

NIER ANNUAL REPORT 2022

We are working
on many fronts
to enrich life through
environmental research



The National Institute of Environmental Research (NIER) was established in 1978 as the sole institute for research into the entire environment. Since then, NIER has put every effort into creating a better environment for the public through a wide range of research from environmental health, climate&air, water, resources to energy.

Drawing on the outstanding research base, we have provided support for research and policies responsive to the environmental concern of people. To relieve the concern, our focus goes towards a Roadmap, Future-Oriented Research, and Environmental System.

The long-term roadmap will be a breakthrough role for us to come into a world-class institute.

The future-oriented research will be conducted enhancing the lives of people.

The environmental system for efficiently handling urgent environmental issues will be established.

Going forward, we will do our best for the happiness of people with our efforts in creating a better environment.

Thank you

Dongjin Kim, President of NIER

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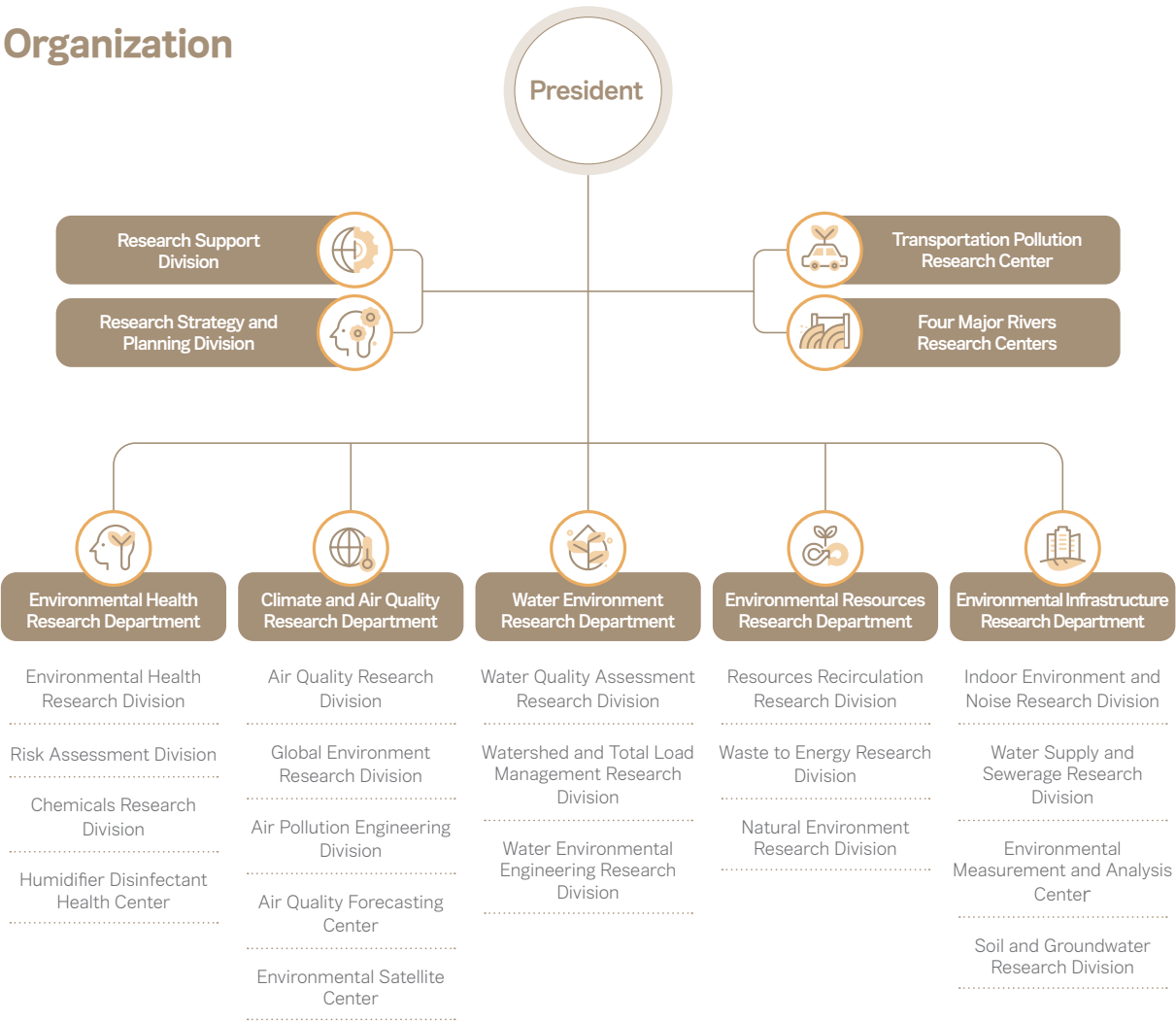
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History

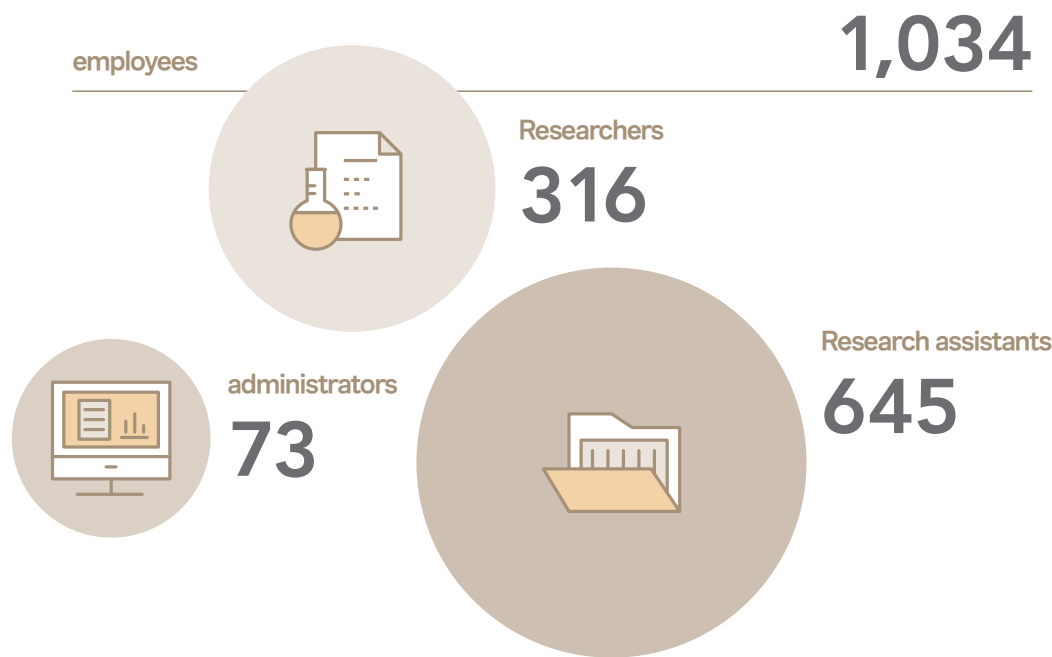


Organization



Workforce

Our people on December 2021



Budget

(Unit: KRW in millions)

Year	2020	2021
Budget	91,577	103,098
Operating Expenses	1,585	1,667
Personnel Expenses	27,856	29,047
Projects	62,136	72,384
- Environmental Research	49,503	58,998
- Research DB Establishment	1,933	2,125
- Research Infrastructure	10,700	11,261

Research Volume

NIER's research projects are classified depending on their financial sources: government funded research projects conducted by NIER and the Ministry of Environment. The total number of research projects in 2019, 2020 and 2021 was 250, 250, and 287, respectively.

(Unit: KRW in millions)

Source of finance	Total		Ministry of Environment		NIER	
	Project	Budget	Project	Budget	Project	Budget
2021	287	89,561	142	58,464	145	31,097
2020	250	64,602	117	37,692	133	26,910
2019	250	62,020	90	30,676	160	31,344

Research Equipment

NIER has 1,646 units of major equipment

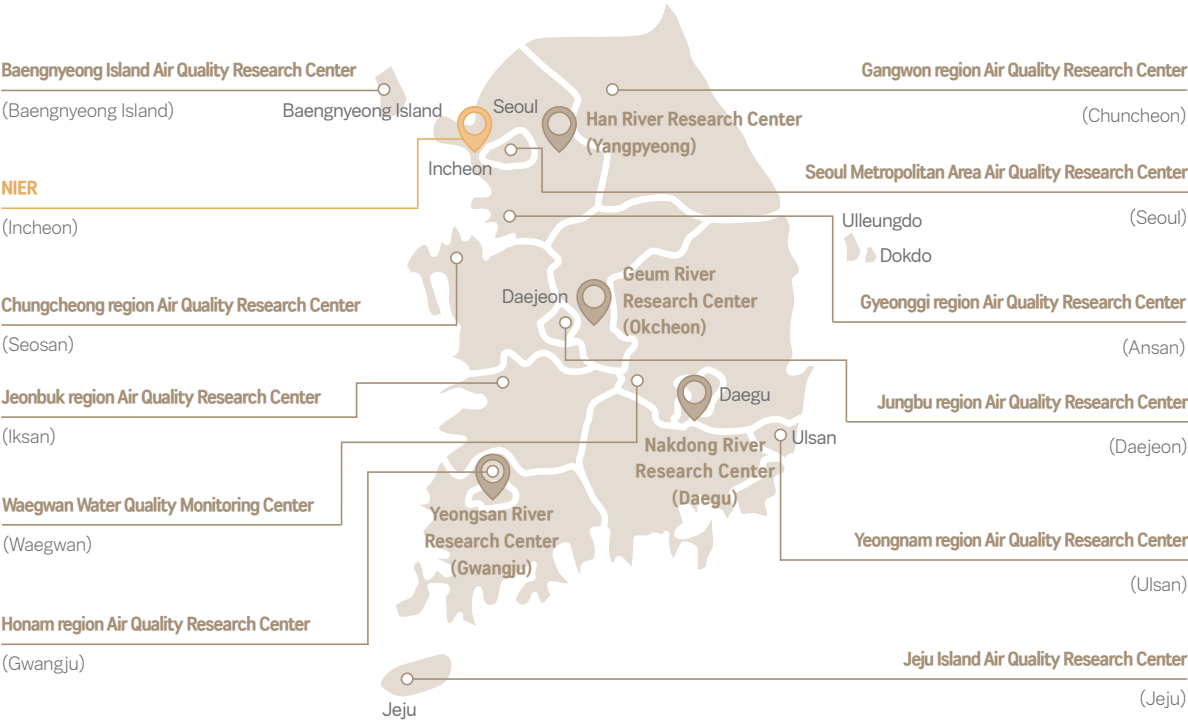
(Unit: EA / KRW in millions)

Division	Equipment	Unit	Amount
Environmental Health Research Department	Animal testing equipment, etc.	231	12,576
Climate & Air Quality Research Department	Air quality meter, etc.	565	35,630
Water Environment Research Department	Inductively coupled plasma mass spectrometry, etc.	159	9,800
Environment Resources Research Department	X-ray diffractometer, etc.	88	5,522
Environment Infrastructure Research Department	MC-ICP/MS, etc.	292	21,726
Transportation Pollution Research Center	Automotive exhaust gas analyzer, etc.	179	55,310
Four Major Rivers Research Centers	Phase-contrast microscope, etc.	332	17,723
Total		1,846	158,287

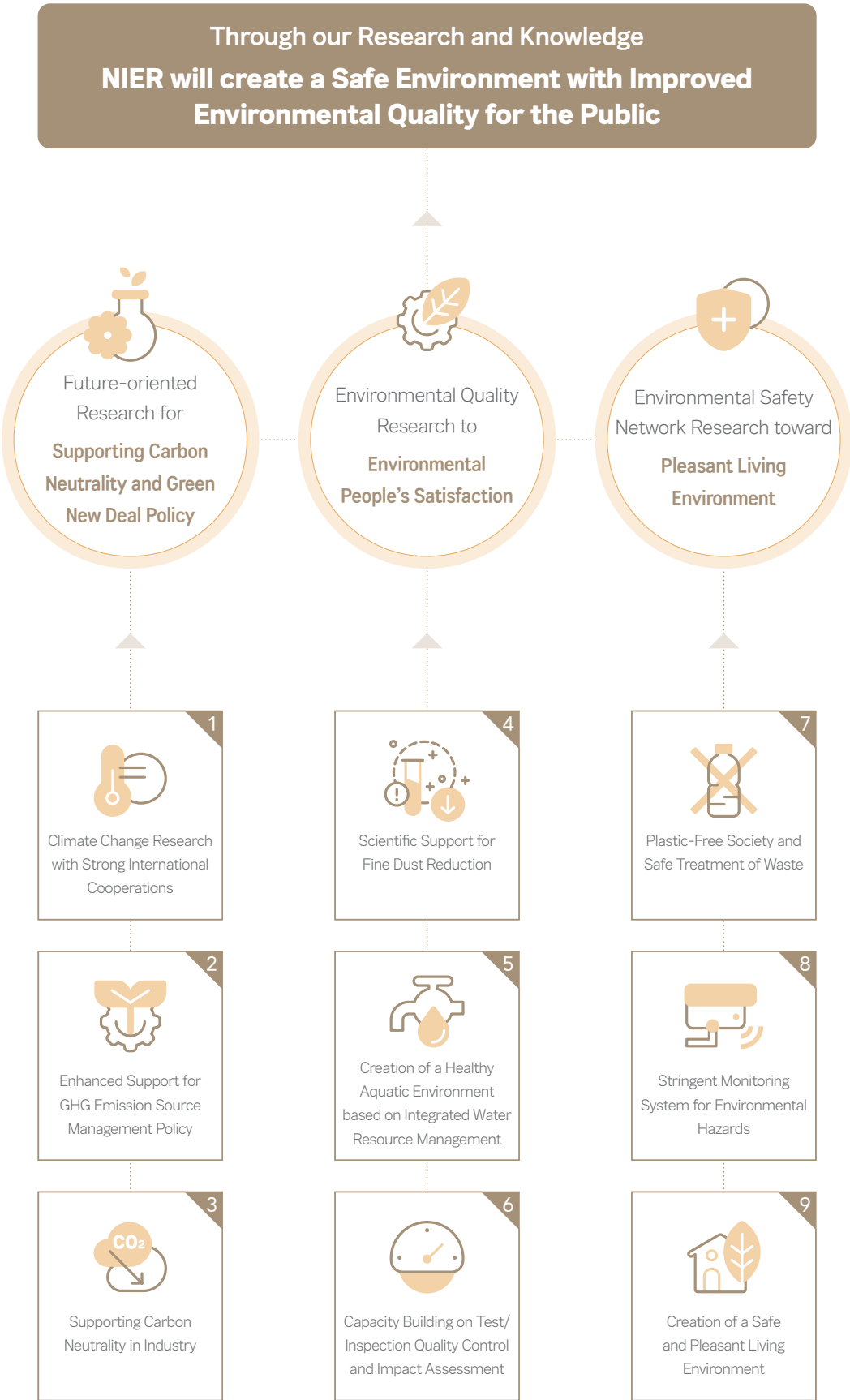
Research Facility



Affiliated Centers



Vision in 2021





Environmental Health Research

We are building a strong safety net for everyday life by expanding the environmental health monitoring system and strengthening the foundation for chemical management to protect the public from harmful environmental factors.

Development and operation of the national environmental health monitoring system

Research on the health effects of environmental exposure on residents in areas vulnerable to pollution

Operation of Korean Children's Environmental Health Study (Ko-CHENS) and World Health Organization (WHO) Collaborating Centre

Conducting Risk assessments and inhalation toxicity studies of hazardous chemicals

Hazard assessments of newly emerging pollutants in aquatic environments and carbon-based nanomaterials

Hazard assessment using petroleum-based material assessments and non-test data

Investigation and research on substances of international interest, such as persistent pollutants

Research on the behavioral characteristics of persistent organic pollutants in the environment

Management of biocides/consumer chemical products and the establishment of a safety system

Health monitoring of humidifier disinfectant victims

Research on the human health effects of humidifier disinfectants and toxic chemicals



Climate and Air Quality Research

We are devoting efforts to research to strengthen scientific air quality management and provide various types of air pollution information to improve air quality for the public.

Constructing a comprehensive research foundation for a region-specific air environment, such as for air pollutants that can travel long distances

Identifying the causes of air pollution through three-dimensional monitoring and expanding the measurement infrastructure

Establishing a research foundation for identifying air pollution characteristics and devising tailored countermeasures by region

Conducting research on national climate change adaptation and constructing an urban air GHG monitoring system

Ensuring international cooperation to improve air quality, such as joining an international organization for GHG verification

Conducting research on enhancing odor measurement techniques to improve the living environment for the public

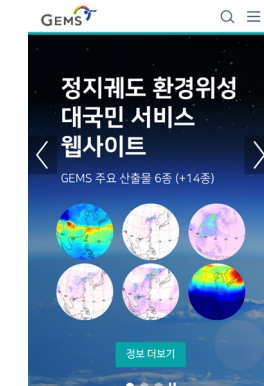
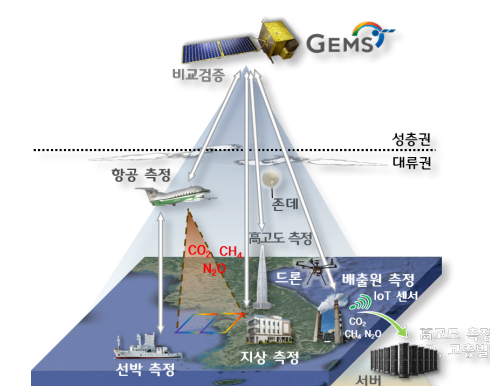
Examining the air pollutant emission characteristics of air emission facilities

Expanding forecast service operations, such as long-term forecasting for nationwide air quality

Conducting research on enhancing forecasting technologies, such as by improving air quality forecasting accuracy

Operating ground stations for Geostationary Environment Monitoring Spectrometer (GEMS) and providing satellite image data

Conducting research on verifying and improving geostationary environmental satellite data and developing utilization technology





Water Environment Research

We are researching to preserve a clean and safe water environment and create a healthy aquatic ecosystem so that the public can enjoy a pleasant water environment.

Forecasting changes in the water environment based on convergence technology

Prediction of water environmental change based on remote sensing

Conducting research on the state of pollution of unregulated trace chemicals in public waters and management measures

Exploring new paradigms for algae response based on molecular biology

Expanding substances regulated under the Total Load Management System and studying tailored management methods

Supporting tailored policies to manage non-point pollutants and improve water circulation

Investigating pollutants in rural areas, such as livestock excreta

Examining the distribution characteristics of microplastics in freshwater bodies and sediments

Conducting research on reinforcing industrial wastewater management and ecotoxicity operating system

Assessing aquatic ecosystem health and diagnosing causes of damage



Environmental Resources Research

We materialize resource circulation society by waste reduction, safety treatment of hazardous waste, and waste-to-energy. In addition, we conduct researches on collecting and analyzing environmental specimens and eco-friendly land management.

Research on reducing final disposal through waste flow analysis

Studying the life-cycle assessment (LCA) of waste plastics recycling

Performing environmental assessment of recycling designation and approval work and improving related systems

Research on the establishment of a hazardous waste information and management system that can respond to international conventions

Research on the preparation of hazardous waste information according to industrial waste classification

Studying waste-to-energy recovery technologies

Conducting research on improving the inspection system for waste treatment facilities

Investigating relevant standards like pyrolysis and melting of waste

Exploring performance assessment technologies for waste incineration facilities

Enhancing environmental values of land supporting sustainable & eco-friendly development

Research on the standard guideline of environmental impact assessment

Environmental quality evaluation using cryogenic biological specimens

Research on establishment of integrated management systems for facilities discharging pollutants





Environmental Infrastructure Research

We are helping create a safe and clean-living environment by reinforcing the basis for managing hazardous household substances so that the public can enjoy a healthy life.

Conducting air quality research on various indoor spaces such as new apartment houses and multi-use facilities

Studying exposure reduction from sensory pollution such as noise and light pollution in everyday life

Establishing a basis for characterizing and managing hazardous household substances such as radon, asbestos, and microorganisms

Expanding the monitoring of trace hazardous substances in tap water and performing research on safety management

Studying the advancement of standards and management for sewage treatment plant effluents

Conducting research on management basis and response for hazardous microorganisms in water environments

Improving the quality of environmental test and inspection results and confirming with international standards (ISO17025 & 17043)

Establishing and revising national (KS) and international (ISO) standards in the environment field and official environmental pollution test methods

Exploring methods to trace environmental pollutants using stable isotopes

Establishing a foundation for advanced soil and groundwater standards and vitalizing risk assessment

Researching management methods for soil and groundwater-contaminated regions

Operating the soil and groundwater information system (SGIS); verifying, assessing, and analyzing monitoring network results



Transportation Pollution Research

We provide science-based support for national environmental policies for assessing the performance of zero-emission vehicles, including electric vehicles, and preventing and managing pollutants from mobile pollutants.

Studying test methods and contribution calculation for non-exhaust systems (e.g., tires and brakes)

Conducting research on environmental friendliness and performance assessment of zero-emission vehicles such as electric vehicles

Performing emission gas control logic assessment and verifying and analyzing the effects of test method implementation using real roads

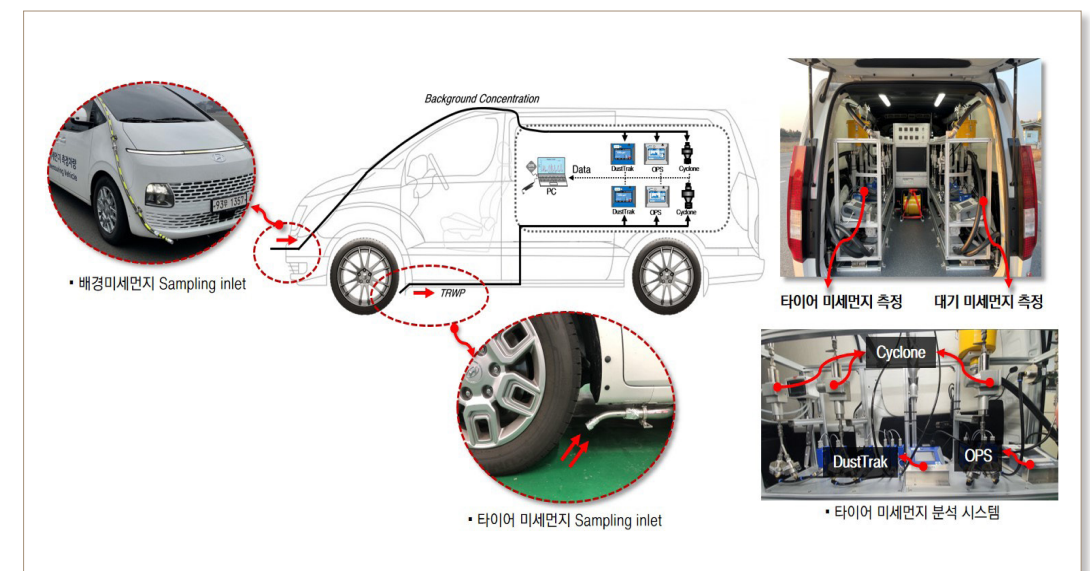
Providing policy support for implementing emission gas management systems in the non-road sector

Managing GHGs and emissions from the transportation sector

Responding to international standards for measuring automobile emissions

Conducting research on developing national emission factors in the transport sector and improving emission calculation methods

Improving quality control and system for automobile fuels, additives, and catalysts and managing fuel-based pollutants





Four Major Rivers Research

We provide science-based support for water environment policies to preserve the water quality and aquatic ecosystems of the four major rivers.

Promoting investigative research projects on environmental issues in watersheds to create a healthy water environment

Monitoring water quality and sediments at the national level to support climate change policies

Measuring mainstream and tributary flows to maintain a Total Maximum Daily Load (TMDL)

Detecting and tracking radioactive materials in public waters to improve the management of a safe water environment

Taking preventive measures to improve the water quality through the development of algal bloom alarm systems and water quality forecasting systems

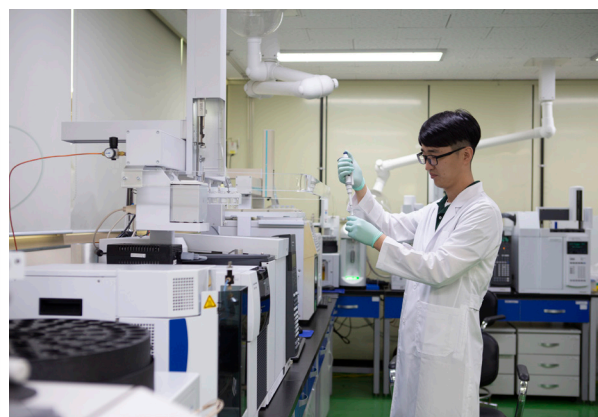
Monitoring the aquatic ecosystems of weirs in the four major rivers

Monitoring and tracking Norovirus in the drinking water in vulnerable areas during periods of drought

Operating the United Nations Environment Program (UNEP) GEMS/ Water Program to produce data describing the national water quality

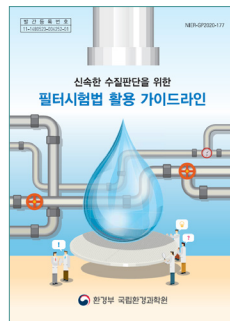
Conducting detailed studies on non-point pollutants and watersheds

Providing support for water pollution incidents and issues related to the water environment



Swiftly managing foreign substances such as rust in tap water (February 25, 2021)

From February 26, NIER will distribute a guide on filter test methods for managing foreign substances in tap water to local governments and other water service providers. This guide will help water service providers enable swift response and preemptive management when they discover abnormalities in tap water caused by colored particles like rust. The guide contains information on standardized filter test and application methods, field application cases, and filter discoloration simulation results according to water quality conditions. The filter test method involves simply and quickly measuring whether water quality is abnormal due to rust and other impurities. Specifically, 1l of tap water is filtered through a membrane filter with a pore diameter of 0.45 μ m, and the thickness of filtered foreign substances is visually checked. This method enables measurements within 10 minutes and point-to-point or time-based comparisons. The filter test results can also be compared with existing water quality measurements, allowing water service providers to judge the situation swiftly in the event of an emergency. Normally, water can be periodically monitored to identify and prepare for regions of concern for water quality accidents beforehand. This guide can be downloaded from NIER's Environmental Information Library (ecolibrary.me.go.kr/nier) or MOE's Digital Library (library.me.go.kr). NIER commented, "The test and application methods in this guide will help effectively manage foreign substances in tap water, providing effective guidelines to supply clean tap water."



Two Toxicity Assessment Humidifier Disinfectant Health Centers designated. Investigation of diseases expanded (March 4, 2021)

On March 4, NIER announced the designation of two Humidifier Disinfectant Toxicity Assessment Health Centers (hereinafter "health centers"). These centers are dedicated to studying the effects of diseases caused by the toxicity of humidifier disinfectants. The designated health centers are the Korea University Ansan Hospital and the Korea Institute of Toxicology. Following this designation, there are now 13 total health centers, which include 10 medical health monitoring sites and 1 mental health monitoring site (including 148 regional counseling centers nationwide) designated in March last year. Other than asthma and lung fibrosis of humidifier disinfectant victims, the toxicity assessment health centers focus on the occurrence and toxicological mechanisms of various respiratory and chronic diseases such as cancer, etc. The Korea University Ansan Hospital uses computed tomography to monitor the development and progress of cancer and other chronic diseases. The Korea Institute of Toxicology uses inhalation exposure test technology to examine respiratory diseases and the toxicological mechanisms of various health effects. The findings of the toxicity assessment are used as basic data for estimating the causal relationship between humidifier disinfectants and health effects. The results are also applied in diverse ways for damage relief, such as early diagnosis and medical support for humidifier disinfectant victims when the possibility of disease occurrence is confirmed. The NIER will finalize the research plans submitted by the toxicity assessment health centers by this month and plans to fully begin the research project on humidifier disinfectant disease from April this year. NIER commented, "Toxicity studies thus far have served an important role in determining the health damage from humidifier disinfectants. Through these health centers, it will be possible to identify the causal relationship with health impacts and provide support for victims together."

Improving air quality in the region. Gangwon Air Environment Research Center opened (March 26, 2021)



On the afternoon of March 26, NIER will hold an opening ceremony at the Gangwon Air Environment Research Center (hereinafter "research center") located in Chuncheon-si, Gangwon-do. The Gangwon Research Center has a total area of approximately 728 square meters and is three stories above ground. It plans to constantly monitor air pollutants in the Gangwon area, a windy region in the metropolitan area, and identify the causes of air pollution. Additionally, to identify the characteristics of high-concentration fine dust generated in Gangwon, the NIER will sign a business agreement with Kangwon National University on the day of the opening ceremony and conduct joint air quality research in the Gangwon region. The Gangwon Research Center is the tenth following Baengnyeongdo, Seoul metropolitan area (Seoul), Honam area (Gwangju), the central area (Daejeon), Jeju-do, Yeongnam area (Ulsan), Gyeonggi area (Ansan), Chungcheong area (Seosan), and Jeonbuk area (Iksan). After a preliminary operation period of six months, it will commence full operation in the second half of this year. To more accurately monitor air pollutants, it will operate 13 types of 19 measuring devices, including fine dust (PM-10), ultrafine dust (PM-2.5), metal components (e.g., lead, calcium, arsenic, manganese, and nickel), ionic components (e.g., sulfate and nitrate), and carbon components (e.g., organic carbon and inorganic carbon). The opening of the Gangwon Research Center is an example of the Ministry of Environment and NIER actively responding to the needs of local communities like civic groups in the Gangwon region. Once the research center is fully operational, it will enable comprehensive research on the characteristics of fine dust in the metropolitan area, including Gangwon-do. This will be achieved through integrated analysis with 22 urban air monitoring networks, 6 heavy metal monitoring networks, and 10 suburban air monitoring networks installed in Gangwon-do. Meanwhile, the NIER conducted a study in 2018 regarding the high concentrations of fine dust in the Gangwon region. The results stated that the topographical effects of the Taebaek Mountains cause pollutants introduced from windward regions (regions from which the wind blows) and locally emitted pollutants to accumulate without being discharged, maximizing the generation of secondary pollutants (e.g., ultrafine dust). Regarding the recent high concentrations of fine dust (February 10–15, 2021), due to the inflow of pollutants from the upper layers, the fine dust concentration in Gangwon was the first in South Korea to rise above "Unhealthy." NIER commented, "The Gangwon Research Center will become a focal point for regional air quality research and sharing and communicating information about fine dust with local residents. By obtaining and sharing high-resolution observation data, we will establish the center as a base research institute for air quality in the Gangwon region."

Monitoring ultrafine dust at industry complex with advanced measurement using sunlight

(April 7, 2021)

NIER announced that it recently developed a solar occultation flux (SOF) measurement technique that measures substances causing ultrafine dust from only stacks but also fugitive emissions from production processes using sunlight from long distances in real time. Fugitive emissions are air pollutants directly emitted into the atmosphere from storage facilities and valves at factories without passing through specific outlets such as stacks. This had made it difficult to accurately calculate emission quantities and find pollutant sources and apply emission standards. The new SOF measurement technique creates a large virtual pillar between the sun and measuring equipment, surrounds the entire factory like a high wall, finds the point of leakage, and quantitatively calculates the amount of emissions. This measurement method is a proven technique used in the management of large petrochemical complexes in the United States, Sweden, etc.. In Europe, it is used as the Best Available Technology (BAT) for measuring the emissions of substances that cause ultrafine dust. The Ministry of Environment implemented this SOF equipment with its supplementary budget in December 2019, and the NIER established the measurement technique for this equipment through a test operation last year. The measurement technique can be applied to quantitatively calculate and reduce fugitive emission pollutants in the air environment, and companies can reduce production costs by preventing leakage of raw materials or products. Moreover, as it can remotely monitor pollutants emitted from stacks higher than 100 m without directly entering the factory, it raises awareness about pollutant emissions and can prevent illegal emissions. During operation of the Second Fine Dust Seasonal Management System Period (December 2020 to March 2021), the NIER performed field measurements using the SOF equipment in large petrochemical complexes such as in Daesan. During the period, the NIER measured pollutants generated during abnormal operation or leakage from processes by measuring movement. In particular, a leak was discovered in a specific storage tank, and measures were taken to improve it. Through mobile-based remote spectral observation, the NIER plans to measure the concentrations of volatile organic compounds, which produce ultrafine dust and ozone, and investigate emissions to develop measurement-based emission factors. NIER commented, “Aside from monitoring air pollutant emissions, this SOF technique will support mutual growth with companies as a revolutionary scientific technology that can diagnose leakage in processes.”



<Figure.1 SOF mobile lab>



<Figure.2 Internal measuring equipment>

Information on water pollutants by work site industry “at a glance” (June 9, 2021)



On June 9, NIER will publish its Water Pollutant Emissions Inventory Guide (hereafter “guide”). It was created based on the results of field surveys of wastewater discharge facilities according to industry classification in South Korea (536 locations nationwide). The objective is to enable the efficient management of wastewater discharge facilities. Information on discharge characteristics by industry is crucial because, in the wastewater generated by industrial facilities, the water pollutant items and concentrations significantly vary according to industry. The NIER created this guide to provide an emissions inventory for 82 industries and information on emission characteristics by type of wastewater discharge facility to the managers of wastewater discharge facilities. The guide contains the purpose of the publication, composition, method of use, and emissions inventory tables for 82 industries. Further, to use the guide efficiently, the NIER also prepared a summary to improve readability and information delivery. In particular, the emissions inventory is based on the analysis results of water pollutants

from field surveys of wastewater discharge facilities and a review of literature from developed countries (e.g., the United States and the European Union). It contains 51 water pollutant items for the 82 wastewater discharge facilities classified in Annex 4 of the “Enforcement Rule of the Water Environment Conservation Act.” The 51 water pollutant items are organized on one page so that readers can quickly check them at a glance. The NIER plans to continuously update the guide by surveying newly designated water pollutants and new emission standard items. The guide can be downloaded from NIER’s Environmental Information Library (ecolibrary.me.go.kr/nier) or MOE’s Digital Library (library.me.go.kr); the summary of the guide is distributed through the local government’s department in charge of permit grants. NIER commented, “For authorities in charge of permit grants for wastewater discharge facilities, we expect this guide to provide practical information such as items and concentrations of water pollutants that can be discharged by different wastewater discharge facilities.”

Respiratory rehabilitation video for humidifier disinfectant victims (June 27, 2021)

NIER created a “respiratory rehabilitation video” and explanation guide and will release it on June 28. The aim is to help improve the health of victims suffering from respiratory diseases due to humidifier disinfectants, such as by improving breathing and relieving symptoms. The video can be viewed on NIER’s YouTube channel (www.youtube.com/nierner0), and the guide can be downloaded from NIER’s Environmental Information Library (ecolibrary.me.go.kr/nier) and Korea Environmental Industry & Technology Institute’s Humidifier Disinfectant Damage Support Portal Resource Center (healthrelief.or.kr). The approximately 40-minute respiratory rehabilitation video was produced based on research results related to rehabilitation technologies for humidifier disinfectant health damage. The video features professional models and exercise experts who demonstrate movements with voice guidance. The video comprises eight topics, including respiratory exercises to strengthen breathing and inspiratory muscle, arm/leg exercises to improve muscle strength, and stretching exercises to enhance flexibility. The guide contains explanations of the purpose, precautions, and tips for each exercise by topic. When developing the respiratory rehabilitation video, the NIER conducted a pilot test over eight weeks with 27 participants in a humidifier disinfectant health monitoring program. The results demonstrated that breathing-related health indicators somewhat improved. The dyspnea score (mMRC), an index assessing respiratory health status, improved (average 1.7 → 1.0), and the results of a six-minute walking test that measures aerobic exercise ability also improved (average 498m → 522m). The NIER plans to support the victims with respiratory disease so that they can safely use of this respiratory rehabilitation video by prescribing exercises of an appropriate type and intensity at ten Humidifier Disinfectant Health Centers nationwide. NIER commented, “We expect victims with difficulty visiting hospitals due to the recent spread of COVID-19 to be able to follow respiratory rehabilitation exercises easily in their home while watching this video.”



Han River Environment Eco Center, Meet aquatic life at Paldang Lake in virtual reality (June 28, 2021)

NIER will establish a virtual reality (VR) Paldang Lake Experience Center at the Han River Environment Eco Center (located in Yangpyeong-gun, Gyeonggi-do) and begin operation from June 28. The Han River Environment Eco Center within the Han River Water Environment Research Center will hold a new exhibition using VR technology. The aim is to provide more diverse information on the water environment and ecology of the Han River in existing exhibition spaces, including an exhibition aquarium, five senses experience center, information kiosks, and ecological postcard making. The VR experience center showcases two types of content: “viewing content” that exhibits the ecological environment of Paldang Lake through a head-mounted display and “experiential content” where users can enjoy the aquatic life of Paldang Lake in games of hide-and-seek. The experience hall also contains integrated unstaffed VR kiosks that users can select directly. The VR experience screen is transmitted to a display on the unstaffed kiosk; therefore, family and friends accompanying the headset user can also enjoy the contents. Sensors attached to the device also recognize the user’s hand gestures, enabling an intuitive experience and deepening the VR exhibit’s immersion. The Han River Water Environment Research Center is adding more exhibits using advanced technologies. For example, it implements “Water of Time,” which retells the history and development of the Han River, and “Dragonfly Story,” an augmented reality experience that relates the life cycle of dragonflies, on the unstaffed kiosks’ high-resolution screens. NIER commented, “This experience center will become a new exhibition method for sharing information on the ecology of Paldang Lake. We plan to expand it through diverse digital exhibits and develop it into the best ecological experience center in South Korea.”



Measuring air pollution levels such as lead with pine needles

(July 22, 2021)

NIER announced that it recently established a standardized research basis for measuring air pollution using pine needles, which are easily found in the environment. This study focuses on the fact that heavy metal air pollutants like lead (Pb) floating in the air can be absorbed and accumulated during the respiration of leaves. Of needle-shaped leaves that have been attached to trees for at least two years and can be collected regardless of season, this study used pine needles. The measurement technique involved collecting pine needles around the region of interest, transferring them to a laboratory, and analyzing the pollution level. First, one-year pine needles above a certain height (approximately 3 m) are evenly collected, pulverized in a cryogenic state, and homogenized and preprocessed to measure the pollutants. Subsequently, using analysis techniques like inductively coupled plasma mass spectrometry and gas chromatography-mass spectrometry, pollutants like lead, cadmium (Cd), chromium (Cr), and polycyclic aromatic hydrocarbons (PAHs) are measured. The NIER research team explained that this pine needle technique could be used to measure air pollution even in areas that have been difficult to measure due to the inability to introduce separate measuring devices or the lack of air pollution monitoring stations. This study is also meaningful because it established a foundation for research on developing environmental indicators using biological species like pine needles. From next year, the NIER plans to promote research on air pollution measurement using biological indicators, such as through pilot measurements of air pollution using pine needles in certain regions. NIER commented, “We plan to develop various biological and environmental indicators based on pine needle specimens and the Environmental Specimen Bank and actively utilize biological indicators to measure environmental pollutants in the air, water, and soil.”

Two Korean test and analysis methods for the environment established as international standards

(September 16, 2021)

NIER announced that two domestic environmental test and analysis methods proposed to the International Organization for Standardization (ISO) were finally approved as international standards and will be published on September 17. The two internationally established methods are “Soil quality—Determination of selected explosives and related compounds (ISO 11916-3)” and “Water quality—Determination of microcystins (ISO 22104),” which were developed through the government’s standard development support project. “Soil quality—Determination of selected explosives and related compounds (ISO 11916-3)” was proposed to the ISO in 2018 by Professor Lee Gun Taek of the National Instrumentation Center for Environmental Management at Seoul National University. After three years of discussion and verification, it was finally approved in August of this year and published. This international standard established a procedure for analyzing compounds related to explosives using liquid chromatography-mass spectrometry, a precision analysis technique. It is important as it promotes soil remediation projects, such as by providing a technique to diagnose sites contaminated with explosives accurately. “Water quality—Determination of microcystins” was proposed to the ISO by the NIER. After four years and four months of discussions, revisions, and developments by international experts, it was finally approved in July of this year and published. This international standard enables the precise analysis of microcystins. Thus, it is expected to be used for water management in numerous countries worldwide. Additionally, two new standards proposed by the NIER (“Method for evaluating air purifier’s reduction performance of airborne mold” and “Guide for separation ease of PET bottle labels”) were approved based on voting by ISO member countries in January and August of this year, respectively. These standards are being developed into international standards. NIER commented, “The establishment of these international standards is an opportunity to demonstrate the global competitiveness of South Korea’s environmental measurement and analysis technologies. After completing international standardization, they can be introduced as Korean Standards (KS) and actively utilized. Through training for international environmental standards experts beginning in the second half of this year, we will enhance the standard development capabilities of environmental technology experts across diverse fields.”

Environmental Specimen Bank International Conference to be held. Attended by experts from 11 countries, including Germany

(September 28, 2021)

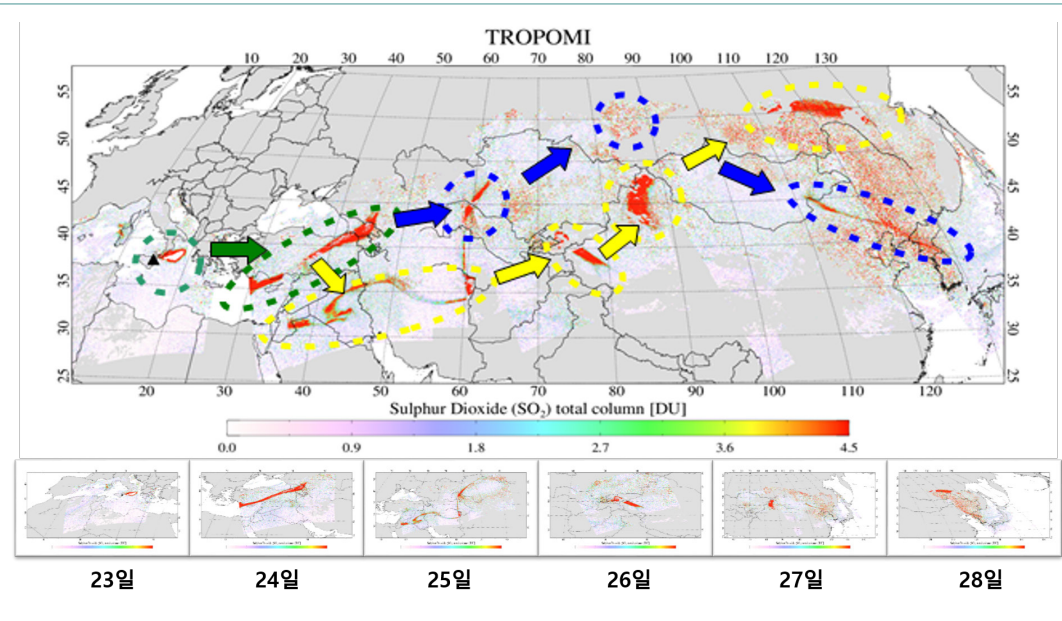


From September 28 to 30, NIER will hold the Sixth Environmental Specimen Bank(ESB) International Conference at Songdo Central Park Hotel (located in Yeonsu-gu, Incheon) via online virtual conference. It will be attended by approximately 40 participants, including heads of environmental specimen banks and experts from 11 countries, including the German Environment Agency and the US National Institute of Standards and Technology. At the international conference, representatives from each nation will share experiences and application cases of environmental pollution analysis, including cryogenic storage techniques for environmental specimens, and discuss cooperative measures to address organic persistent pollutants that cause cross-border pollution. The conference comprises a total of seven sub-topics under the major topics of (1) Establishment and Operation, (2) Utilization, and (3) Roles and Challenges of ESB. In the first topic, Operation of ESB, Sweden and Germany, which first established ESB in the 1960s and 1970s, and South Korea and China, which later established banks in the 2000s, share their experiences operating ESB and their current status. In the second topic, Measures for Stable Management of Cryopreserved Specimens, the US National Institute of Standards and Technology, France, and ESB of South Korea discuss and share technologies. Further, in the third and fourth topics, Utilization of Cryopreserved Specimens, attendees review the past state of environmental pollution with specimens collected over several decades, examine cases in Italy, Germany, and Spain that assessed the accumulation of pollutants through the ecological food chain, and discuss utilization methods. In the fifth topic, Challenges of ESBs, the German Environment Agency, and others present the application feasibility of the latest technologies, such as environmental gene analysis (eDNA) and non-target analyses that use environmental specimens. Subsequently, in the sixth topic, Roles of Environmental Specimen Banks in Pollutant Management Policy, the EU, Japan, and South Korea present their respective cases. Finally, in the seventh topic, the attendees will discuss in-depth plans to reinforce cooperation between the ESBs of each country. NIER commented, “Through this conference, we will analyze the accumulation of pollutants in the ecosystem and their impacts using environmental specimens and explore paths to support the establishment of pollutant management policies based on this analysis. Meanwhile, we will actively promote cooperation between the ESBs of each country.”

Volcanic gas from Italy captured by Geostationary Environment Monitoring Spectrometer

(November 2, 2021)

On November 2, NIER published on its Environment Satellite Center website (nesc.nier.go.kr) images captured by GEMS(Geostationary Environment Monitoring Spectrometer) showing sulfur dioxide (SO₂) generated from the volcano Mount Etna in Italy moving through the Asian continent and passing over the northern sky of the Korean Peninsula. Mount Etna, located in the eastern part of Sicily in Italy, is the largest active volcano in Europe. It has been erupting continuously since February 16 of this year, and it erupted again on October 23 at 17:00 KST. In the images from GEMS monitoring air pollutants of Asia an hourly basis during daytime, some sulfur dioxide gas first flowed in over the northern part of the Korean Peninsula on October 27. On October 28, it moved to the south of the Peninsula and passed over some parts of Gangwon-do. Despite the volcano erupting in Italy nearly 9,000 km away from the Korean Peninsula, the volcanic gas moved to Asia as it was a large-scale eruption. The NIER research team examined the effects of the gas in South Korea and they found that as of October 28, there was no large change in sulfur dioxide concentration at the ground observatory in the region. Meanwhile, the NIER identified the path of volcanic gas from Mount Etna by adding more data from European low-orbit environmental satellite(TROPOspheric Monitoring instrument), which had scanned the movement of the gas once or twice a day before it moving into Asia region. As a result, sulfur dioxide emitted by the volcanic eruption (October 23) was separated into two air currents on October 25 while moving toward the eastern region of the Asian continent, and one air current moved toward the Korean Peninsula. On March 22, 2021, the Environmental Satellite Center of NIER released the first set of Asia air quality image data of eight types, including Nitrogen dioxide concentrations, Aerosols, Ozone concentration, Effective cloud fraction, three UV-related products(Plant response index, Vitamin D synthesis index, DNA damage index), and Sulfur dioxide concentration. Since then, it has released satellite data analysis reports on unusual phenomena (e.g., volcanic eruptions) via the Environmental Satellite Center website (nesc.nier.go.kr). Not to mention to major volcanoes in Japan (e.g., Mount Aso and Sakurajima) and in the Philippines and Indonesia located near the Korean Peninsula, like the case of Mount Etna, when sulfur dioxide traveled long distances is captured by GEMS, the ESC provides a corresponding analysis report. NIER commented, "Even if a volcano erupts thousands of kilometers away in Italy, if it is a large-scale eruption, volcanic gas can move to the Asian region, and we can use GEMS to identify its traveling path by the hour." and added "NIER will make a full effort to monitor and respond to future air pollution with a three-dimensional monitoring system that combines the advantages of satellites with the existing ground monitoring network."



Tripartite Presidents Meeting among NIER, CRAES, and NIES

(November 3, 2021)

On November 4, NIER will hold the 18th Tripartite Presidents Meeting (TPM) online at Songdo Central Park Hotel (located in Yeonsu-gu, Incheon) with the Chinese Research Academy of Environmental Sciences (CRAES) of China and the National Institute for Environmental Studies (NIES) of Japan to improve environmental quality in Northeast Asia. In this meeting, Kim Dong Jin (President, NIER), Li Haisheng (President, CRAES), and Kimoto Masahide (President, NIES) will discuss ways to promote cooperation in environmental research among the three institutes, with looking into joint research progress in the Potential Research Areas (PRAs) of air quality, water quality, climate change, and environmental health, expected to strengthen research cooperation with each other. Air quality and environmental health areas are led by the NIER, the water quality field and the climate change field are led by CRAES and NIES, respectively. Through this meeting, researchers from the three institutes will share views on the following: (1) improvement of forecasting models in the air quality field; (2) research progress for integrated water management systems in the water quality field; (3) proposals of new research topics for future cooperation in the climate change and environmental health fields. On top of sharing views, the global issue of climate change adaptation will be discussed in depth, following the online talks at the 17th Tripartite Presidents Meeting (TPM 17) in December, 2021 virtually held by NIES, where Japan's Climate Change Adaptation Center was introduced. In the special session of climate change adaptation, six presentations in total would be made, two from each of the three institutes. The Korean research institute will share the results of two studies, its major roles in climate change adaptation, and urban climate mapping based on climate change adaptation and environmental planning. The Japanese research institute will introduce its regional adaptation plan through cooperation with the Climate Change Adaptation Center and the Asia-Pacific Climate Change Adaptation Information Platform Project. The Chinese research institute will share the research results on GHG emissions from landfills with achieving carbon neutrality. NIER commented, "the TPM is a highly meaningful meeting to discuss paths toward a close cooperation between three institutes to address future environmental issues and improve the environmental quality of Northeast Asia."

Additional technical review to determine the suitability of industrial diesel exhaust fluid for vehicles

(November 18, 2021)

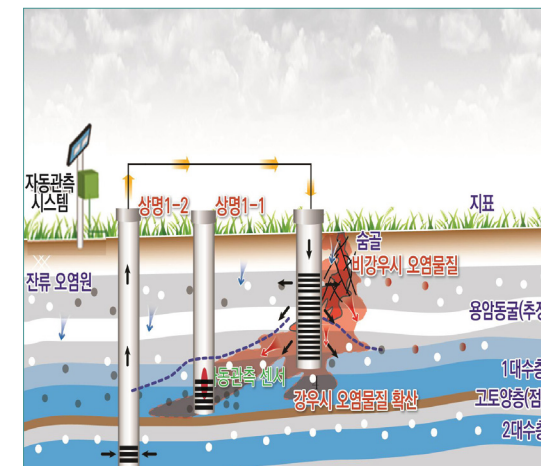
On November 16, NIER announced the experimental results thus far on whether industrial diesel exhaust fluid (DEF) can be converted to vehicle DEF. In this experiment, the NIER prepared six samples of non-vehicle urea to match vehicle DEF (urea concentration around 32.5%). Of these, two samples with medium and high aldehyde concentrations were injected into a vehicle, which were then examined over 11 days from November 2 to determine whether the pollutant emission standards after driving were met. To analyze the air pollutants emitted after driving, these two samples (samples (1) and (2)) were injected into the DEF tank (capacity of approximately 15l) of a diesel truck with a displacement of 2500cc (Kia Bongo 3, 2021 model); after driving, the exhaust gas was analyzed. According to the analysis results, all air pollutant regulations, including carbon monoxide (CO) and nitrogen oxide (NOx), were met. The air pollutant concentrations were generally similar to that of commercially available vehicle DEF. For aldehyde, sample (1) demonstrated a decrease of 7.9% compared to vehicle DEF, and sample (2) demonstrated an increase of 19.8%. DEF manufacturers, automakers, and air environment experts opined that additional tests would be preferable to accurately evaluate the environmental impacts of industrial DEF and safety on selective catalytic reduction in vehicles. They also noted that the applicability of industrial DEF might vary with the component content, given that the component content of industrial DEF highly varies with its purpose of manufacture. Therefore, the NIER judged that this test alone is insufficient to assess the applicability of non-vehicle DEF and plans to perform a technical review that adds two samples with a lower aldehyde concentration and a test vehicle (3.5-ton Hyundai Mighty).



Confirmed improvement of groundwater quality in area of Jeju-do where livestock manure was spilled (November 25, 2021)

(November 25, 2021)

NIER announced that according to the “Jeju-do Hallim-eup Livestock Manure Spill Area Groundwater Quality Improvement Demonstration Project (2020-2021)”, the water quality was significantly improved, such as a reduction in groundwater nitrate nitrogen by up to 90%. On November 7, 2019, the NIER signed a business agreement with Jeju Special Self-Governing Province to promote the “Jeju-do Hallim-eup Livestock Manure Spill Area Groundwater Quality Improvement Demonstration Project” and has been implementing the water quality improvement project since January of last year. The NIER research team investigated the groundwater-contaminated area in Hallim-eup over eight months from April last year. They found that the nitrate-nitrogen concentration in the upper layer of the groundwater (depth of 65–80m) was approximately 30 mg/L. This exceeds the drinking water quality standard of “10mg/L or less” when using groundwater as drinking water. Conversely, the concentration of nitrate nitrogen in the lower layer of groundwater (depth of 180m or less) was approximately 2mg/L or less. To reduce nitrate-nitrogen concentrations in the upper-layer groundwater, the NIER applied the flushing method, which injects clean, uncontaminated groundwater from the lower layer (depth of 180m or less) into the polluted groundwater in the upper layer. This dilutes the high-concentration nitrate nitrogen and washes away various pollutants. From June to November of this year, approximately 40 tons of lower-layer groundwater were pulled up and injected into the upper layer per hour for 24 hours. After about five days after injection, the nitrate-nitrogen concentration in the upper-layer groundwater decreased to 3-4 mg/L, an improvement effect of up to 90%. This is markedly lower than the 10mg/L water quality standard for drinking water. Moreover, in June of this year, the NIER constructed a water quality monitoring system (automatic device analysis) that can inspect the ammonia nitrogen and nitrate nitrogen in the groundwater in the area in real time. The system collects groundwater at regular 1-hour intervals through air injection and continuously measures changes in groundwater water quality through automatic analysis equipment. The NIER plans to develop a “site-connected nitrate-nitrogen reduction system” that adds remote monitoring functionality to the real-time water quality monitoring system by 2024 and establish a scientific basis for managing water quality in areas vulnerable to groundwater pollution. NIER commented, “We will install the automatic site analysis equipment in areas vulnerable to groundwater pollution to continuously monitor changes in water quality and contribute to preserving clean groundwater in Jeju with techniques that reduce groundwater pollutants.”



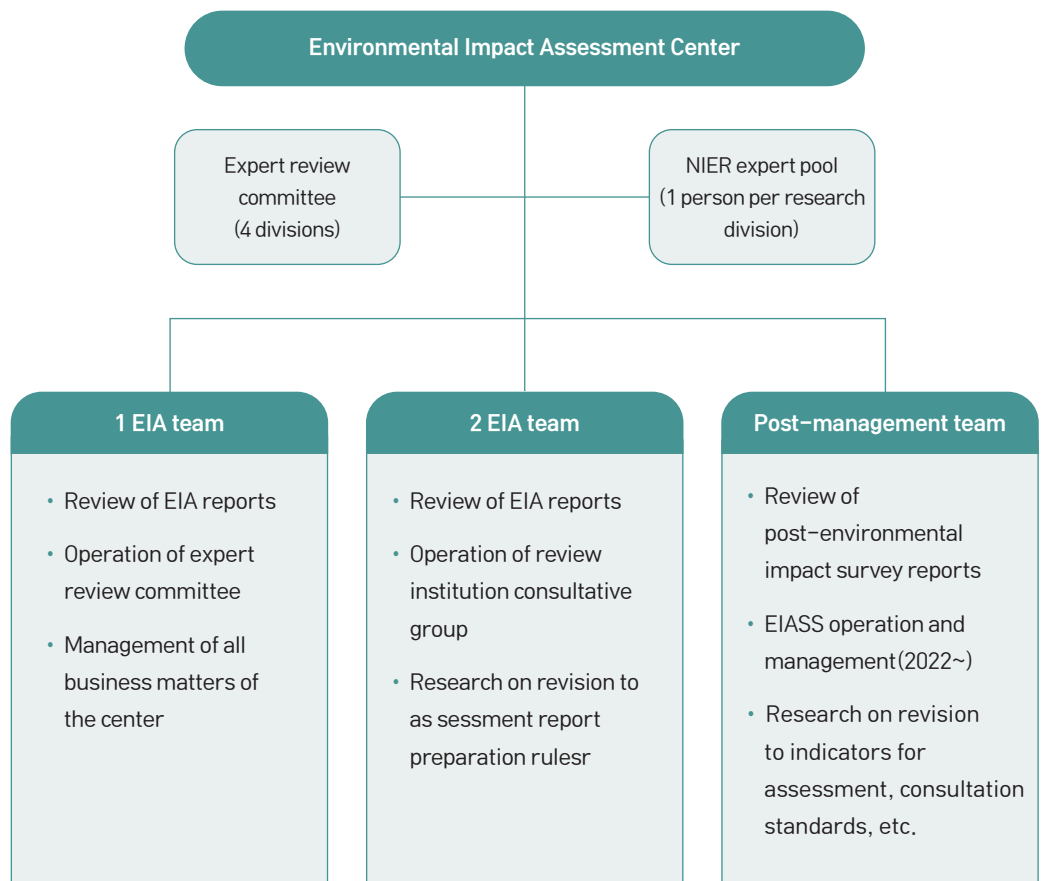
Schematic diagram of flushing method



Injection system(front)

Full operation of NIER Environmental Impact Assessment Center (December 19, 2021)

NIER recently opened its Environmental Impact Assessment Center (located in Seo-gu, Incheon) and will commence full operation from January next year to further develop the environmental impact assessment (EIA) system. EIA is a system introduced in 1977 to devise measures to prevent environmental pollution by investigating and assessing environmental impacts that may occur beforehand in the process of implementing large-scale development projects or important government policies. The Environmental Impact Assessment Center comprises three teams (two EIA teams and one post-management team) composed of a total of 18 members. It is run as a system in collaboration with an expert review committee from the NIER and experts in charge of each research department. Its main tasks are to review strategy, environment, small-scale EIA reports, and post-management project assessments of various development projects and conduct research on related guidelines. It is also responsible for supporting the assessment system, which includes managing the EIA Support System (EIASS) to efficiently store and utilize information produced during system operation. The Environmental Impact Assessment Center plans to play a pivotal role in future response research by identifying technological advancements and the diverse needs of the public in advance, integrating the results of relevant institutions, and reflecting them in the system. The Environmental Impact Assessment Center plans to enhance the review of EIA reports to improve system operation and leverage the expertise of the NIER across all environmental fields to raise the EIA capabilities of South Korea. NIER commented, “The EIA system realizes all policy goals to promote eco-friendly and sustainable development and a healthy and pleasant life for the public. The Environmental Impact Assessment Center will significantly contribute to strengthening the system’s foundation and enhancing its effectiveness.”



Concentrations of environmentally hazardous substances in Koreans were mostly down from three years ago (December 28, 2021)

The NIER (President Kim Dong Jin), a body of the Ministry of Environment, opened up the results of the Fourth Korean National Environmental Health Survey (KoNEHS) conducted over three years from 2018 to 2020. For this survey, blood and urine samples were collected from 6,381 Koreans aged three years and over from 245 regions and 181 childcare and educational institutions sampled nationwide. Overall, the concentrations of 33 environmentally hazardous substances in South Koreans decreased or were similar to those three years ago, while some bisphenols and parabens somewhat increased. Regarding heavy metals, the concentration of lead in the blood of adults was 1.51 $\mu\text{g/L}$, a decrease compared to the previous survey results (first to third surveys). However, the concentrations of mercury in the blood of adults and middle/high school students were 2.96 $\mu\text{g/L}$ and 1.38 $\mu\text{g/L}$, similar to those of the third survey. Cadmium concentrations in urine were decreased in all age groups compared to the third survey, with particularly large decreases for infants and young children and teenagers. Bisphenol-A concentrations in urine were decreased in all age groups compared to three years ago. Although the 1.44 $\mu\text{g/L}$ concentration in elementary school students was relatively high, this is much lower than Germany’s health effects recommendations (HBM-I). Meanwhile, bisphenol-F and -S increased in all age groups compared to the third study, but most had low concentrations of less than 0.3 $\mu\text{g/L}$. Bisphenol-F and -S, which are used as substitutes for bisphenol-A, may have similar exposure routes to bisphenol-A; thus, continuous observation is necessary. Concentrations of phthalate (diethyl-hexyl phthalate metabolite) in urine were decreased in all age groups compared to three years ago, with high concentrations in infants and elementary students. Children have a higher food intake and respiration rate per unit of body weight than adults (about two to three times). Infants and young children, in particular, have behavioral characteristics such as sucking on toys or playing on the floor, which may be the cause for higher exposure levels to endocrine disruptors such as bisphenol-A and phthalates. As such, more attention is needed on the activity spaces and products used by sensitive groups such as children. Of the perfluorinated compounds added to the fourth survey, blood concentrations of perfluoro octanoic acid (PFOA) were 6.43 $\mu\text{g/L}$ and 3.66 $\mu\text{g/L}$ in adults and middle and high school students, respectively. Further, perfluoro octane sulfonic acid (PFOS) concentrations were 15.1 $\mu\text{g/L}$ and 7.97 $\mu\text{g/L}$ in adults and middle and high school students, respectively, similar to the previous domestic surveys. These values are lower than the levels of concern for health effects (Germany, HBM-II) of 10 $\mu\text{g/L}$ (PFOA) and 20 $\mu\text{g/L}$ (PFOS) recommended by the German Human Biomonitoring Commission. Perfluorinated compounds are used as waterproof coatings in various industrial processes and consumer goods. They do not easily decompose in the human body and accumulate over long periods; hence, continuous observation is required. These results will be released in early January next year as nationally approved statistics (No. 106027) on the National Statistics Portal (www.kosis.kr) and the Environmental Statistics Portal (stat.me.go.kr). Meanwhile, the NIER will conduct the Fifth KoNEHS on 5,850 South Koreans from 2021 to 2023. NIER commented, “The exposure levels to environmentally hazardous substances in Koreans have been mostly decreasing or are similar to three years ago. We will more closely examine endocrine disruptors and perfluorinated compounds, further expand the types of surveyed substances, and precisely analyze diverse exposure factors in daily life.”

Summary

Environmental Health Research

- Development and operation of national environmental health monitoring system
- Research on the health effects on residents in areas vulnerable to environmental pollution
- Children’s environmental health research and biobank establishment
- Expansion of chemical risk assessment and establishment of on-site exposure assessment method
- Inhalation toxicity assessment of quaternary ammonium compounds and revision of chemical test methods
- Research on genotoxicity assessment method applying evidence assessment matrix to non-test date
- Management of biocides/consumer chemical products and the establishment of a safety system
- Research on the behavioral characteristics of persistent organic pollutants in the environment
- Research on identifying epidemiologic correlations between humidifier disinfectant exposure and major diseases

Climate and Air Quality Research

- Opening of Gangwon Air Quality Research Center to expand Gangwon air quality research
- Research on three-dimensional monitoring for monitoring air pollutants affected by domestic and foreign factors
- Establishment of basis for studying air pollution characteristics by region
- Opening of Operation Plan of National Adaptation Center for Climate Crisis
- Establishment of a monitoring system for GHG in urban area
- Joined international organization for GHG verification and international joint research between Korea, China, and Japan
- Research on developing methods for measuring atypical odor outlets
- Research on the air pollutant emission characteristics from stationary sources(II)
- Expansion of national air quality forecast service
- Model improvement to enhance air quality forecasting accuracy
- Geostationary environment monitoring satellite image data released to the public
- Technology development for GEMS utilization and release GEMS data
- Conducted pre-campaign GEMS Map of Air Pollution (GMAP 2021)

Water Environment Research

- Forecasting changes in water environment based on convergence technology(I)
- Prediction of water environmental change based on remote sensing(I)
- A study on the monitoring and management of unregulated hazardous compounds in river water(II)
- Research on new paradigms for algae response based on molecular biology
- A study on new targets and customized plans for total pollution load management
- A policy supporting research to manage non-point source pollutants and improve water cycle(VI)
- A study of environmental pollution source originated from livestock excreta in rural areas(VI)
- Research on distribution characteristics of microplastics in freshwater(III)
- Research on reinforcing industrial wastewater management and ecotoxicity operating system
- Research and assessment of aquatic ecosystem health and diagnosing causes of damage

Environmental Resources Research

- Research on life cycle assessment of plastic waste recycling: Focusing on ELV and WEEE
- Research on expansion a list of waste types and discharging industries subject to hazardous characteristics
- Research on the characteristics of microplastics generated during waste treatment process: Focusing on the investigation of analysis techniques for monitoring(I)
- Research on reducing final disposal waste amount through waste flow analysis
- Research on establishing detailed inspection methods for waste treatment facilities
- Research on implementation measures for waste-to-energy incentive system
- Support for sustainable, eco-friendly development and improving the environmental value of national land
- Research on environmental quality assessment using cryopreserved biological samples
- Research on the foundation of an integrated environmental management system for facilities that pollute the environment

Environmental Infrastructure Research

- Establishment of indoor radon management basis and research on reduction measures for (newly built) multi-family housing(I)
- A Study on the assessment of Noise Annoyance according to Living noise source
- Research on strengthening water safety through management of tap water contaminants
- Research on establishing a response system for harmful microorganisms in water environments
- Development and technology transfer of automatic measurement system for taste and odor substances in tap water
- Strengthening test and inspection quality management for high-quality national environmental data
- Vitalization of joint research on environmental issues and pollutant tracing research
- Research on risk-based soil pollution management and improvement of the impact assessment system in apprehensive areas
- Advancement of integrated groundwater management and strengthening groundwater quality management in areas vulnerable to pollution
- Operation and improvement of the Soil and Groundwater Information System (SGIS)

Transportation Pollution Research

- Research on the characteristics of non-exhaust gas emissions by mobile pollutants
- Automobile catalyst (DEF) emergency supply status and response

Four Major River Research

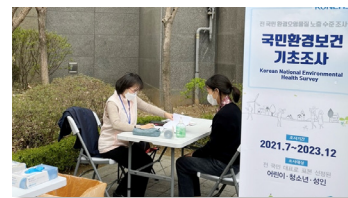
- Effect of Aquatic Macrophyte on Water Environment of Lake Paldang
- Prediction on water quality variations in Paldang reservoir by climate change(I)
- A Study on best management of critical source areas with non-point pollution according to climate change(I)
- Investigation on the origin of organic pollutants in the upstream of Miho-stream and management strategies for the corresponding small watersheds(II)
- Application of habitat analysis and modelling for improvement of aquatic ecosystem health in the Yeongsan River(II)
- A study on the chronology of lake sediments using radioisotope techniques

01 Environmental Health Research Department



Development and operation of a national environmental health monitoring system

The KoNEHS was conducted to determine the exposure levels to environmentally hazardous factors in the human body. Based on basic statistical data, we analyzed big data and discovered new environmental health indicators, raising the public's environmental health level. In the fifth survey (2021–2023), 5,850 participants were selected through the sample design of the first year to analyze the exposure levels of 64 environmentally hazardous substances such as heavy metals in biological samples. We are also collaborating with international organizations, including publishing educational materials for children through the operation of the WHO Collaborating Centre for Vulnerable Population and Environment Health. Moreover, with statistical data published by local governments, we calculated the environmental health levels of local governments nationwide as cumulative impact scores and utilized these results to assess the environmental health in each region. Based on medical usage data from the National Health Insurance Service, we analyzed the spatiotemporal trends and hot-spot regions of environmental health monitoring diseases (respiratory diseases, conjunctivitis, and dermatitis).



Fifth Korean National Environmental Health Survey - Field Survey



The meeting of World Health Organization Partner Institution Joint Research

Research on the health effects on residents in areas vulnerable to environmental pollution

We conducted preemptive monitoring of environmental exposure levels and health effects on residents in areas vulnerable to environmental pollution, including national industrial complexes, abandoned metal mines, and poorly developed regions. In 2021, we conducted Phase 3, Year 4 of the Health Impact Survey on nine national industrial complexes, including Ulsan and Pohang, and devised a two-stage environmental health assessment plan by reassessing environmental health assessment priorities for general industrial complexes. In 84 abandoned mine areas with concern for soil pollution, we identified the environmental pollution and health status of residents and performed post-management for those with high exposure to environmentally hazardous substances. The survey was completed for coal-fired power plants, a First Priority area, and an environmental health assessment was conducted in the area around the Yeongheung Thermal Power Plant, a Second Priority area. From 2021 to 2024, we plan to survey the health effects of residents in 100 locations of Grades 1 and 2 with concern for poor development. Additionally, in response to petitions related to environmentally hazardous substances, we are reinforcing communication with residents and experts and providing support for health damage identification and follow-up measures.



Field survey on health effects of local residents in a national industrial complex



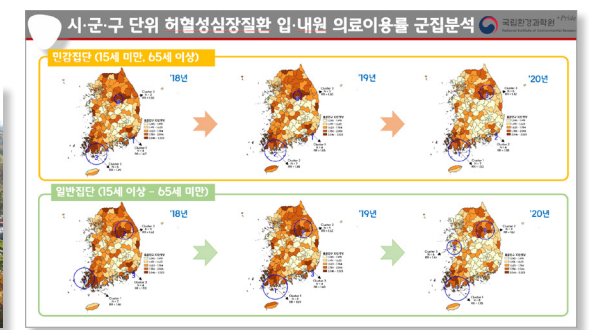
Health effect survey site, thermal power plant [Yeongheung Thermal Power Plant]

Children's environmental health research and biobank establishment

To accurately assess the occurrence of diseases due to environmental exposure, we periodically conducted follow-up surveys on the relationship between environmental exposure and health effects from early childhood (including the fetal period) to adolescence. In connection with the national health information database, we have stored blood and urine samples of each growth phase and examined the effects of hazardous environmental factors on allergies, neurocognitive development, and growth development through surveys and environmental measurements. We are constructing a National Biobank for Environmental Health to store these biological samples stably over long periods and utilize them for basic research on environmental health effects. The National Environmental Health Sample Bank will begin operation in the second half of 2022 and provide scientific data for establishing environmental health policies in the future. We have also conducted a sequential risk assessment of children's activity spaces and children's products (e.g., playgrounds and daycare facilities) since 2020. By 2021, we completely assessed a total of 45 types and devised environmental safety management standards.



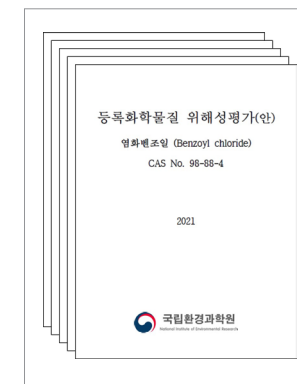
National Biobank for Environmental Health



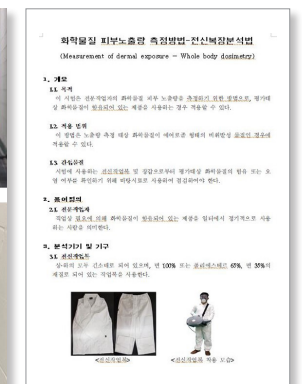
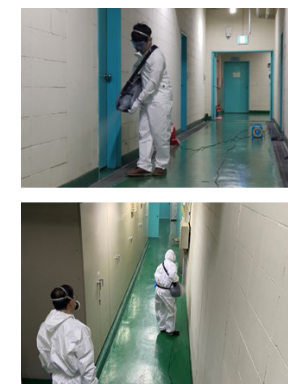
Spatial distribution of diseases in sensitive groups according to environmental exposure

Expansion of chemical risk assessment and establishment of on-site exposure assessment method

An amendment to the Act on Registration, Evaluation, etc. of Chemicals introduced an initial risk assessment for chemicals with simple uses and low exposure potential to enable rapid and efficient risk assessment following the large increase in the number of chemicals subject to registration. As a result, we conducted a risk assessment on 16 initial assessment substances, including benzoyl chloride, along with five priority substances, including chloroform, and presented risk management measures for a total of 21 substances. Further, to systematize the exposure assessment methods according to diverse on-site exposure situations, we classified the exposure assessment methods according to exposure targets, exposure routes, and scenarios and established a mid-to-long-term research roadmap to develop detailed exposure assessment guidelines. We also prepared a standard protocol (draft) for each experimental method by exposure routes through case studies.



Risk assessment report (draft)



Case study on exposure assessment case studies and standard protocol (draft)

Inhalation toxicity assessment of quaternary ammonium compounds and revision of chemical test methods

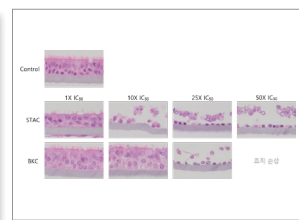
Of the quaternary ammonium compounds used in household chemical products such as COVID-19 disinfectants and humidifier disinfectants, we assessed the inhalation toxicity effects of chemicals with a high risk of respiratory exposure but having insufficient inhalation toxicity data. We also conducted a toxicity assessment study on quaternary ammonium compounds using non-animal test methods, such as the *in vitro* aerosol exposure system* and reconstructed human airway mucosa model**. Further, reflecting the revisions to OECD test guidelines, a collection of testing methods for identifying chemicals hazards, we updated 6 test items in the field of health effects, including 3 items of alternatives to animal test methods (e.g., skin sensitivity and androgen receptor transcriptional activation test), and amended the Regulations on Test Methods for Chemicals (NIER Public Notice).

* An air-liquid interface exposure method that reflects a more realistic exposure scenarios

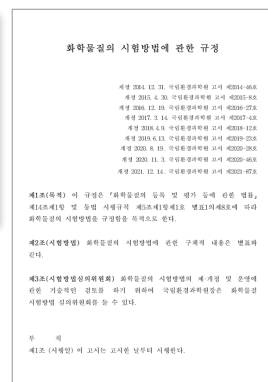
** A 3D airway epithelium model reconstructed with tissue engineering technology based on non-mucosal epithelial cells derived from human



Inhalation toxicity assessment using a whole-body chamber



Histological analysis of reconstructed human airway mucosa models



NIER Public Notice on test method for chemicals

Research on genotoxicity assessment method applying evidence assessment matrix to non-test data

To minimize animal testing required to implement the Act on Registration, Evaluation, etc., of Chemicals and safely manage chemicals, we conducted a hazard assessment study using non-test data. We conducted a case study on the genotoxicity of 20 chemicals by applying the evidence assessment matrix to non-test data. Based on the results, we selected evidence assessment items and standards (e.g., test methods) according to the data. Based on genotoxicity prediction results using the OECD QSAR application toolbox, we provided a foundation for consistent quantitative chemical assessments by applying the evidence assessment matrix optimized for genotoxicity assessment to numerous non-test data, such as literature data.



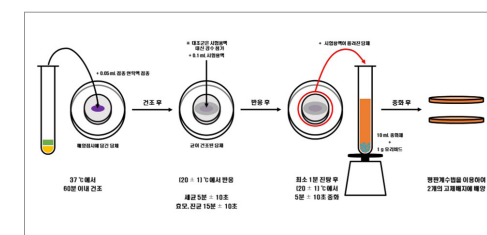
Study design

자료	정량, 가중치		정성	
	자료의 질	ACP 결과	적정성	투명성
Human data	증거력	증거력	증거력	증거력
in vivo-1	판단 근거	상세 내용	판단 근거	상세 내용
in vitro-1	증거력	증거력	증거력	증거력
in vitro-2	판단 근거	상세 내용	판단 근거	상세 내용
대체자료 (QSAR, 3-D, etc.)	증거력	증거력	증거력	증거력
	판단 근거	상세 내용	판단 근거	상세 내용

Evidence Assessment Matrix

Management of biocides/ consumer chemical products and the establishment of a safety system

To verify the sterilization efficacy of each disinfectant, we selected products according to 14 types, including liquid and solid, and assessed the effects and efficacy through suspension and simulated surface tests (porous, non-porous). For most products, the efficacy against mold at the used concentration was not pronounced, whereas that against bacteria and yeast at the used concentration was observed. To evaluate the effect and efficacy required for the biocide approval system, we developed and enabled the use of specific test methods divided into the suspension and simulated surface test methods. Meanwhile, we examined approximately 1,000 disinfectants and disinfectants being distributed and categorized their major uses (e.g., indoor sterilization, daily necessities, and eliminating mosquitos) and formulations (e.g., spray, liquid, and powder). Further, we classified them into general and professional consumer use by product type, selected exposure factors, and performed a human exposure risk assessment. Moreover, by establishing product assessment methods and approval procedures, we provided a basis for systematically and effectively managing various biocides for preventive purposes.



Test of biocide effects and efficacy (simulated surface test)

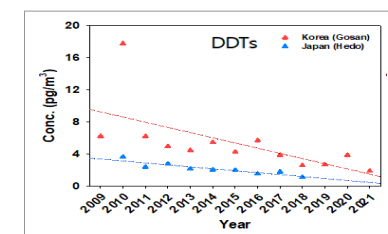


Online system for safe chemical product management

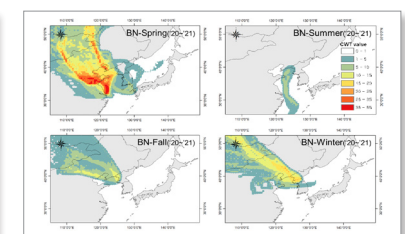
Research on the behavioral characteristics of persistent organic pollutants in the environment

To assess the implementation and effectiveness of the Stockholm Convention on Persistent Organic Pollutants (POPs), we identified the distribution characteristics of each substance through monthly monitoring of airborne POPs in major domestic backgrounds and urban areas. These included Jeju, the domestic site of the Global Monitoring Program (GMP)* in East Asia. According to monitoring results over 12 years (2009–2021), the concentration of organochlorine pesticides (OCPs) at the domestic GMP site (Gosan, Jeju) generally tended to decrease, and the concentration was similar to or slightly higher than the Japanese GMP branch (Hedo, Okinawa). Among polybrominated diphenyl ethers (PBDEs), at all sites, decabromodiphenyl ether (BDE-209) had the highest ratio. Among polychlorinated naphthalenes (PCNs), monochlorinated naphthalene (mono-CN) was most predominantly distributed, while perfluoroalkyl and polyfluoroalkyl substances (PFAS) were detected at higher concentrations in urban areas than background areas. A review of PCNs and PFAS through assessment indicators for tracing pollutants that move over long distances demonstrated the feasibility of using a hybrid-receptor model as an assessment indicator of long-distance transport impact.

* A global monitoring program led by the UNEP for assessing the concentration distribution and movement of POPs in environmental media



Dichlorodiphenyltrichloroethane (DDT) concentration trend at Jeju site (2009–2021)



Hybrid-receptor model of PFAS at Baengnyeong site(2020–2021)

Research on identifying epidemiologic correlations between humidifier disinfectant exposure and major diseases

To provide a scientific basis for relieving damage and proving health damage when victims sue (e.g., investigation and judgment of humidifier disinfectant health damage), we are verifying the epidemiologic correlations* between the exposure of humidifier disinfectant and diseases. Therefore, besides short-term, acute, and respiratory diseases, we are promoting multi-disciplinary investigations and research, such as epidemiologic and toxicological research, clinical medicine, and environmental health reviews on diverse health damage cases that can occur due to the exposure of humidifier disinfectants.

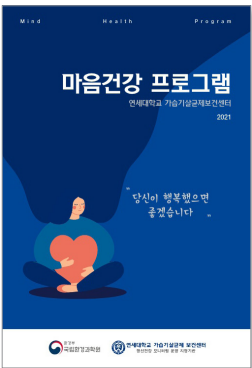
* Epidemiologic correlation: Confirming that the group exposed to the risk factor (humidifier disinfectant) has a greater risk of disease than the group not exposed

In particular, to enhance capabilities for customized toxicity testing for humidifier disinfectants victims, the Korea University Ansan Hospital and Korea Institute of Toxicology(Inhalation Toxicology Center for Airborne Risk Factors) were designated. Centers are plans to continuously derive research results that can identify diverse health effects, including long-term and chronic diseases, utilize these results to determine toxicological correlation, and review various research findings to publish chemical-specific disease reports.

Moreover, the Humidifier Disinfectant Physical and Mental Health Monitoring Project has been continuously run since 2018 to provide victims with medical support and counseling. In 2021, we developed a respiratory rehabilitation program to help humidifier disinfectant victims improve their breathing and relieve symptoms and have distributed a related guide and video. We also provide support services for victims, such as the “Mindful Walking Together” program that allows participants to experience the campus, career path, and parenting education of young people together.



Opening ceremony of Humidifier Disinfectant Health Center for Toxicity Assessment at Korea University Ansan Hospital (April 2021)



Opening of Gangwon Air Quality Research Center to expand Gangwon air quality research

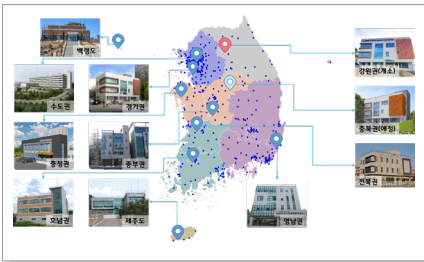
Area	Location
Baengnyeong Island (June 2008)	Baengnyeongdo, Ongjin-gun
Seoul Metropolitan Area (July 2009)	Bulgwang-dong, Seoul-si
Honam region (April 2009)	Oryong-dong, Gwangju-si
Jungbu region (October 2010)	Munhwa-dong, Daejeon-si
Jeju Island (February 2012)	Aewol-eup, Jeju-si
Yeongnam region (February 2013)	Seongan-dong, Ulsan-si
Gyeonggi region (May 2019)	Gojan-dong, Ansan-si
Chungcheong region (November 2019)	Seosan-dong, Seosan-si
Jeonbuk region (November 2020)	Mohyeon-dong, Iksan-si
Gangwon region (December 2021)	Mancheon-ri, Chuncheon-si
Chungbuk region (2022, planned)	Ochang-eup, Cheongju-si

Locations of Air Environment Research Centers by Area

Research on three - dimensional monitoring for monitoring air pollutants affected by domestic and foreign factors

02 Climate and Air Quality Research Department

Air Quality Research Centers are being established and operated to identify air quality characteristics by region and determine the causes of high-concentration air pollution. Following Jeonbuk (Iksan), the 10th Air Quality Research Center was established in Gangwon in 2021. The Gangwon Air Quality Research Center has a total area of approximately 728 square meters and is three stories above ground. It plans to constantly monitor air pollutants in the Gangwon area, a down wind region in the metropolitan area, and identify the causes of air pollution. To more accurately monitor air pollutants, it will operate 13 types of 19 measuring devices, including PM-10, PM-2.5, metal components (e.g., lead, calcium, arsenic, manganese, and nickel), ionic components (e.g., sulfate and nitrate), and carbon components (e.g., organic carbon and inorganic carbon). By obtaining and sharing high-resolution observational data, it plans to serve as a base research institute for air quality in the Gangwon region.

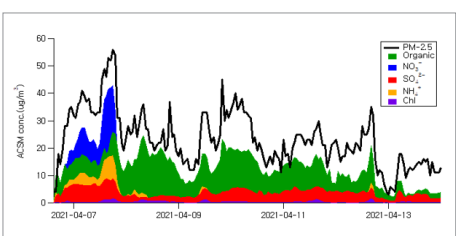
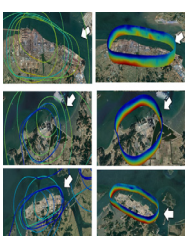


A total of 11 locations of Air Quality Research Centers nationwide



Gangwon Air Quality Research Center (Completed December 2021)

To monitor air pollutants inflow from abroad and domestically generated air pollutants and identify the causes of high concentrations, the center conducted three-dimensional monitoring that combines air, ship, and ground observation. The monitoring period is every year in the spring and winter, including the seasonal management system period. Medium-sized aircraft introduced in 2018 are installed with high-resolution measuring instruments for fine dust (PM-10), black carbon, and approximately 11 volatile organic compounds. The aircraft performed 100 hours of aerial monitoring over the western sea, Seoul metropolitan area, and large emission source areas. The center continues to monitor air pollutant inflow from overseas in connection with ground, air, and ship observations in collaboration with the Korea Meteorological Administration. This includes ship-based monitoring of fine dust and major components (YES-AQ) along the longitudinal profile of the Incheon-Mokpo western sea and the nationwide ground monitoring network of 42 ultrafine dust (PM-2.5) components. Through comprehensive analysis, the research results can be used to calculate inflow and outflow, verify large-scale emission sources, and identify causes of high concentrations.

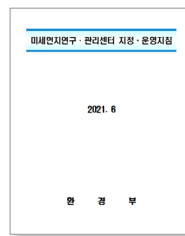


Measurement results of monitoring aircraft and large emission sources

Weather ship and western sea measurement results

Establishment of the basis for studying air pollution characteristics by region

To reduce particle matter(PM) emissions and PM-generating substances and continuously manage its occurrence, the Designation and Operation Guidelines for Particle Pollution Research and Management Centers were established based on the Special Act on the Reduction and Management of Fine Dust (Article 25-2), which was enforced in April 2020. Based on these operating guidelines, the designation of Particle Pollution Research and Management Centers in the Seoul metropolitan and central areas was completed in 2021, and the opening ceremony was held in January 2022. In 2022, we plan to designate and begin the operation of Particle Pollution Research and Management Centers in the southern and southeast areas. Subsequently, in 2023, we plan to designate a Particle Pollution Research and Management Centers in the Gangwon region for international cooperation, thus establishing a regional fine dust research cooperation system that supports four air management zones and international cooperation.



Established Designation and Operation Guidelines for Particle Pollution Research and Management Centers (June 2021)



Opened Particle Pollution Research and Management Centers in Seoul metropolitan area and central area (January 2022)

Opening of Operation Plan of National Adaptation Center for Climate Crisis

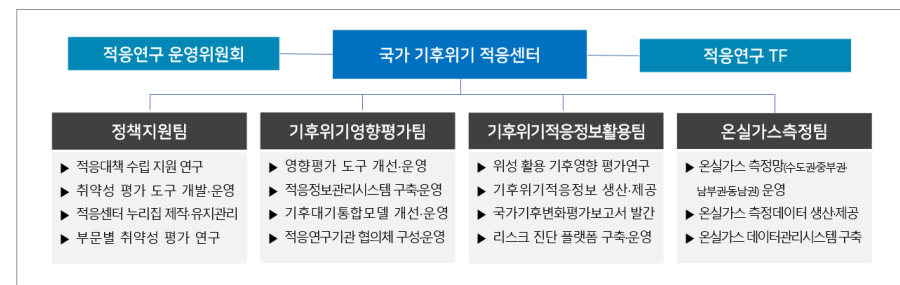
The NIER was designated as the National Adaptation Center for Climate Crisis (NACCC) (December 21, 2021) to produce science-based adaptation information, and the opening ceremony was held on February 21, 2022. The NACCC will leverage the NIER's experts across all environmental fields, research experience, and cutting-edge infrastructure to investigate climate change observation, analysis, and response measures and serve a key role in policy support.

In line with the FRAMEWORK ACT ON CARBON NEUTRALITY AND GREEN GROWTH FOR COPING WITH CLIMATE CRISIS that took effect on March 25, 2022, the center plans to construct a climate crisis adaptation information management system to investigate and assess the impacts, vulnerability, risk, and socio-economic ripple effects of the climate crisis. It also plans to create a consultative group for mutual exchange and cooperation among adaptation research institutes to construct a feedback system to share information and link research results with national policies.

The center comprises a policy support team, climate crisis impact assessment team, a climate crisis adaptation information utilization team, and GHG measurement team. It is run in collaboration with an operating committee composed of experts from each field in the NIER and an adaptation research task force. By providing and applying reliable adaptation information based on scientific evidence, the NACCC will contribute to improving South Korea's ability to adapt to climate change.



Opening ceremony of National Adaptation Center for Climate Crisis (February 2022)



Organizational Chart and Tasks of National Adaptation Center for Climate Crisis

Establishment of a monitoring system for greenhouse gases in urban area

According to the revised guidelines of the Intergovernmental Panel on Climate Change in 2019, measurement-based verification of national GHG emissions worldwide is recommended, but research on GHG monitoring is still in its initial stages. South Korea, one of largest GHGs emitting city, must strengthen its monitoring of urban air GHGs to establish tailored policies and enable integrated climate and atmosphere management that is pacesetting and cost-effective. A business agreement was signed (July 2021) for research exchange in the GHG monitoring field among the NIER, the National Institute of Forest Science, the Seoul Research Institute of Public Health and Environment, and the Seoul National University Graduate School of Environmental Studies. The aim was to enable and strengthen integrated monitoring and survey the state of domestic and overseas urban air GHG monitoring research to establish monitoring systems. Through joint monitoring among various ministries, emission sources were traced by identifying the spatiotemporal characteristics of GHG fluctuations. These research results will be used as key input data for modeling to evaluate the performance of carbon neutralization implementation at national and regional levels and verify observation-based GHG inventory.

순열기	도시	측정항목	측정장비	측정원리
1	인천시 서구 (남동해상)	CO ₂	LI-COR	OF-CLAS
2	국립환경과학원 (인공 지형)	CO ₂ , CH ₄	LGR	CRDS
3	광명도 고성 (사구대기주상)	CO ₂	SMDS	NDR
4	서울시 서초구 (송파대교 남단)	CO ₂ , CH ₄	Picarro	CRDS
5	서울시 강남구 (삼성대교 남단)	CO ₂ , CH ₄	Picarro	CRDS
6	서울시 강남구 (삼성대교 남단)	CO ₂	LI-COR	NDR
7	서울시 강남구 (삼성대교 남단)	CO ₂	LI-COR	NDR
8	서울시 강남구 (삼성대교 남단)	CO ₂ , CH ₄	Picarro	CRDS

Metropolitan area monitoring measurement points



Analysis of spatiotemporal characteristics through monitoring

Joined international organization for GHG verification and international joint research between Korea, China, and Japan

The NIER designates and operates verification agencies for GHG emissions according to the carbon credit trading and target management systems. Further, the Asia Pacific Accreditation Cooperation (APAC) recognized that the implementation of GHG verification tasks and management of verification agencies are in accordance with international standards (ISO). It complies with ISO 17011 (accreditation body requirements) and ISO 14065 (verification agency requirements). We signed a Mutual Recognition Agreement with APAC in November 2021. As a follow-up measure, we signed a Multilateral Recognition Agreement (MLA) in January 2022 with the International Accreditation Forum (IAF), the upper body. Since 2020, led by private sector scientists, we have promoted international joint research (coordinated research projects) on the occurrence mechanisms and interaction effects of ultrafine dust (PM-2.5) and ozone (O₃)—secondary substances among air pollutants in major cities of Korea, China, and Japan. In May 2021, the research results were shared, and a joint report was published through two working group meetings and an annual meeting in November of the same year. The three countries will continue devoting efforts to leading the expansion of international cooperation in the air quality field and establishing an international cooperation system to solve future problems related to climate change and the air environment in Northeast Asia.



IAF MLA Agreement (January 17, 2022)



Annual meeting (online)

Research on developing methods for measuring atypical odor outlets

The current Odor Prevention Act defines an outlet as a forced exhaust vent 5 m or more from the ground and applies emission standards. For all other outlets, it judges whether they exceed the standard based on the results measured at the site boundary. However, most livestock or living odor emission sources where odor complaints frequently occur have atypical outlets with irregular heights or shapes. Accordingly, to enhance the reliability of odor emissions data and cause identification, we developed a method to measure odorous substances emitted from atypical outlets. We presented an odor measurement method in which atypical outlets are classified by shape and created the Guidelines for Measuring Atypical Odor Outlets.

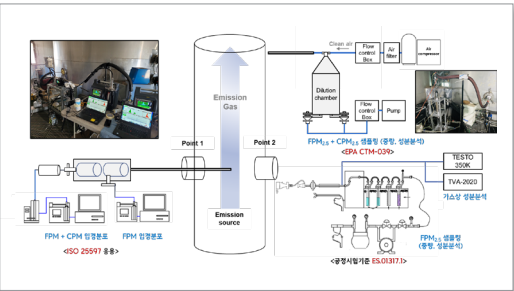
<Measurement method for odorous substances in atypical outlets>

Category	Powered (forced exhaust)				Non-powered (natural exhaust)		
	Curved	Straight	Decentralized	Chimney	Window	Winch	Roof
Photo							
Installed pig house	Weaning, piglets, rearing, fattening	Weaning, piglets, rearing, fattening	Weaning, piglets, rearing, fattening	Weaning, piglets, rearing, fattening	Weaning, piglets, rearing, fattening	Pregnancy, birth, rearing, fattening	Pregnancy, birth, rearing, fattening
Measure ment method							
	Insert collection tube deep into curved exhaust fan up to the front of the fan	Attach temporary pipe with matching diameter to straight exhaust fan and insert collection tube	Insert collection tube between shades	Insert collection tube in a chimney exhaust fan	Close open windows and insert a temporary pipe or collection tube	When the winch is opened, close it and stagnate for 10 minutes and then insert collection tube through the gap	Cannot measure pig houses other than modernized facilities due to risk of collapse
Collected as-is for ventilation (exhaust) vents with other collection piping							

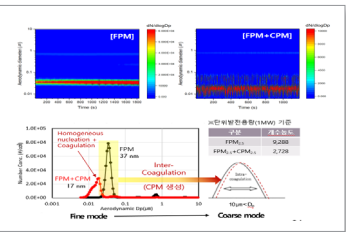
Research on the air pollutant emission characteristics from stationary sources(II)

The size distribution of fine particulate matter emitted from major domestic industrial emission sources was measured to identify emission characteristics of PM including condensable particulate matter. From coal-fired power plants, the emission concentrations of filterable particulate matter (FPM*) and condensable particulate matter (CPM**) that are 2.5 μm or less in diameter are 1.59–3.24 mg/m^3 . Compared to 0.29–0.29 mg/m^3 in LNG power plants, this is 5–11 times higher. The ratio of $\text{CPM}_{2.5}/\text{FPM}_{2.5}$ was 0.1–0.6 in coal-fired power plants and 2.8 in LNG power plants, showing that in LNG power generation, the emission concentration ratio of CPM to FPM is at least four times higher. We plan to continuously investigate the emission characteristics of fine particulate matter from various industrial sources and utilize the results as basic data to devise measures for managing PM-2.5 at industrial emission sources.

* FPM: Primary particulate matter generally emitted in solid or liquid form and be captured by filter
** CPM: Primary particulate matter which exists as a vapor at stack conditions but exists as a liquid or a solid after exiting the stack and being cooled by ambient conditions



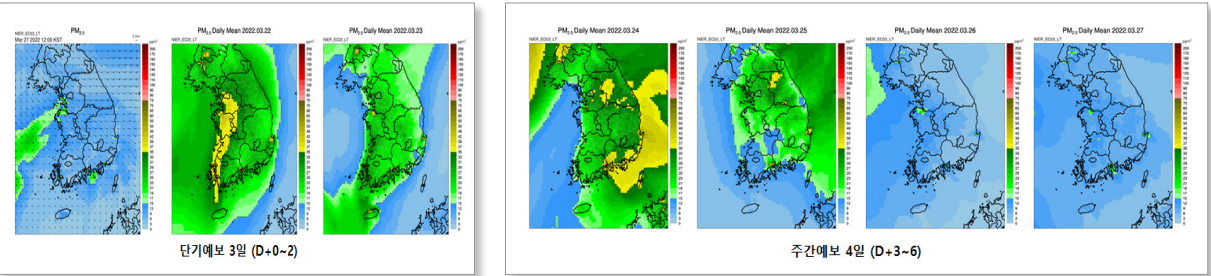
Schematic diagram of real-time PM particle size distribution measurements



Size distribution of fine particulate matter in LNG power plant

Expansion of national air quality forecast service

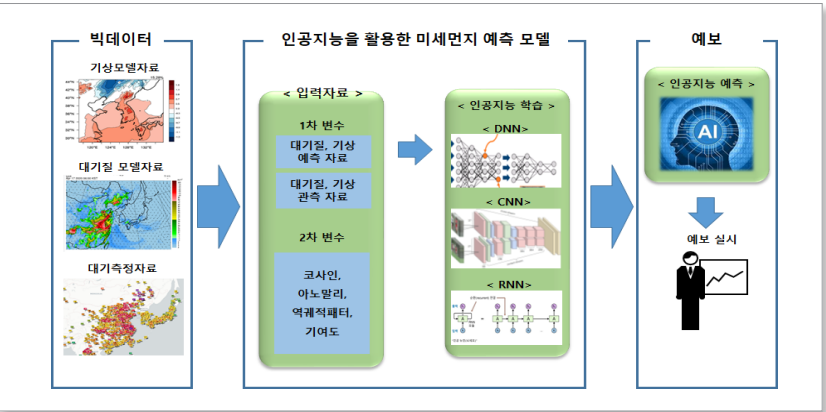
The national air quality forecast system for air quality concentrations (PM-10, PM-2.5, O_3) has been in effect since 2014 to protect public health. Moreover, for crisis management of high ultrafine dust concentrations, policy forecasting is conducted, which includes providing advance information on emergency reduction measures for each local government and notifying upper limits on thermal power generation. The existing short-term forecasting (3 days) in 19 domestic areas was expanded, and weekly forecasting (7 days) has been implemented since November 2020. To meet the public need for expanded air quality forecasting services, we have been laying the foundation for seasonal (3-month interval) forecasting of ultrafine dust and conducting a pilot operation since 2021. We plan to implement a public service after addressing problems from 2024 onward.



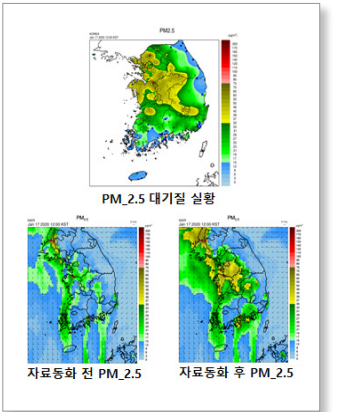
Fine dust model forecasting results

Model improvement to enhance air quality forecasting accuracy

To provide highly reliable air quality forecasting services, we have built a fine dust forecasting system using AI technology, a core technology of the Fourth Industrial Revolution. We implemented AI prediction technology in the ozone forecasting system in a pilot project in 2020. Subsequently, in 2021, we constructed an AI-based forecasting system for the short-term forecasting of ultrafine dust and achieved improved high-concentration forecasting accuracy compared to the existing numerical forecasting model (CMAQ). By laying this foundation, we plan to implement and fully operate an AI-based short-term forecasting system for ultrafine dust in the Fourth Fine Dust Seasonal Management System in 2022. We are also enhancing the numerical model to analyze the causes of high-concentration fine dust and utilize input data for the AI forecasting system. By applying the latest domestic and overseas emissions figures and incorporating data assimilation techniques that optimize the model's initial input data according to air quality conditions, we are improving the accuracy of the forecasting model.



Schematic of air quality forecasting using AI



PM-2.5 spatial distribution before and after data assimilation

Geostationary environmental satellite image data released to the public

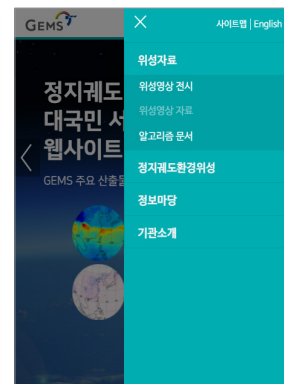
GEO-KOMPSAT-2B(Geostationary Korea Multi-Purpose Satellite, GK-2B)* was launched on February 19, 2020, and has been operating directly from the Environmental Satellite Center(ESC) since November of the same year after completing its in-orbit-test. The ESC generates 21 types of Level-2 data through GEMS(Geostationary Environment Monitoring Spectrometer) observations. After a verification process, 14 types** of image data (eight types from March 22, 2022, and six types from October 29, 2022) have been released on the ESC website (nesc.nier.go.kr). Additionally, the ESC mobile website allows users to access environmental satellite data easily on a smartphone or tablet. By 2022, ESC will publish seven additional types of environmental satellite data, totaling 21 types of air quality data released to the public.

* GK-2B is with its two payloads: GEMS(Geostationary Environment Monitoring Spectrometer) and GOCI- II (Geostationary Ocean Color Imager)

** Aerosol Optical Depth(AOD), Single scattering albedo, UVI-Aerosols index, Visible Light-Aerosols index, Total ozone, Cloud centroid pressure, Effective cloud fraction, cloud radiance fraction, Nitrogen dioxide, Sulfur dioxide, UVI index, Plant response index, DNA damage index, and Vitamin D synthesis index



Main screen of the resource center



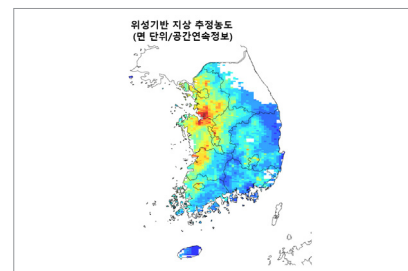
Satellite data selection menu



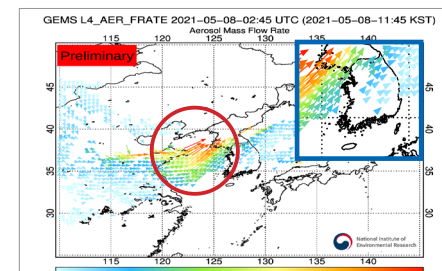
Satellite image selection screen

Technology development for GEMS utilization and release GEMS data

The Environmental Satellite Center(ESC) has developed various technologies to help define the reasons of air pollution in the region using aerosol data observed in from the surface to the top of atmosphere and released them to the public. First, we developed a technology that applies meteorological and various other data and AI techniques to environmental satellite data to convert it to estimated ground-level PM-2.5 and PM-10 concentrations. This enabled to calculate ground concentrations over large areas, making it possible to identify fine dust conditions in blind spots where the ground air monitoring network is inadequate. ESC also developed a technology that estimates the movement and paths of aerosol by converging meteorological information with environmental satellite data. We expect this to be actively used to identify the causes and state of high-concentration air pollutants. On the ESC website, aerosol movement images have been published since November 5, 2021. Further, images of estimated ground-level PM-2.5 and PM-10 concentrations have been published since December 30, 2021. From 2022 onward, ESC plan to develop technologies for estimating ground nitrogen dioxide concentration and sulfur dioxide movement and publish related data.



Example of satellite-based estimated ground concentration [South Korea]



Aerosol movement

Conducted pre-campaign GEMS Map of Air Pollution(GMAP 2021)

The Environmental Satellite Center conducted a pre-campaign of the international joint air quality survey (GMAP 2021) from October 18 to November 25, 2021, to identify air pollutant distributions in the Seoul metropolitan area. Twenty-five domestic and foreign research teams participated in the campaign. They identified air pollutant distributions via three-dimensional monitoring using ground, vehicle, aircraft, and sonde* techniques, and also analyzed and compared the results with GEMS data. In particular, an international research team comprising NASA, the Royal Belgian Institute for Space Aeronomy, the Max Planck Society, and the University of Bremen conducted observations using ground, vehicle, and air remote sensing equipment and actively participated in satellite data verification research. From May to August 2022, the second international joint air quality survey (Phase 1) will take place based on the pre-campaign results to identify the causes of PM-2.5 and secondary pollutants.

* An instrument that measures the vertical distribution of target air pollutants by attaching observational devices to balloons



Ground telemetry device (Pandora)



Vehicle telemetry device (Car-DOAS)



Sonde



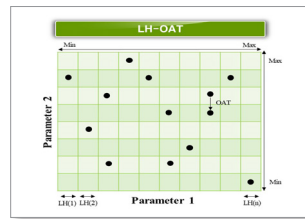
Ground measurement device

03 Water Environment Research Department

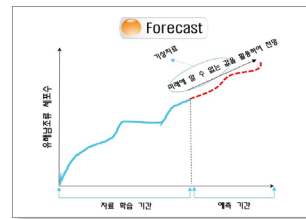


Forecasting changes in water environment based on convergence technology(I) - Application of algae observational data and automatic parameter calibration technique

The NIER forecasts the cyanobacteria cell count, an issue for river water quality in the summer, and provides information to related institutions and the public. The most crucial factor in responding to algal blooms is improving the accuracy of algal bloom forecasting by enhancing algal bloom forecasting technology. To prevent the subjective judgment and intuition of the operator from leading to differing results in the parameter correction stage, this study developed and applied a system to optimize and systematize the parameter calibration procedure of the mechanism-based EFDC-NIER model. We also applied a big data-based algal bloom forecasting technique to the mechanism-based algal bloom forecasting technique in a pilot project. Through this study, we optimized and systematized the EFDC-NIER model's parameter calibration technique and verified the applicability of the data-based model. We expect the techniques proposed in this to enhance water quality (algal bloom) forecasting.



Parameter optimization using LH-OAT technique



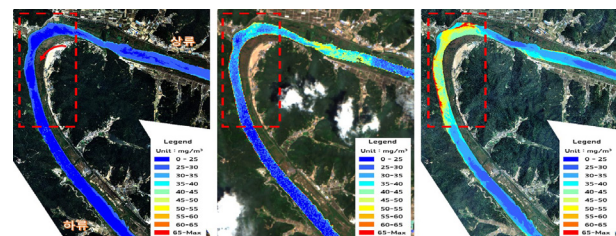
Time series algal bloom forecasting based on deep neural network data

Prediction of water environmental change based on remote sensing(I) - Remote monitoring of water quality in inland waters using satellite imagery

The Water Environment Assessment Research Division has been capturing hyperspectral* images with aircraft to monitor algal blooms since 2015. We have also developed a model for estimating chlorophyll a and phycocyanin concentrations applied to images. As it can be difficult to capture images with aircraft depending on meteorological conditions (e.g., clouds), this must be supplemented by operating various sensor payloads such as satellites and drones. In a 2021 study, we developed a machine learning-based model for estimating the concentrations of chlorophyll a, phycocyanin, and suspended solids using satellites. Based on the coefficient of determination (R^2), the model yielded an accuracy of 0.74 for chlorophyll a, 0.64 for phycocyanin, and 0.63 for suspended solids. We expect that changes in water quality within narrow time intervals can be quickly identified by simultaneously operating satellites and aircraft to monitor water quality remotely.

* Measurement data in which the light spectrum is divided into hundreds of regions used to analyze subjects that respond to narrow wavelength bands

<Spatiotemporal algal bloom remote monitoring using satellite and aerial image data>

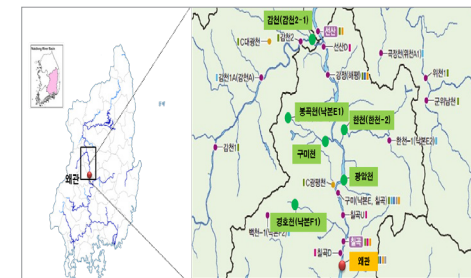


(a) Map of chlorophyll a concentrations using aerial images (June 21, 2019)
(b) Map of chlorophyll a concentrations using satellite images (June 24, 2019)
(c) Map of chlorophyll a concentrations using aerial images (June 25, 2019)

A study on the monitoring and management of unregulated hazardous compounds in river water(II)

The Nakdong River is used as a water source. As a large industrial complex is located near the water system, there is a constant possibility of water pollution accidents from hazardous chemicals, and the area requires various surveys and investigations of unregulated hazardous substances. As such, the Waegwan Water Quality Measurement Center developed 22 additional trace organic compounds and precisely monitored the water quality of the Nakdong River system. We also used a non-target analysis technique* to tentatively identify unknown pollutants midstream of the Nakdong River and derived a list. Through these efforts, we are supporting the establishment of water quality management policies, such as by laying a foundation for securing safe drinking water and determining management priorities.

* Non-target analysis: Qualitative analysis technique that screens unknown detected substances other than target substances



River water survey station



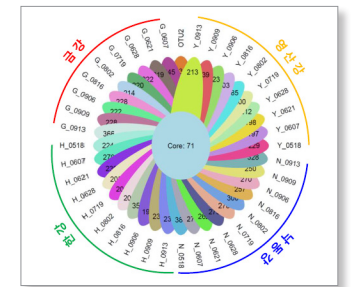
Database of survey results

Research on new paradigms for algae response based on molecular biology

To address the limitations of existing algal bloom response strategies and management research and devise alternatives to resolve algal blooms, we are performing field research on algal bloom control and analyzing the causes of algal blooms based on microbiome analysis. We identified the role of bacteria in influencing the occurrence and death of harmful cyanobacteria in water bodies by analyzing the microbiome network and verified the feasibility of biological algal bloom control through a field-scale (2,000 m²) empirical assessment. Furthermore, through a genotype distribution survey of harmful cyanobacteria in apprehensive areas for algal blooms, we could accumulate genetic information on the origin and behavior of algal blooms. By continuing future research, we expect to be able to develop a molecular biology-based algal bloom monitoring and control technique that can swiftly and accurately detect and trace algal bloom occurrences and effectively control them.



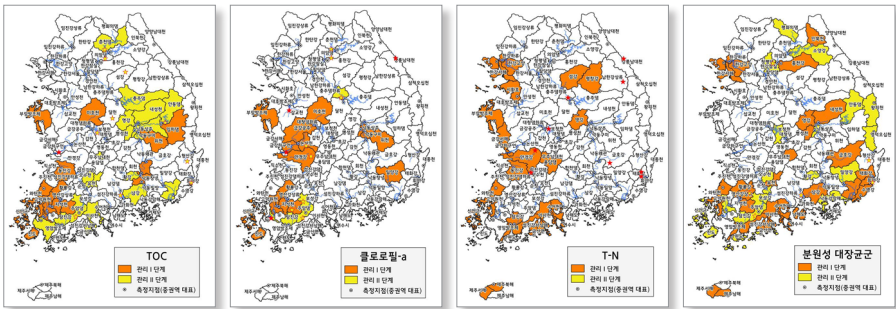
View of field-scale (2,000 m²) empirical facility



Genotype diversity distribution of harmful cyanobacteria in Four Major Rivers

A study on new targets and customized plans for total pollution load management - defining and listing impaired waters

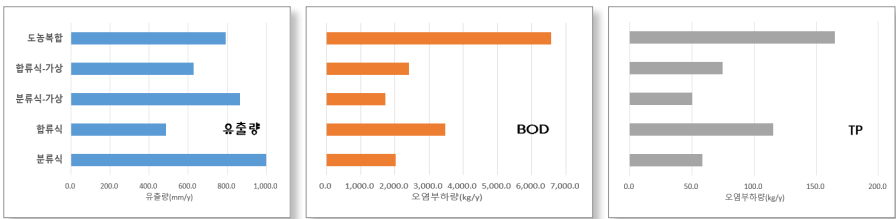
Damaged water bodies can be defined as water bodies that do not meet established water quality standards. While the definition is simple, the detailed assessment method varies with water quality standards and how comparisons are made. This study adopted the “water environment target standard by subbasin” as it is the most similar to the United States’ TMDL standard. For each water quality item, if the target exceeding frequency over ten years is higher than 50%, then it was defined as a damaged water body. Regarding organic matter, the damage ratios of chemical oxygen demand and total organic carbon (TOC), which reflect pollution levels according to refractory organic matter, were higher than that of biochemical oxygen demand (BOD) overall. By region, total phosphorus (TP) had a higher damage ratio in lakes (78.6%) than in rivers (47.6~66.7%), while total nitrogen (TN) fell within the damaged water body range at all points, indicating a nationwide excess state. Suspended solids (SS) had high damage ratios in lakes and fecal coliforms in rivers.



Analysis results on priority management areas of damaged water bodies by water quality item

A policy supporting research to manage non-point source pollutants and improve water cycle (VI)

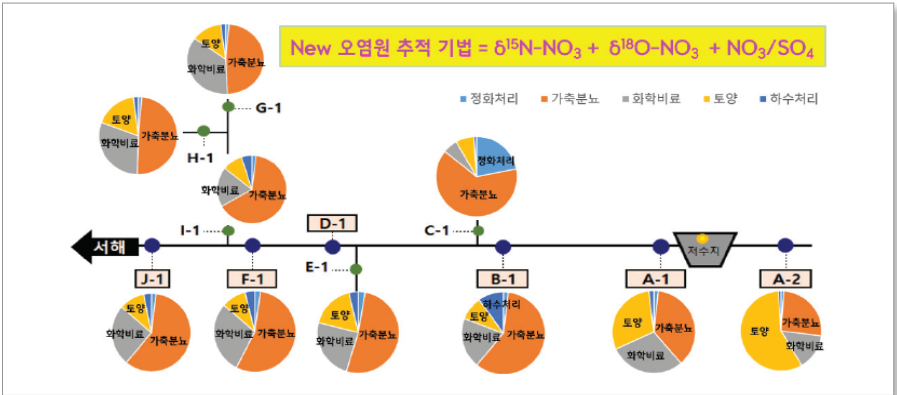
The characteristics of non-point pollutants in combined and separated sewer systems of urban areas were similar to those of the virtual area. In urban-rural complex areas where storage tanks are not reflected and urban clusters, pollutant load was high in the combined sewer system. According to the scenario analysis results using a conduit model, to minimize precipitation and pollutant load flowing into the conduit, distributing the facilities during installation should be prioritized. If a distributed layout is possible, it is effective to install in a combined sewer system. If only concentrated installation is possible, then the effects of reducing rainfall runoff and improving water circulation are high when installed in a location with high urban density and a large impervious area. If the permeable area ratio is the same, then it should be installed where the impervious surface is concentrated rather than in an area where the permeable surface is evenly distributed. Further, when selecting an installation location in an area, areas with a high impervious area ratio should be prioritized.



Non-point pollutant runoff and pollutant load by urban characteristics

A study of environmental pollution source originated from livestock excreta in rural areas(VI) - focusing on environmental pollution assessment

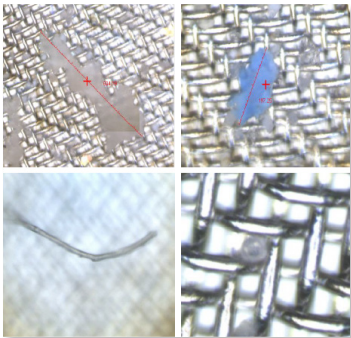
This study aimed to develop a new source tracking approach of combining stable isotopes of nitrate with pollution source indicators that improves nitrate sources tracking and distinguishes between manure and sewage sources. For this purpose, we analyzed isotopic, hydrochemical, and fluorescent characteristics of 78 potential nitrate sources, 77 surface water and 112 groundwater samples distributed in the Gwangcheoncheon watershed, Hongseong-gun, Korea. Based on statistical analyses (e.g., hierarchical cluster analysis, principal component analysis, etc.), we suggested pollution indicators such as Ca/Na, Na/Cl, NO₃/Cl, and/or NO₃/SO₄ ratios. To evaluate the effectiveness of this novel approach and estimate the relative contributions of pollution sources, MixSIAR (stable isotope analysis in R) was successfully applied in the Gwangcheoncheon watershed. The results showed that the novel approach could play an important role in understanding pollution sources in intensive livestock farming watersheds.



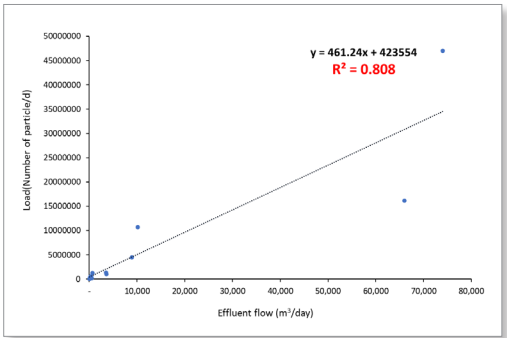
Relative distribution of different nitrate sources in each sampling point in the Gwangcheoncheon watershed

Research on distribution characteristics of microplastics in freshwater (III)

In most water environments, microplastic research is performed on point pollutants (e.g., wastewater treatment plants), rivers, and streams. For the first time in South Korea, among 82 domestic industries, this study surveyed the state of microplastics for 15 industries, including 12 industries with a high probability of generating microplastics and three industries with a low probability. We calculated microplastic concentrations and the removal efficiency by industry and analyzed the characteristics of microplastic emissions by industry. Finally, we calculated the daily load flowing into nearby streams and rivers, considering the concentration of microplastics in the discharge amount. Through this, we could identify the correlation between daily microplastic loads and which factors were more affected by the emission concentration or the discharge amount.



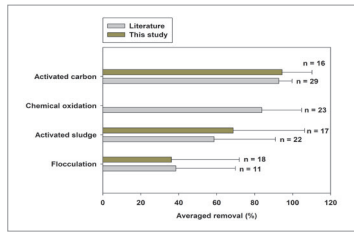
Various types of microplastics



Relationship between treatment plant discharge amount and microplastic load

Research on reinforcing industrial wastewater management and ecotoxicity operating system

Industrial wastewater research is divided into regulated and unregulated fields depending on whether the water pollutant is designated. In the unregulated field, according to the list of priority water pollutants in the Guidelines for the Designation of Water Pollutants, etc. (Ordinance No. 1312 of the Ministry of Environment), we identified the emission characteristics of 36 pesticides with high toxicity and detection frequency in the water system and researched appropriate treatment methods for them. In 2021, the number of industries with the ecotoxicity designation was expanded from 35 to all 82 industries. Therefore, we performed a study to apply the optimal ecotoxicity test species for each discharge facility to manage industrial wastewater effectively. For 21 industries, including textile dyeing and processing facilities, we examined the ecotoxicity conditions of effluent for five test species (*Daphnia magna*, *Vibrio fischeri*, *Ulva pertusa*, *Lemna paucicostata*, and *Spirodela polyrhiza*) and selected the most sensitive test species for each of the 21 industries. As of 2021, the ecotoxicity conditions for 41 industries have been surveyed. By 2023, we plan to expand the research to all 82 industries and establish efficient ecotoxic emission standards.



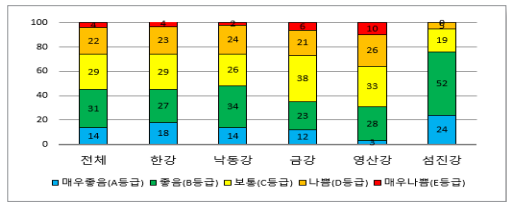
Treatment efficiency by wastewater treatment technology of 36 pesticides

물질명	발류수 최대값(μg/L)	PEC (μg/L)	AWQC (μg/L)	PNEC (μg/L)	HQ*	검출빈도 (%)	위해도
Cyfluthrin	19.56	1.956	0.0006		3.260	2.6	8,359
Metolachlor	121.22	12.122		0.2	60.6	12.8	777
2,4-Dichlorophenoxyacetic acid	211.96	21.196	0.3		70.7	10.3	725
Beta-Endosulfan	15.19	1.519		0.02	76	5.1	389
Tricyclole	1.73	0.173		0.0033	52.4	2.6	134
Benazox	1.63	0.163		0.02	8.2	7.7	63
Oryzasetrobin	10.61	1.061		0.47	2.3	25.6	58
Carbofuran	2	0.2		0.1	2	17.9	36
2,4,6-Trichlorophenol	6.37	0.637		0.19	3.4	10.3	34
MCFA	1.19	0.119		0.016	7.4	2.6	19
2,4,6-Trichlorophenol	3.37	0.337		0.26	1.3	12.8	17
MCFA	5.86	0.586		0.5	1.2	10.3	12
2,4,6-Trichlorophenol	0.75	0.075	0.071		1.1	5.1	5
2,4,6-Trichlorophenol	2.79	0.279	0.17		1.6	2.6	4

A total of 14 priority management pesticides for individual wastewater treatment facilities

Research and assessment of aquatic ecosystem health and diagnosing causes of damage

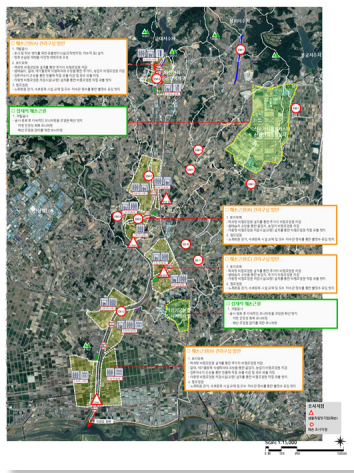
In 1,159 rivers (total 3,035), 108 estuaries, and 221 points (total 325, estuaries 668) nationwide, we surveyed aquatic organisms and river environments such as fish, benthic macroinvertebrates, and diatoms and assessed the health of the aquatic ecosystems. We also derived indicator species for each benthic macroinvertebrate class considering the population density of each biological grade. To ensure the continuity of the aquatic ecosystems, we investigated longitudinal and lateral continuity and prepared a guideline (draft) for investigating and assessing lateral continuity. In the damaged rivers among the river aquatic ecosystem survey points, we diagnosed the causes of impaired stream ecosystems and presented restoration and management measures to eliminate the causes of impaired stream ecosystems.



Health assessment grade ratios for river aquatic ecosystem fish

생물등급	생물지표종 (저서생물)
매우중증(A)	한국강도래, 줄날도래, 동글하루살이, 부채하루살이 등
중증(B)	동막지하루살이류, 동양하루살이, 다슬기, 종주물다슬기 등
보통(C)	참갯지렁이류, 줄날도래 Kub, 아나소열새우류 등
나쁨(D)	수정도아라물달팽이, 징거미새우, 물벌레류 등
매우나쁨(E)	실지렁이, 모기류, 아가미지렁이 등

Benthic indicator species by biological grade



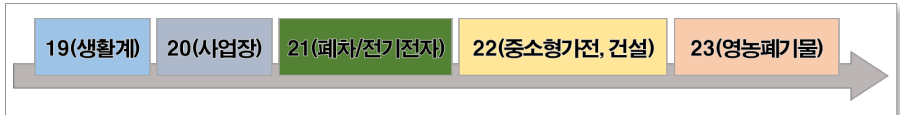
Impaired stream (Iksancheon) restoration and management plan

04 Environmental Resources Research Department



Research on life cycle assessment(LCA) of plastic waste recycling : Focusing on ELV and WEEE

To achieve circular economy and reach the goal of national carbon neutrality, we perform LCA from the generation of plastic waste from ELV(end of life vehicles) and WEEE(waste electrical and electronic equipment) to recycling. Thus, we diagnose issues in current management methods and devise improvement measures.

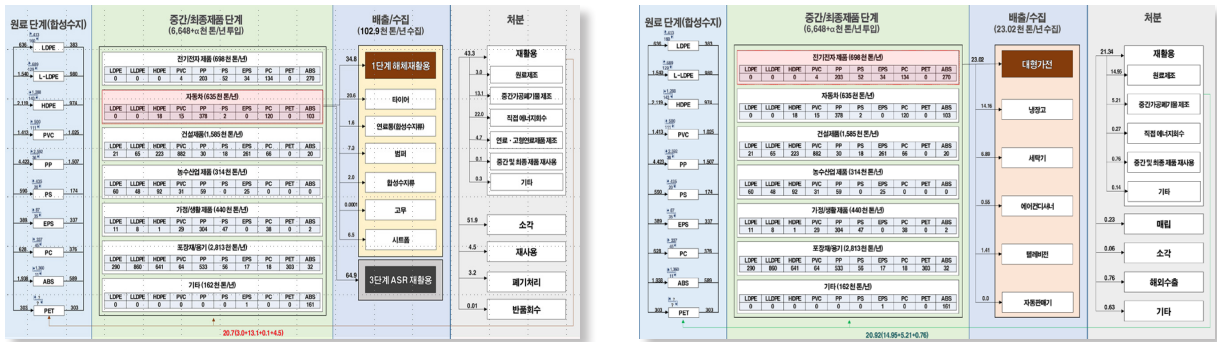


Annual progress plan for LCA of waste plastics

In 2019, 11,678,000 tons of plastic waste was generated and increased 16% from the previous year in Republic of Korea. plastic waste treated via recycling (69%), incineration (25%), and landfill (4%) and originated from industrial wastes (63%), domestic wastes (22%), and separate discharge of EPR (9%). Plastic waste from ELV and WEEE (five types of large home appliances: refrigerator, TV, air conditioner, washing machine, vending machine) were generated, respectively, 158,000 tons (1.4%) and 23,000 tons (0.2%).

We conducted an LCA from raw material to disposal of plastic waste Through a material flow analysis(MFA) using national statistical data and field survey results. Thus, we diagnosed problems that impede recycling of plastic waste from WEEE and ELV and suggest improvement measures. Also, for the safe recycling of plastic waste as resource, we investigated heavy metals(As, Cd, Cr(VI), Cu, Hg, Pb) and organics(PBDEs, DEHP, BBP, DBP, DIBP) regulated by EU's Restriction of Hazardous Substances in electrical and electronic equipment(RoHS) and Korea's Act on Resource Circulation of Electrical and Electronic Equipment and Vehicles.

Through improvement measures based on an LCA of plastic waste recycling, we will move one step closer to reducing waste and maximizing recycled resource utilization to achieve a circular economy and carbon neutrality.



Plastic waste [ELV (left), waste electrical and WEEE (right)] material flow analysis (2019)

Research on expansion a list of waste types and discharging industries subject to hazardous characteristics(I)

To prevent unpredicted accidents like fires and explosions caused by hazardous characteristics* of waste, we are conducting research on expansion a list of the waste types subject to the diagnosis of hazardous characteristics and the industries that discharge them. For this purpose, we have created an annual research plan for five years and are promoting the diagnosis of hazardous characteristics. In the first year, we investigated whether hazardous characteristics were expressed in three waste types, namely synthetic polymer compounds, industrial waste sludge, and wastewater treatment sludge. According to the results, harmful characteristics were expressed in ten cases: three for leaching toxicity, two for flammability, two for oxidative, and three for corrosivity.

* Explosive, flammable, pyrophoric, hydrophobic, oxidative, leaching toxicity, infectious, corrosive, ecotoxic

<The analysis results of hazardous characteristics on samples>

Waste types	Leaching toxicity			Flammability			Pyrophoric			Oxidative			Corrosivity		
	○	△	X	○	△	X	○	△	X	○	△	X	○	△	X
Total	3	-	73	2	15	28	-	-	18	2	1	18	3	1	16
Synthetic polymer compounds	1	-	27	1	15	16	-	-	6	-	-	-	-	-	10
Industrial waste sludge	1	-	20	1	-	11	-	-	12	2	1	18	3	-	6
Wastewater treatment sludge	1	-	26	-	-	-	-	-	-	-	-	-	-	-	-

※ The results on hazardous characteristic : expressed (○), concerned (△), hazardous characteristic-free (X)

Thus, we have created a classification list (draft) containing discharging industries and wastes expressing hazardous characteristics and the list would be used as a reference data to amend the related laws and notices.

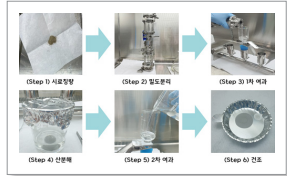


Samples for hazardous characteristics investigation

순서	산업명	폐기물명(종류)	폐기물명	유해특성(표지)	유해특성(표지)
1	고령자요양시설	폐기물	폐기물	유해특성(표지)	유해특성(표지)
2	고령자요양시설	폐기물	폐기물	유해특성(표지)	유해특성(표지)
3	고령자요양시설	폐기물	폐기물	유해특성(표지)	유해특성(표지)
4	고령자요양시설	폐기물	폐기물	유해특성(표지)	유해특성(표지)
5	고령자요양시설	폐기물	폐기물	유해특성(표지)	유해특성(표지)
6	고령자요양시설	폐기물	폐기물	유해특성(표지)	유해특성(표지)
7	고령자요양시설	폐기물	폐기물	유해특성(표지)	유해특성(표지)
8	고령자요양시설	폐기물	폐기물	유해특성(표지)	유해특성(표지)
9	고령자요양시설	폐기물	폐기물	유해특성(표지)	유해특성(표지)
10	고령자요양시설	폐기물	폐기물	유해특성(표지)	유해특성(표지)

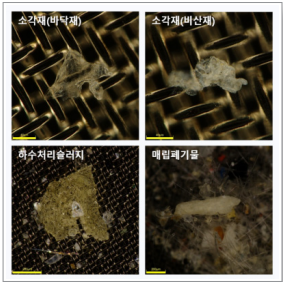
The results on hazardous characteristics investigation

Research on the characteristics of microplastics generated during waste treatment process : Focusing on the investigation of analysis techniques for monitoring(I)



Analysis procedure for microplastics in waste

With rising concerns worldwide about the environmental hazards of microplastics and their effects on human health, continuous research and management of microplastics are necessary. Accordingly, this study investigated the characteristics of microplastics in waste treatment facilities, a source of microplastics in onshore systems, to devise management measures for microplastics in waste. From the results, 8~104MPs/0.1g_{waste} of waste plastic incineration ash, 6~190MPs/0.5g_{waste} of water and sewage treatment sludge, and 50~206MPs/0.5g_{waste} of landfill waste were detected, thus confirming the potential for microplastics to occur in waste. Further, according to a characteristics analysis of the detected microplastics, high percentages of polypropylene, polyethylene (PE), and terephthalate (PET) were detected. Moreover linear, fragmented, and splintered microplastics were identified in the range of 500 μm or less. Based on these research findings, we created the “Analysis Methods for Microplastics in Waste (Draft),” which includes sample collection, pre-treatment, and analysis methods to serve as a reference for analyzing microplastics in waste. We also sought to provide basic data to reinforce the management of the entire domestic microplastics process by establishing a research promotion plan based on the main promotion content, including analysis techniques (technologies) to analyze microplastics in waste, microplastic monitoring for each waste treatment facility (complete enumeration), and microplastic management systems.



Observation of microplastics using an optical microscope

Research on reducing final disposal waste amount through waste flow analysis : Improvement methods for medical waste classification system and sterilization facility standards

The generation of medical waste is continuously increasing due to the development of medical services and population aging, and the throughput of dedicated incinerators is approaching its maximum. This study prepared an improvement plan (draft) for the medical waste classification system and reported it to the Ministry of Environment. We expect this to contribute to medical waste reduction policies. Based on the data used in this study, a sourcebook was published and distributed. We also verified the safety and sterilization effects of chemical sterilization and pulverization facilities, which are not yet permitted in South Korea. To investigate the safety of chemical sterilization and pulverization facilities, we examined continuous grinding ability, moisture content of treatment residues, risks of chemical treatment agents, and whether wastewater is treated. Further, to inspect sterilization, we performed inspections according to treatment capacity, time, and temperature for six WHO Phase III indicator microorganisms*. Through this, we derived the necessary standards (draft) for installing chemical sterilization and pulverization facilities.

* Bacillus subtilis, Staphylococcus aureus, Mycobacterium phlei, Candida albicans, Aspergillus niger, Bacteriophage

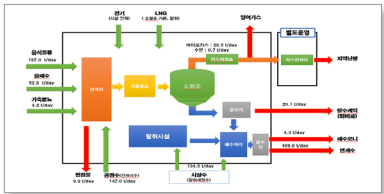


<Standards for Chemical Sterilization and Pulverization Facilities (draft)>

Inspection item	Main inspection content
Pulverization ability of equipment	■ For batch type, whether all input wastes per batch have been pulverized and processed to the next stage
Adequacy of isolation or containment	■ Whether noise, vibration, dust, and spray generated during the process affect the outside
Sterilization inspection Indicator microorganism diversity	■ Application of five WHO Phase III indicator microorganisms during installation and inspection under conditions other than permitted by the current law (gram-positive, gram-negative, acid-resistant, fungal, virus)
Hazardous chemicals	■ Whether wastewater is treated, wastewater toxicity assessment, air quality (e.g., chemical distribution) in a treatment plant

Research on establishing detailed inspection methods for waste treatment facilities

We conducted a study to establish detailed inspection methods to enable more scientific and transparent installations and regular inspections of waste treatment facilities. Waste treatment facilities are divided into six fields, including incineration and landfill; we performed field surveys of 18 waste treatment facilities to devise the inspection methods (draft). To ensure the reliability of the inspection methods (draft), we held three advisory meetings with experts and inspection agency representatives of each field and performed field applicability assessments of 12 facilities. Based on the research results, we improved the inspection methods so that waste treatment facilities are inspected according to strategic standards (e.g., temperature and retention time calculation range) and include measures to secure objective data (e.g., thermal imaging cameras, image information processing devices, and TMS data utilization). We also developed detailed inspection methods (draft) that improve 31 inspection methods, such as converting indirect inspection approaches (e.g., visual inspection and simple document confirmation) to direct approaches (e.g., field measurements).



Flow chart of food waste treatment facility mass balance

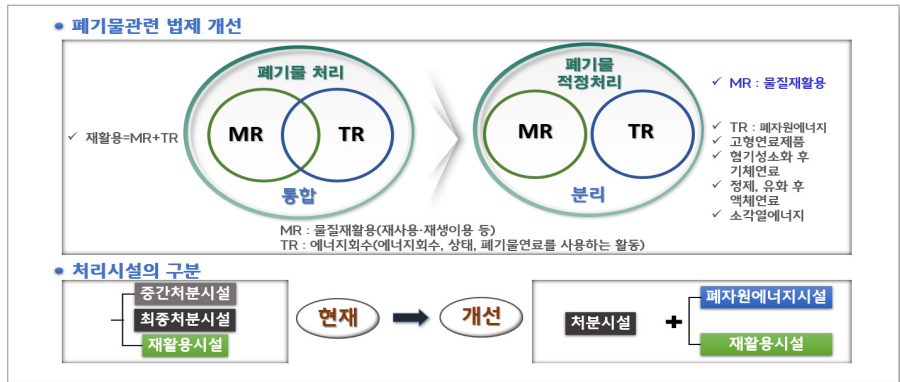


Field survey of the landfill facility

Research on implementation measures for a waste-to-energy incentive system

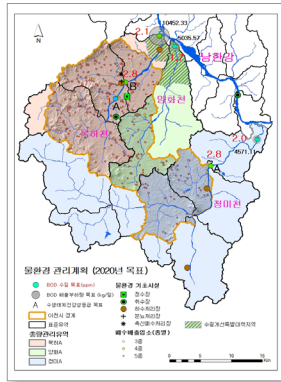
With the 2019 amendment of the Renewable Energy Act and reduction in weight of the supply certificate for energy produced from non-renewable waste* to 0.25, concerns arose about the loss of competitiveness of energy production facilities such as gas, electricity, and heat sources using waste resources. Therefore, to establish an economic support system to stimulate and promote waste-to-energy facilities, we surveyed statistical data on energy production and usage of incineration heat energy recovery, solid fuel, liquid fuel, and gaseous fuel. We calculated the Waste-to-Energy Certificate weight in line with energy recovery efficiency and environmental and economic indicators and devised an incentive system (draft). Moreover, we sought to provide legal standing for the operation, management, and support system of waste-to-energy facilities by enacting the “(Tentative name) Act on the Promotion of Waste-to-Energy Promotion (Draft)” for vitalizing waste-to-energy facilities.

* Wastes originating from fossil fuels like petroleum and coal rather than biological sources



Improvement of the Standing of Waste-to-energy-related Laws (draft)

Support for sustainable, eco-friendly development and improving the environmental value of national land



Comprehensive reference map of water environment management plan in Icheon City

To improve the effectiveness of the EIA system, we opened the Environmental Impact Assessment Center (December 10, 2021) and promoted a comprehensive EIA review, management of the EIA information support system, and climate EIA response research. We devised guidelines for creating and reviewing EIA reports with supplemented field measurement and impact prediction methods for water quality (surface water) and reinforced the standardization and verification role of EIA by proposing revisions to the Regulations on the Preparation of Environmental Impact Assessment Reports, etc. (notice of the Ministry of Environment). We devised a guide (draft) for creating environmental maps in the water environment field to support the integrated management of national land-environment plans, created a summer surface temperature map by si and gun nationwide over the past five years (2016~2020), and proposed its inclusion in the Environmental Conservation Value Assessment Map(<https://ecvam.neins.go.kr>). Furthermore, through a 2019–2021 mobile big data analysis (30 city parks and forests nationwide) and survey (1,000 participants nationwide), we analyzed changes in urban green space usage behavior before and after the outbreak of COVID-19.



Opening of Environmental Impact Assessment Center

Research on environmental quality assessment using cryopreserved biological samples

As part of the “Development of long-term diagnostic indicators for environmental changes and mid- to long-term study on receptor effects,” the Environmental Specimen Bank(ESB) obtained freshwater ecosystem carp and coastal ecosystem black-tailed gull eggs and performed a pollutant analysis. The carp were collected from the Han River Estuary and Yeongsan Estuary (2012, 2014, 2015, and 2018), and five organic pollutants (e.g., PAHs, PCBs, and OCPs) and 38 metals were analyzed in muscle specimens. According to a correlation analysis of pollutant concentrations by carp length, eight items, including mercury, exhibited high accumulation properties. Regarding the black-tailed gull eggs collected from coastal ecosystems (Western sea-Baengnyeongdo, Southeastern sea-Hongdo, Donghae-Ulleungdo) from 2012–2020, we analyzed nitrogen stable isotope ratio and total mercury to correct for the influence of differences in food chain characteristics between breeding sites on the accumulation of mercury concentration and analyzed the results. For Baengnyeongdo and Ulleungdo, the correction caused an overall increase in mercury concentration, and for Hongdo, southeastern sea, an overall decrease. In the future, we plan to collect and analyze the live food of black-tailed gulls (e.g., fish), zooplankton, and phytoplankton.



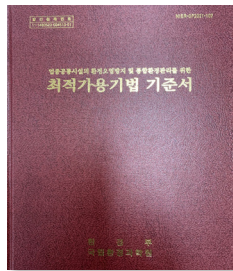
Common carp (Han River)



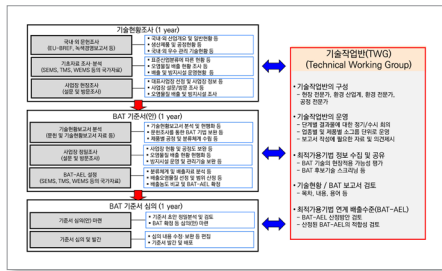
Black-tailed gull eggs (Hongdo, southeastern sea)

Research on the foundation of an integrated environmental management system for facilities that pollute the environment

To facilitate the application of Best Available Techniques (BAT), technically and economically feasible environmental management techniques that can effectively reduce pollutant emissions and the like, in work sites, we have been publishing (enacting and amending) BREFs in 19 industries subject to integrated management since 2016. The BREF contains the general conditions of the specific industry, main processes, pollution emission levels by process, and BAT. It also contains the Best Available Techniques Associate Emission Level (BAT-AEL) used in setting the maximum emission standard and the emission impact analysis within the range of possible pollutant emission levels during normal operation when applying BAT in emission facilities. The final BREF is published and distributed after a domestic and overseas status survey of the industry, drafting a BREF, review by the technical working group, and deliberation by the Central Environmental Policy Committee. In 2021, we published a BREF for industrial boilers and proposed consistent, integrated permit standards for boilers commonly operated by industries. We are also working on revising new BREFs for the waste treatment and cement manufacturing industries and amending the published BREFs.



Common Industry BREF



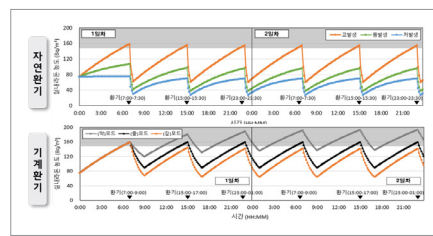
BAT Reference Publication Procedure

05 Environmental Infrastructure Research Department

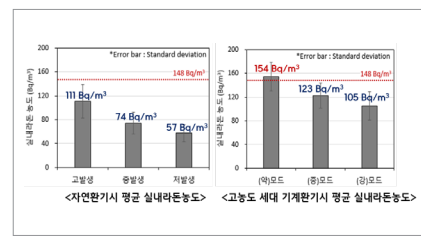


Establishment of indoor radon management basis and research on reduction measures for (newly built) multi-family housing(I)

The need to reduce indoor radon in apartment buildings and manage its sources has recently emerged due to exposure to high indoor radon concentrations in newly built multi-family housing. Thus, to prevent health damage caused by radon exposure, the Living Environment Research Division has provided proper ventilation methods since 2020, such as operating mechanical ventilation facilities in multi-family housing. For natural ventilation using windows, it suggests ventilating for at least 30 minutes with cross ventilation (opening the living room and kitchen windows simultaneously). For mechanical ventilation, it suggests operating for at least 2 hours on medium mode. It is considered that methods above can make average indoor radon concentration stay below the recommendation level(148 Bq/m³) for 8 hours. The Division also devised a radon exhalation rate test method using the closed chamber technique for various indoor building materials and an indoor radon contribution rate assessment method based on the mass-balanced model. It promotes research to secure basic data necessary for managing building materials known as sources of radon in multi-family housing, such as investigation of the correlation between exhalation rate and indoor radon concentration.



Proper ventilation method



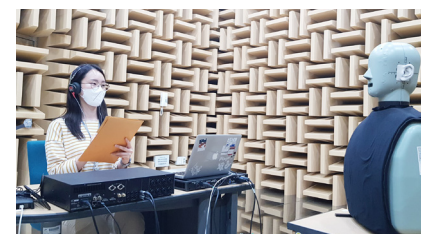
Daily average indoor radon concentration during proper ventilation

A Study on the assessment of Noise Annoyance according to Living noise source(I)

In 2018, the WHO recommended implementing noise management policies considering the country's specific environmental conditions based on the noise annoyance felt by people rather than the decibels of the noise. Accordingly, the NIER is promoting research on noise annoyance to identify causes of annoyance and subjective sensory indices like sharpness and roughness, focusing on living noise sources, where most complaints originate. For this purpose, we first constructed a sound source playback and evaluation system in an anechoic chamber and found that people feel different levels of annoyance from natural sounds and artificial noises even at the same decibels. By heavily promoting research on annoyance evaluation, focusing on noise sources with frequent complaints (e.g., construction sites), we expect the paradigm to shift from source-oriented living noise management to human-oriented management.



Environmental noise recording using a 2-channel noise measurement system



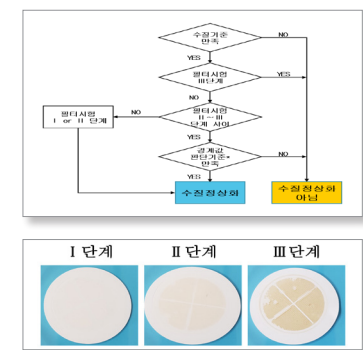
Annoyance evaluation using an anechoic chamber auditory evaluation system

Research on strengthening water safety through management of tap water contaminants

Red or black tap water is sometimes supplied to homes due to foreign substances generated in the tap water supply process or separated from the pipeline, occasionally leading to big complaints. This has spurred concern about tap water contaminants, with increasing households using faucet filters and the like. When a foreign substance-related accident occurs, the government and water service providers face difficulties stabilizing water quality and resolving complaints, and the public's perception of tap water safety worsens. Accordingly, the NIER published the "Guidelines on Filter Test Methods for Rapid Judgment of Water Quality" to help water service providers respond quickly and effectively to abnormal water quality caused by colored particles, and to manage aesthetic aspects of water quality objectively and scientifically even in normal times. The book contains a standardization (draft) of filter test methods, examples of setting criteria for normalization in case of abnormal water quality, and application methods.



Guidelines on Filter Test Methods for Rapid Judgment of Water Quality



Example of water quality normalization judgment in foreign substance accident

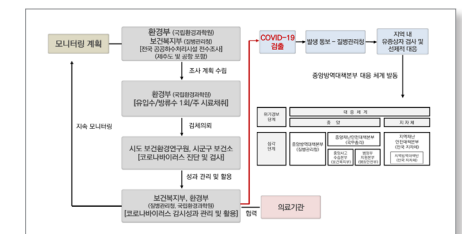
Research on establishing a response system for harmful microorganisms in water environments

Antibiotic-resistant bacteria caused by the misuse of antibiotics pose a serious threat to public health. The WHO has stressed the need to build an antibiotic resistance monitoring system and integrated monitoring system for people, animals, and the environment under the concept of One-Health. Accordingly, a joint project among seven ministries was implemented. In the environmental field, we made a standard operating procedure for analyzing antibiotic-resistant bacteria based on culture-dependent method and accumulated related data through antibiotic resistance assessments and monitoring studies to establish a response system for antibiotic-resistant bacteria in water environments. Further, we plan to contribute to national antibiotic resistance management from the perspective of One-Health by investigating the distributions of antibiotic-resistant bacteria and control technologies in water environments.

To enable a science-based response to the COVID-19 pandemic, we performed research on building an analysis system using sewage-based mechanics. Accordingly, we established a COVID-19 standard analysis method and quality control method. In 2022, we plan to propose a mid-to-long-term management system plan for novel viruses through a pilot study monitoring influent and effluent from sewage treatment facilities in areas with COVID-19 clusters.



Multi-sectoral joint project to One Health approach against antimicrobial resistance



Pilot study of sewage treatment facility COVID-19 monitoring

Development and technology transfer of automatic measurement system for taste and odor substances in tap water

Algae is occurring in large quantities in water sources due to climate change, making it difficult for drinking water treatment plants to treat taste and odor substances (geosmin, 2-MIB) originating from algae. Although geosmin and 2-MIB have no problems in terms of health and safety, they are not properly eliminated in the general water treatment process. As little as 0.00001 milligrams per liter can cause bad taste and odor degrading the reliability of tap water. Effectively treating these substances requires quickly measuring the concentrations flowing into the drinking water treatment plants. The NIER developed a system to automatically measure taste and odor substances in tap water in real time and transferred the technology to a company for commercialization. Once a commercialized automatic measurement device is released, we expect it to be possible to improve the treatment efficiency of taste and odor substances by injecting suitable chemicals at the proper time and reducing water treatment budgets.



Real-time automatic measurement system of taste and odor substances



Domestic and foreign patents related to technology transfer (owned by NIER)

Strengthening test and inspection quality management for high - quality national environmental data

To ensure the suitability of environmental data from testing and inspection institutions in the environmental field, we conducted proficiency tests in nine fields (1,152 laboratories, 116 items). Consequently, we found that 1,141 laboratories (99.0%) were satisfactory. We also conducted site evaluations (594 laboratories, 13,564 consulting cases) and found that 361 laboratories (98.0%) were satisfactory. Further, we piloted the “Equipment Reliability Assessment System (Test Beds)” to resolve performance-related concerns and stimulate the market for domestic environmental measuring instruments (water quality field: TOC, TN, TP). For the operation of KS and ISO standards in the environmental field, in collaboration with 11 NIER departments and external experts, we announced 193 KS national standards and gathered and submitted domestic opinions on 316 ISO standards. Both standard methods proposed to ISO were finally approved as international standards. We are also devoting efforts to enhancing the accuracy and reliability of environmental measurement data, such as by establishing and revising 242 standards across six fields, including air pollution process test standards.



Equipment reliability assessment (testbeds)



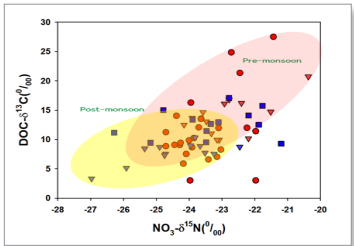
2021 Online Conference of Quality Control Institutions

Vitalization of joint research on environmental issues and pollutant tracing research

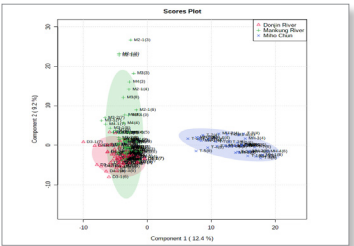
To identify environmental pollution history and causal relationships, we developed pollution tracers and conducted a field application pilot study. To utilize stable isotope ratios as a chemical finger-printing technique, first, we established an analysis technique for stable zinc isotope ratio ($\delta^{66}\text{Zn}$) in environmental atmospheric fine dust. Second, we assessed the field applicability of water quality total organic carbon/nitrogen stable isotope ratio ($\text{DOC-}^{13}\text{C}$, $\text{NO}_3\text{-}^{15}\text{N}$) analysis. Third, we performed a field application study of a heavy metal environmental pollution history survey technique using tree rings. Finally, we conducted joint research with the NIES** of Japan to improve the stable isotope analysis system for low-concentration mercury in the environment to support the Minamata Convention on Mercury*. Through the operation of the Environmental Scientific Investigation Research Group and the Environmental Isotope Analysis Research Group, we have promoted exchange and cooperation between institutions for joint research. This includes conducting training on stable isotope analysis equipment and promoting discussions on precision and accuracy comparison tests of analysis values using standard materials. We also devised a quick search method that can analyze the mass information of all substances in a sample by deviating from the existing method of selecting a target material to analyze specifically. Further, we are developing a technique for tracing pollutants by analyzing pollutant patterns.

* Minamata Convention: International convention to reduce the human and environmental risks of mercury, a major hazardous substance, by managing mercury throughout its life cycle, including trade, manufacturing, air emissions, and waste treatment

** NIES: National Institute for Environmental Studies of Japan



Dual plot of $\text{DOC-}^{13}\text{C}$ vs $\text{NO}_3\text{-}^{15}\text{N}$



Classification by water system according to pollutant distribution characteristics

Research on risk - based soil pollution management and improvement of the impact assessment system in apprehensive areas

For follow-up measures to the amendment (November 2018) of the Enforcement Rules of the Soil Environment Conservation Act related to the designation of dioxin soil pollutants, we created dioxin soil pollution standards (draft) considering domestic background concentrations and risks. Subsequently, we conducted a survey pilot project to designate unregulated soil pollutant monitoring items and devise an operation plan according to the Second Master Soil Environment Conservation Plan (2020–2029). We also prepared revised (draft) guidelines for post-environmental pollution impact surveys in the vicinity of abandoned mines and improved the methods (draft) of investigating residual pesticides in the soil and water quality of golf courses. Moreover, we operated a National Standards Expert Committee in the soil quality(ISO/TC 190) and have established, amended, repealed, and confirmed 66 national standards (KS) and reviewed 63 international standard proposals (ISO).



Field survey of the region around an abandoned mine



Soil sample collection from a golf course

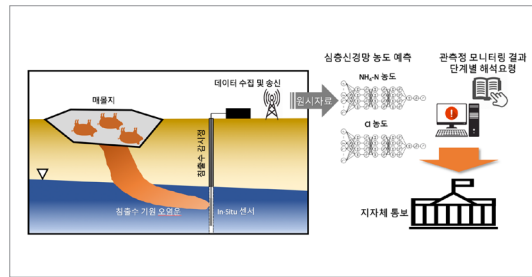
Advancement of integrated groundwater management and strengthening groundwater quality management in areas vulnerable to pollution

In line with the water management unification (2018), we established an advanced strategy for the integrated management of groundwater including the harmonized groundwater-surface water quality management and the enactment of monitoring system. Through a survey on unregulated groundwater pollutants, we proposed new standard candidate substances (PFOA, PFOS) for 2021. We also rearranged the Standard Method for groundwater monitoring items and standardized the field item measurements. For the water quality management in vulnerable areas to pollution, we are operating the Safe Groundwater Call Center*. Further, we performed a survey that aimed to identify national background concentration of natural radioactive substances (e.g., radon) from total 201 sites of the national groundwater monitoring network in 2021. Moreover, we took the initiative in resolving current issues by developing an AI-based leachate runoff assessment model (patent registration) and improving groundwater quality in livestock manure spill areas (Hallim-eup, Jeju-do). Through the Nitrate Nitrogen Groundwater Quality Improvement Research Project (five villages in Chungnam), we assessed pollutant contributions and forecasted improvements in groundwater quality.

* Safe Groundwater Call Center (1899-0134): Approximately 1,500 cases, including civil complaint responses and inspection applications; water quality inspection project with 2,100 households



NIER-Korea Institute of Geoscience and Mineral Resources Business Agreement (May 2021)



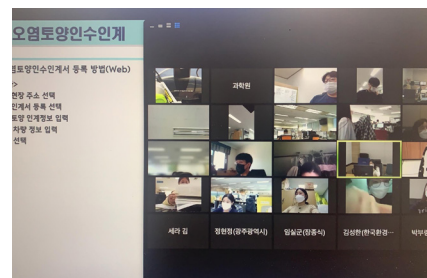
AI-based leachate runoff assessment conceptual model

Operation and improvement of the Soil and Groundwater Information System

In accordance with Article 4-5 of the Soil Environment Conservation Act (November 2017), we are building a system (2019–2022) for the history management of soil pollution, including the current status of facilities of potential pollution source and soil pollution site life cycle (e.g., nationwide soil surveys and remediation), within the SGIS (<https://sgis.nier.go.kr>). Moreover, we have developed user-tailored statistical functions based on data linkage to support soil pollution management policies. We restructured the website to reflect the amended soil and groundwater-related laws and notices, enhanced the exported polluted soil management system, and have improved data quality and maintained the system to ensure data reliability. To improve the system's user convenience, we conducted virtual training (approximately 180 participants) with local government officials and other stakeholders.



Soil and Groundwater Information System (SGIS) Homepage



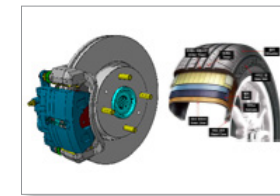
SGIS User Training

06 Transportation Pollution Research Center



Research on the characteristics of non-exhaust gas emissions by mobile pollutants

Owing to stricter emission standards on exhaust gas, an automobile pollutant, many studies have been conducted. However, research on non-exhaust system pollutants from tires and brakes is insufficient. Accordingly, since 2020, the Transportation Pollution Research Center has been performing studies on the amount of abrasion dust generated from non-exhaust systems and its contribution to air pollution. In 2021, we are conducting a study to estimate the contribution of abrasion particles to PM in the atmosphere using specific components of tires. We are conducting another study to analyze the characteristics of abrasion dust emitted when driving on the road by developing a device that directly collects and measures abrasion particles from vehicles. Additionally, we are actively participating in international harmonization, such as by joining the UN's World Forum for Harmonization of Vehicle Regulation (WP29) and proposing opinions on inter-laboratory studies and test methods.



Brakes and tires



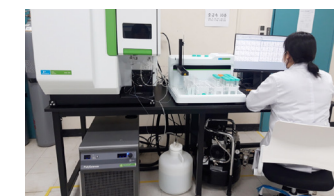
Road measurement system



Brake abrasion test

Automobile catalyst (DEF) emergency supply status and response

Owing to the Chinese urea export restrictions after September 2021, in November of the same year, South Korea had a shortage of catalysts (DEF) for diesel vehicles. The number of DEF quality inspections, which was around ten per year on average before the DEF shortage (before October 2021), substantially increased to 1,165 over four months from November 2021 to the end of February 2022. To handle the surging demand for inspections, the legal processing period was shortened significantly from 20 days to three to five days; five new inspection agencies, including the Korea Environment Corporation, have been designated to enable swift inspections. Moreover, in accordance with active administrative measures, 48 pre-inspections for internationally certified DEF (AdBlue, API) were temporarily exempted from November 10 to December 31. To stabilize the supply and demand of urea and DEF, we examined the feasibility of converting industrial urea to vehicle use and confirmed the feasibility of manufacturing use. We also supported the analysis of 34 samples requested by smuggling and illegal distribution regulators (e.g., environmental, police, and customs agencies). Additionally, in collaboration with the Korea Trade-Investment Promotion Agency (KOTRA), we analyzed various factors such as foreign industries and shared the information.



Catalyst (DEF) manufacturing standard inspection

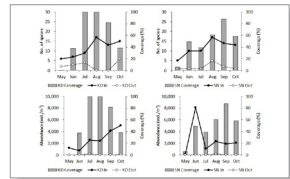


Feasibility test of industrial urea as vehicle DEF

07 Four Major Rivers Research Centers



Effect of Aquatic Macrophyte on Water Environment of Lake Paldang



Comparison of the number of species and population density of aquatic insects inside and outside water chestnut communities



Cyanobacteria trapped in water chestnut communities

We comprehensively investigated the effect of aquatic plant communities on water quality and aquatic ecosystems in Paldang Lake. In 2021, we surveyed and compared water quality and aquatic ecosystems inside and outside water chestnut and lotus communities. Although we observed no significant difference in water quality between the inside and outside of the communities, we observed an increase in turbidity, TP, and chlorophyll a (Chl.a) in some water chestnut communities. The number of species and population density of phytoplankton, zooplankton and aquatic insects were higher inside the aquatic plant colonies than outside, indicating that aquatic plant communities provide habitats for various organisms. We also investigated odor substances and the amount of odor substance-producing gene; 2-MIB* concentrations and the amount of 2-MIB-generating gene were higher inside the water chestnut communities than outside. Further, the amount of 2-MIB-generating gene were higher on the surface of water chestnut than lotus. Moreover, we observed a phenomenon that cyanobacteria become trapped in water chestnut communities and cannot move with the flow of water, demonstrating the potential for water chestnut to induce an increase in odor substances. We also developed a 2-MIB real-time PCR** analysis method to verify the occurrence probability of odorous substances in Paldang Lake.

* 2-MIB: Abbreviation for 2-Methylisoborneol, a type of odor substance

** Quantitative real-time polymerase chain reaction: Method for simultaneously amplifying DNA and measuring DNA amounts

Prediction on water quality variations in Paldang reservoir by climate change(I)

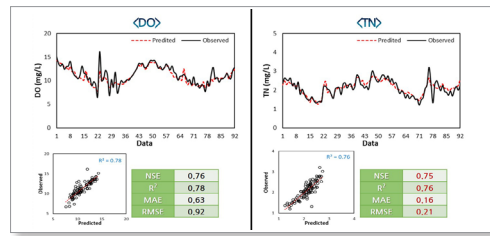
- Application of data-based model through high frequency monitoring

Water flowing from the South and North Han Rivers and Gyeongangcheon meet at the Paldang reservoir, a water source for residents in the Seoul metropolitan area. Hence, due to the large spatio-temporal fluctuations, it is critical to understand its characteristics and change patterns. This study implemented and operated a high-frequency monitoring system in the Paldang reservoir water source and predicted water quality according to climate change using a data-based model. The predicting accuracy of changes in water quality according to water depth in the Paldang reservoir improved when conducting simulations using meteorological, flow rate, and water quality data of the surface, middle, and lower layers.

In particular, we yielded excellent predicting results for dissolved oxygen (DO) concentration (NSE 0.95 in the Random Forest model), and optimal models were derived with Random Forest (RF), eXtreme Gradient Boost (XGB), and deep neural network. Next year, we also plan to utilize high-frequency data in the three optimal models to predict long- and short-term changes in water quality according to climate factors. We expect the model accuracy to improve with high-frequency data in units of hours and days.



High-frequency monitoring system constructed in the Paldang reservoir

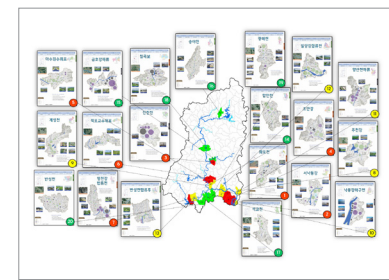


Simulation results of RF model, the optimal data-based model

A Study on best management of critical source areas with non-point pollution according to climate change(I)

In 195 small zones of the Nakdong River system, we conducted a vulnerability assessment of non-point pollution sources according to future climate changes and determined management priorities based on the environmental variables of non-point pollution sources derived from prior research. We used six variables in the vulnerability assessment (future precipitation, non-point load, impervious area, runoff curve number, water quality, and excess rate of water quality standard). Each variable was normalized* and indexed, the percentage values were summed, and each was ranked. In the case of the upper small zones, we captured aerial images and performed field surveys to identify the distributions of non-point pollution sources and issues and explore corresponding solutions. According to land use characteristics, we examined the operation methods of agricultural drainage ditches, the distribution of livestock farms, and the ratio of separated sewer systems, identified problems, and established appropriate management measures.

* Min-Max Normalization: Reflects all data on the same scale. Raw data values can be converted to within a range of 0 to 1 and evaluated with identical criteria



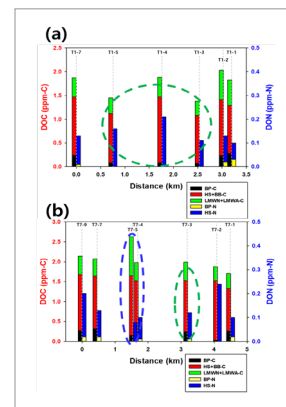
Distribution of pollution in small zones vulnerable to non-point pollution

구분	상위 5% 소관 구역	관리방안
Cluster 1 (농업)	농업지역	(가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저
	농촌지역	(가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저
	농촌지역	(가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저
	농촌지역	(가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저
Cluster 2 (도시 + 농업)	도시지역	(가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저
	도시지역	(가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저
	도시지역	(가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저
	도시지역	(가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저
Cluster 3 (도시)	도시지역	(가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저
	도시지역	(가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저
	도시지역	(가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저
	도시지역	(가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저 (가) 비닐하우스 등 시설물 관리 철저

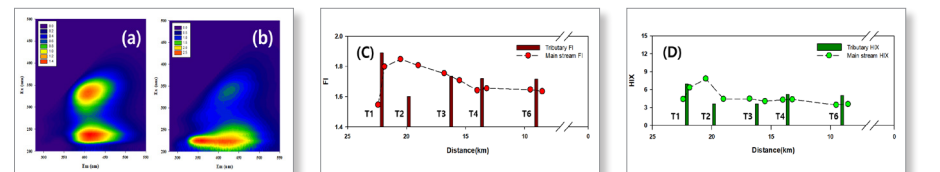
Non-point pollution management measures tailored to small zones

Investigation on the origin of organic pollutants in the upstream of Miho-stream and management strategies for the corresponding small watersheds(II)

Through a two-year survey of the upstream watershed of Mihocheon, we found that the BOD concentrations of the mainstream and inflow streams have decreased overall, whereas livestock pollutants showed an increasing trend. Through this study, we could classify organic pollutants in rivers using various fluorescence spectroscopic characteristics, which enabled us to identify the scope of the pollutants' impact on the tributaries and mainstream. After rapidly identifying specific pollutants via fluorescence analysis, it was possible to identify the characteristics of organic pollutants in connection with SEC-OCD/OND more effectively. We derived structural measures for installing constructed wetlands in Natgeoreumcheon and Jungsancheon watersheds and installing livestock manure public sewage treatment facilities in connection with public sewage treatment facilities in Mihocheon. For non-structural measures, we proposed livestock manure collection, agricultural drainage management, nutrient management and activation of local governance.



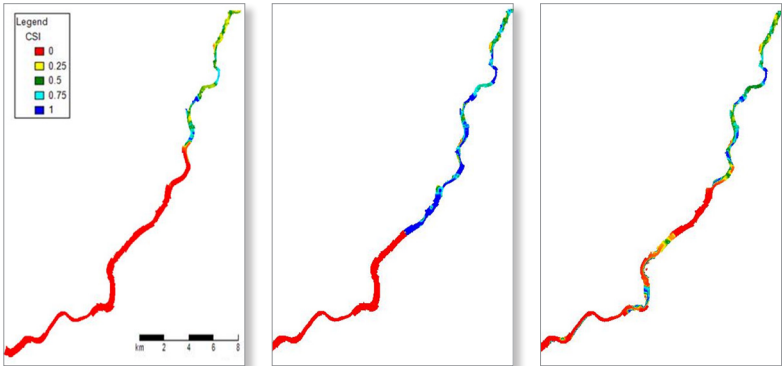
Molecular weight analysis using SEC-OCD/OND (a) Livestock farms, (b) Food factory effluent



Identification of pollutants and pollution effects using fluorescence spectroscopy characteristic; Identification of pollution effects using (a) livestock wastewater, (b) industrial wastewater EEM, (c) FI, and (d) HIX

Application of habitat analysis and modelling for improvement of aquatic ecosystem health in the Yeongsan River(II)

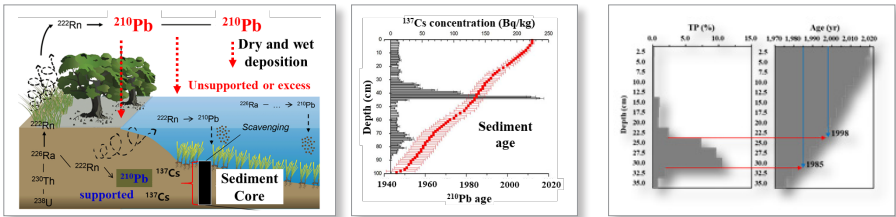
To predict and efficiently manage changes in aquatic ecosystems caused by environmental changes, a model that integrates and analyzes the interactions between physical, chemical, and biological factors is necessary. For this purpose, we combined the 3D hydraulic and water quality model Delft3D and the aquatic ecology model HABITAT to build an integrated hydraulic-water quality-aquatic ecology prediction model applicable to the Yeongsan River system. Based on field survey data of the Yeongsan River system, we constructed habitat suitability curves for each species according to physical and chemical factors and simulated changes in habitat suitability caused by weir operation for *Squalidus chankaensis tsuchigae*, *Cyprinus carpio*, and *Micropterus salmoides*. We also calculated the changes in average suitable habitat area of target fish species and analyzed the tolerance level of occurring fish species to changes in the physical environment.



Changes in suitable habitat area of *Squalidus chankaensis tsuchigae* by weir operation scenarios

A study on the chronology of lake sediments using radioisotope techniques

Sediment chronology is a very useful tool for verifying historical pollution records using artificial (e.g., ¹³⁷Cs) and natural (e.g., ²¹⁰Pb) radioisotopes from sediment cores. This study was conducted to establish a research foundation for sediment chronology techniques and apply them to agricultural reservoirs to assess the pollution sources of polluted sediments. By establishing a specimen preparation technique for radioisotopes (²¹⁰Pb, ²²⁶Ra) analysis and a customized simple calibration method, we laid the foundation for research on sediment chronology. We could estimate the sedimentary dating of polluted sediments by applying the vertical distributions of radioisotope concentrations obtained from this method to the sediment chronology model. We have presented the research findings as evidence for identifying the scientific causes of polluted sediments. In the future, this technique can be applied to sediment management policies to assess the cause of polluted sediments.



Sediment chronology according to circulation and sedimentation of ²¹⁰Pb and ¹³⁷Cs in an aquatic environment

Estimated sedimentary dating of high-concentration polluted sediment

3

Annex



Research Achievement in 2021

Research Project List
Science Citation Index(SCI) Paper List

International Cooperation in 2021

International Conference and Academic Activities
International Joint Research
International Partnership

Research Project List

No.	Department	Division	Title of Project
1	Environmental Health Research Department	Environmental Health Research Division	Evaluating of Exposure to Environmental Pollutants and Health Effects of Inhabitants in Industrial Complexes area(3rd stage)- Gyeong-gi·Chungcheong(IV)
2	Environmental Health Research Department	Environmental Health Research Division	Evaluating of Exposure to Environmental Pollutants and Health Effects of Inhabitants in Industrial Complexes area (3rd stage)- Gwangyang·Yeosu(IV)
3	Environmental Health Research Department	Environmental Health Research Division	Evaluating of Exposure to Environmental Pollutants and Health Effects of Inhabitants in Industrial Complexes area(3rd stage)- Ulsan·Onsan(IV)
4	Environmental Health Research Department	Environmental Health Research Division	Evaluating of Exposure to Environmental Pollutants and Health Effects of Inhabitants in Industrial Complexes area(3rd stage)- Pohang
5	Environmental Health Research Department	Environmental Health Research Division	A study on exposure assessment of air pollutants from emission sources
6	Environmental Health Research Department	Environmental Health Research Division	Human biomonitoring of persistent organic pollutants(Ⅰ)
7	Environmental Health Research Department	Environmental Health Research Division	Environmental Health Assessment of Areas Around Coa l-fired Power Plants - Yeongheung Power Plant
8	Environmental Health Research Department	Environmental Health Research Division	Advancement of tools for data analysis and follow-up of Korean children's environmental health study(Ⅰ)
9	Environmental Health Research Department	Environmental Health Research Division	Studies on Risk Assessment and Management System Improvement of Hazard Substances for Children's Products
10	Environmental Health Research Department	Environmental Health Research Division	Research and risk assessment for children's product(Ⅱ)
11	Environmental Health Research Department	Environmental Health Research Division	Studies on Exposure to Environmentally Hazardous Factors in Children's Activity Zone(V)
12	Environmental Health Research Department	Environmental Health Research Division	Environmental Health Assessment of Ondong Village Residents
13	Environmental Health Research Department	Environmental Health Research Division	Comprehensive Evaluation of environmental health in the Genaral Industrial Complex
14	Environmental Health Research Department	Environmental Health Research Division	Environmental and Health Effects Survey of Inhabitants around 3rd Phase abandoned Metal Mines(III)
15	Environmental Health Research Department	Environmental Health Research Division	The 4th Comprehensive Evaluation and 5th Survey Planning of the Korean National Environmental Health Survey
16	Environmental Health Research Department	Environmental Health Research Division	Preliminary Feasibility Study for health Damage in Pohang Industral Complex
17	Environmental Health Research Department	Environmental Health Research Division	Environmental exposure and health effects survey among residents living near area with potentially severe environmental pollution(Ⅰ)
18	Environmental Health Research Department	Environmental Health Research Division	Retrospective Cohort Study of Air Pollution and Its health Effects on Residents around Major Indeustrial Complex(IV)
19	Environmental Health Research Department	Environmental Health Research Division	Korean National Environmental Health Survey (KoNEHS) - Annual Report on Cycle 5, 1st year (2021) -
20	Environmental Health Research Department	Environmental Health Research Division	Establishment of environmental health monitoring system based environment and health big data(Ⅱ)
21	Environmental Health Research Department	Risk Assessment Division	Support for Registration of Nanomaterials in K-REACH and Establishment of a system for Constructing Assessment Data(Ⅱ)
22	Environmental Health Research Department	Risk Assessment Division	Environmental Exposure Assessment of Nanomaterials(Ⅱ)
23	Environmental Health Research Department	Risk Assessment Division	Improvement of hazard data management for registered existing and new chemicals(IV)

No.	Department	Division	Title of Project
24	Environmental Health Research Department	Risk Assessment Division	Screening level risk assessment for registered chemicals
25	Environmental Health Research Department	Risk Assessment Division	Risk Assesment of Registered chemicals - Survey on exposure(Ⅱ)
26	Environmental Health Research Department	Risk Assessment Division	Risk assessment of Registered chemicals-harzard assessment(Ⅱ)
27	Environmental Health Research Department	Risk Assessment Division	Research on Development of a Quantification method for Hazardous Substances(Ⅰ)
28	Environmental Health Research Department	Risk Assessment Division	Assessing the multimedia model development potential for heavy metals and its applicability(Ⅲ)
29	Environmental Health Research Department	Risk Assessment Division	Research on improving classification and labeling(Ⅱ) of chemical substances(Ⅱ)
30	Environmental Health Research Department	Risk Assessment Division	Study on chemical substance hazard assessment technique(Ⅱ) - Integrated omics assessment technique
31	Environmental Health Research Department	Risk Assessment Division	A study on the development of risk assessment methods for chemical substances (Epigenetic approach)(Ⅱ)
32	Environmental Health Research Department	Risk Assessment Division	Empirical studies and future research roadmap for chemicals' social-economic analysis
33	Environmental Health Research Department	Risk Assessment Division	A study on Verification Method for Effective Review of Chemical Safety Report (CSR)
34	Environmental Health Research Department	Risk Assessment Division	Monitoring study to evaluate the accumulation of contaminants of emerging concern in aquatic ecosystem(Ⅰ)
35	Environmental Health Research Department	Risk Assessment Division	Improvement of ecotoxicity testing methods for nano regulations in Korea(III)
36	Environmental Health Research Department	Risk Assessment Division	Risk Assesment of Registered chemicals(Ⅱ)
37	Environmental Health Research Department	Risk Assessment Division	The study on non-testing approaches to hazard assessment of chemicals: Genotoxicity(Ⅰ)
38	Environmental Health Research Department	Risk Assessment Division	Toxicity assessment study on chemicals contained in consumer products(V)
39	Environmental Health Research Department	Risk Assessment Division	A study on the hazard assessment approaches for petroleum substances(Ⅰ)
40	Environmental Health Research Department	Risk Assessment Division	Hazard assessment of contaminants of emerging concern (CECs) in the aquatic environment(Ⅰ)
41	Environmental Health Research Department	Risk Assessment Division	Development of the methods for realistic quantitative exposure assessment(Ⅰ)
42	Environmental Health Research Department	Chemical Research Division	A Study on the Investigation and Management of Antimicrobial parts for humidifiers
43	Environmental Health Research Department	Chemical Research Division	Safety assessment of Internationally Approved Active substance (2021) - Disinfectants
44	Environmental Health Research Department	Chemical Research Division	Safety assessment of Internationally Approved Active substance (2021) - Rodenticide, Other preservative
45	Environmental Health Research Department	Chemical Research Division	Safety assessment of Internationally Approved Active substance (2021) - Insecticides, Repellents
46	Environmental Health Research Department	Chemical Research Division	A study on establishment of exposure assement evaluation information for quarantine workers by using biocidal products

No.	Department	Division	Title of Project
47	Environmental Health Research Department	Chemical Research Division	Studies on Management Plan for Biocidal Approval and Evaluation Guidelines
48	Environmental Health Research Department	Chemical Research Division	Establishment of a detailed evaluation procedure for the authorisation of biocidal products
49	Environmental Health Research Department	Chemical Research Division	Development of the Environmental Risk Assessment Methodology for Biocide
50	Environmental Health Research Department	Chemical Research Division	Development of efficacy and hazard assessment guidance for authorization of biocidal products(III) – A study on the effective concentraion of sterilizers
51	Environmental Health Research Department	Chemical Research Division	A study on improvement of exposure and risk assessment evalution procedure of biocides(III)
52	Environmental Health Research Department	Chemical Research Division	A Study on the development of a test guideline for biocide(III) – In-situ biocidal active substance produced by photocatalic reaction
53	Environmental Health Research Department	Chemical Research Division	Establishment of efficacy test guidelines for insecticides
54	Environmental Health Research Department	Chemical Research Division	Advancement and Application of Test Method for Microplastics in Household Chemical Products
55	Environmental Health Research Department	Chemical Research Division	Establishment of media integrated monitoring platform for emerging pollutants(I)
56	Environmental Health Research Department	Chemical Research Division	A study on improvement of standard analysis procedures of chemicals included consumer products
57	Environmental Health Research Department	Chemical Research Division	A study for minimum risk biocides eligible for the simplified authorisation procedure
58	Environmental Health Research Department	Chemical Research Division	A Study on improvement of safety management of biocides and household products(III)
59	Environmental Health Research Department	Chemical Research Division	A study on the development of exposure scenarios and risk assessment for biocidal products(III) – Algaecide, Rodenticide, Repellent
60	Environmental Health Research Department	Chemical Research Division	A study on the fate of persistent pollutants in atmosphere(III)(노샘)
61	Environmental Health Research Department	Humidifier Disinfectant Health Center	Studies on mechanisms for cytotoxicity induced by humidifier disinfectants of PHMG-p and CMIT/MIT(I)
62	Environmental Health Research Department	Humidifier Disinfectant Health Center	Quantitative Analysis on Biological Uptake and in vivo Behavior of Humidifier Disinfectant(I)
63	Environmental Health Research Department	Humidifier Disinfectant Health Center	A Study on the epidemiological correlation between humidifer disinfectant and health effects(I)
64	Environmental Health Research Department	Humidifier Disinfectant Health Center	A Study on Health Damage of Humidifier Disinfectants using National Health Insurance Big Data(III)
65	Environmental Health Research Department	Humidifier Disinfectant Health Center	Investigation and evaluation of neurotoxicity of ingredients in humidifier disinfectants using zebrafish
66	Environmental Health Research Department	Humidifier Disinfectant Health Center	A study on exposure and health damage of humidifier disinfectants(II)
67	Environmental Health Research Department	Humidifier Disinfectant Health Center	A study on characteristics of health effects on humidifier disinfectants using by monitoring DB(I)
68	Climate and Air Quality Research Department	Air Quality Research Division	Research on 3-dimensional distribution of atmospheric gaseous pollutant using remote sensing spectrometer(III)
69	Climate and Air Quality Research Department	Air Quality Research Division	Analysis of Short and Long- Term Regional Air Quality Trends
70	Climate and Air Quality Research Department	Air Quality Research Division	Ultrafine dust(PM-1) observation-based research(I)
71	Climate and Air Quality Research Department	Air Quality Research Division	A Framework for Assessment of Air Quality in the Air Control Zone(I)
72	Climate and Air Quality Research Department	Air Quality Research Division	Studies on characteristics of hazardous air pollutants by the local air quality management Area(I)

No.	Department	Division	Title of Project
73	Climate and Air Quality Research Department	Air Quality Research Division	Research for development of box model for analysis of air quality characteristics(II)
74	Climate and Air Quality Research Department	Air Quality Research Division	A development of a predictive model for the secondary organic aerosol (SOA) formation through the multiphase reaction of volatile organic compound in urban environments(I)
75	Climate and Air Quality Research Department	Air Quality Research Division	Studies on the present status of simple particulate matter measurement instruments and preparation for follow-up management(II)
76	Climate and Air Quality Research Department	Air Quality Research Division	A study on Improvement of Air Quality Standard for Hardening Air Quality Management Regulation on Fine Particulate Matters(I)
77	Climate and Air Quality Research Department	Air Quality Research Division	Development of a protocol for data confirmation of physical and optical characteristics of PM-2.5(II)
78	Climate and Air Quality Research Department	Air Quality Research Division	Studies on Atmospheric Oxidation Processes to Understand Formation of the Fine aerosols and Surface Ozone(I)
79	Climate and Air Quality Research Department	Air Quality Research Division	Studies on the aerosol formation processes in Baekryeong island using a reaction chamber(III)
80	Climate and Air Quality Research Department	Air Quality Research Division	Investigation on the formation processes of secondary inorganic species in Seoul and Gwangju – Focusing on sulfate, nitrate, and ammonium
81	Climate and Air Quality Research Department	Air Quality Research Division	Pollution characteristics and management of PM-1 in the Seoul metropolitan area
82	Climate and Air Quality Research Department	Air Quality Research Division	Identify concentration distribution by ammonia emission characteristics and prepare measures for quality control of real-time observation data(II)
83	Climate and Air Quality Research Department	Air Quality Research Division	Secondary formation potential of biogenic and anthropogenic VOCs in Ulsan(II)
84	Climate and Air Quality Research Department	Air Quality Research Division	The characteristics of air quality and contribution of emission sources by region(II) – Focusing on the Seoul metropolitan industrial area –
85	Climate and Air Quality Research Department	Air Quality Research Division	A study of volatile organic compound reactivity in Seoul metropolitan area
86	Climate and Air Quality Research Department	Air Quality Research Division	The study of Long-range transboundary secondary aerosols based on multi platform observations(V)
87	Climate and Air Quality Research Department	Global Environment Research Division	2nd('20~'22) Korea-China Joint Research on Ambient Air Quality(II)
88	Climate and Air Quality Research Department	Global Environment Research Division	Collaborative Research on Long Range Transport Air Pollutants in Northsat Asia(IV)
89	Climate and Air Quality Research Department	Global Environment Research Division	A Study on development of environmental standards for substances causing change in climate and ecosystem(II)
90	Climate and Air Quality Research Department	Global Environment Research Division	Development of Climate Pollutants Emission Inventory for East Asia(V)
91	Climate and Air Quality Research Department	Global Environment Research Division	Development of Korea Industrial Standard(KS) for guidelines for non-face-to-face remote verification and research of plan for international standardization
92	Climate and Air Quality Research Department	Global Environment Research Division	Studies on the International Mutual Recognition of Greenhouse Gas Verification and Advancement of the Verification for the Phrases III of K-ETS(I)
93	Climate and Air Quality Research Department	Global Environment Research Division	Roadmap and Implementation Strategy for Climate Change Research to Realize Carbon Neutrality
94	Climate and Air Quality Research Department	Global Environment Research Division	A Study on the establishment of national database for the verification of reduction effects on sources of air pollution and climate change(II)
95	Climate and Air Quality Research Department	Global Environment Research Division	A study on establishment of a monitoring system for greenhouse gases in urban area
96	Climate and Air Quality Research Department	Global Environment Research Division	A study on the characteristics of PM-2.5 in major cities of South Korea and China(II)
97	Climate and Air Quality Research Department	Air Pollution Engineering Division	A study on emissions stsndard for GHP(Gas Heat Pump)
98	Climate and Air Quality Research Department	Air Pollution Engineering Division	Studies on the Estimation of Pollutant Emission Using Optical Techniques in the Mixed-use development Areas(II)

No.	Department	Division	Title of Project
99	Climate and Air Quality Research Department	Air Pollution Engineering Division	Improving the emission factor of air pollutants in air emission facilities(III)
100	Climate and Air Quality Research Department	Air Pollution Engineering Division	Study on the Generation Characteristics of Each Type of Fine Particulate Matter from Air Emission Facilities
101	Climate and Air Quality Research Department	Air Pollution Engineering Division	Improving the Air pollution process test standard of Air emission Sources field(2021)
102	Climate and Air Quality Research Department	Air Pollution Engineering Division	Supporting national standard development of Air emission source field(2021)
103	Climate and Air Quality Research Department	Air Pollution Engineering Division	A study on the estimating of the emission standards for 3 new species in air pollutants
104	Climate and Air Quality Research Department	Air Pollution Engineering Division	Studies on potential candidate materials of air pollutant(IV)
105	Climate and Air Quality Research Department	Air Pollution Engineering Division	Research on VOCs emission sources in urban areas(III)
106	Climate and Air Quality Research Department	Air Pollution Engineering Division	A Study on the Emission Characteristics of hazardous air pollutants in Discharge Facility Exempted from Air Pollution Control Equipment Installation
107	Climate and Air Quality Research Department	Air Pollution Engineering Division	Compilation of VOCs Speciation Data with Emission Sources(III)
108	Climate and Air Quality Research Department	Air Pollution Engineering Division	A Study on the Introduction of Dust Suppressants Management Guidelines to Prevent Fugitive Dust
109	Climate and Air Quality Research Department	Air Pollution Engineering Division	Research on the development of methods for measuring odors in irregular outlets
110	Climate and Air Quality Research Department	Air Pollution Engineering Division	Development of air emission source management techniques through the use of big data
111	Climate and Air Quality Research Department	Air Pollution Engineering Division	Monitoring of Hazardous Air Pollutants and Health Risk Assessment in the Industrial Area(IV)
112	Climate and Air Quality Research Department	Air Pollution Engineering Division	Research on advanced methods for management of odor facilities and odor complaints
113	Climate and Air Quality Research Department	Air Pollution Engineering Division	A study to prepare a plan to reduce air pollutants generated during priods of startup of the LNG HRSG power plant
114	Climate and Air Quality Research Department	Air Pollution Engineering Division	investigation of ammonia emission and development of emission factors(III) - investigation of ammonia emission during production process
115	Climate and Air Quality Research Department	Air Pollution Engineering Division	A study on the investigation of the HAPs emission sources and developing emission factors(III)
116	Climate and Air Quality Research Department	Air Pollution Engineering Division	A study on advanced technologies to monitor PM precursors using optical remote sensing
117	Climate and Air Quality Research Department	Air Pollution Engineering Division	A study on the air pollutants emission characteristics from stationary sources (II) - Real-time measurements of size-segregated PM at power plant
118	Climate and Air Quality Research Department	Air Pollution Engineering Division	A Study on calculation of odor emissions and real-time odor monitoring research in odor area(I)
119	Climate and Air Quality Research Department	Air Pollution Engineering Division	A Study on the emission characteristics of hazardous air pollutant(V)
120	Climate and Air Quality Research Department	Air Quality Forecasting Center	Application and development of the next generation air quality forecasting model(I)
121	Climate and Air Quality Research Department	Air Quality Forecasting Center	A Study on Construction of Air Quality Prediction Modeling System considering Interaction between Air quality and Meteorology(V)
122	Climate and Air Quality Research Department	Air Quality Forecasting Center	The research for operational use and advancement of ultra-fine resolution air-quality model on forecasting area(I)
123	Climate and Air Quality Research Department	Air Quality Forecasting Center	A Development of Short-term Prediction tool for PM-10 and PM-2.5 Concentrations using Artificial Intelligence(IV)
124	Climate and Air Quality Research Department	Air Quality Forecasting Center	Development of Mid-term Prediction tool for PM-10 and PM-2.5 Concentrations using Artificial Intelligence(IV)

No.	Department	Division	Title of Project
125	Climate and Air Quality Research Department	Air Quality Forecasting Center	Development of a long-range prediction system of air quality based on statistical-dynamical approach(II)
126	Climate and Air Quality Research Department	Air Quality Forecasting Center	A study on the optimization of integrated forecasting modeling system for air quality forecast(II)
127	Climate and Air Quality Research Department	Air Quality Forecasting Center	A study on improving air quality predictability using data assimilation technique(I)
128	Climate and Air Quality Research Department	Environmental Satellite Center	The Satellite Integrated Joint monitoring of Air Quality (SIJAQ)(I) - Based on the ground and airborne observations
129	Climate and Air Quality Research Department	Environmental Satellite Center	The Satellite Integrated Joint monitoring of Air Quality (SIJAQ)(I) - Based on the Remote Sensing, Satellite and Modeling
130	Climate and Air Quality Research Department	Environmental Satellite Center	Development of trace gas and aerosol retrival algorithms of ground based UV-VIS remote sensing instrument for satellite product validations
131	Climate and Air Quality Research Department	Environmental Satellite Center	A research on night-time GEMS data generation using artificial intelligence technique(I)
132	Climate and Air Quality Research Department	Environmental Satellite Center	A Study on Correction & Calibration of Receiving Antenna Data for Geostationary Satellite(GEMS) - Performance Enhancement Support Methods of Receiving System
133	Climate and Air Quality Research Department	Environmental Satellite Center	Development of Application Technique for Climate Change Using GK2B GEMS data(I) - Planned Study
134	Climate and Air Quality Research Department	Environmental Satellite Center	Geostationary Environment Monitoring Spectrometer(GEMS) Full Layer Concentration Calculation Algorithm and Input Data Improvement Study(I)
135	Climate and Air Quality Research Department	Environmental Satellite Center	A Preliminary Study on the Big Data Analysis Using GK2B GEMS
136	Climate and Air Quality Research Department	Environmental Satellite Center	Research and Development on New Level 2 output of GEMS Hyper-Spectral Analysis(I)
137	Climate and Air Quality Research Department	Environmental Satellite Center	A Study on the Monitoring of the Atmospheric Pollution by Disasters Using GK2B GEMS
138	Climate and Air Quality Research Department	Environmental Satellite Center	Development of Retrieval Algorithm (S/W) for Airborne Remote Sensing(I)
139	Climate and Air Quality Research Department	Environmental Satellite Center	A study on reanalysis method of GEMS(Geostationary Environment Monitoring Spectrometer) AMF(Air Mass Factor)(III)
140	Climate and Air Quality Research Department	Environmental Satellite Center	Development of Aerosol Fusion Data Using GEMS with other GEO satellites -Improvement of aerosol optical depth and modeling of emission data
141	Climate and Air Quality Research Department	Environmental Satellite Center	Ground level air quality quantification using GEMS(Geostationary Environmental Monitoring Spectrometer) - Incorporation with In-Orbit Test results
142	Climate and Air Quality Research Department	Environmental Satellite Center	Improvement and evaluation of retrieval algorithm on GEMS
143	Climate and Air Quality Research Department	Environmental Satellite Center	Planning Research for the Development of Next-Generation Geostationary Environmental Satellite and Satellite Ground Stations
144	Climate and Air Quality Research Department	Environmental Satellite Center	Applications of satellite data(II) - Aerosol analysis techniques using GEMS
145	Climate and Air Quality Research Department	Environmental Satellite Center	Study on the plan to expand utilization of satellite data(II) - GEMS official data production and its quality analysis
146	Water Environment Research Department	Water Quality Assessment Research Division	A comprehensive analysis of the water environment and quality to the four major rivers
147	Water Environment Research Department	Water Quality Assessment Research Division	Genotype distribution of harmful cyanobacteria in the four major rivers of Korea(I)
148	Water Environment Research Department	Water Quality Assessment Research Division	A study on the suitability analysis for the introduction ofgreen algae technology and product quality certification
149	Water Environment Research Department	Water Quality Assessment Research Division	Acquisition of hyperspectral airborne images and measurement of optical properties for remote sensing of algal blooms('21)
150	Water Environment Research Department	Water Quality Assessment Research Division	A Study on Water Quality Variations in Four Major River Tributaries using Deep Learning Techniques

No.	Department	Division	Title of Project
151	Water Environment Research Department	Water Quality Assessment Research Division	Establishment of Integrated HABs Research System across Ministries
152	Water Environment Research Department	Water Quality Assessment Research Division	Intensive Monitoring on the Regional Distribution of Phytoplankton in the Weir Areas(IV)
153	Water Environment Research Department	Water Quality Assessment Research Division	Water quality continous monitoring base on sensor in 4 major river(IV)
154	Water Environment Research Department	Water Quality Assessment Research Division	Research on improvement of prediction techniques for water quality prediction and water pollution accident
155	Water Environment Research Department	Water Quality Assessment Research Division	Bloom control based on regulation of aquatic microbial community(II)
156	Water Environment Research Department	Water Quality Assessment Research Division	Feasibility and Improvement of Target Standards for Water Sub-basin
157	Water Environment Research Department	Water Quality Assessment Research Division	Acquisition of hyperspectral images and measurement of optical properties for algal bloom in inland using drone-borne hyperspectral sensor(' 21)
158	Water Environment Research Department	Water Quality Assessment Research Division	A study on the monitoring and management of unregulated hazardous compounds in river water(II)
159	Water Environment Research Department	Water Quality Assessment Research Division	Prediction of water environmental change based on remote sensing(I) - Remote monitoring of water quality in inland waters using satellite imagery
160	Water Environment Research Department	Water Quality Assessment Research Division	Forecasting changes in water environment based on convergence technology (I) - Application of algae observational data and automatic parameter calibration technique
161	Water Environment Research Department	Water Quality Assessment Research Division	A Study on the characteristics of algae blooms in rivers and reservoirs of Korea(IV) - The distribution and investigation of genetic diversity on high-risk harmful cyanobacteria -
162	Water Environment Research Department	Watershed and Total Load Management Research Division	Livestock Excreta Survey and Assessment of Environment Impact(I) - Case Study of Saemangeum Watersshed
163	Water Environment Research Department	Watershed and Total Load Management Research Division	A study on feasibility of digital twin technology on establishing watershed management
164	Water Environment Research Department	Watershed and Total Load Management Research Division	A Study for TOC-customized TMDL implementation plan
165	Water Environment Research Department	Watershed and Total Load Management Research Division	A study of developing the policy framework on the implementation and assessment of water cycle management system
166	Water Environment Research Department	Watershed and Total Load Management Research Division	A study on the methodology for prioritizing water cycle management areas
167	Water Environment Research Department	Watershed and Total Load Management Research Division	Monitoring and Investigation on Pollutant Loads in Non-point Sources Management Areas (2021)
168	Water Environment Research Department	Watershed and Total Load Management Research Division	Support for field-investigation and estimation by pollution source
169	Water Environment Research Department	Watershed and Total Load Management Research Division	Policy Application of Sustainable Nutrient Management in Rural Areas(III)
170	Water Environment Research Department	Watershed and Total Load Management Research Division	Establishment of a standardization system for data linked to sources of pollution from other ministries
171	Water Environment Research Department	Watershed and Total Load Management Research Division	A study of environmental pollution source originated from livestock excreta in rural areas(VI) - focusing on environmental pollution assessment
172	Water Environment Research Department	Watershed and Total Load Management Research Division	A policy supporting research to manage non-point source pollutants and improve water cycle(VI)
173	Water Environment Research Department	Watershed and Total Load Management Research Division	A study on new targets and customized plans for total pollution load management - defining and listing impaired waters
174	Water Environment Research Department	Water Environmental Engineering Research Division	Surveys of aquatic ecosystem changes by discharge of the weir in 4 major rivers (2021)
175	Water Environment Research Department	Water Environmental Engineering Research Division	Assessment of the effect of water quality on sediment and the variation of sedimentary environments in the weirs of four major rivers
176	Water Environment Research Department	Water Environmental Engineering Research Division	Research on occurrence of microplastics in sediments of surface water : Focused on Han-river watershed

No.	Department	Division	Title of Project
177	Water Environment Research Department	Water Environmental Engineering Research Division	Establishment of a monitoring system for un-regulated water pollutants (2021)
178	Water Environment Research Department	Water Environmental Engineering Research Division	Derivation of water quality standards to protect ecosystem and human health(2021)
179	Water Environment Research Department	Water Environmental Engineering Research Division	Study on extended authorization of water pollutants and establishment of the discharge limits
180	Water Environment Research Department	Water Environmental Engineering Research Division	Investigation on the contaminated sediments in river near industrial complexes
181	Water Environment Research Department	Water Environmental Engineering Research Division	Pilot monitoring and evaluation of abandoned metal mines and industrial complexes
182	Water Environment Research Department	Water Environmental Engineering Research Division	Field Examination of Discharge Quantity about 'Specific Substance Harmful to Water Quality' of Wastewater Discharge Facility
183	Water Environment Research Department	Water Environmental Engineering Research Division	Survey and Assessment fo estuary ecosystem(2021)
184	Water Environment Research Department	Water Environmental Engineering Research Division	Diagnosis of causes for the impaired stream ecosystems
185	Water Environment Research Department	Water Environmental Engineering Research Division	Evaluation of river ecosystem continuity
186	Water Environment Research Department	Water Environmental Engineering Research Division	The survey for restoring stream ecosystem continuity(2021)
187	Water Environment Research Department	Water Environmental Engineering Research Division	Stream/River Ecosystem Survey and Health Assessment(2021)
188	Water Environment Research Department	Water Environmental Engineering Research Division	A study on the Water and Sediment Quality in the Downstream of Hyeongsan River(II)
189	Water Environment Research Department	Water Environmental Engineering Research Division	A Study on Improving the Standards of Survey and Assessment Methods for Lake Ecosystem Health
190	Water Environment Research Department	Water Environmental Engineering Research Division	Estimation and verify evaluation of environmental ecological flow(IV)
191	Water Environment Research Department	Water Environmental Engineering Research Division	Characteristics of microplastic distribution in freshwater(III)
192	Water Environment Research Department	Water Environmental Engineering Research Division	Optimal treatment of non-regulated hazardous substances in wastewater(III)
193	Water Environment Research Department	Water Environmental Engineering Research Division	Application and Development of Ecosystem Health Assessment Focused on Benthic Macroinvertebrate-based Index(VI)
194	Water Environment Research Department	Water Environmental Engineering Research Division	A Study on the development of an ecological river restoration guidelines considering the ecosystem
195	Water Environment Research Department	Water Environmental Engineering Research Division	Physiological responses of freshwater fish to environmental changes(III)
196	Environmental Resources Research Department	Resources Recirculation Research Division	A study on the expanding application for the recycling of incineration ash
197	Environmental Resources Research Department	Resources Recirculation Research Division	A study on the analysis of the impact of waste import restrictions and the preparation of a reduction roadmap(II)
198	Environmental Resources Research Department	Resources Recirculation Research Division	A study on the sterilization effect inspection and safety confirmation for medical waste chemical treatment
199	Environmental Resources Research Department	Resources Recirculation Research Division	Research on expansion a list of waste types and discharging industries subject to hazardous characteristics(I)
200	Environmental Resources Research Department	Resources Recirculation Research Division	Research on the characteristics of microplastics generated during waste treatment process: Focusing on the investigation of analysis techniques for monitoring(I)
201	Environmental Resources Research Department	Resources Recirculation Research Division	Survey on final disposal minimization through waste streams analysis(III) - Improvement for medical waste classification system, inspection standard and techniques of sterilization -
202	Environmental Resources Research Department	Resources Recirculation Research Division	A study on removal and identification for hazardous characteristics of wastes(II) - 6 hazardous characteristics including the oxidizing -

No.	Department	Division	Title of Project
203	Environmental Resources Research Department	Resources Recirculation Research Division	Research on life cycle assessment(LCA) of plastic waste recycling(III) - Focusing on ELV and WEEE-
204	Environmental Resources Research Department	Waste to Energy Research Division	Study on the designation of a waste treatment facility inspection institution and the establishment of a follow-up management system
205	Environmental Resources Research Department	Waste to Energy Research Division	Strategies for Promoting Utilization of Renewable Waste Energy(IV)
206	Environmental Resources Research Department	Waste to Energy Research Division	A study on the inspection methods for waste treatment facilities
207	Environmental Resources Research Department	Waste to Energy Research Division	A study on institutional improvement for proper management in waste treatment facilities(III) - Focusing on the residues of SRF manufacturing -
208	Environmental Resources Research Department	Waste to Energy Research Division	A study on the introduction of the waste to energy incentive system
209	Environmental Resources Research Department	Natural Environment Research Division	Preparation of measures to apply the effect of reducing water pollutants in indirect treatment facilities
210	Environmental Resources Research Department	Natural Environment Research Division	A Study on Revision of BREF(BAT References) for Inorganic Chemicals, Fertilizers and Nitrogen Compounds(I)
211	Environmental Resources Research Department	Natural Environment Research Division	Establishment of Predictive emission monitoring systems (PEMS)
212	Environmental Resources Research Department	Natural Environment Research Division	Establishment of standardization plan for integrated environmental management of workplaces(V)
213	Environmental Resources Research Department	Natural Environment Research Division	A Study on Revision of BREF(BAT References) for Petroleum Refining and Fine Chemicals Industry(I)
214	Environmental Resources Research Department	Natural Environment Research Division	Smart integrated environment management system establishment pilot project
215	Environmental Resources Research Department	Natural Environment Research Division	A Study on the Establishment of BREF(BAT References) for Cement Manufacturing (I) : Status of Technology
216	Environmental Resources Research Department	Natural Environment Research Division	A Study on Revision of BREF(BAT References) for the Steel, Non-Ferrous Metals and Organic Chemical Industries(II)
217	Environmental Resources Research Department	Natural Environment Research Division	A Study on the BREF(BAT References) for the Waste Treatment Industry(II)
218	Environmental Resources Research Department	Natural Environment Research Division	Application of spatial environmental information and green infrastructure for integrated management of land plans and environmental plans(IV) - focusing on water environment
219	Environmental Resources Research Department	Natural Environment Research Division	Analysis of changes in urban green spaces utilization by COVID-19 using mobile big data
220	Environmental Resources Research Department	Natural Environment Research Division	The assessment system of environmental quality using biosamples(III)
221	Environmental Resources Research Department	Natural Environment Research Division	Characteristics of Food Chain Transfer and Accumulation of Persistent Pollutants in Bird Eggs(I)
222	Environmental Resources Research Department	Natural Environment Research Division	Study on the Standard Guideline of Environmental Impact Assessment (2021) - focusing on Water Environment
223	Environmental Infrastructure Research Department	Indoor Environment and Noise Research Division	A status investigation on unregulated pollutants emitted from buiding materials
224	Environmental Infrastructure Research Department	Indoor Environment and Noise Research Division	A study on emission characteristics of NVOC concentration from woods and wood based panels
225	Environmental Infrastructure Research Department	Indoor Environment and Noise Research Division	Establishment of indoor radon management basis and research on reduction measures for (newly built) multi-family housing(I)
226	Environmental Infrastructure Research Department	Indoor Environment and Noise Research Division	A study on the survey and management of indoor air pollution source(IV) -Re-evaluation of indoor air quality guideline for newly-built apartment and derivation of guideline value for new pollutants-
227	Environmental Infrastructure Research Department	Indoor Environment and Noise Research Division	A study on the indoor air quality management for business facilities(III)
228	Environmental Infrastructure Research Department	Indoor Environment and Noise Research Division	A Study on light pollution assessment using satellite image information(I)

No.	Department	Division	Title of Project
229	Environmental Infrastructure Research Department	Indoor Environment and Noise Research Division	A Study on the assessment of Noise Annoyance according to Living noise source(I)
230	Environmental Infrastructure Research Department	Indoor Environment and Noise Research Division	A pilot study on the impact investigation of naturally occurring asbestos area(I)
231	Environmental Infrastructure Research Department	Water Supply and Sewerage Research Division	A study on the establishment of coronavirus analysis system for influent wastewater of public sewage treatment facilities
232	Environmental Infrastructure Research Department	Water Supply and Sewerage Research Division	Study of the Actual Condition and Management of New Emerging Contaminants in the Water Treatment Plant of Nakdong River Water System(2021)
233	Environmental Infrastructure Research Department	Water Supply and Sewerage Research Division	Monitoring and Control of Antimicrobial Resistance Bacteria in the Urban Water Systems(I)
234	Environmental Infrastructure Research Department	Water Supply and Sewerage Research Division	Study on establishment of particle management system for drinking water
235	Environmental Infrastructure Research Department	Water Supply and Sewerage Research Division	Study on investigation and Management improvement of Drinking Water Treatment Chemicals(Disinfectants)
236	Environmental Infrastructure Research Department	Water Supply and Sewerage Research Division	Multiomics Analyses of Drinking Water Microbiome Continuum for Improved Urban Water Safety(I)
237	Environmental Infrastructure Research Department	Water Supply and Sewerage Research Division	A Study on establishment of a monitoring system for antibiotic-resistant bacteria in the water environment(I)
238	Environmental Infrastructure Research Department	Water Supply and Sewerage Research Division	A Study on Management of Unregulated Trace Hazardous Compounds in Drinking Water (2021)
239	Environmental Infrastructure Research Department	Water Supply and Sewerage Research Division	A study on management of micro plastics in tap water in Korea (2021)
240	Environmental Infrastructure Research Department	Water Supply and Sewerage Research Division	A study on the investigation of microplastics discharge characteristics with the type of sewage treatment area(I)
241	Environmental Infrastructure Research Department	Water Supply and Sewerage Research Division	A Study on discharge characteristics and management measures of micropollutants from the sewage treatment plants and water reclamation facilities(II)
242	Environmental Infrastructure Research Department	Environmental Measurement and Analysis Center	The Investigation of KS certified commercial products in 2021
243	Environmental Infrastructure Research Department	Environmental Measurement and Analysis Center	The study on proficiency testing for indoor air quality and odor(2021)
244	Environmental Infrastructure Research Department	Environmental Measurement and Analysis Center	Revision of KS in the environmental field and support for committee operation in 2021
245	Environmental Infrastructure Research Department	Environmental Measurement and Analysis Center	A study on the development of KS and ISO for environmrntal area
246	Environmental Infrastructure Research Department	Environmental Measurement and Analysis Center	A study on the test method and standard for the test bed field test of environmental measuring equipment
247	Environmental Infrastructure Research Department	Environmental Measurement and Analysis Center	Utilization of mercury isotope in foliage and soil for atmospheric mercury source tracing(II)
248	Environmental Infrastructure Research Department	Environmental Measurement and Analysis Center	A study on pollution tracker in various environments and field application(III)
249	Environmental Infrastructure Research Department	Environmental Measurement and Analysis Center	A Study on reliability evaluation method of environmental sensor(III) - Noise·vibration and odor -
250	Environmental Infrastructure Research Department	Environmental Measurement and Analysis Center	Rapid Detection Method of Environmental Contaminants - Suspect/Nontarget Analysis of Harmful Substances in Aquatic Environment
251	Environmental Infrastructure Research Department	Soil and Groundwater Research Division	A study on the management of groundwater quality around livestock burial sites(I)
252	Environmental Infrastructure Research Department	Soil and Groundwater Research Division	Survey on Naturally Occurring Radioactive Materials (N.O.R.M.) in private groundwater wells(2021)
253	Environmental Infrastructure Research Department	Soil and Groundwater Research Division	Studies on Management Plan of Pesticides used on Golf Course(I)
254	Environmental Infrastructure Research Department	Soil and Groundwater Research Division	Nitrate mamnagement for groundwater quality improvement in agricultural and livestock area(V)

No.	Department	Division	Title of Project
255	Environmental Infrastructure Research Department	Soil and Groundwater Research Division	Drinking Groundwater Quality Survey for the Unserved Areas of Public Water Supply(2021)
256	Environmental Infrastructure Research Department	Soil and Groundwater Research Division	Water quality survey on unregulated contaminants in groundwater(2021)
257	Environmental Infrastructure Research Department	Soil and Groundwater Research Division	Study on Groundwater Quality Improvement of Livestock Excrement Spill Area(2021) – Targeted on Livestock Wastewater Contaminated Areas in Hanlim-eup, Jeju –
258	Environmental Infrastructure Research Department	Soil and Groundwater Research Division	Support for the Development of National Standards in the Soil Quality (ISO/TC190) (2021)
259	Environmental Infrastructure Research Department	Soil and Groundwater Research Division	Pilot Project of Soil Ecological Risk Assessment (2021)
260	Environmental Infrastructure Research Department	Soil and Groundwater Research Division	Research on Determination of Groundwater Standard and Management Process for Groundwater Contaminants(2021)
261	Environmental Infrastructure Research Department	Soil and Groundwater Research Division	Study on Naturally Occurring Radioactive Materials(N.O.R.M) in Groundwater in South Korea(2021)
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138	Effects of Exposure to Lead and Cadmium on Health of Inhabitants of Abandoned Metal Mine Area in Korea	ARCHIVES OF ENVIRONMENTAL CONTAMINATION AND TOXICOLOGY	80	2	490~498



International Conference and Academic Activities

No.	Date	Research Activities	Host County	Division
1	2021-01-11~2021-01-16	16th meeting of the POPs review committee(online)	Swiss	Chemicals Research Division
2	2021-01-12~2021-01-15	UN ECE WP29 82th GRPE(United Nations Economic Commission for Europe, The Working Party on Pollution and Energy)	Switzerland (Geneva)	Transportation Pollution Research Center
3	2021-02-16	Children's Environmental Health Collaborating Centres Network Call	USA	Environmental Health Research Division
4	2021-02-22~2021-02-23	20th Korea-Japan Co-operative Joint Research on POPs and Other Relative Chemicals, and the Government Official Meeting (GOM)	Japan/virtual	Risk Assessment Division
5	2021-03-01~2021-03-02	The 16th Water Environment Partnership in Asia(WEPA) Annual Meeting	Japan	Water Environmental Engineering Research Division, Water Supply and Sewerage Research Division
6	2021-03-19	Kick-off Meeting for Joint Research between the WHO CC and WHO ACE	Korea	Environmental Health Research Division
7	2021-04-07~2021-04-09	35th Meeting of the OECD Working Party on Good Laboratory Practice	France/virtual	Risk Assessment Division
8	2021-04-15	Children's Environmental Health Collaborating Centres Network Call	USA	Environmental Health Research Division
9	2021-04-20~2021-04-23	33rd Meeting of the Working Party of the National Coordinators of the Test Guidelines Programme (WNT)	France/virtual	Risk Assessment Division
10	2021-05-13	1st Working Group Seminar for Joint Research between the WHO CC and WHO ACE	Korea	Environmental Health Research Division
11	2021-05-26	5th Meeting of the Working Party on Biocides	OECD (Germany)	Chemicals Research Division
12	2021-05-31	The 12th China-Korea Joint Workshop on Air Quality, China-Korea Policy and Technology Sharing Workshop for Air Pollution Prevention	Korea	Global Environment Research Division
13	2021-06-01~2021-06-04	UN ECE WP29 83th GRPE(United Nations Economic Commission for Europe, The Working Party on Pollution and Energy)	Switzerland (Geneva)	Transportation Pollution Research Center
14	2021-06-08~2021-06-10	1st Meeting of the Chemicals and Biotechnology Committee (CBC)	France/virtual	Risk Assessment Division
15	2021-06-15	Children's Environmental Health Collaborating Centres Network Call	USA	Environmental Health Research Division
16	2021-06-22~2021-06-24	21st Meeting of the Working Party on Manufactured Nanomaterials	France/virtual	Risk Assessment Division
17	2021-06-22~2021-06-24	15th OECD Working Party on Resource Productivity and Waste (WPRPW) meeting	Online meeting	Resource Recirculation Research Division
18	2021-06-23~2021-06-25	5th Meeting of the Working Party on Hazard Assessment (WPHA)	France/virtual	Risk Assessment Division
19	2021-06-25	International Organization for Standardization (ISO TC224) Drinking water, wastewater and stormwater systems and services	France	Water Supply and Sewerage Research Division
20	2021-06-27~2021-06-28	Emerging contaminants in the environment conference(online)	USA	Chemicals Research Division
21	2021-06-28~2021-06-29	5th Meeting of the Working Party on Exposure Assessment (WPEA)	France/virtual	Risk Assessment Division
22	2021-07-26~2021-07-30	Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal Fifteenth meeting	Online meeting	Resource Recirculation Research Division
23	2021-07-26~2021-07-30	10-11th meeting of the conference of the Parties to the Stockholm Convention on POPs(online)	Swiss	Chemicals Research Division
24	2021-08-22~2021-08-27	35th Congress of the International Society of Limnology (On-Line)	Korea	Nakdong River Environment Research Center
25	2021-09-13~2021-10-22	Participated in the 2021 planery and Working Group Meeting in Soil Technical Committee of International Standard Organization (ISO/TC190)	Germany	Soil and Groundwater Research Division

No.	Date	Research Activities	Host County	Division
26	2021-09-29	7th ISO/TC 300 meeting(Solid recovered materials, including solid recovered fuels)	Online meeting	Waste to Energy Research Division
27	2021-09-26~2021-09-30	International Orgrnization fo Standardization Indoor air commitment (ISO TC146 SC6)	France	Indoor Environment and Noise Research Division
28	2021-09-28~2021-09-30	International Conference on Environmental Specimen Banks 2021	Republic of Korea	Natural Environment Research Division
29	2021-10-25	International Organization for Standardization (ISO TC147/SC4) Microbiological methods	Germany	Water Supply and Sewerage Research Division
30	2021-10-26~2021-10-27	10th analysis training of POPs in East Asian Countries(online)	Korea	Chemicals Research Division
31	2021-10-26~2021-10-28	Nature Conferences (Oral) - Waste Management and Valorisation for a Sustainable Future	Korea	Resource Recirculation Research Division
32	2021-10-26~2021-10-28	Nature Conference on Waste Management and Valorisation for a Sustainable Future (Virtual Poster)	Korea	Waste to Energy Research Division
33	2021-11-01~2021-11-05	4-11th meeting of the conference of parties of the Minamata convention on mercury(online)	Swiss	Chemicals Research Division
34	2021-11-08	2021 Europe Biobank Week(Vitual conference)	Germany	Environmental Health Research Division
35	2021-11-08~2021-11-09	7th OECD BAT Expert meeting	OECD	Natural Environment Research Division
36	2021-11-09	Dioxin 2021 international symposium(online)	China	Chemicals Research Division
37	2021-11-10	15th Tripartite Policy Dialogue on Chemicals Management among Korea, China and Japan	China/virtual	Risk Assessment Division
38	2021-11-12	UN ECE WP29 84th GRPE(United Nations Economic Commission for Europe, The Working Party on Pollution and Energy)	Switzerland (Geneva)	Transportation Pollution Research Center
39	2021-11-16~2021-11-18	16th OECD Working Party on Resource Productivity and Waste (WPRPW) meeting	Online meeting	Resource Recirculation Research Division
40	2021-11-18~2021-11-19	18th Meeting of the QSAR Toolbox Management Group	France/virtual	Risk Assessment Division
41	2021-11-22~2021-11-23	The 12th International GEMS workshop	Korea	Environmental Satellite Center
42	2021-11-23	The 13th China-Korea Joint Workshop on Air Quality, China-Korea Policy and Technology Sharing Workshop for Air Pollution Prevention	Korea	Global Environment Research Division
43	2021-11-24	The 2th Collaborative Research Program Annual Meeing	Korea	Global Environment Research Division
44	2021-12-01~2021-12-02	NORMAN General Assembly Meeting 2021(online)	EU	Chemicals Research Division
45	2021-12-08	2nd Working Group Seminar for Joint Research between the WHO CC and WHO ACE	Korea	Environmental Health Research Division
46	2021-12-15	The 4th International Microplastics Symposium	Korea	Water Supply and Sewerage Research Division

| International Joint Research |

No.	Research Topic	Country/Institute	Division
1	GEMS Map of Air Pollution 2021	USA/NASA, Belgium/BIRA, Germany/MPIC, Germany/Bremen Univ. etc.	Environmental Satellite Center

| International Partnership |

No.	Date	Institute	Title of Cooperation
1	2021-01-27	GISTDA	MEMORANDUM OF COOPERATION BETWEEN THE NATIONAL INSTITUTE OF ENVIRONMENTAL RESEARCH, REPUBLIC OF KOREA AND THE GEO-INFORMATICS AND SPACE TECHNOLOGY DEVELOPMENT AGENCY, THAILAND ON SPACE AND GEOSPATIAL INFORMATION FOR ENVIRONMENTAL AND POLLUTION ISSUES
2	2021-03-03	Information and Research Institute of Meteorology, Hydrology and Environment	MEMORANDUM OF UNDERSTANDING BETWEEN INFORMATION AND RESEARCH INSTITUTE OF METEOROLOGY, HYDROLOGY AND ENVIRONMENT, MONGOLIA AND NATIONAL INSTITUTE OF ENVIRONMENTAL RESEARCH, REPUBLIC OF KOREA ON RESEARCH AND DEVELOPMENT IN THE FIELD OF ATMOSPHERIC ENVIRONMENT SCIENCE, TECHNOLOGY AND APPLICATIONS
3	2021-03-24	LAPAN	MEMORANDUM OF UNDERSTANDING BETWEEN NATIONAL INSTITUTE OF ENVIRONMENTAL RESEARCH OF THE REPUBLIC OF KOREA AND NATIONAL INSTITUTE OF AERONAUTICS AND SPACE OF THE REPUBLIC OF INDONESIA ON RESEARCH AND DEVELOPMENT IN THE FIELD OF ATMOSPHERIC ENVIRONMENT SCIENCE, TECHNOLOGY AND APPLICATIONS
4	2021-11-29	Asia Pacific Accreditation Cooperation (APAC)	Asia Pacific Accreditation Cooperation (APAC) Mutual Recongition Arrangement(MRA)

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