand, for the Research Concerning Bioengineering and Ecoengineering Strategy.

was found that wetland systems are very effective in removing nitrogen and phosphorus from domestic wastewater, and in simultaneously suppressing CH_4 emission by transforming it into CO_2 through the introduction of methane-oxidizing bacteria.

International Health Effects Research Team

This team has assessed the health risks associated with air pollution from burning coal in Asia-Pacific countries, such as China, and will evaluate possible risk-reduction strategies. International cooperative research on exposure assessment for both indoor and outdoor air pollution from coal burning has been carried out in China. The results show elevated levels of atmospheric pollutants from coal combustion in both indoor and outdoor air.

We analyzed fluoride pollution in indoor air and the incidence of fluorosis in rural areas of China. Airborne fluoride has potential toxicological significance in China, where an estimated 18 million people are suffering from dental fluorosis and an estimated 330 000 are suffering from skeletal fluorosis, both caused by coal burning. In fluorosis areas, many families use coal from local mines; coal is the main energy source for heating, drying and cooking. Since the local coal contains high

concentrations of fluoride, indoor fluoride pollution and fluoride contamination in food are very serious in fluorosis areas (Fig. 8-a) and an extremely high prevalence of dental (Fig. 8-b) and skeletal fluorosis has been detected through health surveillance.

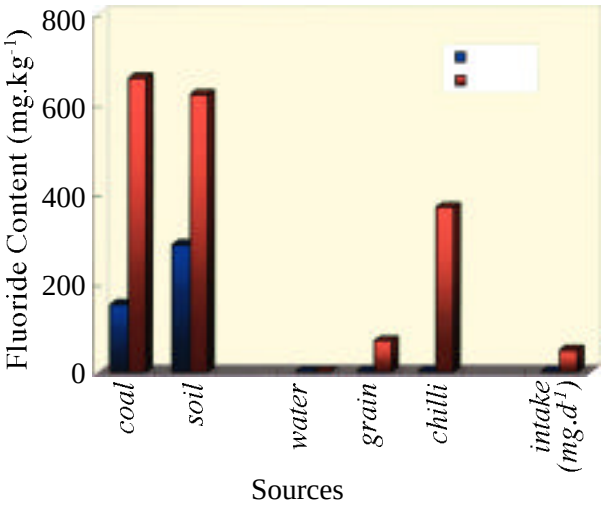


Fig. 8-a
Main sources of fluoride pollution in fluorosis and non-fluorosis areas in China.

Fig. 8-b
Diagnosis of dental fluorosis in the affected area of China.

International Ecosystem Management Research Team

The aquatic ecosystems of lakes and rivers are complex and their understanding requires long-term monitoring or labor-intensive field work. This Team has been investigating the trophic interactions in lake ecosystems by conducting mesocosm experiments and by monitoring the biological and chemical environment of lakes Kasumigaura, Japan, and Donghu, China (with the Institute of Hydrobiology, Chinese Academy of Science). The main goal of the Team's activities is to seek desirable uses of aquatic resources while preserving a sustainable level of biological, commercial, and recreational values of the respective ecosystems.

During the summer of 1997, we investigated, using a set of enclosures, the responses of physical and chemical environmental variables and of zoo- and phytoplankton abundance to the stocking and removal of the filter-feeding planktivore, silver carp (*Hypophthalmichthys molitrix*). This experiment aimed at determining whether the responses comply with the so-called "cascading trophic theory" and are reversible between the two contrasting manipulations. We found that the abundance of large phytoplankton (> 40 µm) significantly decreased when silver carp were stocked but increased when the fish were removed, relative to a reference enclosure (Fig. 9).

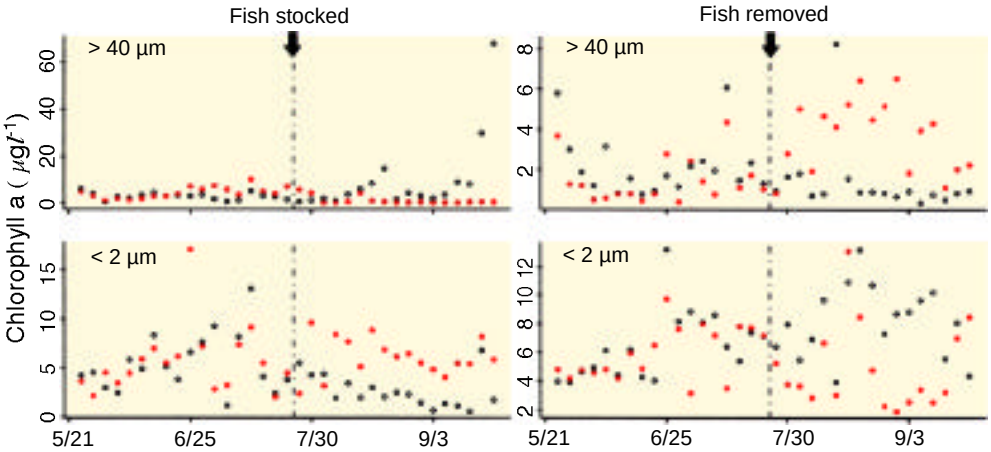


Fig. 9
Changes in chlorophyll *a* concentrations (top panels: > 40 µm; bottom panels: < 2 µm) following the stocking and removal (left and right panels, respectively) of silver carp (*Hypophthalmichthys molitrix*) during summer 1997. Red circles are measurements in the experimental enclosures, while open circles are in reference enclosures. The reference enclosures of the left panels contained no fish, and those of the right contained fish throughout the experiments.

Conversely, the abundance of small phytoplankton (< 2 µm) significantly increased when fish were stocked but decreased upon removal of fish (Fig. 9). These results suggest that the planktivorous silver carp are capable of suppressing cyanobacterial blooms and improving water visibility. However, the fish change the (phyto) plankton community into one dominated by smaller individuals and species.

International Atmospheric Environment Research Team

This team has studied the origin of atmospheric aerosols, using a chemical mass-balance method, and chemical reaction mechanisms on the surface of aerosols in highly polluted urban air over the East Asian Continent. Big cities in this area, such as Beijing, are exposed to high atmospheric concentrations of both anthropogenic aerosols and soil aerosols originating in deserts and other arid areas. One research topic is designed to increase our basic understanding of the environmental behavior of one of the soil aerosols, "Kosa" aerosol. The calcite mineral present in Kosa aerosol may be a major contributor in reactions with acidic gases in the urban air. Kosa aerosol is expected to be a key substance that may accelerate or ameliorate environmental air pollution in large East Asian cities.

We have been carrying out collaboration and cooperative research with several foreign laboratories including the China-Japan Friendship Environmental Protection Centre in Beijing, China (Fig. 10). Aerosol sampling was carried out every month by high-volume sampler (Fig. 11). Carbonaceous aerosol concentrations in winter in Beijing were extremely different from those in summer, which may be explained by the winter rise in fossil fuel combustion. The concentration of carbonaceous aerosol was often over 200 µg m^{-3} in winter and less than 100 µg m^{-3} in summer. Sulfate aerosol concentration was found to be closely correlated with that of carbonaceous aerosol. Expeditionary investigation and sampling are being undertaken in a basic study of the relationship between the chemical characteristics of original soil and those of Kosa aerosol.

Fig. 10
View of the collaborative mini-symposium on Kosa aerosol in Beijing, China.

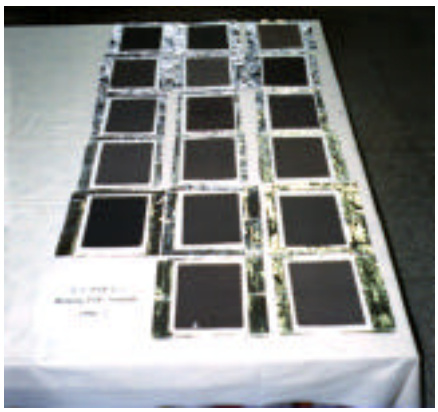
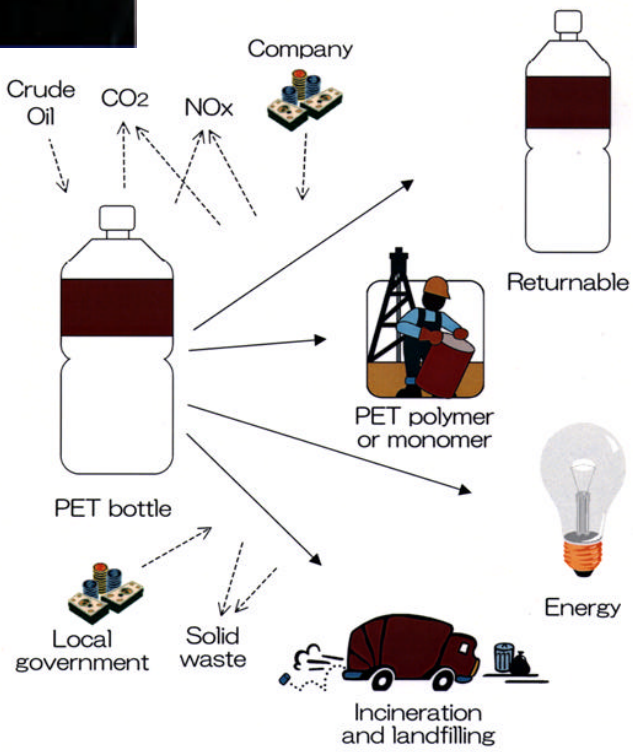


Fig. 11
The variation in sample color collected in China during 1 year of monitoring.

Independent Senior Researchers

In addition to the above-mentioned 15 research teams, 4 independent senior researchers are working in specialized areas: environmental statistics, diffusion process analysis, ecosystem preservation, and environmental policy-making in developing countries, respectively.

Social and Environmental Systems Division



What type of recycling is preferable?

Environmental problems may 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 adversely affect or 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 concerns itself primarily with present and future ways of interaction between social and environmental systems.

In FY 1997, the Division, with its Principal Researcher (PR) and its 4 research units—the Environmental Economics (EE), Resources Management (RM), Environmental Planning (EP), and Information Processing and Analysis (IP) Sections—conducted basic research on the following 14 topics.

Selected Basic Research Topics of the Social and Environmental Systems Division

	Research Theme	Responsible section
(1)	Some Fundamental Issues in Environmental Cognition and Perception	(PR)
(2)	Treatment of Qualitative Information Concerning Environmental Problems	(PR)
(3)	Socio-economic Analysis and Policy Assessment for Environmental Management	(EE)
(4)	Potentially Effective International Collaboration for Global Environmental Protection	(EE)
(5)	Economic Impact of Environmental Policies	(EE)
(6)	Environmental Impact Associated with Water Resources Development	(RM)
(7)	Recovery, Reuse and Recycling of Potential Resources for Waste Reduction and Their Impacts on Social and Environmental Systems	(RM)
(8)	Modeling and Policy Studies for Local and Regional Environmental Planning	(EP)
(9)	Information Processing Systems for Geographic and Image Data	(IP)
(10)	Modeling and Simulation Methodologies for Environmental Evaluation	(IP)
(11)	Landscape in Terms of Environmental Perception and Evaluation	(EP)
(12)	Estimation of External Costs in Implementation of the Packaging Recycling Law (1995)	(EE)
(13)	Climate Change and Its Impact on River Water - Model Development	(EP)
(14)	Improvement of Numerical Calculation of Noise Propagation by Means of the Boundary Element Method	(IP)

The first 2 research topics, which were conducted primarily by the Principal Researcher and associates, deal with some selected basic issues concerning people's awareness and perceptions of the environment, which are fundamental to the formulation of policy for environmental conservation. Topic (1) produced clarification of the relationship between existing scientific disciplines and the holistic approach to understanding various environmental issues. Topic (2) was successful in identifying a variety of interpretations of people's environmental cognition from various descriptions by respondents obtained in free-association surveys.

Environmental Economics Section

Two selected issues were studied under research topic (3): the relationship between household energy consumption patterns and people's environmental conservation attitudes and behaviors was analyzed; and a survey on public environmental knowledge and perceptions was conducted to identify how they are affected by the media and how effective they are in promoting environment-friendly behavior among consumers. Industrial ecology studies were also performed under this research topic. A mandatory recycling program based on the Packaging Recycling Law was studied in the context of "extended producer responsibility (EPR)".

Research topic (4) deals with policy science analysis and assessment concerning the Framework Convention on Climate Change. In order to analyze the process of negotiations for the final agreement on the reduction of CO_2 emissions beyond the year 2000, a specific survey method was developed to predict future trends among the signatory Parties. In addition, under research topic (12), an estimate of external costs incurred in implementing different schemes of collection and recycling of PET bottles was made for three different municipalities ,namely, Tokyo Special District, and Osaka City and Kawaguchi City. The EPR was discussed with respect to internalization of the costs.

The effects of carbon tax on the macro-economy were studied, under research topic (5), for the same reduction target in CO_2 emission in the presence or absence of a tax reform. Assuming a tax reform, the effect would be a reduction of about 10 percent in the net GDP.

Resources Management Section

Under research topic (6), data were collected to build a model to evaluate the environmental as well as the socio-economic impact of a water resource development project. Data on water quality changes in both drinking water and agricultural irrigation systems for the Lake Kasumigaura watershed were collected and analyzed.

Research topic (7) deals with the development of Life Cycle Assessment (LCA) methodology for assessing the life-cycle resource use and environmental impacts of processing equipment and products that should be recycled. Studies of several types of plastic and metal beverage containers were used as case studies, for which relevant data for inventory analysis were collected to improve our LCA method. An extended analysis of a refuse incinerator with power generation for its entire life-cycle was also performed.

Environmental Planning Section

Improvement of local environmental plans is a central theme in research topic (8). Many regional and local authorities, prefectural as well as municipal, are now engaged in formulation of their own basic environment plans in conformity with the National Basic Environment Plan. Important, common issues arising from the planning process were carefully identified and analyzed in this study. In the planning process, public participation at venues such as public hearings and information provision were found to be two key factors for public acceptance of the plans.

Under research topic (11), some descriptions of the local landscape from the diaries

and travelogues of foreigners who visited Japan during the Edo and Meiji periods were confirmed, and many factors were identified in order to determine landscape value.

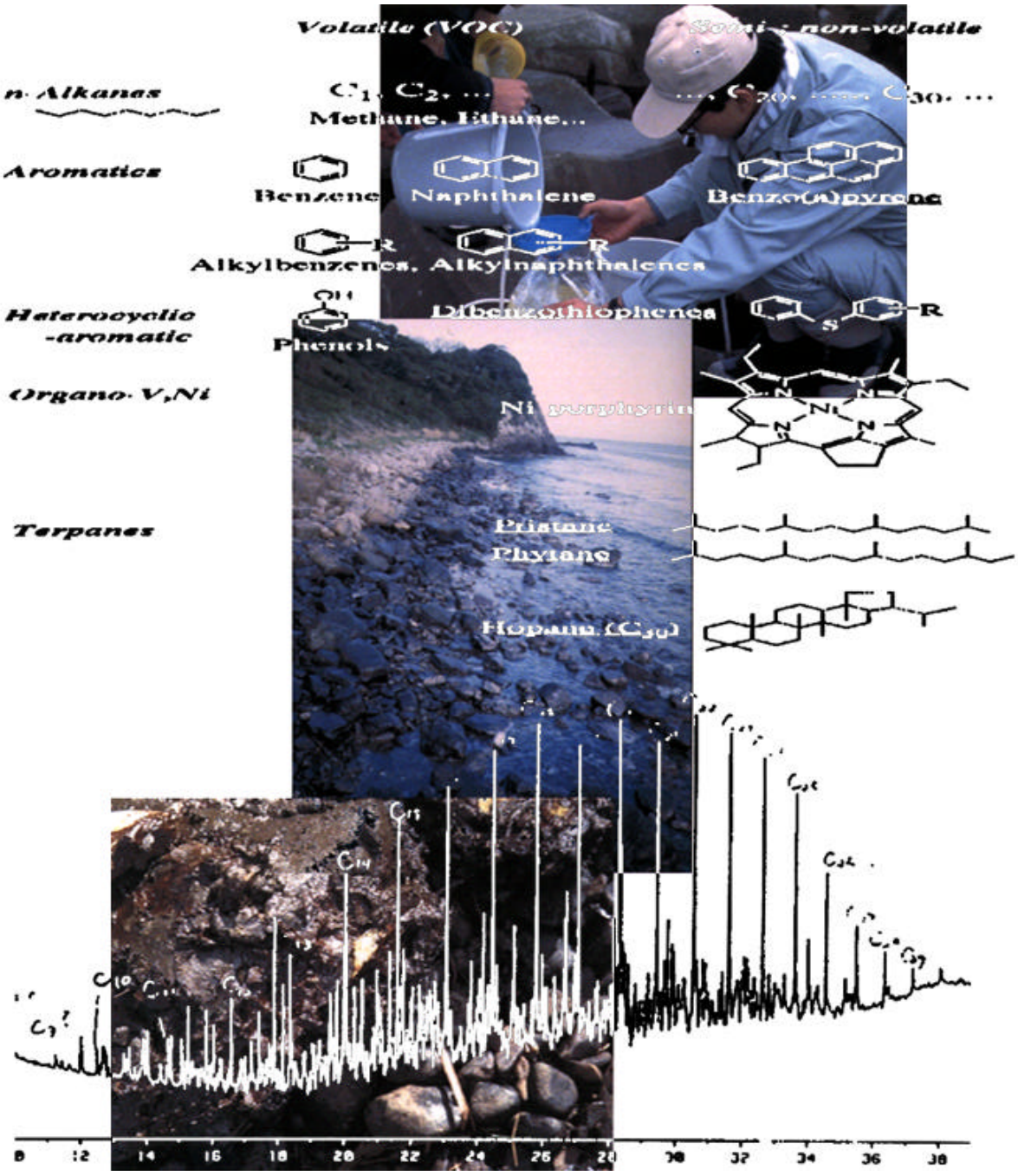
In addition, under research topic (13) we made a computer model to simulate climate change and its impact on the quantity of river water. The model still needs refinements, but is capable of computing fluctuations in surface water flow under various conditions.

Information Processing and Analysis Section

Developments under research topic (9) have produced improved image data processing techniques for analysis of remotely sensed monitoring data such as the geographic and image data obtained from various earth observation satellites. Continuous image data from the NOAA/AVHRR have been obtained from the two NIES NOAA data receiving stations located in Kuroshima (Okinawa) and in Tsukuba, respectively. Data from these stations were used to develop a regional mosaic and vegetation index map for East Asia. Techniques to merge satellite data and geographic information are also being developed. We have developed a NOAA/AVHRR data search system to retrieve specific image data efficiently. It can be accessed through the NIES internet home page.

Research topic (10) concentrates on development of models to analyze and evaluate quantitatively environmental changes, and simulations based on these models, incorporating a new technique of transformation to predict changes. An elaborate traffic-noise propagation model was developed under research topic (14) using a boundary element method and the noise pyopagation was more precisely simulated than conventional geometric sound propagation models under various environmental conditions.

Environmental Chemistry Division



Oil pollution in the Japan Sea

The Environmental Chemistry Division consists of 4 Sections that conduct fundamental research on environmental measurements, and on the fates and toxicology of chemicals. The Analytical Instrumentation and Methodology Section conducts research on analytical methods and instrumentation for environmental analysis, in particular using mass spectrometric systems. The Analytical Quality Assurance Section conducts research on standardization and quality assurance in environmental analysis. The Environmental Chemodynamics Section focuses on chemical state, chemical speciation, and isotope analyses, as well as their application to understanding the environmental fates of chemicals. The Chemical Toxicology Section conducts studies on the chemical structure and toxicity of both natural and anthropogenic toxic compounds.

In FY 1997, eight basic research projects covering a wide range of environmental pollution by various chemicals were implemented. Also, a new research project began on developing technologies and methodologies for automatic sampling and analysis of toxic air pollutants. Members of the Division participated in 6 research projects organized by the project research divisions, and conducted 7 special projects subsidized by the Science and Technology Agency. Two programs supporting environmental monitoring of chemicals are continuing: the Environmental Specimen Banking Program, which has been carried out for 17 years, with special emphasis on monitoring background pollution levels around Japan; and the Environmental Certified Reference Material (CRM) Program. By the end of 1997, 18 CRMs had been prepared, 11 of which were certified for metal composition.

Brief accounts of some of the important results from the Division's research in 1997 follow:

Development of a continuous monitoring system for toxic air pollutants

The continuous monitoring system consists of a stainless steel canister sampling unit and a gas chromatograph/mass spectrometer. The developing system can simultaneously determine 45 volatile organic compounds. In 1997, design of the system, improvement of parts of it, efficiency tests of each part, and programming for automatic control, were carried out.

Environmental partitioning of chlorinated organic compounds

Emissions of chlorinated organic compounds into the environment were estimated from their national production volumes. Distribution of the emitted chlorinated compounds among air, water, soil and sediment was estimated using a simple fugacity model. The estimated distributions of volatile chlorinated compounds corresponded well with monitoring data, but discrepancies were observed for semivolatile compounds.

Measurement of isoprene over the southern ocean

Isoprene is a photochemically reactive hydrocarbon emitted mainly by terrestrial plants. Isoprene in the marine atmosphere was measured over Southeast Asian waters, and the western Pacific and eastern Indian oceans. High concentrations (>200 ppt) of

isoprene were observed near tropical lands and over the southern ocean, suggesting long-range transport of isoprene emitted by tropical forests and high emission levels of isoprene from the Southern Ocean.

Thermal decomposition of halon alternatives

Various fire-fighting agents are widely used all over the world as alternatives to halons. In this study, a halon and 7 halon alternatives were pyrolyzed to determine what toxic pollutants form during fire fighting. Organic products of thermal decomposition were analyzed by gas chromatography/mass spectrometry. A large amount of hydrogen fluoride forms by pyrolysis of any fluorinated compound. Also, thermal decomposition of fluorinated nitrogen-containing compounds produces high levels of nitrogen oxides.

Analytical method for measuring trace carbonyl compounds in environmental samples

A new analytical method to determine trace carbonyl compounds in environmental samples and in foods and beverages has been developed. This system consists of derivatization and gas chromatography/mass spectrometry. Seventy-two carbonyl compounds were derivatized with cysteamine to corresponding thiazolidines. Using this method, furfural concentrations in the Japanese commercial alcohol beverage, sake, were determined.

Vertical cycling of seawater in the Japan Sea as revealed by accelerator mass spectrometry

The Japan Sea is a fairly enclosed environment, liable to be polluted by human activities. To elucidate the cycling of seawater, samples were taken from various depths at many stations between Niigata and Vladivostok, and the $^{14}C/^{12}C$ ratios of dissolved inorganic carbon were analyzed by accelerator mass spectrometry (Fig. 1). The variation in $^{14}C/^{12}C$ ratios showed that younger seawater penetrates deeply on the Russian side, while older seawater rises close to the surface on the Japanese side. Based on differences of ^{14}C content, the turnover time of Japan Sea bottom water was estimated to be around 100 years.

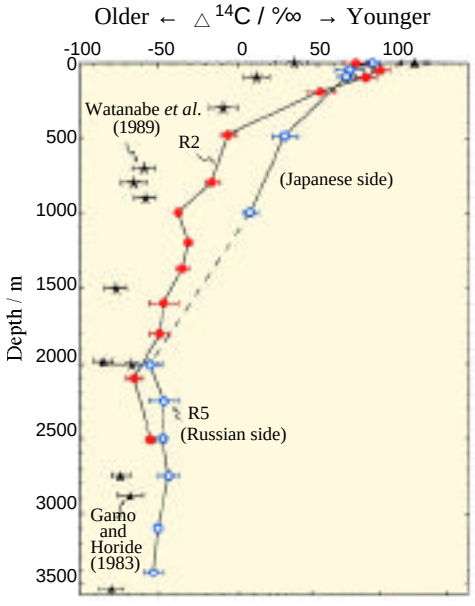


Fig. 1
$^{14}C/^{12}C$ ratios of dissolved inorganic carbon in the Japan Sea.

Monitoring of oil pollution along the Japan Sea coast

Heavy oil spilled from sunken Russian tanker has caused severe pollution along the Japan Sea coast. Characterization of heavy oil and monitoring of its environmental fate continued in FY 1997. A chromatographic feature of polycyclic aromatic hydrocarbons that include benzo(a)pyrene (B(a)P) was found to be a sensitive and characteristic marker for this oil, and was used as a temporal quantitative measure of oil pollution. This feature remains not only in the residual oil but also in seawater and organisms from the polluted area. The B(a)P content in environmental samples, however, was found to decrease considerably over time (typically to 1/10 of the original level in mussels after 10 months).

Finding and analysis of a new type of microcystin

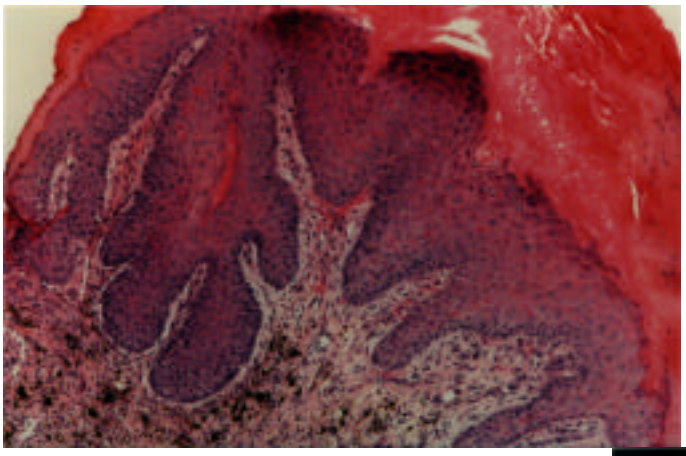
Toxic cyanobacterial blooms occur worldwide in eutrophic lakes, ponds, and drinking-water reservoirs. The most common toxins in the blooms are hepatotoic cyclic heptapeptides, named microcystins. Until 1995, it was believed that all microcystins contained a dehydroalanine (Dha) unit. We found a novel microcystin variant (Dhb-microcystin) that contained dehydrobutyrine (Dhb) instead of Dha, from the European filamentous cyanobacterium *Oscillatoria agardhii*. Several variants that contained the Dhb unit were isolated from bloom material obtained in Scotland. The toxicities of the Dhb-microcystins were found to be almost same as those of Dha-microcystin variants. However, Dhb-microcystin has not been found in Asian strains of cyanobacteria.

Paleo-environmental reconstruction of northern Asia using Baikal sediment cores

International research collaboration has continued in the Baikal area of Russia, focusing on global climate change and its effects on ecosystems and biodiversity. Various interesting analytical results from BDP-96 cores are accumulating. Historical change of climate and vegetation over the last 5 million years is under discussion.

In winter 1998, new undisturbed sediment cores (601 m) were successfully obtained with good recovery rate (>91%) from Academician Ridge in Lake Baikal. The age of the core bottoms (601 m) is predicted to be more than 12 million years.

Environmental Health Sciences Division



Papilloma on skin of metallothionein knock-out mouse induced by exposure to UV-B light and a carcinogen

The main scope of this Division's research activities covers experimental and epidemiological studies on risk assessment of environmental agents that are harmful to human health. Among the agents we study are nitrogen dioxide, diesel exhaust particles (DEP), heavy metal compounds, organohalogen compounds, endocrine disruptors, Japanese cedar (sugi) pollen, ultraviolet radiation, and noise. The severity and manifestation of health effects, as well as the development of detection and assessment methodology, are the primary research themes of this Division. Depending upon the distribution of a given agent in the environment and its possible health effects, research topics are classified as either domestic or global environmental issues.

During FY1997, we performed 11 regular research programs. Experimental studies were performed in three sections; Biochemistry and Physiology, Experimental Pathology and Toxicology, and Biological and Health Indicators. Studies that deal with human populations were carried out in the Environmental Epidemiology Section. Research objectives that were considered to be both domestic and global environmental issues have been also pursued as research projects or programs supported by the Global Environment Research Programs or Special Research Programs, in collaboration with scientists of the Global Environment and Regional Environment divisions. In addition, research supported by the Science and Technology Agency and other funding bodies was also performed. In this year's report we describe studies performed in the Experimental Pathology and Toxicology Section focusing on gene expression by coplanar polychlorinated biphenyls.

Expression of pi-class glutathione S-transferase, a tumor marker enzyme, by coplanar polychlorinated biphenyl congeners in rat liver cells

Coplanar polychlorinated biphenyl (PCB) congeners are chlorinated at the meta and para positions, and their structure is similar to that of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) (Fig. 1). These compounds have been shown to be potent carcinogens, and are suspected of promoting tumors. Recently, coplanar PCBs have also been recognized as endocrine disruptors. Congeners of this type incorporated into cells bind to an arylhydrocarbon-receptor (Ah-R), and the ligand-bound Ah-R activates expression cytochrome P450 (CYP)-IA and related drug-metabolizing enzyme genes through interaction with a specific DNA sequence on these genes termed the xenobiotic

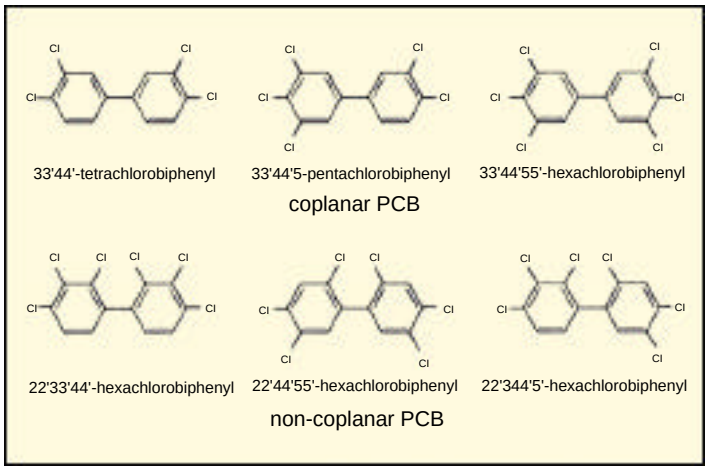


Fig. 1
Structures of PCBs.

responsive element (XRE). However, the carcinogenicity and other toxic effects of coplanar PCB cannot be explained simply by the expression of CYP genes.

We systermically surveyed the genes expressed by coplanar PCB congeners. Studies on the mechanism of expression of these genes are expected to reveal a novel signal transduction pathway activated by coplanar PCBs. When primary cultured rat liver parenchymal cells were exposed to a most toxic coplanar PCB congener (3,3',4,4',5-pentachlorobiphenyl, PenCB), these compounds specifically induced expression of pi-class glutathione S-transferase (GST-P). This protein is a marker enzyme of preneoplastic hepatic foci, but is latent in the normal liver tissue. We are interested in the pathway for expressing GST-P in the normal liver cells exposed to PenCB.

Expression of GST-P is suppressed by protein kinase inhibitors and glucocorticoid

Since GST-P is known to be expressed in growing cells such as tumor cells, we surveyed cell growth factors that express GST-P in primary cultures of rat liver parenchymal cells. We found that the epidermal growth factor (EGF) was an effective inducer. EGF exerts its effect by activating tyrosine kinase on EGF receptors, which in turn activate protein kinases, including protein kinase C, through a cascade of phosphorylation. Recent studies revealed that EGF activates the transcription factor AP-1 (the heterodimer of c-Jun and c-Fos) via protein kinase C, and thet AP-1 binds to the TPA (a tumor promoter) responsive element (TRE) on the 5'-upstream region of the gene for its expression. The 5'-upstream region of the GST-P gene was shown to contain TRE and a related element termed GPE-I (GST-P enhancer I) but not to contain XRE, indicating a possibility that PenCB may mimic the effect of EGF. Inhibitors of protein kinase C and related kinases (H7 and phloretin) reduced expression of GST-P m-RNA by both PenCB and EGF, suggesting that PenCB activates protein kinase C or related kinases to express GST-P, and that an AP-1 related transcription factor may play a role in the expression of GST-P by PenCB (Fig. 2).

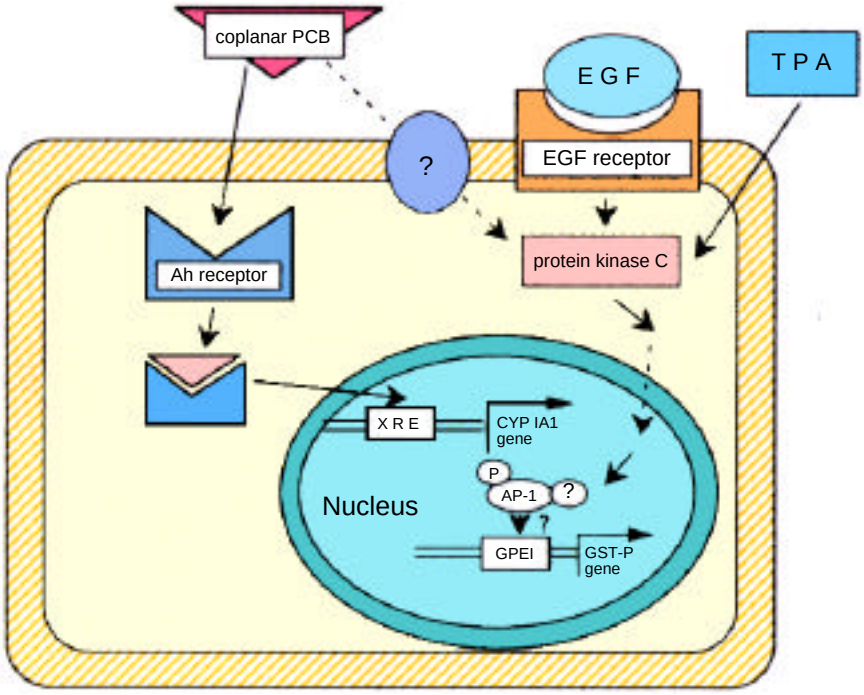


Fig. 2
A possible mechanism for expression of the GST-P gene by a coplanar PCB.

Phosphorylation of c-Jun stimulated by a coplanar PCB

AP-1 activity is known to be determined by the phosphorylation of c-Jun. Liver parenchymal cells were treated with either PenCB or EGF and labeled with ^{32}P-phosphate. After immunoprecipitation and separation on gel electrophoresis, ^{32}P-phosphate incorporated into c-Jun was analyzed by autoradiography (Fig. 3). PenCB as well as EGF stimulated phosphorylation of c-Jun, but non-coplanar PCBs and TPA had no effect. The phosphorylation of c-Jun may be a novel pathway for gene expression caused by coplanar PCBs.

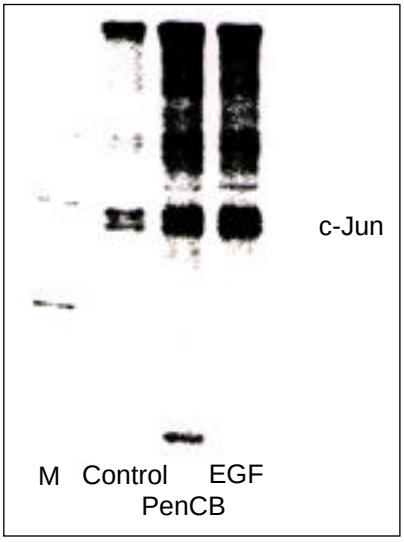


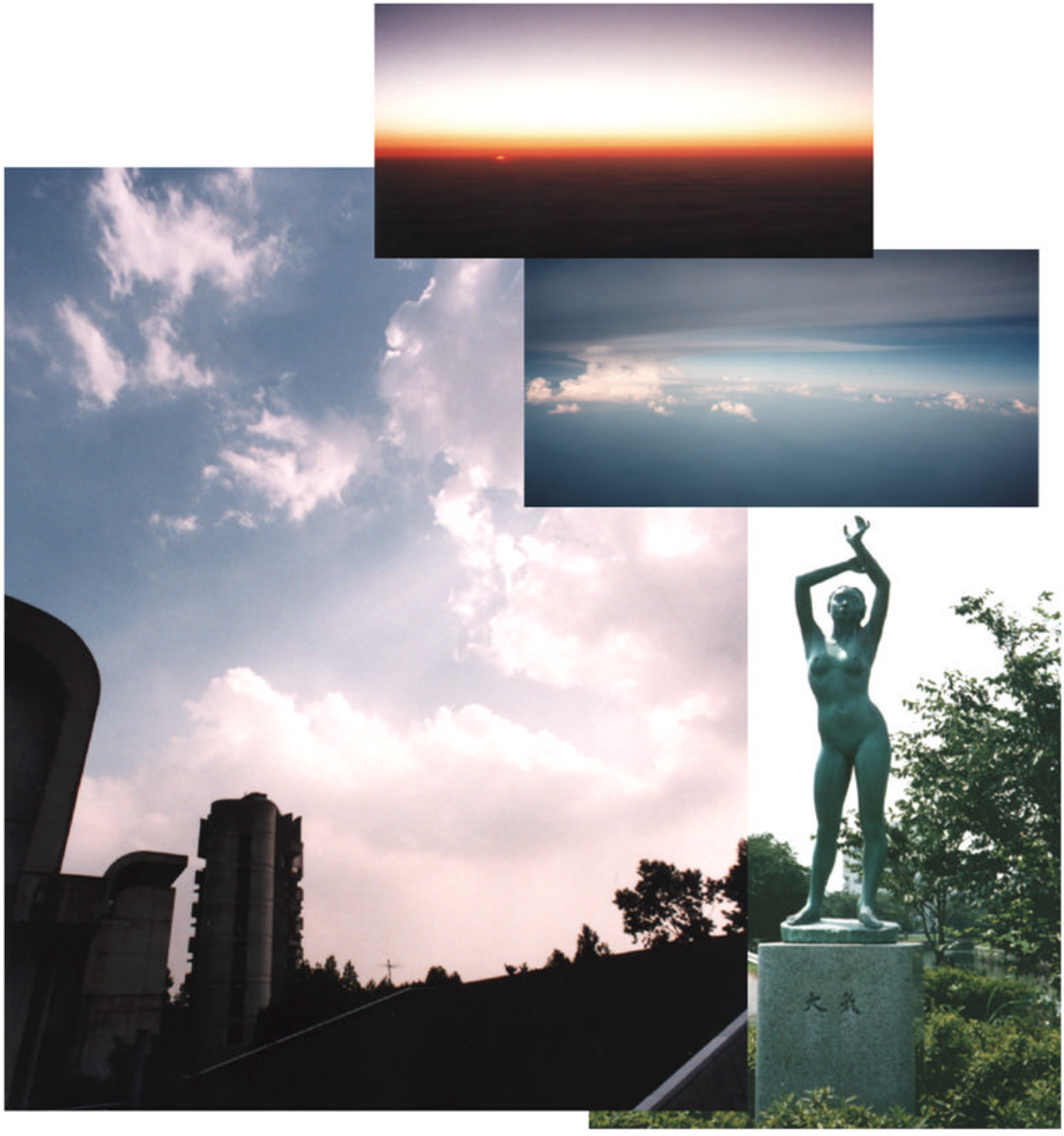
Fig. 3
Stimulated phosphorylation of c-Jun by PenCB or EGF. Lane M, markers of molecular mass.

Responsive element for expression of GST-P gene by a coplanar PCB

The 5'-flanking region required for the expression of the GST-P gene by PenCB was confirmed by chloramphenicol acetyltransferase (CAT) assay; the GPE-I element was found to be essential to stimulate gene expression by PenCB. This element is known to be required for GST-P expression in hepatocarcinoma. GPE-I may be also involved in GST-P expression by PenCB in normal liver parenchymal cells (These results are partly presented at the 23rd Symposium on Toxicology and Environmental Health. Matsumoto, M. et al. (1998) Jpn. J. Toxicol. Environ. Health 44, p-47).

Coplanar PCB and its related compounds are thought to exert toxicity not only by the Ah receptor-mediated pathway but also by the above-mentioned yet unknown pathway via a protein kinase cascade. This pathway remains to be clarified.

Atmospheric Environment Division



The Atmospheric Environment Division conducts basic research on the distribution, properties and reactions of atmospheric pollutants, as well as on related tropospheric and stratospheric chemistry and physics. The Division consists of four sections, Atmospheric Physics, Chemical Reaction, Upper-Atmospheric Environment and Atmospheric Measurement. Several facilities, inlcuding a photochemical reaction chamber, lidar (laser radar), ozone lidar, aerosol chamber and wind tunnel, are operated in cooperation with the Global Environment and Regional Environment divisions.

Atmospheric Physics Section

The Atmospheric Physics Section focuses on the analysis and numerical modeling of atmospheric dynamics. A major research topic is analysis of the global climate system using observational data and the CCSR/NIES climate model developed through joint research with the University of Tokyo. The results facilitate studies of both global- and regional-scale environmental issues, such as the evaluation of climate change by a climate and mass transport model. Concrete research topics include evaluation of the effect of atmospheric greenhouse gases and aerosols on global-scale climate change (Fig. 1); evaluation of regional-scale climate change; and development of atmospheric circulation and mass transport models for the tropospheric system.

Chemical Reaction Section

The Chemical Reaction Section deals with the photochemical and thermal reactions of a relatively small number of reactive atmospheric constituents. Studies of the photochemistry and kinetics of free radicals related to photochemical smog, acid deposition, and the fates of airborne chemicals in both the troposphere and stratosphere have been carried out.

Impact of halogen compounds on tropospheric photochemical ozone

Chloropicrin (CP; CCl_3NO_2), one of substitutes of methyl bromide, has been used as a soil and structure fumigant. Its use is now regulated for protection of stratospheric ozone. The impact of CP on photochemical ozone was demonstrated in a 6-m^3 photochemical reaction chamber. The concentration of photochemical ozone was enhanced by injection of CP. This has been explained in terms of the balance between the reduction of ozone by Cl atoms and enhancement of ozone production due to the photolysis of released NO_2. The depletion of photochemical ozone by injection of Cl_2, Br_2, and I_2 has also been demonstrated in the chamber.

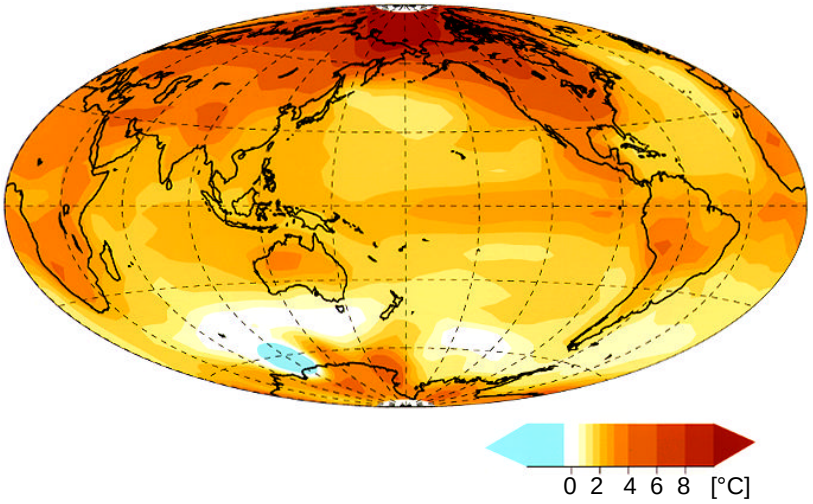


Fig. 1
Transient response of the CCSR/NIES coupled atmosphere-ocean general circulation model in a scenario of gradual increase in atmospheric greenhouse gases and sulfate aerosol concentrations: geographical distribution of change in mean surface air temperature (K) over 50 years (2040-2090); greenhouse gas concentration in equivalent carbon dioxide in 2060 is projected to double that in 1990.

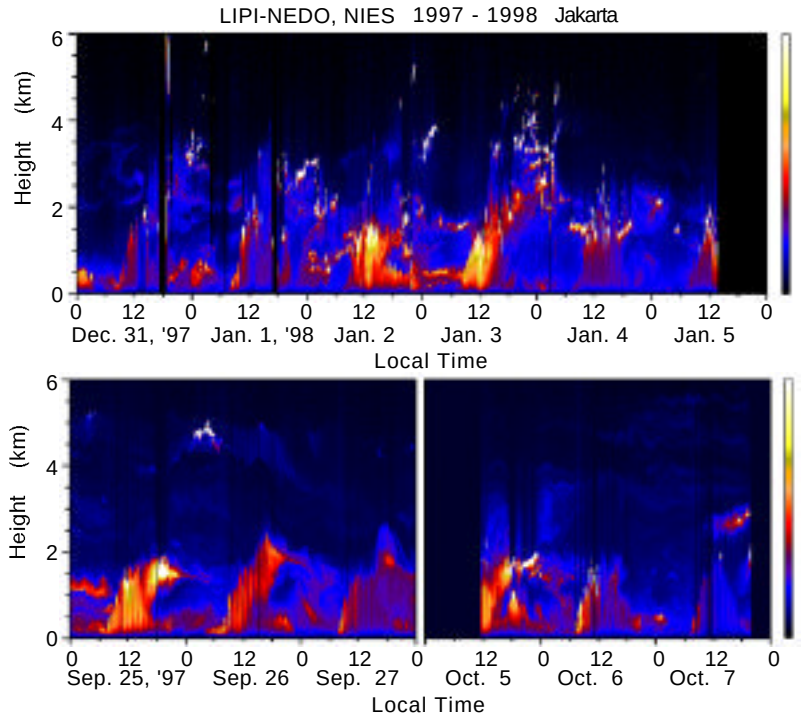


Fig. 2
Variations in the vertical profile of aerosols measured with a Mie scattering lidar in Jakarta. Differences between the wet season (upper) and the dry season (lower) are seen in the atmospheric boundary layer structures.

Laser-induced fluorescence detection of methyl-substituted vinoxy radicals

Five laser-induced fluorescence spectra were observed in O atom reactions with methyl-substituted ethylenes ($R_1R_2C=CR_3R_4$; R_1-R_4 = H or CH_3). Similar spectra were also observed in H-atom abstraction reactions from the corresponding carbonyls (R_1R_2CH-$C(O)$-R_3; R_1-R_3 = H or CH_3). For example, the $CH_2C(O)CH_3$ radical could be generated in the photolysis of, and in the H-atom abstraction reaction from, acetone ($CH_3C(O)CH_3$). Hence, observed spectra were identified to be emissions from methyl-substituted vinoxy radicals (R_1R_2C-$C(O)$-R3; R1-R_3 = H or CH_3).

Upper-Atmospheric Environment Section

This Section uses lidars (laser radars) and laser remote-sensing methods to conduct observational studies of the atmosphere.

Aerosols and clouds have been observed in Tsukuba with ground-based lidars. A climatological study has been carried out from the radiative transfer aspect in a study on global warming. Optical characteristics of cirrus clouds and aerosols are studied with new lidar techniques such as high-spectral-resolution lidar. Observations using lidar in Jakarta started in 1997 (Fig. 2).

A space-borne lidar is being developed by the National Space Development Agency (NASDA) for launch early in the next century. This sensor will be an effective tool for observing global distribution of clouds and aerosols. A study has begun on data reduction algorithms and data utilization for this space-borne lidar.

Open-air measurement of atmospheric trace species using the laser long-path absorption method is another topic. An experiment using the Retroreflector in Space (RIS) was carried out as part of the Advanced Earth Observing Satellite (ADEOS) program. The absorption spectrum of ozone was measured successfully with this method for the first time.

Atmospheric Measurement Section

The special emphasis of this section is on field studies of trace atmospheric constituents including greenhouse gases, reactive chemical species, and aerosols. To understand their origins, distribution, and fate in the troposphere, measurements of their concentration and isotopic composition have been carried out on a global and/or regional scale. Previous airborne measurements over oil fields in the western Siberian lowlands suggested that there were fossil methane emissions from natural gas leakage there. To distinguish fossil methane from biogenic methane produced in wetlands, the radioisotope carbon-14 (^{14}C) content of the methane was measured because methane associated with natural gas has virtually no ^{14}C (half-life 5730 yr). Air samples were collected in 100-L stainless-steel canisters at 9×10^5 Pa at three altitudes—75 m, 2000 m, and 6000 m—over oil fields near Surgut (lat 61°18'N, long 73°38'E) both in summer and winter. After separation and purification of methane from sample air, the ^{14}C in the extracted methane was measured by accelerator mass spectrometry (AMS) at our institute. The methane concentration was usually higher at lower altitudes and the ^{14}C content decreased with increasing methane concentration (Fig. 3). Assuming that the methane obtained at 6000 m reflects the background condition, more than 60% of the excess methane sampled over Surgut both in summer and winter was derived from fossil methane.

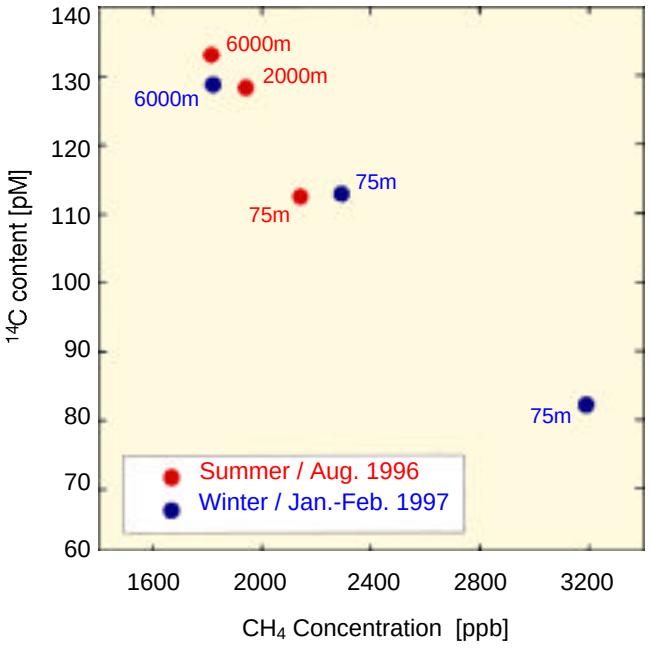
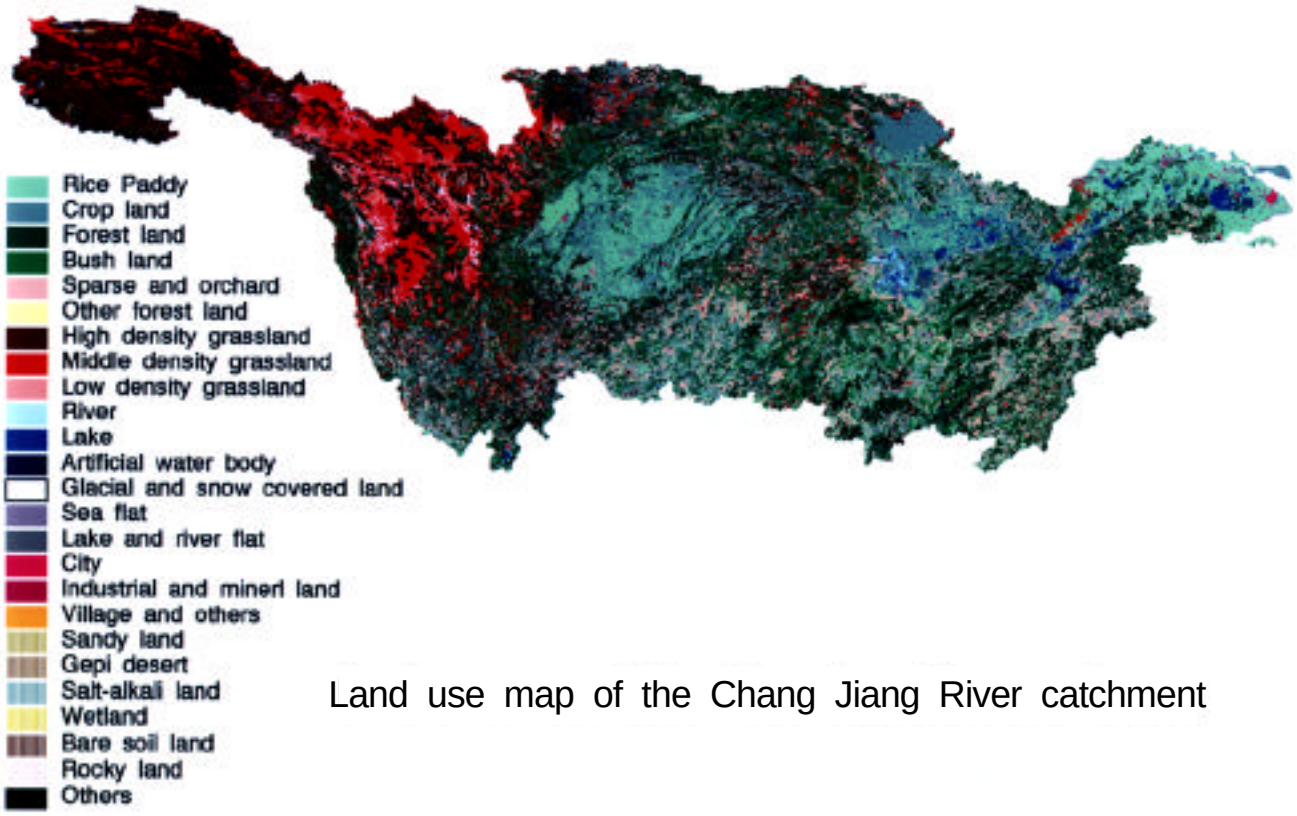


Fig. 3
Relationship between methane concentration and the ^{14}C content in air samples obtained over oil fields near Surgut in western Siberia in summer and winter.The ^{14}C contents are reported using the percent modern (pM) scale, which is defined by pM = $(^{14}C_{sample}/^{14}C_{standard}) \times 100$.

Water and Soil Environment Division



Land use map of the Chang Jiang River catchment

The Water and Soil Environment Division conducts both fundamental and applied research on transport, biological degradation and chemical reactions of pesticides, organic matter, heavy metals, chlorinated aliphatic compounds and biologically available nutrients in aquatic and soil systems. The results of these studies are integrated into biogeochemical models that contribute to the conservation and protection of the environmental quality of such systems.

The Division consists of four sections, Water Environment Engineering, Water Quality Science, Soil Science and Geotechnical Engineering. Experimental facilities, including a freshwater microcosm, a marine microcosm, lysimeters, the Environmental Biotechnology Laboratory and the Kasumigaura Water Research Station, are currently used in these studies in collaboration with the Global Environment and Regional Environment divisions.

Water Environment Engineering Section

Development of a comprehensive watershed management model for the Chang Jiang River

The remarkable progress in socioeconomic activities in the Chang Jiang River catchment may result not only in damage to the catchment area but also to pollution of the East China Sea. We have developed a mathematical model that describes and simulates aquatic environmental conditions in the watershed, with the aim of finding strategies for sustainable development and at the same time preserving the aquatic ecosystem from the river catchment to the sea. The final goal is to establish a comprehensive watershed management model for the Chang Jiang River catchment. Basically, a mathematical model based on the physical background can be applied to any watershed irrespective of size. However, the Chang Jiang River catchment is so large that we have constructed and verified the applicability of the model step by step. This type of comprehensive model consists of three sub-systems: i) a monitoring system, ii) a geographic information system; and iii) a transport model for water and materials. This year we have extensively developed sub-systems ii) and iii). The main research results are as follows.

Construction of a database of land uses in China. In collaboration with the Institute of Remote Sensing Applications, Chinese Academy of Science, People's Republic of China (IRSACAS), we constructed a database of land uses from 1990 through 1993, and verified its accuracy based on field surveys. The land uses are categorized into six main groups (cultivated field, forest, grassland, aquatic area, town and industrial areas, and bare land) and several sub-categories.

Construction of a Digital Elevation Model (*DEM*). A highly accurate DEM is needed as a primary means of increasing the accuracy of the model for transport of water and materials. Under our collaboration with IRSACAS, we have constructed a DEM with a 50-m grid size, which will enable us to simulate the river network in plains such as the Chang Jiang Great Plain.

Development of a snowmelt runoff model. The source of the Chang Jiang River is at a high altitude, over 5000 m. Knowledge of snowmelt characteristics is important to

describe and predict the runoff. We have developed a snowmelt runoff model based on conventional hydrometeorological relationships. In this system, the watershed is divided into many sub-watersheds connected by a channel network. The runoff in each sub-watershed is calculated by the snowmelt model based on the radiation budget and the modified Stanford runoff model. The validity of the runoff system model has been verified by applying it to the Kushiro Mire in the eastern Hokkaido.

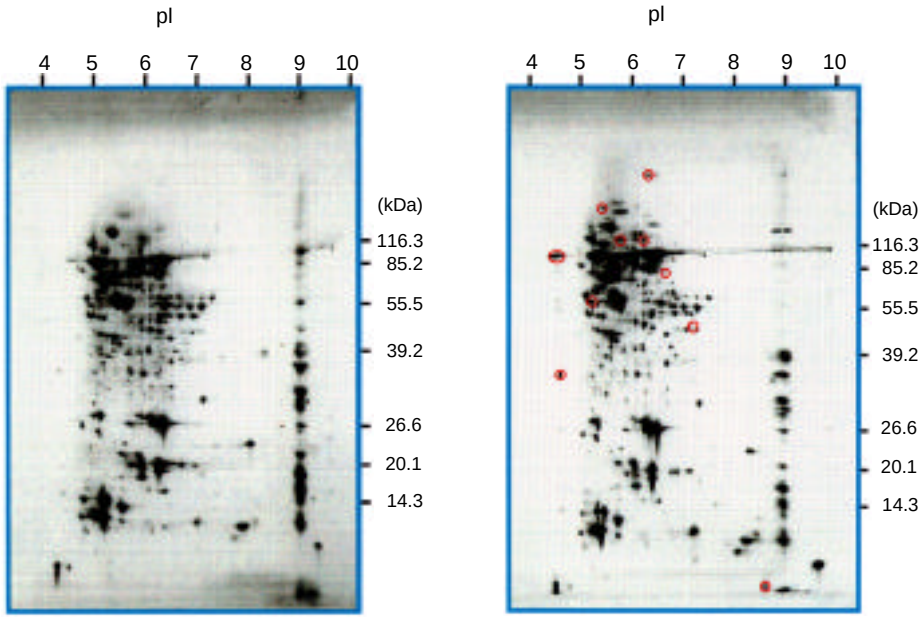
Water Quality Science Section

Response of a methanotrophic bacterium to water pollutants

Many microorganisms in nature live in an environment that does not provide optimal growth conditions, and they must respond quickly to change in order to compete successfully. As a response to harmful environmental conditions such as nutrient starvation, temperature changes and other growth-restrictive conditions, a cell may produce additional proteins, referred to as stress proteins. It has been reported that when cells are exposed to starved, they acquire enhanced resistance to a variety of stresses, thereby enhancing survival. We investigated the induction and enhancement of stress proteins in a methanotrophic bacterium, *Methylocystis* sp. M.

The responses of *Methylocystis* sp. M to six different water pollutants, carbon starvation and temperature (heat and cold) shock were examined using two-dimensional gel electrophoresis. A total of 48 polypeptides were induced, and these stress proteins were classified into 3 groups. Some of the chemically-induced proteins were the same as those induced by carbon starvation and temperature-shock proteins, but 7 polypeptides were induced only chemically by trichloroethylene (TCE) (Fig. 1). TCE-stress protein synthesis required 1-2 hours at a concentration of TCE that had no affect on growth.

Some of the stress proteins detected in this study will be used in approaches for the detection of environmental contaminants. The utility of a gene fusion consisting of a promoter of a TCE-specific stress protein gene with the lux structural gene would be



(A) Without TCE (B)With TCE

Fig.1
Silver-stained 2D-polyacrylamide gel electrophoresis of protein extracts of *Methylocystis* sp. M from (A) unexposed control cells and (B) cells exposed to TCE for 2h. The spots induced by TCE are marked with circles.

very useful for monitoring environmental TCE contamination at sublethal concentrations.

Soil Science Section

Leaching of heavy metals from soils treated with sludges

Organic wastes, such as sewage sludges, applied to farmland as fertilizer contain considerable amounts of heavy metals. In order to study the leaching of heavy metals from soils treated with sludges, soils were extracted with acids, and the resulting extractants analyzed for zinc (Zn) and copper (Cu). The results obtained were as follows:

(1) Extraction rates of Zn from sludges (without soils) increased with decreasing pH of the extractants at pH levels lower than 5.5; more than 90% of the total Zn was extracted at pH 2. Extraction rates of Cu also increased at pH levels lower than 4. (2) Extraction rates of Zn from soils (without sludges) were ca. 5% even at pH 1. (3) Extraction rates of Zn and Cu from soils treated with sludges increased at pH levels less than 5.5 and 4, respectively, regardless of the types of soil and sludge. (4) The extraction rates from soils treated with sludges remained approximately constant for more than 10 years after the application.

The leaching of heavy metals from soils treated with sludges was pH-dependent, and the soils retained the long-term ability to release heavy metals under acidic conditions.

Geotechnical Engineering Section

Land subsidence in Muikamachi, Niigata

Niigata Prefecture experiences heavy snowfall during winter. The maximum depth of snowfall in most areas of the plain and basin is more than 3 meters. In order to avoid disruption of daily life of citizens during winter, various methods of clearing snow have been adopted. In 1968, a method to melt snow by sprinkling groundwater from pipes set up along roads and parking lots, etc. was implemented in Nagaoka City and it has rapidly become popular.

Serious land subsidence was caused by repeated loading due to changes in groundwater level. For instance, in Muikamachi, which has the heaviest snowfall in the area, groundwater level was rapidly lowered in winter by a maximum of 16 m; the ground surface subsided about 3 cm in the winter of 1996-1997 (Fig. 2).

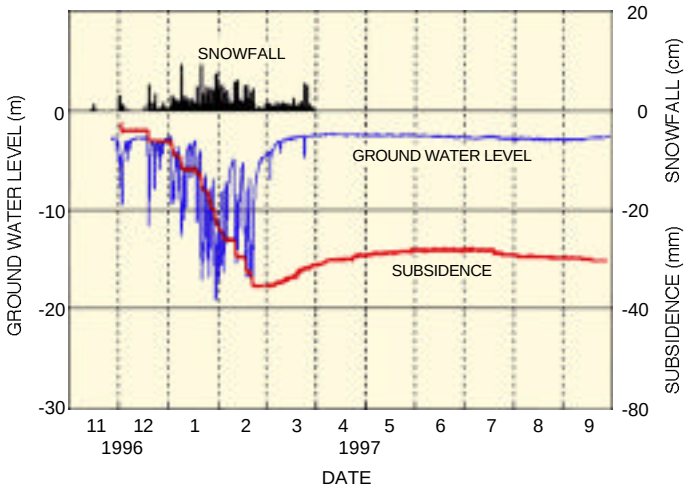
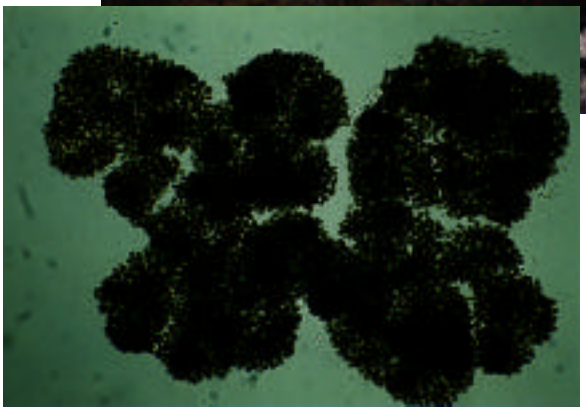


Fig. 2
Ground water level and subsidence measured with a new observation well at urban Muikamachi, Niigata Prefecture.

Environmental Biology Division



The Environmental Biology Division consists of four sections: Molecular Biology, Environmental Microbiology, Environmental Plant Science, and Ecosystem Study. 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 towards the conservation of genetic biodiversity, species, and ecosystems. In 1997, the Division performed 18 studies funded by NIES, one study funded by the Environmental Research and Technology Division (Environment Agency), 3 studies funded by the Science and Technology Agency, and 2 studies funded by the Ministry of Education, Science, and Culture.

Molecular Biology Section

In this Section, we have been carrying out physiological and molecular biological studies on the mechanisms of plant tolerance to stress caused by various environmental conditions.

Since plants cannot move, they must endure various adverse environmental conditions in order to survive. Knowledge of the underlying tolerance mechanisms is needed for developing new techniques in environmental preservation. It is especially important to identify and isolate genes that are involved in protective mechanisms against various stress conditions. We began these studies using molecular genetic approaches, consisting of: 1) screening of mutants of *Arabidopsis thaliana* that are either more sensitive or resistant to environmental stresses than the wild-type plants; 2) physiological and genetic characterization of the mutants; and 3) isolation of the genes responsible for the aberrant sensitivities of the mutants. After establishing conditions to select such mutants, we have isolated 14 mutants sensitive to an air pollutant, ozone (Fig. 1) and 10 mutants which are sensitive to chilling in the light. We will use these mutants for molecular genetic studies of plant stress tolerance.

Environmental Microbiology Section

Studies in environmental microbiology have included: 1) the diversity of microorganisms; 2) the distribution and culture of charophytes that are in urgent need of protection; and 3) diversity of algal-lytic bacteria, which may affect the blooming of microalgae in eutrophic lakes.

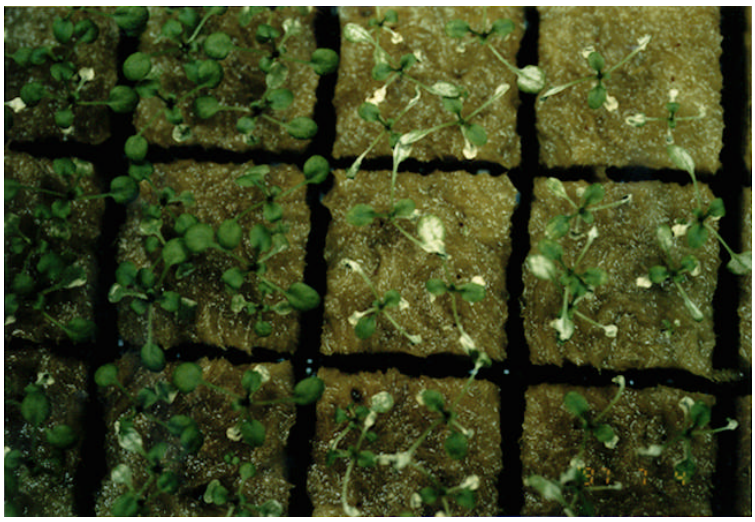


Fig. 1
One of the ozone-sensitive mutant lines of *Arabidopsis thaliana*. Seedlings of a mutant strain (right side) exhibit severe chlorotic damage while wild-type plants (left side) show little damage after exposure to 0.2-ppm ozone for 24 h.

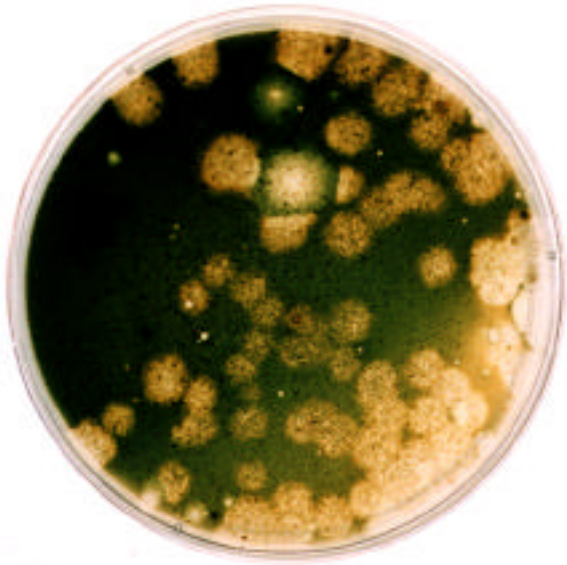


Fig. 2
Colonies of algal-lytic bacteria on a plate in which *Microcystis aeruginosa* was precultured. *M. aeruginosa* decomposed around the bacterial colonies (clear zone of the plate).

As the first step in studying algal-lytic bacteria, samples were collected from 11 eutrophic lakes in Japan, China and Thailand. A total of 29 strains of algal-lytic bacteria that were able to decompose *Microcystis aeruginosa* (NIES-90) were isolated (Fig. 2). Algal species decomposed by these isolates varied among the isolates; only 20 strains were able to decompose *Oscillatoria agardhii* (NIES-610). The strains were assigned to the genus *Lysobacterium*, because they had rod-shaped cells, a cell length of 4 to 10µm, guanine and cytosine content of DNA bases (GC content) higher than 60%, and unformation of fruiting bodies on media including horse dung. The GC content of isolates formed 2 groups, one around 62% (group A) and the other about 69% (group B). The similarity of the 16S rDNA sequence among strains of the same group was very high (> 0.95), while that between strains of different groups was low (0.86). These results suggest that the algal-lytic bacteria may consist of several distinct genetic groups.

Environmental Plant Science Section

In this Section, studies have been carried out on: 1) the effects of desertification and global warming on plants; 2) amelioration of air pollution by plants; 3) strategies to prevent desertification; 4) conservation of species distributed in alpine and subalpine regions; and 5) the development of new techniques for diagnosing effects of stress on plants.

Salinization of soil is a serious problem in desert regions of northwestern China. To investigate salinity adaptation of *Kalidium caspicum*, a halophyte distributed in highly salinized locations in these regions, we evaluated the effects of salinity on seed germination and seedling survival. Moistening the seeds with 3-M NaCl solution for 30 days caused no adverse effects on their capacity to germinate. However, when the seeds were incubated in media with different NaCl concentrations (Fig. 3), the seedling radicles showed high sensitivity to salinity; for example, at a NaCl concentration of 0.18 M, 80% of the seeds germinated, but all the seedling radicles died before elongating beyond 5 mm (Fig. 3). We suggest that seedling establishment of this species is made possible by the leaching of salt from the soil surface by snowmelt in the early spring.

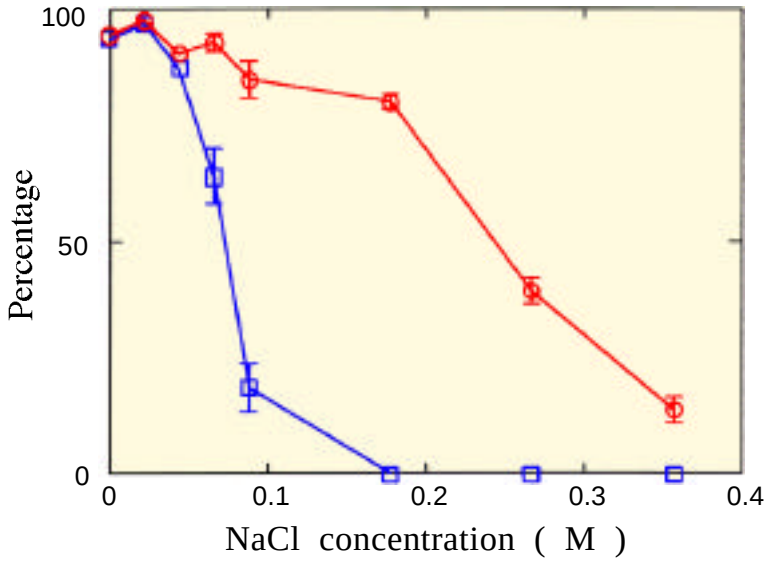


Fig. 3
Effects of NaCl on seed germination and seedling survival of *Kalidium caspicum*.

○: percentage of seeds germinated;
□: percentage of seedling radicles that survived beyond a length of 5 mm.

Ecosystem Study Section

This Section has investigated: 1) the effects of environmental stress on plants in transitional zones of lakes and wetlands; 2) the habitat of littoral zoobenthos; 3) the food-web structure of benthic communities in streams; and 4) the use of modified river beds for colonization by aquatic plants and animals.

Seasonal and diel drift patterns of *Chironomus yoshimatsui* and related species in relation to environmental parameters were studied in the Otto River. Considerable larval and pupal drift was observed during May to September when water temperature exceeded 20°C. Maximum seasonal drift of pupae and larvae amounted to 135 m^{-2} s^{-1} and 690 m^{-2} s^{-1}, respectively. Larval drift of *C. yoshimatsui* was primarily correlated with its larval density in the sediments. Larval density was correlated with the abundance of sediments. Diel drift of pupae and larvae was high in the scotophase and highest 1 to 4 hours after sunset; this periodicity was observed on 3 sampling occasions (Fig. 4). We could find no particular environmental parameters significantly correlated with this diel drift, the periodicity of which was similar to that of *C. decorus* studied in the USA. The diel drift pattern of *C. decorus* was presumed to be caused by spontaneous drift in the absence of effective environmental stress.

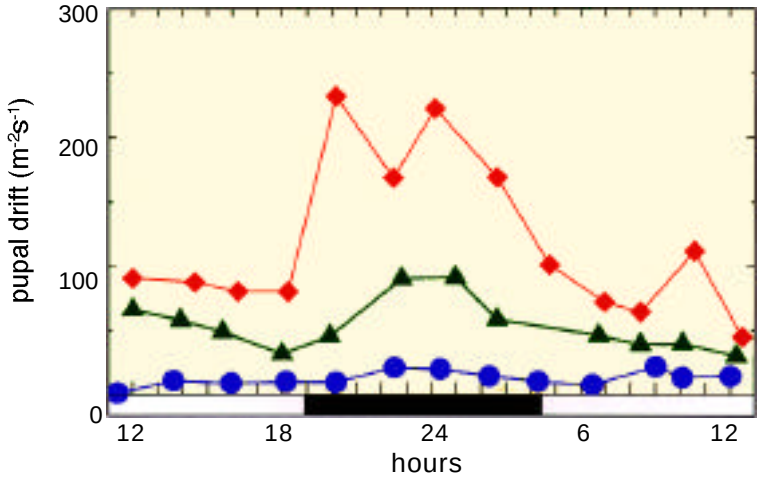
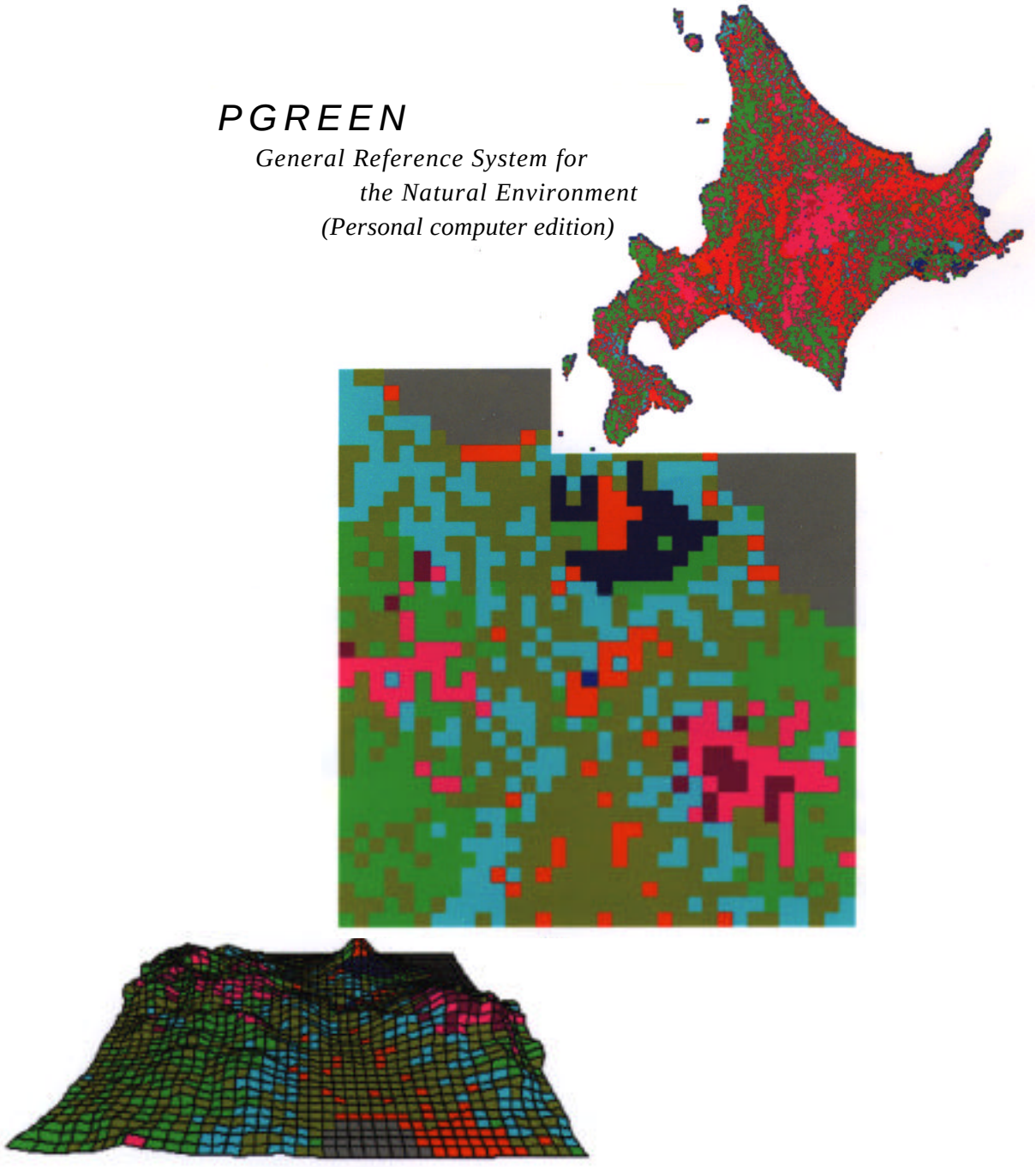


Fig. 4
Diel drift pattern of pupal *Chironomus yoshimatsui*. Horizontal bar below the hour scale indicates photoperiod. Dark area indicates the scotophase from sunset to sunrise.
●: 22-23 May;
✱: 4-5 Jun;
◆: 19-20 Jun.

Environmental Information Center

PGREEN

General Reference System for the Natural Environment (Personal computer edition)



The Environmental Information Center is responsible for various functions and services related to collection and provision of environmental information. Databases, a library and a computer system are operated and maintained, enabling the handling of a wide range of environmental information.

Database Section

Processing and provision of Environmental Information Database

1) Monitoring data files.

A wide range of numerical environmental data is necessary for both environmental research and environmental policy development, implementation and enforcement. The Center has compiled, processed, stored, and provided access (in computer-accessible form) to data files of air quality and water quality monitoring data, which are transmitted by local governments to the Environment Agency under the Air Pollution Control Law and the Water Pollution Control Law. These data files are provided to outside users including other governmental organizations and laboratories. Also a duplication service for use by the general public is available for some files. In addition data files are exchanged with other governmental organizations.

2) Natural environment.

Development of a General Reference System for the Natural Environment began in FY 1991, with the aim of providing basic reference materials that facilitate both understanding of present conditions and forecasting of changes in the natural environment. A database system (GREEN) using a UNIX database server, is available on NIESNET to enable searches for and display of environmental data from all over Japan. Since FY 1995, a system to provide database access by personal computers (P-GREEN) has been developed based on previously recorded results and data. P-GREEN is available on Windows-based PCs, enabling graphical display and user friendly operation.

3) Environmental information source information.

Surveys of environmental information have been in progress since FY 1992, with the goal of providing a directory of information sources in a form widely accessible to the general public. The surveys–including information about where and in what mode environmental information is being accumulated (environmental information sources) and explanations of laws, treaties, and terms concerning the environment–were compiled on floppy disks and are being distributed to the general public through a public corporation and through NIES and EICnet WWW servers. We call the database of environmental information sources the “EI-Guide”.

NIESWWW

In March 1996, NIES began to provide environmental information from NIES research activities and results (in English and in Japanese) to the world via Internet on the World Wide Web (URL: http://www.nies.go.jp/).

EIC net

In March 1996, the Center established a computer communication system for the general public called the “Environmental Information & Communication Network” (EICnet) in accordance with the Basic Environment Law, in order to promote national activities for conservation of the environment. This system is available only in Japanese

via telephone, Internet, or the Value-Added Network (VAN). In January 1997, an EICnet WWW server was also established (URL: http://www.eic.or.jp/). In December 1997, the Center started to provide environmental information by facsimile.

Library and Research Information Section

Compilation of documentary information concerning environmental research

Documentary information concerning the environment is essential for competent environmental research and management. Database systems containing informative documents about the environment have been created to meet such needs. In addition, access to other Japanese and foreign commercial databases has been provided to institute users.

Commercial databases available off-line on CD-ROMs or diskettes in the institute include NTIS, Ei Energy and Environment, Environment Library, and Current Contents on Diskette. MEDLINE is available on-line from the ERL Internet Service. Access is also provided to several other on-line databases, JOIS, DIALOG, STN-International, G-Search, and NIFTY-Serve.

Library management and operations

As of March 1998, 37 777 books, 742 technical and scientific serials, 8501 maps, 108 983 microfiches, and various other reports and reference materials were in the NIES library. Library facilities include separate reading rooms for books, for journals, for indexes and abstracts, for reports, and for maps and microfiche as well as a database access room and a photocopying room.

Editing/publication

Reports concerning NIES research activities and results, an official newsletter (the NIES News, in Japanese), and other reference materials are edited by the Center and distributed to many organizations.

Information Management Section

INFOTERRA

INFOTERRA, the Global Environmental Information Exchange Network designed by UNEP to stimulate and support the exchange of environmental information between partners, is operated at the national level by national focal points. Our Center is designated as the INFOTERRA National Focal Point for Japan. As of March 1998, 176 countries were participating in INFOTERRA, and information sources registered in INFOTERRA numbered about 8000 (519 in Japan).

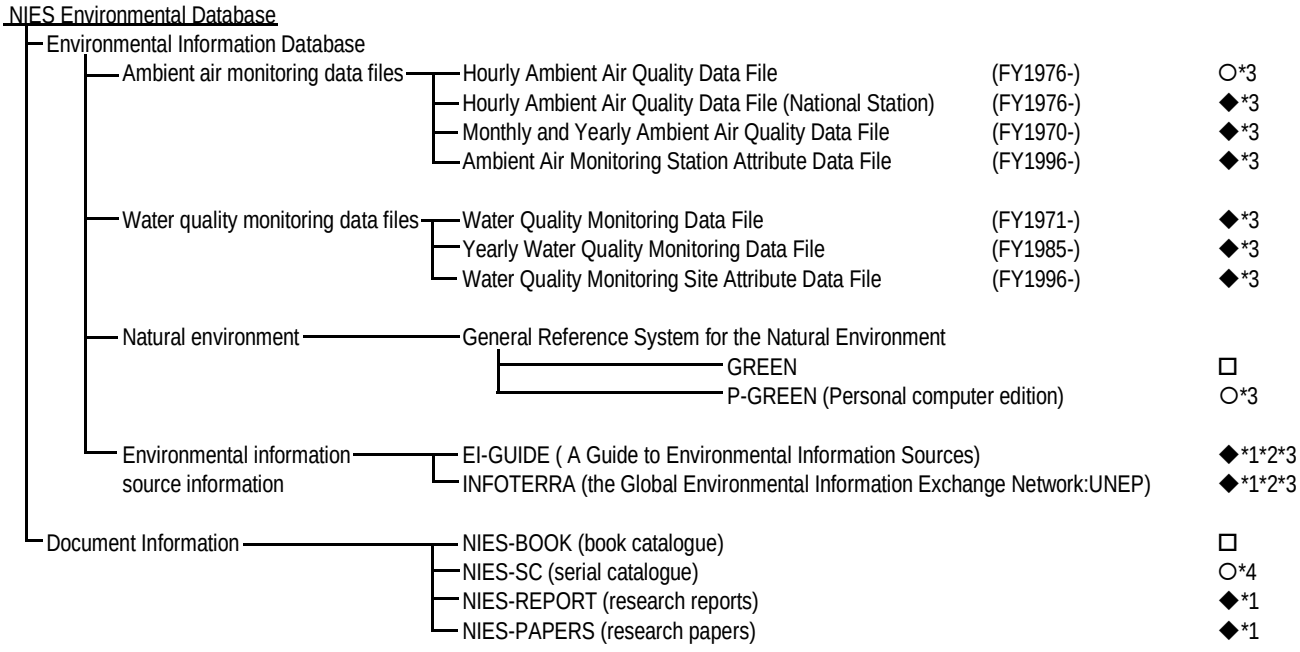
Management and operation of computer and related systems

A new computer system started operation in March 1997. The system is regarded as 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 uses. This UNIX based computing environment consists of a comparatively large-scale supercomputer system (NEC SX-4/32 (32 CPU)) and various subsystems such as a scalar-computing server (IBM RS6000/SP2 (16 CPU)), database servers (3 sets of SUN Enterprise 2/1200 (Oracle7, SAS), and 2 sets of NEC Express 5800/160 Pro (Oracle7 Workgroup), and file servers (a DEC Alpha Server 8400 5/440 (4 CPU), 2

sets of Alpha Server 4100 5/400, a SONY File Bank system, and a Peta Site system).

Our SX-4/32 vector-computing system, including a front-end system (SX-4/4C (4 CPU)), employs the SUPER-UX (UNIX-based) operating system. The system is equipped with a FORTRAN compiler (with high-level debugging, high-efficiency optimization, high-level vectorization and various supportive tools for efficient compilation) and executes large-scale programs to handle global environmental problems. It is also equipped with an image processor and a 3-dimensional graphics processor (SGI Onyx MIPS R10000/R4400 (2 CPU)).

A LAN, the NIES Network (NIESNET), was established at our institute in 1992. File transport in various computer systems, the IP Switch and the IP Switch Gateway were upgraded in March 1997. The network configuration was restructured and large-scale file transport performance was improved. All institute researchers can access the computer system from their own desks through the LAN. Foreign as well as Japanese registered users outside the institute have remote access to the supercomputer system through NIESNET's connection to the Internet via the Inter-Ministry Network (IMnet).



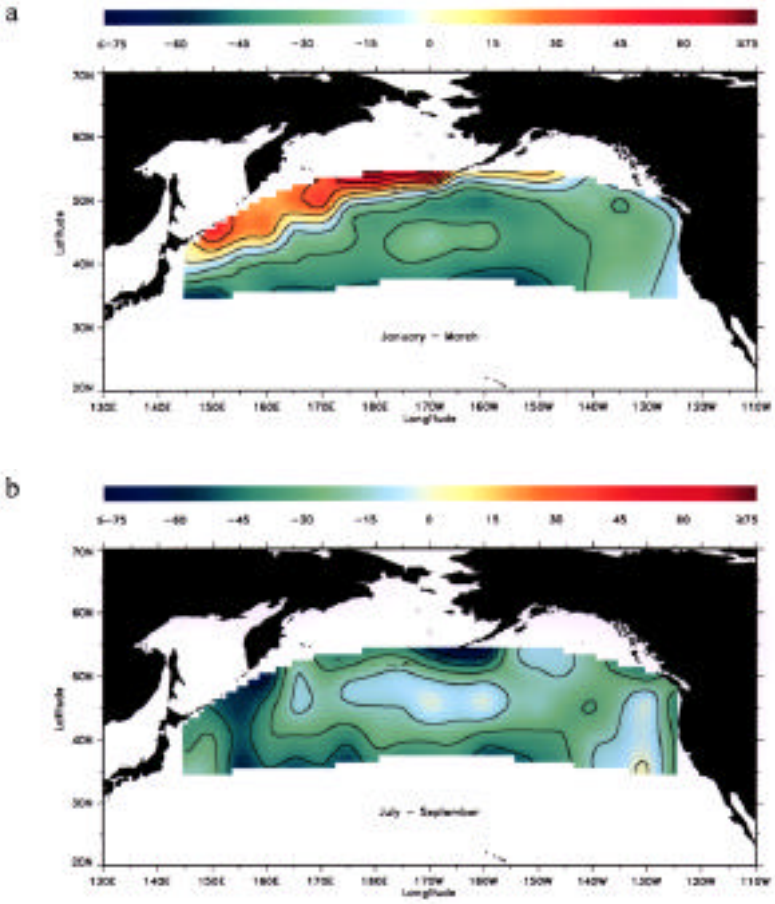
Availability Codes

◆	Provided to general public
○	Provided to administrative organizations, researchers, etc.
□	Restricted to use in NIES
*1	NIES World Wide Web Server (WWW)
*2	EICnet
*3	Provided by electronic media
*4	Provided by paper media

Fig.1
Composition of the NIES environmental database.

Center for Global Environmental Research

The M/S Skaugran (Norway) is our ship-of-opportunity for regular cruises between Japan and Canada.



Delta fCO_2 (difference in CO_2 fugacity between the ocean and the atmosphere) distribution in the North Pacific observed by a ship-of-opportunity monitoring between Japan and Canada. Red and green colors indicate the oceanic source and sink, respectively.
a) January-March
b) July-September

The Center for Global Environmental Research (CGER) was established in October 1990 to contribute broadly to scientific understanding of global change and the elucidation and solution of our pressing environmental problems. CGER has 3 major activities: integration of global environmental research; management of a global environmental database; and global environmental monitoring.

Integration of global environmental research

The objectives of research integration are: 1) to ensure communication and networking among researchers and decision-makers; 2) to cooperate with the Research & Information Office of the Global Environment Department of the Environment Agency in coordinating scientific and socio-economic research on global change; 3) to cooperate in international efforts to establish a research network for global change; 4) to manage research programs using our supercomputer facilities, which are open to researchers at institutes and universities around the world; and 5) to conduct integrated research into policy options for coping with global environmental problems.

Enhancement of communication

CGER hosted several seminars, symposia and conferences on research into global environmental change in FY 1997. Some, such as the annual Global Environment-Tsukuba, brought together researchers and decision-makers with the general aim of enhancing communication. CGER also supported the efforts of groups seeking to organize workshops or symposia on specific research programs. In 1997, such groups included the IGBP symposium 'Global Environmental Research Toward the 21st Century', the steering group meeting of GEO-2 (Global Environment Outlook-2) International Policy Working Group, and the Tsukuba International Workshop on Stratospheric Change and Its Role in Climate and on the ATMOS-C1 Satellite Mission.

Cooperation to promote and coordinate global change research

CGER has advised the Research & Information Office from a scientific point of view, on effective promotion of the Global Environment Research Program. An international research network, involving scientists in both developed and developing countries, is indispensable to advance scientific understanding of global change. CGER set up the 'Scientist Network on Indonesian Forest Fire (SNIFF)' in November 1997, for information exchange among researchers and decision-makers concerning this problem.

CGER is actively participating in the work of the Intergovernmental Panel on Climate Change (IPCC). The Proceedings of the IPCC Asia-Pacific Workshop on Integrated Assessment Models, held in Tokyo in March 1997, was published by CGER. CGER also supported editing of the translation of the 2nd Assessment Report of the IPCC Working-Group III: 'Economic as Social Dimension of Climate Change'.

Coordinating supercomputer-aided research programs

In March 1992, CGER installed a supercomputer system (NEC SX-3, model 14) and in March 1997, replaced it with a new supercomputer (NEC model SX-4/32) to facilitate research on global change (Fig. 1). An annual supercomputer activity report was published and the 5th Supercomputer Research Workshop was convened by CGER

Fig. 1
The CGER NEC supercomputer.

Fig. 2
The 5th Supercomputer Research Workshop.

to disseminate the advanced knowledge obtained by the users of our supercomputer (Fig. 2).

Integrated research on policy options

A special research category in the Environment Agency's Global Environment Research Program, Integrated Research, is research directed towards actual decision-making processes through the development of conceptual models and the generation of data used widely in interdisciplinary research. The following 3 research projects in this category were implemented in 1997: 1) Studies on Environment-Economic Integrated Assessment Methodologies for Sustainable Development; 2) Design of a Global Environmental Information System for Sustainable Development; and 3) Feasibility Study on Global Environment Risk Management.

Management of a global environmental database

CGER is establishing a global environmental database system as well as producing and distributing UNEP/GRID environmental data sets to support environmental research and decision-making. During FY 1997, as one of the international collaborating centers of the UNEP/GEO-2 Project, the Database Section collected State of the Environment (SOE) data in the Asia-Pacific region for predicting future global environmental conditions. Metadata on outlines of monitoring or research planned by various collaborating programs, on locations of original data, and on ways to access original data sets, were made available through the homepage of the Database Section (English version at http://www-cger.nies.go.jp/cger-e/db/dbhome.html). The IPCC Scenario Database of greenhouse gas emission was developed into a socio-economical database for predicting future environmental conditions in the Asian region. An inventory of the sources of SO_2 discharges in Korea, China and India was made as a basic database for elucidating long-range transboundary air pollution in East Asia, and a similar inventory of NO_2 discharges in China and India was also made. A data set of field observations was arranged and processed: the data set of "High Temporal-Spatial Resolution Marine Biogeochemical Monitoring from Ferries in the East Asian Marginal Seas ('96-'97)" based on observations made by CGER/NIES. A database on the distribution and the characteristics of wetlands and on information concerning related reference articles was made from the viewpoint of protection of wildlife under the Ramsar Convention as well as from the viewpoint of sources of methane as a greenhouse gas. Digital map data on wetlands were prepared based on this database, and the map data were made accessible through the Internet

and CD-ROM. Basic data sets on material flows (PC version) were prepared to assist our understanding of environmental stress in various Asian countries related to the export and import of natural resources. We published on CD-ROM the English version of "Data of IGAC/APARE/PEACAMPOT Aircraft and Ground-based Observations ('91-'95 Collective Volume)". The data are based on experiments performed by NIES and collaborating institutions.

Global Resource Information Database (GRID)

GRID was established in 1985 within UNEP to provide timely and usable environmental data to the world research and policy-making communities. GRID-Tsukuba was founded at CGER in May 1991, as the 8th GRID Center. During FY 1997, 121 data sets were distributed to users in and outside Japan in response to 56 requests. There were 19 inquiries concerning the activities of GRID-Tsukuba and other GRID centersand all of them were addressed. During FY 1997, an original database software, "NOAA/AVHRR Data Search System", was developed to access the image data from the AVHRR sensor of the satellite "NOAA" through Internet or CD-ROM. The GRID metadata directory system introduced in 1996 was implemented.

Global Environmental Monitoring

CGER has observed and recorded data on various global phenomena via long-term monitoring programs. These data are available through published data reports or the data set files provided by international data networks in which CGER participates. The following 11 projects are presently coordinated by CGER.

Ozone monitoring with ozone lidar (laser radar) and millimeter-wave ozone radiometer system

CGER measures the vertical profile of ozone in the lower stratosphere over Tsukuba with an ozone lidar that was installed in August 1988. Monitoring of the ozone layer commenced in October 1990. In FY 1996, the ozone lidar system was modified. The modified system extends the ozone measurement range from 10 km to 45 km. Millimeter-wave measurements started in October 1995. Since then, vertical ozone profiles through the whole stratosphere have been made. The millimeter-wave measurement results were analyzed to clarify temporal variations in ozone levels.

Monitoring of UV-B

Trends in urban ultraviolet-B (UV-B) light intensity in solar radiation resulting from stratospheric ozone depletion were investigated using a Brewer spectrophotometer that we installed on the top of a building in Tokyo. This monitoring has been conducted since November 1993.

Rikubetsu stratospheric monitoring

To monitor the ozone layer over the northern part of Japan, the "Rikubetsu Station for the Detection of Stratospheric Change" (Fig. 3) was founded in Hokkaido in October 1997. NIES and the Solar-Terrestrial Environment Laboratory of Nagoya University have agreed to cooperate in monitoring ozone and related species from there.

Fig. 3
The Rikubetsu Astronomical Observatory.

Japanese atmospheric monitoring stations (Hateruma Island and Cape Ochi-ishi)

The concentrations of greenhouse gases (GHGs) at two stations are continuously monitored to help understand trends in background air quality in Japan. Atmospheric data at the Global Environmental Monitoring Station – Hateruma, the southernmost inhabited island in Japan, should be representative of the air quality of southern Japan. Monitoring at Hateruma Island started in October 1993. To obtain atmospheric background data for northern Japan, monitoring at Cape Ochi-ishi, Hokkaido, started in September 1995.

Monitoring of GHGs over Siberia by airplane

The CO_2 sink of boreal forests and CH_4 emission from natural wetlands and natural gas mining are among the factors that govern variations in the carbon cycle in the northern hemisphere. The vertical concentration profiles of GHGs from heights of 500 to 7000 m above several areas in Siberia were obtained monthly by aircraft sampling followed by laboratory analysis in Japan. Monitoring has been carried out over Surgut in central western Siberia since 1993, over Yakutsk in eastern Siberia at the same latitude (60°N) since 1996, and over Novosibirsk in southwestern Siberia since 1997. The seasonal amplitude of CO_2 variations over Siberia was double that measured in marine air at the same latitude (Fig. 4).

Monitoring of GHGs along a north-south transect in the western Pacific from ship-of-opportunity

Routine sampling of background air along a north-south transect became possible by using a cargo ship traveling regularly, 8 times a year, between Japan and Australia. Additional sampling at higher latitudes began in 1995 by using another cargo ship operating between Canada and Japan. Samples are collected and sent to the CGER laboratory after every voyage for high-precision determination of GHGs such as CO_2, CH_4 and N_2O. The resulting data are useful in the study of the global cycles of GHGs.

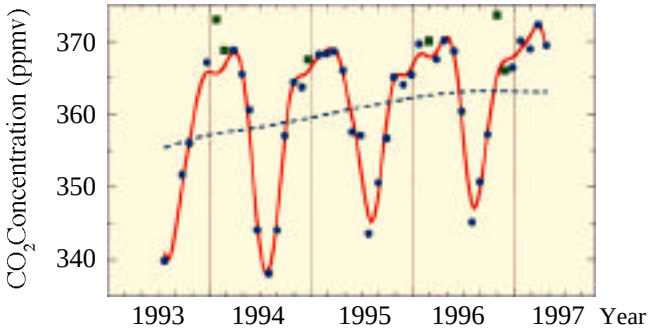


Fig. 4
Temporal variation of CO_2 concentration over Siberia (at a height of 500m).

Monitoring of atmosphere-ocean carbon dioxide exchange by a ship-of-opportunity

CO_2 invasion from the atmosphere to the ocean constitutes one of the most important sinks in global carbon cycling. For estimating the net rate of atmosphere-ocean CO_2 exchange in the North Pacific, CGER installed instruments on a cargo ship operating between Canada and Japan. The partial pressure of CO_2 is automatically measured in air and in the surface waters of the ocean. CO_2 invasion into the ocean in summer and evasion from the ocean in winter was clearly observed in the sub-Arctic North Pacific. In the mid-latitude Pacific, the ocean behaves as a CO_2-sink throughout the year.

High temporal-spatial resolution biogeochemical monitoring of the western Pacific by ships-of-opportunity

The cycles of chemical elements such as C, N, P and Si have changed since pre-industrial and pre-agricultural times. These perturbations are thought to have affected the ocean through the marginal seas. CGER has been measuring temperature, salinity, pH, fluorescence, dissolved nutrients, chlorophyll a and pheopigments in the continuous water intake of the vessel "Sunflower2" (Osaka-Beppu) and of the ferry "Ferry-Kuroshio"(Osaka-Naha) since March 1994. The monitoring system on the former ship was transferred to its successor ship "Sunflower Ivory" in 1997. The "Ferry-Kuroshio" service ended in March 1997 and CGER is planning to continue this mission from a container ship operating between Japan and other Asian countries.

Mapping the vegetation index with NOAA satellite data

The destruction of tropical forests in Southeast Asia is a serious problem. Our vegetation index project uses NOAA/AVHRR data to produce monthly vegetation index images of the East Asia region with 1-km resolution. The resulting images are distributed globally through the UNEP/GRID-Tsukuba Center.

ILAS & RIS, ILAS-II data-handling facility

ILAS and RIS instruments were on the ADEOS satellite which operated from mid-September 1996 to 30 June 1997. Establishment and operation of an ILAS & RIS Data-Handling Facility (DHF) is the responsibility of CGER in cooperation with the Satellite Remote Sensing Research Team. The ILAS & RIS DHF has processed and re-processed the data obtained from ILAS to retrieve final atmospheric gas profiles in the ozone layer. These final products are distributed to interested parties. During FY 1997, the ILAS & RIS DHF was successfully operated. A primary part of the ILAS-II computer system was installed in FY 1997.

GEMS/Water Programs

GEMS/Water, organized by UNEP and WHO, is the Global Environmental Monitoring System for rivers and lakes. A network of 21 stations in Japan has been established for GEMS/Water Phase II activities. Lakes Mashu and Kasumigaura have been registered as network sites. CGER is responsible for coordinating GEMS/Water data transmissions, etc., as the Japanese National Center (focal point). CGER also participates in an Analytical Quality Control (AQC) Programme by providing certified reference materials (CRMs/river sediment) to laboratories analyzing samples from GEMS/Water flux monitoring stations.

Environmental Training Institute

The Training Institute for Environmental Pollution Control was established under the jurisdiction of the Environment Agency in March 1973 to offer training courses in the environmental field for administrative and technical personnel. It was renamed the National Institute for Environmental Studies (NIES), National Environmental Training Institute (NETI) when it was united with NIES in July 1990 in order to strengthen the linkage between training and research.

The structure of Japanese society, particularly with respect to lifestyle and industry, has been changing. Accordingly, new environmental issues have been raised; demands for skills to tackle these new issues have been increasing. Consequently, our range of training subjects has broadened. The training courses cover a range of subjects such as administration, international cooperation and monitoring techniques. In FY 1997, we provided 3 international training courses, 18 administration courses, 10 laboratory analysis courses, one research course, and one international cooperation course (Table 1). The research training course, in which trainees comprehensively study policy formulation based on their own interests, was introduced in 1996. In addition, NETI has supported training programs organized by local governments to cope with the recent development of environmental administration and increasing need for training.

A total of 27 000 persons completed training courses by the end of March 1998. Persons who take part in our training courses come from a variety of organizations. More than 70% are from local governments, about 20% from the central government, and a little less than 10% from public-service corporations (Fig. 1). NETI has also accepted trainees from overseas, particularly from developing countries.

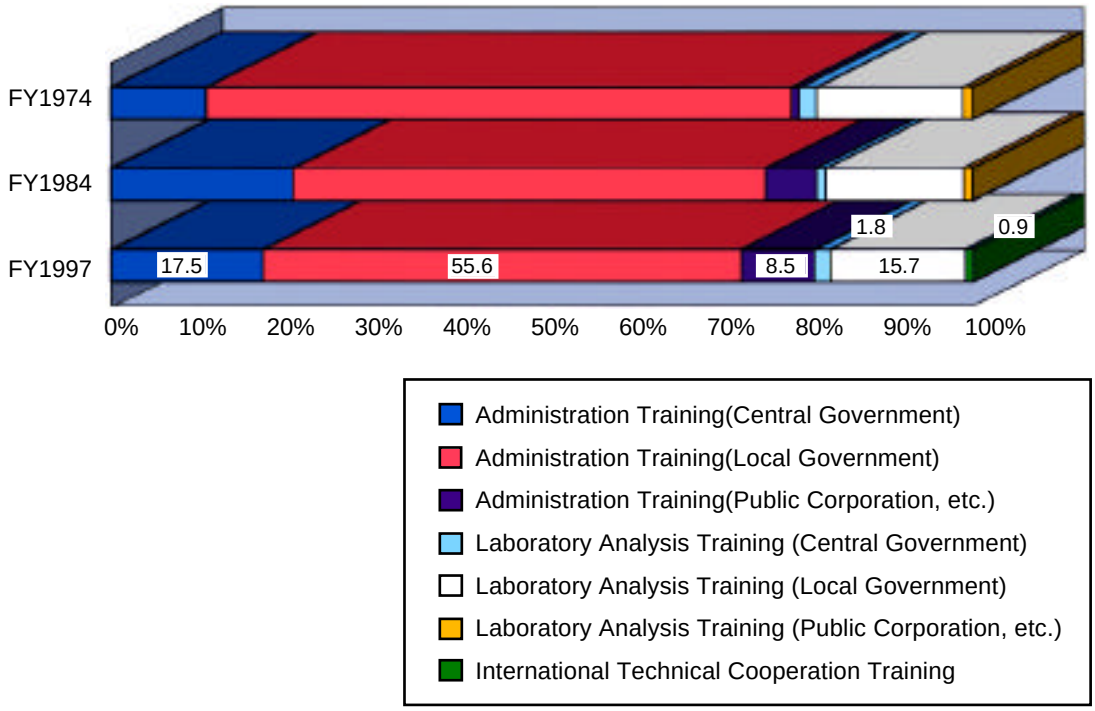


Fig. 1
Participation from Affiliated Organizations in FY 1974, 1984, and 1997.
*Percentage of International Cooperation Training Courses is included in that of Administration Courses.

Table 1

Administration Training Courses

Course Name	Length (days)	Participants
Seminar for Environmental Policy Manager/Supervisor	5	41
Regional Environment (Environmental Management)	5	56
Environmental Impact Assessment	6	117
Environmental Education (Administrative)	5	58
Environmental Education (Practical)	3	31
The Basic Environment Plan	5	73
Nature Conservation	6	85
Wildlife Conservation	5	53
National Park Management	5	39
Air Pollution Control	6	75
Noise and Vibration Control	5	83
Water Pollution Control	6	119
Conservation of Ground Environment	5	23
Information Management	8	40
Staff of the Environment Agency	5	20
New Recruits of the Environment Agency (Class I)	8	19
New Recruits of the Environment Agency (Class II & III)	5	11
Newly Assigned for Regional Environmental Intelligence Officers	4	11
Comprehensive Policy Formulation	58	5
Sub Total	155	959

Laboratory Analysis Training Courses

Course Name	Length (days)	Participants
Instrumental Analysis	13	43
General Analysis	8	19
Air Quality Analysis	13	34
Odor Substance Analysis	8	13
Water Quality Analysis	13	41
Instrument Analysis (Special Program A)	5	20
Instrument Analysis (Special Program B)	5	8
Special Topic Analysis	0	0
Thematic Analysis (1) Periphytic Algae	5	16
Thematic Analysis (2) Plankton	5	16
Thematic Analysis (3) Bottom-Dwelling Fauna	5	16
Sub Total	80	226

International Cooperation Training Courses

Course Name	Length (days)	Participants
Global Environmental Conservation	8	27
Leaders of Overseas trainees	5	12
Introduction to International Environmental Cooperation (2 courses held)	5 × 2 times	22
Sub Total	23	61

International Technical Cooperation Training Course

Course Name	Length (days)	Participants
Environmental Monitoring (Water Quality)	32	12
Grand Total	290	1,258

An Investigative Committee for the Future Status of the National Environmental Training Institute was commissioned by the Chief of the National Planning and Coordination Bureau of the Environment Agency. The Committee was organized in February 1994 to discuss comprehensively the necessary functions of NETI from middle- and long-term perspectives. The Committee pointed out that NETI should continue to endeavor to develop human resources and stressed the importance of allowing personnel in the environmental sectors to acquire intersectoral, international, and interdisciplinary perspectives. NETI recently decided to provide training courses for experts who will collaborate with people in developing nations to solve environmental problems. The Institute installed new facilities including multimedia equipment, an international conference room, and analytical laboratories where appropriate techniques for developing nations are studied.

<Global Environment Research Projects>

Mechanisms of global warming caused by the increase of greenhouse gases, Nojiri, Y., 1990-1998

Depletion of the ozone layer, Nakane, H., 1996-1998

Acidic precipitation, Satake, K., 1996-1998

Role of ocean flux in variations of the global environment and marine pollution, Harashima, A., 1996-1998

Maintenance mechanisms of tropical forest ecosystems, Furukawa, A., 1996-1998

Human dimension of global environmental change, Nishioka, S., 1994-1997

Integrated studies for conserving the global environment, Nishioka, S., 1990-1997

Satellite remote sensing, Sasano, Y., 1989-2002

<Special Research Projects>

Evaluation of the risk of chronic pulmonary diseases due to diesel exhaust exposure and mechanisms of pathogenesis, Sagai, M., 1993-1997

Methodology for assessment of exposure to hazardous chemicals from waste landfills, Shiraishi, H., 1994-1997

Biomonitoring methodology for ecological risk assessment of chemical substances, Hatakeyama, Shigehisa; 1995-1997

Methodology for quantification of environmental loads and their environmental impact assessment regarding transport systems and material cycle systems, Moriguchi, Y., 1996-1998

Bioremediation mechanisms for contaminated soil and groundwater, Yagi, O., 1996-1998

Biogeochemical cycles and self-purification in shallow coastal areas for preservation of the marine environment, Kohata, K., 1996-1998

Health risk assessment of exposure to extremely low frequency electromagnetic field, Nitta, H., 1997-1999

Origin and dynamics of recalcitrant organic matter in lake and its effects on lacustrine ecosystems and water quality, Imai, A., 1997-1999

Reproductive and developmental effects of hormone-like chemicals in the environment, Yonemoto, J., 1997-1999

<International Joint Research Projects>

Collaboration on water pollution renovation technology in developing countries, Inamori, Y., 1994-1998

Health risks of air pollution from coal burning and risk reduction in developing countries, Ando, M., 1994-1998

Community change and ecosystem management of shallow, eutrophic lakes, Takamura, N., 1995-1999

Development and application of environmental analysis and evaluation methods for atmospheric aerosols in China, Nishikawa, M., 1996-2000

International collaborative research on environmental management of watershed, Watanabe, Masataka; 1996-2000

<Others>

Development of bioeffect sensors for environmental chemicals, Mochitate, K., 1995-1999

Paleoenvironmental studies of Baikal sediment cores, Kawai, T., 1995-1999

Development of advanced, sustainable water and waste water treatment systems, Inamori, Y., 1995-1997

Development of technology and methodology for automatic sampling and analysis of air toxic compounds, Tanabe, K., 1997-1999

Tsukuba International Workshop on Stratospheric Change and Its Role in Climate and on the ATMOS-C1 Satellite Mission

October 20-22, 1997
Meteorological Research Institute & Tsukuba Culture Hall "ARS", Tsukuba, Japan

The purpose of the workshop was to present and discuss current ideas and scientific findings on Stratospheric Processes and their Role in Climate (SPARC), which is a project of the World Climate Research Programme (WCRP); and to promote Japanese research related to SPARC and to the ATMOS-C1 mission, a proposed satellite mission to make observations of atmospheric trace constituents related to ozone depletion and global warming. This workshop was sponsored by the Meteorological Research Institute (MRI) and was supported by the Center for Global Environmental Research (CGER), NIES, the Science and Technology Agency (STA), the National Institute for Resources and Environment (NIRE), the Communications Research Laboratory (CRL), the National Space Development Agency (NASDA), and the Earth Science and Technology Organization (ESTO). There were 103 participants from 9 countries and 51 papers presented.

Meeting towards Cooperative Marine Environmental Monitoring in the Asian Marginal Seas (CoMEMAMS)

January 7-8, 1998
Ishigaki Memorial Hall, Tokyo, Japan

Marine environmental issues in Asian marginal seas are becoming more important not only to individual countries but also as a common regional concern. NIES has proposed a marine environmental monitoring program using merchant ships that operate in Asian marginal seas. To initiate this program meaningfully with broad scope, good scientific prospects and with wide expertise, and to provide a basis for future cooperation, discussions were held between invited specialists from China, Korea, Malaysia and Singapore as well as from Japan. The outcome of the meeting was to define the program as Cooperative Marine Environmental Monitoring in the Asian Marginal Seas (CoMEMAMS); monitoring by ships of opportunity should be promoted under the advice of the newly created CoMEMAMS Panel composed of scientists and specialists from the coastal countries involved, in order to cope with all the marine environmental issues affecting the region, which are very diverse in causality and time scale.

The 1st Japan-China Joint Workshop on Environmental Risk Analysis

March 4-5, 1998
NIES, Tsukuba, Japan

This joint workshop with Chinese scientists concerned with environmental risk issues was held in collaboration with the National Institute for Environmental Studies and the Institute of Policy and Planning Sciences, Tsukuba University, in order to exchange information on the situation with regard to risk research and risk management before the First China-Japan Conference on Risk Assessment and Management (CJCRAM), which will be held in Beijing in November 1998. CJCRAM is a recently established bilateral research forum aiming to bring together Chinese and Japanese risk researchers and managers from universities, research institutes, enterprises and public and governmental agencies, to discuss and review basic ideas, methodologies, case studies and new advances in the field of risk research and risk management. After overview addresses by Drs. Ikeda (Japan Society of Risk Analysis) and Zhao (National Natural Science Foundation of China), 15 individual presentations related to risk perception in general, risk studies (mainly from China) and risk management were made as the first step in exchanges between the two countries.

Steering Group Meeting of GEO2 International Policy Working Group

March 9-11, 1998
United Nations University, Tokyo, Japan

UNEP has initiated a new assessment program entitled Global Environment Outlook (GEO). The program aims at producing regular, comprehensive State of Environment (SOE) reports and associated technical and data reports, at regional and global levels. The first issue of the biennial GEO Report was produced in 1997. The second issue, GEO2, containing chapters on SOE, policy responses and emerging issues, is in preparation. An International Policy Working Group (IPWG) is one component of the GEO participatory assessment process. The purposes of the Group are to review environmental policies, advise on various policies related to matters to be addressed under GEO, and support the preparation of policy sections of the GEO reports. To initiate the establishment of the GEO IPWG, a Steering Group Meeting was organized in Japan for March 9 to 11, 1998, to review the available drafts of the various GEO2 sections on policy issues and to produce the following outputs: (a) draft terms of reference for the IPWG; (b) a proposal for the composition of the IPWG; and (c) a proposal for a modus operandi and work plan. This meeting was organized by UNU, UNEP and the Center for Global Environmental Research (CGER), NIES. The Steering Group Meeting consisted of 9 members from distinguished organizations overseas and two domestic members from CGER.

Global Environment Tsukuba '97

–A New Viewpoint on Global Change Research: Forwarding Global Environment Risk Research Plans–

March 24, 1998
Kokuyo Hall,
Tokyo, Japan

It is inevitable that there are, to some extent, uncertainties in assessing the effects of global change on environment and human society as well as in describing processes of global change itself. We cannot wait for complete assessments and understanding if we are to cope with pressing global environment issues. A reasonable decision-making process under such uncertainties has been eagerly sought. With this background, the Environment Agency of Japan (EA) has announced that high priority should be put on research on risk management for global environment issues and on related decision-making and negotiation processes. The aims of this symposium were to exchange information on current research activities on global environment risk assessment and management, to identify key research themes to be promoted in these fields, and to initiate a relevant international research network. The symposium was organized by the Center for Global Environmental Research (CGER) of NIES and was supported by the Research and Information Office, Global Environment Department, EA. There were 165 participants including 4 scientists from Europe and the USA; 7 lectures were presented. More intensive discussion between speakers and researchers in NIES concerned with these topics took place on the day after the symposium. The proceedings of this symposium will be published in early-1999.

COUNTRY
No. Title
Collaborating Institution
NIES Partner

AUSTRALIA
1. Biogeochemical studies on the trace elements in marine environments
Western Australian Marine Research Lab.
Environmental Chemistry Div.
2. Development of new methodologies to assess physiological effects of environmental pollutants
Dept. Biochemistry, Univ. Tasmania
Environmental Health Sciences Div.
3. Cooperative research on global environmental monitoring
CSIRO
Atmospheric Environment Div.
4. A comprehensive database of microbial diversity: cyanobacteria
University of NSW
Environmental Biology Div.
5. 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.
Regional Environment Div.
2. Advanced sewage treatment processes by soil system applicable to China
Institute of Applied Ecology, Chinese Academy of Sciences
Regional Environment Div.
3. Development of wastewater and water resources treatment processes applicable to China
Chinese Research Academy of Environmental Sciences
Regional Environment Div.
4. Preparation and evaluation of environmental certified reference materials
China-Japan Friendship Environmental Protection Center
Environmental Chemistry Div.
5. Development of monitoring method and surveillance of dry deposition
China-Japan Friendship Environmental Protection Center
Atmospheric Environment Div.
6. International joint research project on health effects of environmental pollution and their prevention in China
Institute of Environmental Health and Engineering
Regional Environment Div.
7. Molecular epidemiological study on clarification of risk factors of the increased lung cancers in China
China Medical University
Regional Environment Div.
8. A study on the carrying capacity of specified region in East China Sea and the impacts of runoff on marine ecosystem
Department of International Cooperation State Oceanic Administration
Water and Soil Environment Div.
9. A study on the health effects of heavy metals in China
Environmental Medical Research Institute, Beijing Medical University
Environmental Health Sciences Div.
10. Research on the development of water pollution control techniques for the Taihu Lake in China by bio/ecoengineering
Chinese Research Academy of Environment Sciences
Water and Soil Environment Div.

FINLAND
1. Accumulation of heavy metals by bryophytes in acidic environments
Dept. Botany, Helsinki Univ.
Global Environment 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.

GERMANY
1. Monitoring of stratospheric ozone by laser radar
Hohenpeissenberg Meteological Observatory
Global Environment Div.
2. Observational studies of the arctic ozone layer using satellite, airborne and other sensors
Div. Climate and Atmospheric Research, BMFT
Global Environment Div.
3. Comparative study on total material flow balance between Japan and Germany
Wuppertal Institute for Climate, Environment and Energy
Regional Environment Div.
4. Evaluation method of environmental burden
Federal Environmental Agency
Social Environmental Systems Div.
5. Research on the changing composition of the atmosphere
Univ. Bayreuth
Atmospheric Environment Div.
6. Studies on eutrophication and related problems in closed water bodies
Nuclear Research Center, Karlsruhe
Water and Soil Environment Div.
7. Satellite measurement of atmospheric gases (ADEOS project)
Alfred Wegener Institute
Global Environment Div.

ISRAEL
1. Novel applications of supersonic free jet for environmental measurement
Sch. Chemistry, Tel Aviv Univ.
Environmental Chemistry Div.

KOREA
1. Aircraft and ground-based observations of acidic and/or oxidative pollution in East Asia
Environment Research Center, Korean Institute of Science and Technology
Global Environment Div.
2. Monitoring of ocean environmental parameters from a Japan-Korea ferry boat
Korea Ocean Research and Development Institute
Global Environment Div.
3. A joint-study on health effects of high-tech-related materials
Gyeong-Sang Natl. University
Regional Environment Div.
4. Cross-cultural comparison of landscape evaluation between Japanese and Korean
KyungPook University
Social and Environmental Systems Div.
5. Organotin pollution and “imposex” in sea snails in Korea
Yosu National University
Regional Environment 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
Regional Environment Div.
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
Limnological Institute, Russian Academy of Sciences
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. Fundamental studies on the conservation of river, lake and wetland ecosystems in the Far East
Institute of Biology and Pedology, Far East Branch
Environmental Biology Div.
6. Evaluation of the role of the Far East Siberian forest in the global environment preservation
Yakutsk Biology Institute
Global Environment Div.

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. Development of risk assessment methodologies using in vitro toxicity testing
Dept. Toxicology, Uppsala Univ.
Environmental Health Sciences Div.
2. Health risk assessment of heavy metal exposure: Effects of increase in human activity
Kalolinska Institute
Environmental Health Sciences Div.

U. K.
1. Solubilization of toxic heavy metals from man-made objectives by acid rain
Dept. Earth Science, Univ. Sheffield
Regional Environment Div.

2. In vivo NMR spectroscopy method and its application to the field of environmental health
   Dept. Biochemistry, Univ. Cambridge
   Environmental Health Sciences Div.
3. Effects of environmental pollution on the metabolism of trace elements in man
   Rowett Research Institute
   Environmental Health Sciences Div.
4. Algae and Protozoa
   CCAP, Institute of Freshwater Ecology
   Environmental Biology Div.

U. S. A.
1. Preparation and evaluation of certified reference materials for marine monitoring
   NOAA
   Regional Environment Div.
2. Ecological and physiological aspects of methanotrophs
   Dept. Microbiology, Biochemistry and Molecular Biology, Univ. Maine
   Water and Soil Environment Div.
3. Development of bioremediation technologies for cleanup of contaminated soil
   Center for Environmental Biotechnology, Univ. Tennessee
   Water and Soil Environment Div.
4. Precise measurement of the greenhouse gases in the global baseline atmosphere
   Climate Monitoring and Diagnostics Lab, NOAA
   Center for Global Environmental Research
5. Direct impacts of global warming on morbidity in human community
   National Institute of Environmental Health Sciences
   Regional Environment Div.
6. Effects of logging on lakes ecosystems
   University of Alaska Fairbanks
   Regional Environment Div.
7. Human impacts on biodiversity and nutrient cycling in mire wetland
   Smithsonian Institute
   Environmental Biology Div.
8. Establishment of phytotron research network
   Duke University
   Environment Biology Div.

CANADA	Agreement between National Institute for Environmental Studies and Institute of Ocean Sciencies (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, Peoples'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 Changjian 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)
INDIA	Memorandum of Understanding between the Indian Council of Agricultural Research and the National Institute for Environmental Studies for Collaborative Research on Desertification (1993).
KOREA	Agreement for Collaborative Research to develop a Korean Greenhouse Gas Emission 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).
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 Cooperative Research Projects between National Institute for Environmental Studies, Environment Agency of Japan and Institute of Atmospheric Optics, Russian Academy of Sciences (1997)
THAILAND	Memorandum of understanding between Kasetsart University, Bangkok, Thailand and National Institute for Environmental Studies, Japan (NIES) for collaborative research on microalgal and protozoan biochemistry and toxicology, systematics and diversity, and application (1995).
UN	Memorandum of Understanding referring to the establishment and operation of a GRID-compatible Centre in Japan (1991).

<Host Division>

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

<Global Environment Division>

Cameron, Owen Kyle, U. K., 1997. 4. 1~
Global Warming Mitigation Strategies; Government-Industry Responses (Morita, T.)

Hooper, Rowan Earle, ENGLAND, 1997. 9. 1~
Individual variation of parasite resistance in Calopterigid damselflies (Tsubaki, Y.)

Jiang, Kejun, CHINA, 1997. 4. 1~
An International exchange Study for developing AIM/ China Emission Model (Morita, T.)

Kang, Hyung-Shin, KOREA, 1997. 6. 1~
An International Study for Global Warming Emission Scenarios (Morita, T.)

Kournossenko, Serguei, RUSSIA, 1997. 6. 1~1997. 8. 31
Analysis of variability of the vertical profiles of ozone based on ozone sonde data (Nakane, H.)

Kreher, Karin, NEW ZEALAND, 1997. 2. 1~1998. 1. 31
Interpretation of ILAS data and analysis using a one dimensional box model (Sasano, Y.)

Lukyanov, Alexander, RUSSIA, 1997. 7. 11~
Studies on the Arctic ozone depletion mechanisms using the chemical transport model (Nakane, H.)

Pandey, Rahul, INDIA, 1998. 1. 7~1998. 3. 31
An International exchange Study for developing AIM/ India Emission Model (Morita, T.)

Plaistow, Stewart John, ENGLAND, 1997. 4. 1~
The maintenance of alternative male phenotypes in the damselfly Mnais costales. the role of stored energy reserves (Tsubaki, Y.)

<Regional Environment Division>

Albinger, Otto, AUSTRIA, 1995. 11. 1~1997. 11. 1
Relationships between bacteria and aquatic organisms in waters (Takamura, N.)

Allinson, Graeme, AUSTRALIA, 1997. 9. 22~1997. 10. 25
Determination of the age of quaternary marine sediments in Southern Australia by means of uranium method (Morita, M.)

Cho, Hyeon Seo, KOREA, 1997. 12. 13~1998. 2. 27
PAH contamination in marine ecosystem (Shiraishi, H.)

Franzen, Robert Gustav, FINLAND, 1995. 10. 1~1997. 10. 1
Interactions of small mutagenic compounds with nucleosides in order to reveal the reaction mechanisms between small mutagenic compounds and DNA Chains (Morita, M.)

Kong, Hai-Nan, CHINA, 1996. 7. 1~
Development of CH_4 and N_2O Emission Control Using Ecoengineering Systems Such as Wetland, Soil Trench and Oxidation Pond. (Inamori, Y.)

Park, Hyun-Geoun, KOREA, 1997. 8. 12~1998. 3. 31
Development of Appropriate Wastewater and Sludge Treatment Technology for Controlling CH_4 and N_2O emission Applicable to Korea. (Inamori, Y.)

Piver, Warren T., U. S. A., 1997. 9. 22~1997. 11. 2
Impacts of Global Warming on Human Morbidity (Ando, M.)

Prabhakaran, Krishnan, INDIA, 1997. 1. 13~
A study on evaluating stress due to physical environmental factors (Kabuto, M.)

Santiago, Florenda Iyagan, PHILIPPINES, 1997. 6. 14~1997. 9.13
Organotin compounds in 2 species of tropical gastropods (Horiguchi, T.)

Sarkar, Shubhashish, INDIA, 1997. 6. 3~
The role of zinc involved in the antioxidative mechanisms against oxidative stress induced by environmental pollutants (Yonemoto, J.)

Weisburd, Richard S. J., U. S. A., 1996. 6. 2~1997. 4. 1
Analysis of the recycling process in electric vehicle (Shimizu, H.)

Wu, Xiao-Lei, CHINA, 1995. 8. 1~1998. 3. 31
Development of Appropriate Wastewater and Sludge Treatment Technology for Controlling CH_4 and N_2O Emission Applicable to China (Inamori, Y.)

<Environmental Chemistry Division>

Srivastava, Vishal Chandra, NEW ZEALAND, 1996. 2. 17~1998. 2. 8
Study on chemical structures and toxicities of cyanobacterial toxins isolated from freshwaters in Asian countries (Kaya, K.)

Suliman, FakhrEldin Osman, SUDAN, 1998. 1. 26~
Development of monitoring system for volatile organic compounds (Soma, Y.)

Sundram, Arulmozhiraja, INDIA, 1997. 9. 11~
Structure, energy and reaction of Dioxin (Fujii, T.)

<Environmental Health Sciences Division>

Cherian, Mooencheril Geroge, CANADA, 1998. 3. 5~
Roles of heavy-metal binding proteins in the detoxification of heavy-metal toxicity (Tohyama, C.)

Jana, Nihar Ranjan, INDIA, 1997. 6. 15~
Mechanism of male reproductive functions of environmental endcrine disruptors (Tohyama, C.)

Melotkov, Andrew Olegovich, RUSSIA, 1997. 2. 24~
Toxicological role of metallothionein in the nucleus (Satoh, M.)

Zhang, Baoxu, CHINA, 1997. 7. 1~
Combined effects of ultraviolet ray and toxic chemicals on skin carcinogenesis in the mouse with a special reference to oxidative stress (Tohyama, C.)

<Atmospheric Environment Division>

Glagolev, Mikhail, RUSSIA, 1997. 10. 2~1998. 3. 31
Modeling of Production, Oxidation and Transportation Processes of Methane in Wetland Peat-soil (Inoue, G.)

Namboothiri, Parameswaran Sankaran, INDIA, 1996. 8. 1~
Observational Studies on the Coupling of Dynamical and Chemical Processes in the Middle Atmosphere (Sugimoto, N.)

Sivanesan, Subramanian, INDIA, 1998. 2. 1~
Studies on the photooxidation processes of minor atmospheric constituents using a 6m^3 photochemical chamber (Washida, N.)
Zils, Regis, FRANCE, 1996. 12. 13~
Studies of chemical reactions related to the estimate of the ozone destruction impact (Washida, N.)

<Water and Soil Environment Division>

Dou, Xiping, CHINA, 1997. 12. 1~1998. 3. 30
Modeling of sediment transport in East China Sea (Watanabe, M.)
Gong, Jianxin, CHINA, 1997. 7. 1~1998. 3. 31
Development of the land use/change dataset of CHINA (Otsubo, K.)
Jiao, Nianzhi, CHINA, 1997. 11. 1~
Biodiversity of picoplankton in East China Sea (Watanabe, M.)
Noel, Mary-Helene, FRANCE, 1996. 4. 22~
The role of water/sediment interaction as a component of marginal sea ecosystem (Watanabe, M.)
Saefulhakim, Sunsun, INDONESIA, 1997.10. 1~1997.12. 31
Development of the land/use change dataset of Indonesia (Otsubo, K.)
Veerapong, Saenjan, THAILAND, 1997. 12. 1~1998. 3. 31
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Wang, Quan, CHINA, 1997. 9. 1~
Estimation of environmental load from land to East China Sea (Watanabe, M.)

<Environmental Biology Division>

Andrei, A. Gontcharov, RUSSIA, 1997. 11. 1~
Studies on species diversity of microalgae based on reproductive isolation mechanisms (Watanabe, M.)
Zheng, Youbin, CHINA, 1998. 3. 19~
Responses of tree seedlings to CO_2, O_3 concentrations and climate predicted for the 21st century (Shimizu, H.)

<Center for Global Environmental Research>

Dong, Xuhui, CHINA, 1997. 7. 2~
Co-operative study on the evaluation of emission control on the indoor and outdoor environment in the model area– Establishment of measurement method for fluoride discharged from burning of coal and bio-briquette (Hatakeyama, S.)
Gao, Shidong, CHINA, 1997. 4. 1~
Co-operative study on the local production and spread of bio-briquetting technique–Selection of suitable biomass and binder for low ash content bio-briquette (Hatakeyama, S.)

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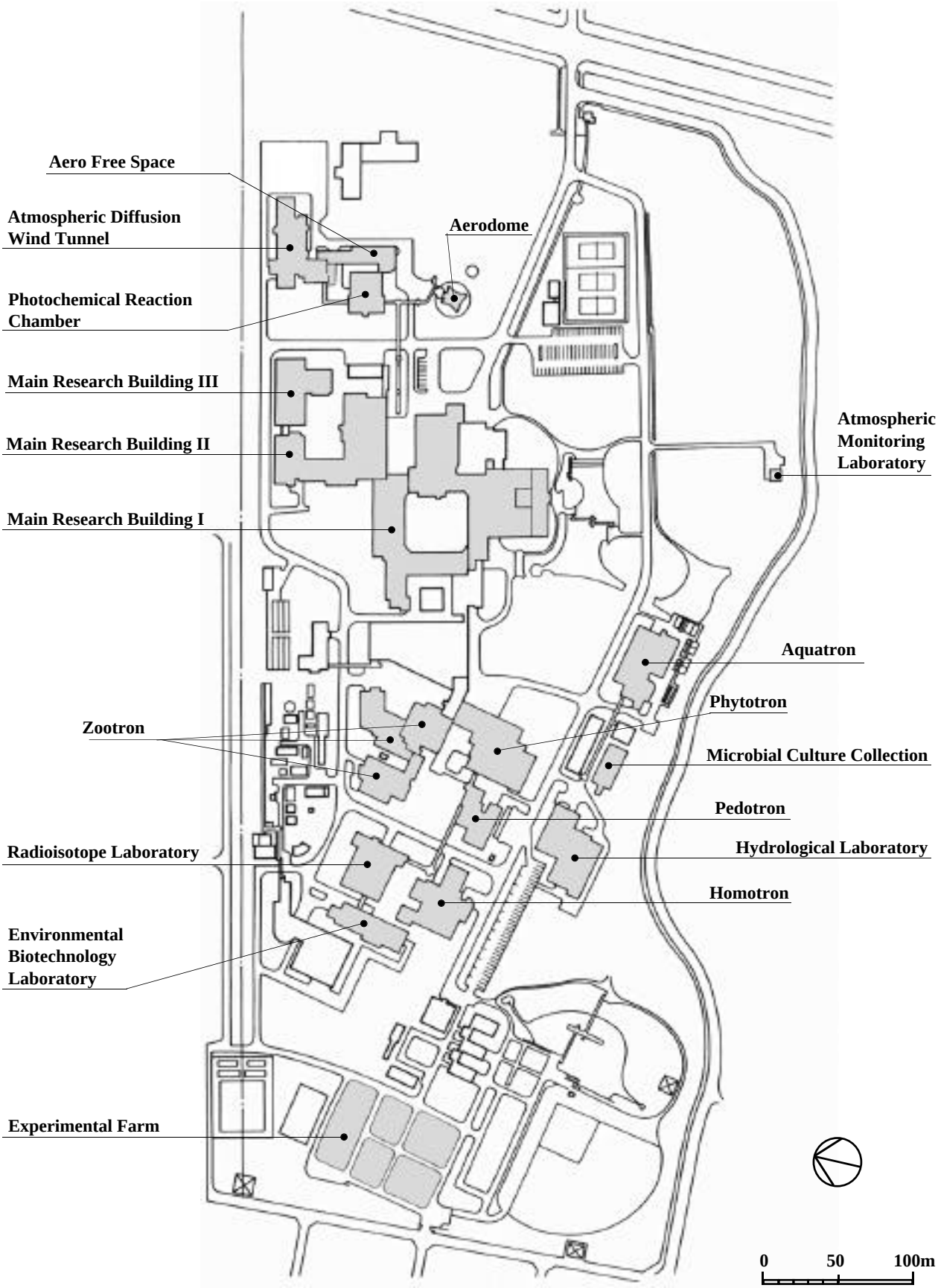
Aero Free Space
Atmospheric Diffusion Wind Tunnel
Aerodome
Photochemical Reaction Chamber
Main Research Building III
Main Research Building II
Main Research Building I
Atmospheric Monitoring Laboratory
Aquatron
Phytotron
Zootron
Microbial Culture Collection
Pedotron
Radioisotope Laboratory
Hydrological Laboratory
Homotron
Environmental Biotechnology Laboratory
Experimental Farm
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.

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.

Experimental Farm
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 long-term changes in the baseline levels 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 foot of the 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.

Lake Kasumigaura Water Research Station
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.

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 for the Improved Limb Atmospheric Spectrometer (ILAS) and the Retroreflector in Space (RIS)

ILAS and RIS are satellite-borne sensors for measuring atmospheric constituents, such as ozone, and were developed by the Environment Agency of Japan as components of the Advanced Earth Observing Satellite (ADEOS), named Midori after launching. In August 1996, ADEOS was launched by an H-II rocket from the Tanegashima Space Center of Japan. Data obtained by ILAS/RIS are processed, archived and distributed by NIES. The data handling facility includes a parallel processing computer system, a high-speed network system and software, optimized for processing the data from these satellite sensors.

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 Monitoring 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 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 α emitters is forbidden.

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

Director General	1
Deputy Director General	1
Research Coordinators	4
General Affairs Division	37
Global Environment Division	21
Regional Environment Division	45
Social and Environmental Systems Division	16
Environmental Chemistry Division	16
Environmental Health Sciences Division	20
Atmospheric Environment Division	18
Water and Soil Environment Division	18
Environmental Biology Division	16
Environmental Information Center	18
Center for Global Environmental Research	9
Environmental Training Institute	18
Total	258

Field of Expertise

Basic Sciences	82
Engineering	44
Agricultural Sciences	20
Medical Science	15
Pharmacology	7
Fisheries Science	3
Economics	2
Total	173

Division Section/Team	Position	Staff Member	Extension	E-mail (@nies.go.jp)
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	Deputy Director General	GOHSHI, Yohichi	2301	gohshi
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	Research Coordinator	SASAOKA, Tatsuo	2303	tsasaoka
	Research Coordinator	TADAMI, Yasunobu	2304	tadami
	Research Coordinator (∗)	SEYAMA, Haruhiko	2305	seyamah
	Research Coordinator (∗)	UTSUNOMIYA, Yojiro	2306	utunomiy
	Research Coordinator (∗)	SUGIYAMA, Ken-ichiro	2307	kensugi
	International Research Coordinator	SUDO, Kin-ichi	2308	ksudo
	International Coordination Researcher	UEHIRO, Takashi	2309	uehiro
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Accounting Section				
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Facility Section				
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	Deputy Director (∗)	NAKANE, Hideaki	2491	nakane
	Independent Senior Researcher	MURANO, Kentaro	2537	murano
Global Warming Mechanism Research Team				
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		MASUI, Toshihiko	2524	masui
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		AKIYOSHI, Hideharu	2393	hakiyosi
Acid Deposition Research Team				
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		HARADA, Shigeki	2509	sharada
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(∗) Multiple roles

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(∗)	MATSUSHIGE, Kazuo	2527	matusige
(∗)	MORIGUCHI, Yuichi	2540	moriguti
(∗)	MORITA, Tsuneyuki	2541	t-morita
(∗)	NAKAJIMA, Koki	2489	knakajim
(∗)	NAKANE, Hideaki	2491	nakane
(∗)	NOJIRI, Yukihiro	2499	nojiri
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(∗)	SASANO, Yasuhiro	2444	sasano
(∗)	SHIBATA, Yasuyuki	2450	yshibata
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Professor	NAKAMURA, Yuji		
Professor	WATANABE, Seiji		
Professor	SHINOMIYA, Miho		

(∗) Multiple roles

ADEOS	Advanced Earth Observing Satellite
Ah-R	aryhydrocarbon-receptor
AIM	Asian-Pacific Integrated Model
AMS	accerelator mass spectrometry
APARE	East Asia/North Pacific Regional Experiment
APN	Asia-Pacific Network for Global Change Research
AVHRR	Advanced Very High Resolution Radiometer
BAHC	Biospheric Aspects of the Hydrologic Cycle
CAT	chloramphenicol acetyltransferase
CCSR	Center for Climate System Research
CGER	Center for Global Environmental Research
CP	Chloropicrin
CRA	comparative risk assessment
CRM	certified reference material
CYP	cytochrome P450
CYP1A1	cytochrome P450 1A1
DEM	Digital Elevation Model
DEP	diesel exhaust particles
DHF	Data Handling Facility
EGF	epidermal growth factor
EPR	Extended Producer Responsibility
FA	Fluctuating Asymmetry
GC content	guanine and cytosine content of DNA bases
GCM	General Circulation Model
GDE-I	GST-P enhancer I
GEMS/Water	Global Environmental Monitoring System/ Assessment of Freshwater Quality
GOES	Global Omnibus Environmental Survey
GIS	Geographical Information System
GRID	Global Resource Information Database
GST-P	pi-class glutathione S-transferase
HDP	Human Dimensions Programme on Global Change
ID-SPM	in door suspended particulate matters
IGAC	International Global Atmospheric Chemistry
IGBP	International Geosphere Biosphere Programme
IgE	immunoglobulin E
IgG1	immunoglobulin G1
ILAS	Improved Limb Atmospheric Spectrometer
IPCC	Intergovernmental Panel on Climate Change
IRSACAS	Institute of Remote Sensing Applications, Chinese Academy of Science
LAN	Local Area Network
LCA	life cycle assessment
LCIA	life cycle impacts assessment
LU/GEC	Land Use for Global Environmental Conservation
LUCC	Land Use/Cover Change
LUTEA	LUCC under Temperate East Asia
MHC	Major Historical Complex
NASDA	National Space Development Agency
NDSC	Network for the Detection of Stratosphere Change
NETI	The National Environmental Training Institute
NIES	The National Institute for Environmental Studies
NOAA	National Oceanic and Atmospheric Administration
OD-SPM	out door suspended particulate matters
OS DOC	Ozone Sounding as a tool for Detection of Ozone Change
PCB	polychlorinated biphenyl
PEACAMPOT	Perturbation by the East Asia Continental Air Mass to the Pacific Oceanic Troposphere
PenCB	pentachlobiphenyl
RIS	Retroreflector In Space
RT-PCR	reversed transcription polymerase chain reaction
SPM	suspended particulate matters
START	Global Change SysTem for Analysis, Research, and Training
STEL	Solar Terrestrial Environment Laboratory
TCDD	tetrachlorodibenzo-*p*-dioxin
TCE	trichloroethylene
TEACOM	Temperate East Asia Regional Committee for START
TRE	TPA responsive element
UNEP	United Nations Environment Programme
VOC	volatile organic compound
WHO	World Health Organization
WWW	World-Wide Web
XRE	xenobiotic responsive element

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