Research Themes in the Fiscal Year 2015

Center for Environmental Science in Saitama (CESS)

I. Specific Study

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

(1) 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 $PM_{2.5}$.

(2) Study on Metal Elements in $PM_{2.5}$ and PM1 Samples Obtained during Long-Term Observation (Atmospheric Environment Group: S. Yonemochi, N. Umezawa, R. Matsumoto, K. Sasaka, S. Hasegawa / 2015–2017)

Many people and the mass media have become interested in air pollution caused by fine particulate matter ($PM_{2.5}$), especially transboundary air pollution, since the serious $PM_{2.5}$ pollution that occurred in China in January 2013.

We have observed $PM_{2.5}$ daily since 2000 with the standard method defined by Ministry of the Environment, and we have also conducted weekly observations of $PM_{2.5}$ and PM_1. Chemical analyses of these PM samples show that elemental metals provide information on the transboundary transport of PM.

In this study, we are continuing these observations of PM, focusing on metal elements, to elucidate the causes of various air pollution events, such as episodes of high $PM_{2.5}$ concentration, in connection with transboundary air pollution.

(3) Study on Source Apportionment of $PM_{2.5}$ Caused by Local- and Regional-Scale Pollution (Atmospheric Environment Group: S. Hasegawa, S. Yonemochi, N. Umezawa, R. Matsumoto, K. Sasaka / 2015–2018)

The rate of achieving environmental quality standards for $PM_{2.5}$ is still low. The increase in $PM_{2.5}$ concentration in Japan is caused not only by long-range transport of pollutants from distant areas but is also caused by local- and regional-scale pollution. Episodes of high $PM_{2.5}$ concentrations have often been observed only in the Kanto region; this is the central region of Japan, and includes Saitama as a constituent prefecture. This fact suggests that the

influence of local- and regional-scale pollution is larger in the Kanto region than in other regions. We aim to clarify the contributions of local- and regional-scale pollution in order to take effective countermeasures against emission sources.

In this study, chemical compositions of $PM_{2.5}$ will be observed, and the available $PM_{2.5}$ monitoring data and chemical compositions of ambient $PM_{2.5}$ and $PM_{2.5}$ sampled from exhaust streams will be utilized for the data analyses. The observations and data analyses will be carried out in cooperation with other local governments in the Kanto region, and nationwide through various collaborative studies. One of our major targets is to estimate the contribution of local- and regional-scale pollution to obtain a plausible inventory of emission sources.

(4) 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.

(5) Application of Water Quality Simulation Model to Eutrophic Rivers, and Proposal for River Water Quality Management Measures (Water Environment Group: T. Kakimoto, K. Ikeda, I. Mishima, K. Watanabe / 2015–2017)

The concentration of chlorophyll a, an index of algal blooms, in the rivers of Saitama Prefecture is relatively high; high concentrations are observed, especially in the eastern and southern areas of the prefecture, where concentrations reach a level equal to those of eutrophic lakes. High concentrations of algae in waterbodies result in deterioration of transparency, pollution by excessive organic matter, and bad odors, and also cause large diurnal changes in pH and dissolved oxygen as a result of algal photosynthesis and respiration. It is well known that a reduction in nutrients (e.g., Nitrogen and Phosphorus, nutrients essential for algal growth) is necessary to improve the water quality of rivers suffering from high algal concentrations. However, there is little information about the desired levels of nutrients sufficient to control abnormal algal growth. In these circumstances, we have developed a mathematical ecosystem model that represents algal growth as a function of nutrient concentrations and simulates the behavior of organic matter originating from algae. Because the interactions among concentrations of nutrients, algae, and organic matter depend on the characteristics of the waterbody under examination, we describe these components and interactions quantitatively in the ecosystem model. We intend to use the developed model to propose methods of preventing the water quality of rivers from deteriorating due to eutrophication.

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

(1) 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.

(2) 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.

(3) Occurrence of Volatile Methylsiloxanes in the Atmospheric Environment (Chemical Substances Group: Y. Horii, K. Minomo, N. Ohtsuka, M. Motegi, K. Nojiri / 2015–2017)

Several volatile methylsiloxanes (VMS) have recently been identified as priority chemicals for environmental risk assessment due to their persistence in the environment and bioaccumulative potency. A major proportion of existing VMS ends up in the atmosphere, and information about VMS in the atmospheric environment is essential to reveal the environmental processes and environmental fate of VMS and to evaluate their potential risk. However, information concerning the concentration and distribution of VMS in the

atmospheric environment in Japan is still very limited.

In view of the urgent need for environmental risk assessment of VMS, the objectives of the present study include the development of a high-precision analysis of VMS in air samples from Saitama Prefecture and a study of occurrence of VMS in the atmospheric environment.

First, air sampling conditions using a low- volume, -mass- flow pump in combination with solid-phase extraction cartridges will be optimized for the sampling of VMS, including cyclic and linear VMS. This sampling method will then be applied to continuous monitoring of VMS at our center to examine seasonal variations of VMS in the atmospheric environment. Moreover, diurnal variations of VMS will be examined by air sampling at a high temporal resolution. Finally, environmental monitoring of VMS will be conducted in several locations in Saitama Prefecture. The results will be analyzed together with emission source and meteorological information to reveal the environmental fate of VMS.

(4) Study on the environmental behavior of radioactive materials in an ecological garden (Environmental Radioactivity Monitoring Group: T. Yamazaki, 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) Estimation of Solid Waste Stabilization in Landfills in a Recycling-based Society (Material Cycles and Waste Management Group: Y. Isobe, Y. Watanabe / 2015–2017)

The lifetimes of landfills in Japan are increasing because of the decreasing amounts of municipal solid waste (MSW) and increasing rates of MSW recycling in recent years. Landfills in Saitama Prefecture also show these typical trends: a decrease in the annual waste amount, and an increase in the ratio of landfilled noncombustible waste because some cement plants use MSW incineration ash as a raw material in cement production. Because landfill management requires a long period and involves huge costs, it is necessary (1) to predict changes in the quantity and quality of waste in the near future, (2) to understand the processes of waste stabilization, and (3) to estimate the period required for waste stabilization. In this study, we will design and implement a pilot-scale testing area in a

landfill and measure several chemical substances leached and emitted from the waste to estimate solid waste stabilization in a landfill.

(2) Impact on Natural Environment and Regional Society from Geothermal Heat Exchange Systems (Environmental Geotechnology Group: H. Hamamoto, S. Hachinohe, T. Ishiyama, Water and Geo-Environment Division: H. Shiraishi, Global Warming Countermeasures Group: T. Shimada, Water Environment Group: K. Watanabe, Environmental Radioactivity Monitoring Group: T. Yamazaki / 2015–2017)

Renewable energy is an important element in solving global warming and/or energy problems. Geothermal heat exchange systems are a useful type of renewable energy. Accordingly, we have developed a new method of estimating and mapping heat potential for geothermal heat exchanger systems and have mapped heat potential in the Saitama area. It is also important to evaluate the influence of such systems on the natural environment and regional society when such systems become widely adopted. In this research, we are evaluating the effects of such systems on the reduction of CO_2 emissions based on social statistical data and results of demonstration experiments. Furthermore, we are evaluating the influence of such systems on the subsurface microbial environment and heat interference.

4. Evaluation and conservation of biodiversity at regional scale

(1) Fundamental Research on Conservation of Endangered Animals and Plants in Saitama (Natural Environment Group: M. Miwa, H. Tsunoda, T. Yonekura, K. Oh, H. Kanazawa, Global Warming Countermeasures Group: T. Shimada / 2015–2017)

In this research, we are collecting data on the endangered animals and plants listed in the Saitama Red Data Book. This includes information on their distribution, information on the literature concerning them and information on activities aimed at their conservation. Also, with respect to endangered species designated for conservation by ordinance of Saitama Prefecture, we are investigating the environment of their habitat and their life history. We aim to unify this information and data from the investigation into a database and make the database available to be used for consultation about endangered species and activities aimed at their conservation in Saitama.

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

(1) Research on Extreme Weather and Local Climate Events under Changing Global Climate in Saitama (Global Warming Countermeasures Group: M. Hara, T. Shimada, Y. Muto / 2015–2016)

Up until the 2000s, the influence of the global warming had been clearly observed only in the polar regions and on small islands. Recently, however, the frequency and strength of extreme weather events and local climate events that can be regarded as disasters, have been gradually changing, even in areas with mild climates, such as Saitama Prefecture.

Kumagaya City is located in the north of Saitama Prefecture and is famous for being one of the hottest cities in Japan in summer. In August 2007, the AMeDAS (Automated

Meteorological Data Acquisition System) observation site in Kumagaya City observed the highest Surface Air Temperature (hereafter, SAT) ever recorded at the time in Japan. The SAT has continued to rise since 1900, and the rate of increase in the SAT reached 6.0 °C/100 years from 1980 to 2014.

The rapid rise of the SAT in recent years in Saitama has been caused not only by the global warming but also by the urban heat island phenomenon due to expansion of the Tokyo metropolitan area. The influence of this rise of SAT can appear in various fields, such as human health, agriculture, and the ecosystem. So far, climatological information and data about extreme weather and local climate events in Saitama have not been systematically collected and analyzed. In this study, we are collecting and analyzing climatological information and data to better understand and elucidate the mechanisms of past and future extreme weather and local climate events in Saitama.

(2) Impact on Natural Environment and Regional Society from Geothermal Heat Exchange Systems (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, 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)
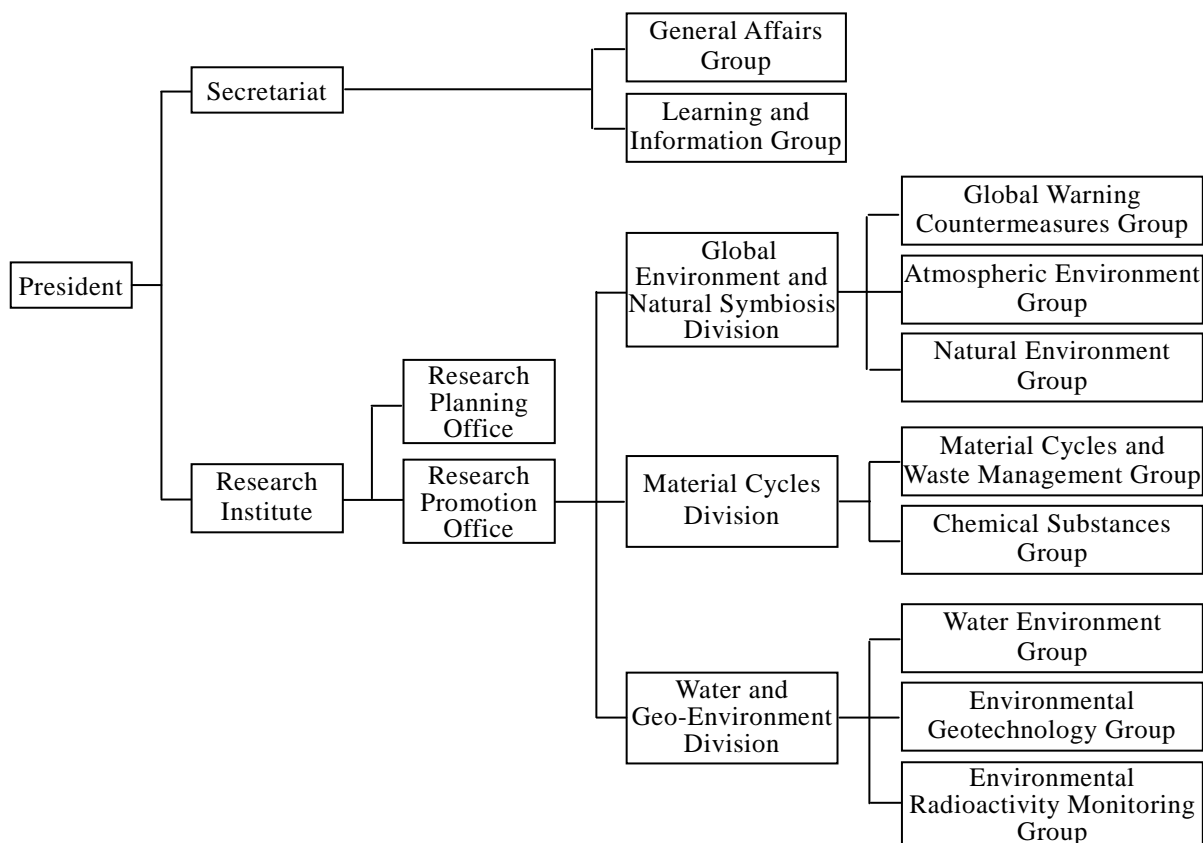
Tropospheric ozone (O_3) is considered one of the most phytotoxic of all air pollutants. Current O_3 concentrations in Japan have been shown to reduce the production of agricultural crops. In this century, concurrent with O_3 air pollution, global atmospheric carbon dioxide (CO_2) has continued to increase 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.

(4) Influence on Evapotranspiration by Photovoltaic Power Generation Equipment on Landfill Sites (Material Cycles and Waste Management Group: T. Hase / 2015–2017)

Since the enforcement of the Feed-in Tariff law for renewable energy in 2012, photovoltaic power (PV) generation has been actively embraced in Japan. As a result, the spacious areas available on landfill sites are being increasingly used to install PV generation systems. However, there is a fear that the introduction of PV equipment on landfill sites may influence landfill management by, inter alia, decreasing evapotranspiration, increasing the volume of leachate, and increasing leachate treatment costs. This is because the PV equipment shades the landfill surface, and evapotranspiration is one of the factors controlling water balance in landfill sites. In this research, I will observe surface climatic parameters such as temperature and solar radiation on a landfill site where PV generation equipment is installed to estimate the influence of changes in evapotranspiration on the water balance in landfill sites.

Organization of Center for Environmental Science in Saitama (CESS)

- President
  - Secretariat
    - General Affairs Group
    - Learning and Information Group
  - Research Institute
    - Research Planning Office
    - Research Promotion Office
      - Global Environment and Natural Symbiosis Division
        - Global Warning Countermeasures Group
        - Atmospheric Environment Group
        - Natural Environment Group
      - Material Cycles Division
        - Material Cycles and Waste Management Group
        - Chemical Substances Group
      - Water and Geo-Environment Division
        - Water Environment Group
        - Environmental Geotechnology Group
        - Environmental Radioactivity Monitoring Group

Center for Environmental Science in Saitama (CESS)
914 Kamitanadare, Kazo-city, Saitama 347-0115
Phone: +81-480-73-8331／Fax: +81-480-70-2031
http://www.pref.saitama.lg.jp/cess/