Research Themes in the Fiscal Year 2016

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) Study on metal element in PM2.5 and PM1 samples of long-term observation (Atmospheric Environment Group: S. Yonemochi, K. Sasaka, S. Hasegawa, K. Nojiri, Y. Fujii,Research Promotion Office: N. Umezawa, R. Matsumoto ／2015-2017)

Many people and the mass media have become interested in air pollution caused by fine particulate matter (PM2.5), especially transboundary air pollution, since the serious PM2.5 pollution that occurred in China in January 2013.

We have observed PM2.5 daily since 2000 with the standard method defined by Ministry of the Environment, and we have also conducted weekly observations of PM2.5 and PM1. Chemical analysis of these PM samples show that elemental metals provide information on the long-range transportation 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 PM2.5 concentration, in connection with transboundary air pollution.

(2) Study on Source Apportionment of PM2.5 Caused by Local- and Regional-Scale Pollution (Atmospheric Environment Group: S. Hasegawa, S. Yonemochi, N. Umezawa, R. Matsumoto, K. Sasaka, K. Nojiri, Y. Fujii / 2015–2018)

The rate of achieving environmental quality standards for PM2.5 is still low. The increase in PM2.5 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 PM2.5 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 PM2.5 will be observed, and the available PM2.5 monitoring data and chemical compositions of ambient PM2.5 and PM2.5 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.

(3) 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 Planning 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.

(4) 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.

(5) Applicability of fluorescence PARAFAC-EEM to river water quality monitoring (Water Environment Group: K. Ikeda, T. Kakimoto, I. Mishima, K. Watanabe; 2016–2018)

Parallel factor analysis with excitation emission matrix fluorescence (PARAFAC-EEM) is a novel and powerful form of spectrofluorometry for separating out, detecting, and quantifying aquatic organic matter. Application of this method to river water quality monitoring could make it possible to detect the components that strongly influence river water quality and to thus evaluate quality. PARAFAC-EEM could help in water quality management through real-time detection of quality deterioration and clarification of the causes. However, there have been few reports of the use of this method in the long-term monitoring of river contamination by domestic waste water. In this fundamental study, a technique for applying PARAFAC-EEM will be developed by using fluorescence data from the river waters of Saitama Prefecture. The behaviors of fluorescent components will then be determined and the corresponding organic matter will be characterized.

A water quality evaluation model will be constructed by performing a correlational analysis between the intensity of fluorescent components and water quality indexes such as BOD .

Finally, a method of assessing the origin of the contaminants will be developed by collecting fluorescence data as a kind of fingerprint of the source of pollution.

(6) Land displacement monitoring in Saitama Prefecture supported by remote sensing (Environmental Geotechnology Group: S. Hachinohe; Environmental Geotechnology Group: H. Hamamoto, T. Ishiyama; Research Promotion Office: H. Shiraishi; Global Warming Countermeasures Group: M. Hara; Water Environment Group: T. Kakimoto; 2016–2018)

Land subsidence damage in Saitama Prefecture is still ongoing, especially in dry years, although the seriousness of the damage is decreasing result of pumping regulation policy from 1960s. Furthermore, because this prefecture is located in the center of the largest alluvial plain in Japan and is undergoing continued urban development, the extent of urban land vulnerable to flooding is increasing. In this research, we are evaluating and optimizing a procedure for monitoring land displacement by using synthetic aperture radar onboard satellites. We will use the procedure to analyze the regional characteristics of land subsidence problems in Saitama Prefecture.

(7) Background levels and geographic distribution of heavy metals in natural soils in Saitama Prefecture (Environmental Geotechnology Group: T. Ishiyama, S. Hachinohe, H. Hamamoto; 2016–2018)

Recently, naturally derived soil contamination with heavy metals such as lead, arsenic, and fluorine has been reported in various part of Japan, including Saitama Prefecture. For adequate evaluation of soil contamination derived from natural processes it is very important to analyze the background levels and geographical distributions of heavy metals in natural soils. In this study, we are testing the background levels and leaching of heavy metals in natural soils in Saitama Prefecture and examining the geographical distributions of these heavy metals.

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, S. Takemine, Atmospheric Environment Group: 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 survey contamination levels of these flame retardants in ambient air, river water, and riverbed sediment 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. Minomo, M. Motegi, Y. Horii, S. Takemine, Atmospheric Environment Group: K. Nojiri/2014–2016)

Chronic toxicities of neonicotinoid insecticides to vertebrates, such as reductions of immune and reproductive system functions, 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 Substance Group: Y. Horii, K. Minomo, N. Ohtsuka, M. Motegi, S. Takemine, Atmospheric Environment Group: K. Nojiri/2015-2017)

Some volatile methylsiloxanes (VMS) have recently been identified as priority chemicals for environmental risk assessment due to their persistence in the environment and bioaccumulative potency. The information of VMS in the atmospheric environment as a major compartment existing VMS is essential to reveal their environmental processes, fate and evaluation of their potential risk. However, the information concerning concentration and distribution of VMS in the atmospheric environment in Japan is still very limited. In view of an urgent need for environmental risk assessment of VMS, the objectives of present study include development of a high precision analysis of VMS in air samples and study of occurrence of VMS in atmospheric environment from Saitama Prefecture. Firstly, in specific, air sampling conditions of VMS including cyclic and linear VMS are optimized using a low volume-mass flow pump in combination with solid phase extraction cartridges. Then, the developed sampling method is applied to continuous monitoring of VMS at CESS in order to examine seasonal variations of VMS in the atmospheric environment. Moreover, diurnal variations of VMS are examined by performing air samplings in high resolution time. Finally, an environmental monitoring of VMS in several locations of Saitama Prefecture is conducted. The results is analyzed with emission source and meteorology information in order to reveal environmental fate of VMS.

(4) Development of methods for rapid analysis of hazardous chemical substances in the atmosphere and evaluation the risks posed by such substances in emergencies (Chemical Substance Group: M. Motegi, N. Ohtsuka, K. Minomo, Y. Horii, S. Takemine; Atmospheric Environment Group: K. Nojiri; 2016–2019)

The release of large amounts of the hazardous chemical substances (HCSs) used in factories to the environment through accidents or disasters raises serious concerns about the effects of these substances on ecosystems and human health. The implementation of two regulations, the Pollutant Release and Transfer Register Law and Saitama Prefecture's Ordinance to Preserve the Living Environment, has made it possible to determine the amounts HCSs handled in factories over the past decade or so and the amounts released and transferred to the other places. Although there is a risk that HCSs might be discharged to the environment in emergency situations, standard analytical procedures and risk assessments have not yet been established for some HCSs in japan. In this study, we are developing procedures for the rapid analysis of high-risk HCSs (selected on the basis of information on their toxicity and amounts handled). We then intend to survey HCS levels in the atmosphere around factories under non-emergency conditions. We will also create a manual of procedures for assessing the risks posed by HCSs.

(5) Study on the environmental behavior of radioactive materials in an ecological garden (Environmental Radioactivity Monitoring Group: T. Yamazaki, S. Yonemochi, T. Ito, Global Warming Countermeasures Group: T. Shimada, Natural Environment Group: M. Miwa, Research Promotion Office: H. Shiraishi, N. Umezawa /2014-2017)

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, M. Nagamori, M. Kawasaki, T. Hase, K. Suzuki,Research Promotion Office: 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 CO2 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.
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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.

(2) Evaluating the impacts of sika-deer browsing on shrub-layer vegetation and the use of deer hunting to restore shrub species
(Natural Environment Group: H. Tsunoda, M. Miwa, T. Yonekura, K. Oh; Global Warming Countermeasures Group: T. Shimada; 2016–2018)

The abundance of sika deer (Cervus nippon) has increased in western Saitama Prefecture, and a decline in vegetation cover has been observed as a result of intensive browsing by overabundant deer populations. In this research, we are surveying the temporal patterns of decline of shrub-layer vegetation and indicator of deer abundance to determine the current

status of the impact of deer browsing on vegetation cover. Furthermore, we are comparing the occurrence and behaviors of deer, and the proportions of shrub species browsed by the deer, between areas inside a hunting area and outside a deer-exclusion fence to assess the effects of hunting on shrub species restoration.

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) 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, /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.

(2) 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.

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

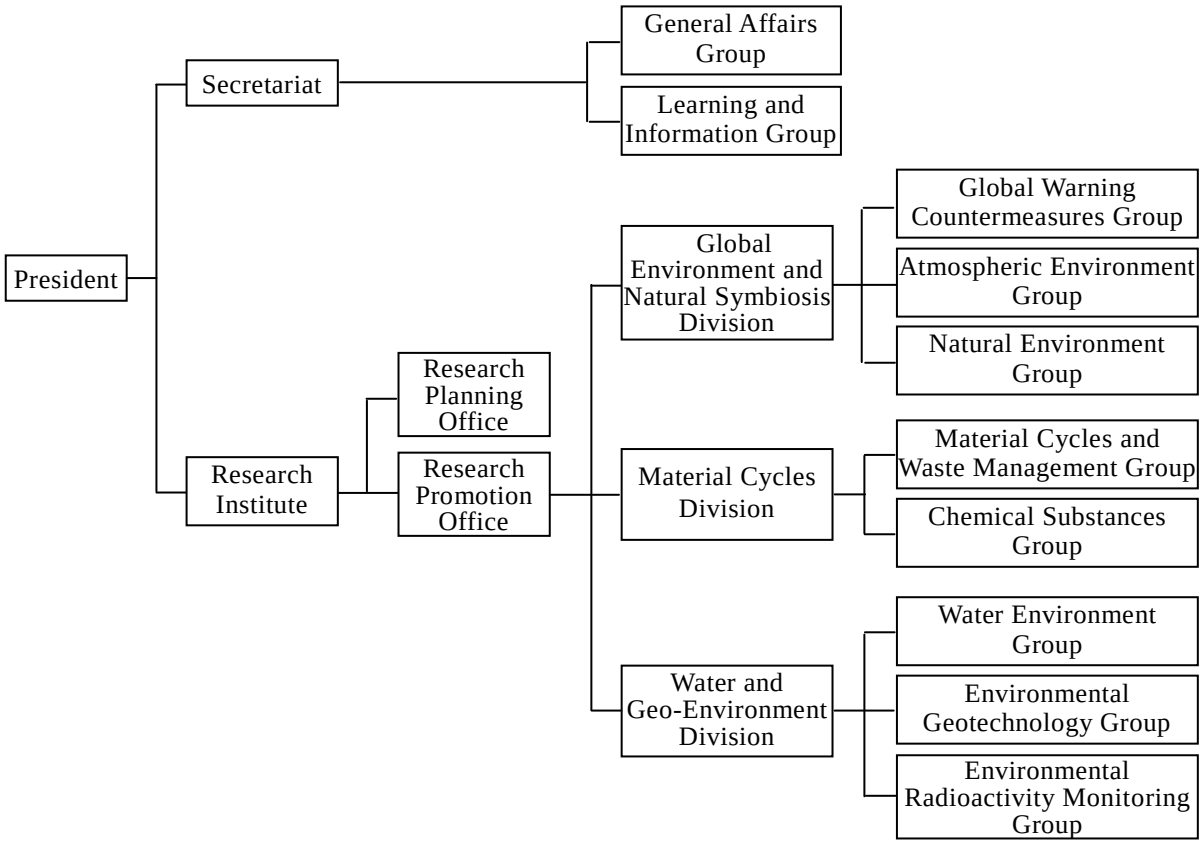
Since the enforcement of the Feed-in Tariff law for renewable energy in 2012, photovoltaic power (PV) generation has been actively embraced in Japan. As a result, the spacious areas available on landfill sites are being increasingly used to install PV generation systems. However, there is a fear that 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.

(4) Study on gaseous mercury in solid waste landfills
(Material Cycles and Waste Management Group: M. Nagamori, T. Hase; Research Promotion Office: Y. Watanabe; 2016–2018)

Mercury-bearing materials have been disposed of in waste landfills from a wide array of sources, including thermometers, batteries, and general waste. Despite the known volatility and toxicity of mercury in the environment, quantitative estimations of mercury emissions from waste landfills on the basis of field measurements have not been widely performed in Japan. As a result of the signing and adoption of the Minamata Convention on Mercury at a diplomatic meeting of the United Nations Environment Programme in October 2013, the discharge and disposal of mercury will now be regulated on a global scale. In this study we intend to examine methods of gaseous mercury collection and to then measure the fluxes of gaseous mercury from gas ventilation pipes and the surfaces of waste landfills. We will then approximate the amounts of gaseous mercury emitted from entire waste landfills.

Organization of Center for Environmental Science in Saitama (CESS)



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