I Specific Study

1. Conservation of regional environments with respect to atmosphere, soil, geological layers, and the water cycle.

(1) Basic Study of Source Apportionment of Primary Emission and Secondary Formation of Fine Organic Particles (Atmospheric Environment Group: S. Hasegawa, S. Yonemochi, N. Umezawa, R. Matsumoto, and K. Sasaka/2011–2014)

The national environmental standard for $PM_{2.5}$ was issued in 2009. The emission of $PM_{2.5}$ and its precursors and secondary formation mechanisms have been identified as particular problems requiring investigation. In particular, organic components have various kinds of sources—primary emission when fossil fuels and biomass are burned, and secondary formation in the atmosphere. This study is measuring levoglucosan (an indicator of biomass burning) and water soluble organic carbon (an indicator of secondary formation). Methods for measurement and source apportionment are being examined to improve estimates of the contributions of primary emissions and secondary formation of fine organic particles.

(2) Evaluation of Air Pollution Events by Use of Full-year Observation Data of Fine Particulate Matters (Atmospheric Environment Group: S. Yonemochi, N. Umezawa, S. Hasegawa, R. Matsumoto, and K. Sasaka/2012–2014)

We previously carried out full-year observations with daily sampling of fine particulate matter ($PM_{2.5}$) based on the standard method used for monitoring $PM_{2.5}$ mass concentration. We also carried out full-year observations with weekly sampling of $PM_{2.5}$ and $PM_{1.0}$. In this study, we continue those observations and use them to evaluate various air pollution events such as high concentration episodes of suspended particulate matter(SPM) and $PM_{2.5}$, transboundary air pollution, and yellow sand events by use of samples and measurement data of fine particulate matter.

(3) Development of Measurement Techniques and Understanding of Current Conditions on Chemical Substances Derived from BVOCs by Photochemical Reactions in Saitama Prefecture (Atmospheric Environment Group: K. Sasaka, N. Umezawa, R. Matsumoto, S. Yonemochi, S. Hasegawa, Chemical Substances Group: K. Nojiri/2013–2015)

Air pollution due to fine particulate matter ($PM_{2.5}$) is a serious environmental problem. Various countermeasures have been taken by national and prefectural governments to lower emissions of volatile organic compounds (VOCs), which are one of the causative agents of $PM_{2.5}$. BVOCs (biological VOCs) are a class of VOCs that are emitted from organisms (*e.g.*, isoprene is emitted from terrestrial plants). However, little is known about the amount of emissions or the behavior of BVOCs and their contribution to $PM_{2.5}$ formation. In this study we are developing an analytical technique for typical chemical products that are derived from BVOCs by photochemical reactions and attempting to better understand the present situation of the products in Saitama prefecture. These chemical products will be useful as molecular markers of $PM_{2.5}$. The ultimate aim of the study is to prepare countermeasures against $PM_{2.5}$.

(4) Investigation of the Current Situation of the Eutrophication Phenomenon in Rivers and Evaluation of the Environmental Impact of Eutrophication (Water Environment Group: M. Takahashi, K. Ikeda, T. Kakimoto, and I. Mishima/2012–2014)

River environments have been improving steadily with advances in sewage treatment and other measures. However, pollution phenomena such as freshwater red tides (algal blooms) and foaming on the surface of rivers still occur, and are commonly caused by organic-matter laden runoff or effluent from areas of primary production. Such organic loads are a serious concern, and indicators of eutrophication therefore require careful monitoring. In this study, we are investigating the current extent and severity of eutrophication in rivers and stagnant water bodies and are evaluating the associated environmental impacts. We are also seeking the best methods for water sample pretreatment and analysis of total organic carbon through modifications to the measurement apparatus, especially for samples including suspended solids.

(5) Water quality assessment based on the bacterioplankton community composition of rivers in Saitama Prefecture (Water Environment Group: K. Watanabe, K. Ikeda, T. Kakimoto, I. Mishima, Research Promotion Office: M. Takahashi/2014-2016)

For water quality management of eutrophic river ecosystems, it is important to elucidate the source, decomposition process, and cycling of organic matter that is damaging to beneficial water use. Bacterioplankton have recently been revealed to play an important role in the decomposition of dissolved organic matter in freshwater ecosystems. Many researchers have reported that the bacterioplankton community composition is closely related to the properties of dissolved organic matter in lakes and ponds. However, information about riverine bacterioplankton community compositions remains limited. In this study, we are examining the material cycling of organic matter by investigating the relationship between riverine bacterioplankton community composition and water quality in Saitama Prefecture.

(6) Study on a Comprehensive Evaluation of Groundwater Quality in Saitama Prefecture and its Application to Administrative Management (Environmental Geotechnology Group: S. Hachinohe, T. Ishiyama, H. Hamamoto, and H. Shiraishi/2011–2014)

A groundwater quality survey found that water quality standards for regulated substances were exceeded in water samples from many wells throughout Saitama prefecture. However, the spatial extent of the polluted aquifer was not clear. In this study, we are analyzing groundwater quality for a range of parameters from samples collected from all parts of Saitama prefecture except mountainous areas. We are using these data to construct a GIS database. We expect that by providing a comprehensive evaluation method with this system, the means will be available to tackle groundwater quality contamination that requires administrative and regulatory solutions.

(7) Study on Atmospheric Weathering Processes of Sulfide Minerals in Marine Sediments and Investigation on the Risk Management for Soil Contamination (Environmental Geotechnology Group: T. Ishiyama, S. Hachinohe, H. Hamamoto, H. Shiraishi, Water and Geo-Environment division: S. Hosono/2012–2014)

When exposed to oxygen, marine sediments containing sulfide minerals (*e.g.*, Fe_2S) weather and become highly acidic, releasing various harmful heavy metals such as lead, cadmium, and arsenic into the environment. Techniques for immobilization of harmful heavy metals and weathering control by maintaining anaerobic conditions are recognized as useful methods for controlling this type of soil contamination. In this study, we are investigating the weathering processes of sulfide minerals and applying the results to risk management for hazardous marine sediments.

(8) Sequential Extraction Fractionation of Heavy Metals in Soil and Soil-to-Plant Transfer of Heavy Metals (Environmental Geotechnology Group: T. Ishiyama, S. Hachinohe, H. Hamamoto, H. Shiraishi, Water and Geo-Environment division: S. Hosono/2012–2014)

In Southeast Asia and China, the contamination of farmland by heavy metals is considered a major social problem; contamination is generally derived from irrigation water polluted with industrial and domestic wastewater. Soil contamination greatly affects the safety of agricultural products produced on the farmlands. Heavy metals exist in the soil in various chemical forms; these include exchangeable states and reducible states. The degree of transfer of heavy metals from soil to agricultural products depends on such changes in state. In this study, we are applying a sequential chemical extraction method to soil and plant samples from contaminated farmland in China and are investigating the relationship between the amounts of heavy metals in each fraction and the soil-to-plant transfer efficiency.

2. Evaluation of the environmental risk from pollutants and countermeasures for risk mitigation in a regional area.

(1) Development for Analysis of Cyclic Volatile Methyl Siloxanes and Their Distribution in the Water Environment (Chemical Substances Group: Y. Horii, M. Motegi, N. Ohtsuka, K. Minomo, and K. Nojiri/2012–2014)

Cyclic volatile methyl siloxanes (cVMS) have been widely used in various industries because they have high thermal, electrical, and chemical stability and are believed to be inert. However, cVMS have recently been identified as priority chemicals for environmental risk assessment because of their persistence in the environment and bioaccumulative potency. In this research, we conduct a comprehensive study including development of a method for analyzing cVMS, investigation of emission sources, such as wastewater treatment plants, and distribution of cVMS in the water environment in Saitama prefecture. This is the first study to analyze individual cVMS from the environment in Japan.

(2) Survey of environmental contamination by organohalogen flame retardants in Saitama Prefecture (Chemical Substance Group: M. Motegi, K. Minomo, N. Ohtsuka, Y. Horii, K. Nojiri/2014-2017)

Hexabromocyclododecane (HBCD) is an organobromine flame retardant used for residential insulation and textile products. HBCD was listed as a persistent organic pollutant (POP) by the Stockholm Convention in 2013, and its import and production have been banned in Japan since 2014. Dechlorane plus (DP), an organochlorine flame retardant that is

added to coating resins of electrical wires and cables, is still marketed. However, DP has recently attracted much attention as an environmental pollutant; it may become a candidate for evaluation as a POP by the convention in the future. Although the environmental persistence and bioaccumulation characteristics of these two flame retardants have been recognized, official analytical methods have yet to be established. In this study, to elucidate their environmental behavior, we surveyed contamination levels of these flame retardants in ambient air, river water, and riverbed sediments in Saitama Prefecture. This study will provide useful information for environmental mitigation of flame retardant contamination.

(3) Seasonal changes in the concentration of neonicotinoid insecticides in river water (Chemical Substance Group: N. Ohtsuka, K. Nojiri, K. Minomo, M. Motegi, Y. Horii/2014-2016)

Chronic toxicities of neonicotinoid insecticides to vertebrates, such as reductions of immune and reproductive system functioning, have recently been reported; concerns about harmful ecosystem effects of neonicotinoid insecticides have been growing. Although we previously found that neonicotinoid insecticides are widely used in Saitama Prefecture, the sources of neonicotinoid insecticides in river water and long-term variations in their concentrations have not yet been elucidated. Moreover, in addition to conventional neonicotinoid insecticides, a neonicotinoid-like compound called fipronil and a new neonicotinoid insecticide called sulfoxaflor are noteworthy because they may have harmful ecosystem effects similar to the conventional neonicotinoid insecticides. In this study, we are surveying seasonal changes in the concentration of these insecticides in river water and will examine the relationships between insecticide concentrations and environmental parameters, including local agricultural practices and weather conditions.

(4) Study on the environmental behavior of radioactive materials in an ecological garden (Environmental Radioactivity Monitoring Group: K. Satake, S. Yonemochi, Y. Kobayashi, Global Warming Countermeasures Group: T. Shimada, Natural Environment Group: M. Miwa, Research Promotion Office: S. Hosono, H. Shiraishi /2014-2016)

Radioactive materials released into the atmosphere by the accident at the Fukushima Daiichi Nuclear Power Station in March 2011 have since been transported by advection and diffusion to the Kanto Plain, where they have been deposited as fallout. Radioactive cesium in particular has reached a high concentration in some areas of the plain. Cesium in fallout is distributed, transported, and accumulated in various environmental substances. Therefore, the transport characteristics of cesium need to be evaluated. An ecological garden has been constructed at our research center in Kazo City as a model of a relatively closed ecosystem environment. In this study, we investigate concentrations of radioactive materials, especially radioactive cesium, in the soil, water, and biota of the ecological garden to clarify their environmental behavior.

3. Construction of resource cycling and energy cycling systems based on prefectural characteristics

(1) Development of a Thermal Response Test Instrument and a Method to Evaluate Subsurface Thermal Environments for a Geothermal Heat Exchange System (Environmental Geotechnology Group: H. Hamamoto, S. Hachinohe, H. Shiraishi, T. Ishiyama, Environmental Radioactivity Monitoring Group: K. Satake/2012–2014)

Renewable energy resources play an important role in resolving both global warming and energy issues. Geothermal heat exchange systems have been used in Europe, the Americas, and China, but only tentatively in Saitama prefecture. One of the reasons for the limited uptake here is the lack of ability to predict the efficiency of a heat exchange system at a planned site. The thermal response (TR) test is extremely helpful to acquire such information. However, measurement instruments are not easily available in Japan because of the unavailability of ready-made instruments. In addition, the TR test is time consuming. In this study, we are developing a simple, easy-to-use measurement instrument and optimized method of TR testing.

4. Evaluation and conservation of biodiversity at regional scale

(1) Research on an Evaluation Method for Aquatic Habitats in Small Rivers and Irrigation Channels (Water Environment Group:Y. Kimochi, H. Tanaka, Natural Environment Group:H. Kanazawa/2013–2014)

Habitats for aquatic organisms have deteriorated in Saitama prefecture. However, little research has been done on the relationship between aquatic organism abundance and habitat. In this research, we are conducting field observations of river environment, water quality, and the biomass of various aquatic organisms, and examining the aquatic habitats of these organisms, mainly in irrigation channels in Kumagaya City. The data are arranged in the form of "Karte: clinical records" before analysis. We also intend to use existing methods for habitat evaluation and aim to construct practical and useful methods based on field data.

5. The current state of global warming, its effects on the environment, and application of countermeasures in Saitama prefecture.

(1) Evaluation of N_2O Production Potential in Wastewater Treatment Processes (Water Environment Group: I. Mishima/2012–2014)

The reduction of emissions of greenhouse gases such as N_2O and CO_2 from wastewater treatment processes can contribute to the mitigation of global warming. N_2O is produced during biological nitrification and de-nitrification processes, and CO_2 is generated by electric power consumption for aeration in the treatment process. Our previous studies showed that controlling the NO_2 concentration changed the N_2O production rate. The objective of this study is to evaluate the N_2O production potential by observing the relation between N_2O and NO_2 behaviors.

(2) Development of a Thermal Response Test Instrument and a Method to Evaluate Subsurface Thermal Environments for a Geothermal Exchanger System (details given above under Research Theme 3)

II Basic Research

- **Solutions for important problems in environmental conservation**
- **Technological developments in analytical measurements**
- **Construction of an environmental database**

(1) Construction and Operation of a Database on the Natural Environment by Applying a Geographical Information System—Research on the transition of forest and its functions (Global Warming Countermeasures Group: T. Shimada, Y. Masutomi, Natural Environment Group: M. Miwa/2013–2015)

A database of the natural environment in Saitama prefecture has been constructed by using a geographical information system (GIS). We are conducting a detailed analysis of the transition in forest using the database to evaluate the potential for forestland in the prefecture to contribute to global warming mitigation.

(2) Assessment of Variations in Efficiency among Varieties of Resource Plants for Phytoremediation of Contaminated Soils (Natural Environment Group: K. Oh, M. Miwa, T. Yonekura, H. Kanazawa, Atmospheric Environment Group: S. Yonemochi, Material Cycles and Waste Management Group: Y. Isobe, Water and Geo-Environment Division: S. Hosono/2013-2016)

Soil contamination with heavy metals and other harmful substances is a worldwide environmental concern. Phytoremediation is the use of green plants and their associated microbiota for the in situ treatment of contaminated soils; it has received increasing attention as a cost-effective and eco-friendly technology.

Conventional phytoremediation methods use purpose-bred plants that have high capacity for the accumulation of contaminants, but they are expensive to use. We are focusing on the development of more cost-efficient soil phytoremediation through the application of crops that can be used for biofuel or other economic uses instead of the purpose-bred plant varieties. Such crop plants can generate resources at the same time as they effect phytoremediation of contaminated soils. We found that some biofuel crops such as maize and sunflower, because of their large biomass production, had similar or greater phytoremediation potential for heavy metals than purpose-bred plants. However, little information is available on the differences in phytoremediation efficiency among varieties of resource crops. The objectives of this study are to assess the differences in efficiency among varieties of resource plants and to select the crop varieties that are most suitable for soil phytoremediation.

(3) Effects of ozone and elevated carbon dioxide, singly and in combination, on yield of Japanese rice cultivars grown in Saitama Prefecture (Natural Environment Group: T. Yonekura, K. Oh, M. Miwa, Global Warming Countermeasures Group: T. Shimada/2014-2016)

Tropospheric ozone (O_3) is considered one of the most phytotoxic of all air pollutants. Current O_3 concentrations in Japan have been shown to reduce the production of agricultural

crops. In this century, concurrent with O_3 air pollution, global atmospheric carbon dioxide (CO_2) has continued to increase alarmingly. Because plant functions such as photosynthesis and biomass production are sensitive to changes in the CO_2 concentration, elevated CO_2 concentrations are likely to influence future agricultural production. However, little is known about the potentially interactive effects of elevated O_3 and CO_2 concentrations on the growth and yield of important Japanese agricultural crops such as rice. Therefore, to assess the risk to Japanese rice production posed by O_3 air pollution and climate change, we investigated the growth and yield responses to elevated O_3 and CO_2, singly or in combination, of rice cultivars grown in Saitama Prefecture.