Research Institute of Science for Safety and Sustainability

Introduction to the Institute 2026

Create the Future, Collaborate Together

NATIONAL INSTITUTE OF
ADVANCED INDUSTRIAL SCIENCE
AND TECHNOLOGY

Research Institute of Science for Safety and Sustainability (RISS)

Director
Masashi GAMO

Deputy Director
Kunihiko WAKABAYASHI

Deputy Director
Kiyotaka TSUNEMI

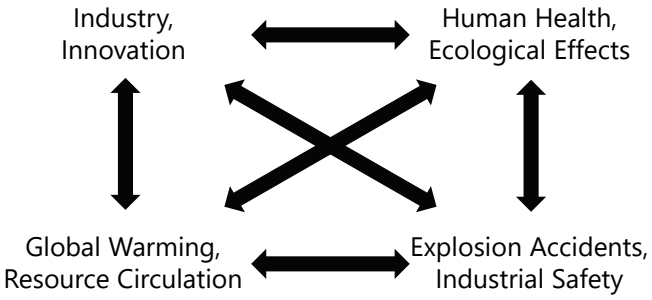
Principal Researcher/
Leader of IDEA Lab.
Kiyotaka TAHARA

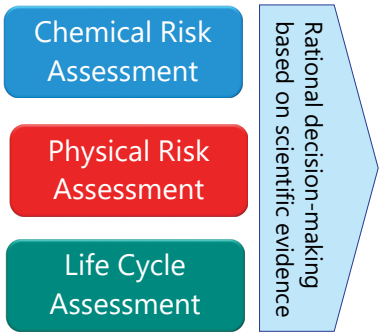
Principal Research Manager
Tei SABURI

During the period of the 6th Medium-Long Term Goals (FY2025–2031) of the National Institute of Advanced Industrial Science and Technology (AIST), the development of countermeasures to address energy, environmental, and resource constraints has been identified as one of the AIST's organization-wide R&D priorities for solving social issues.

The Research Institute of Science for Safety and Sustainability (RISS), a member of the Department of Energy and Environment at AIST, is responsible for research to develop technologies that harmonize environmental protection with economic development. Our mission is to create scientific evidence that contributes to the realization of a safe and sustainable society.

In order to respond to changing domestic and international requirements for chemical management, resource circulation/circular economy, carbon neutrality, natural resource conservation, and biodiversity conservation, we are constructing assessment technologies and methods for environment, safety, and sustainability. We are also conducting practical assessments for solving social issues by leveraging our expertise in areas such as chemical risk assessment, physical risk assessment, and life cycle assessment. Through these activities, we aim to quantify the complex risk tradeoffs inherent in societal challenges and thereby support rational decision-making.

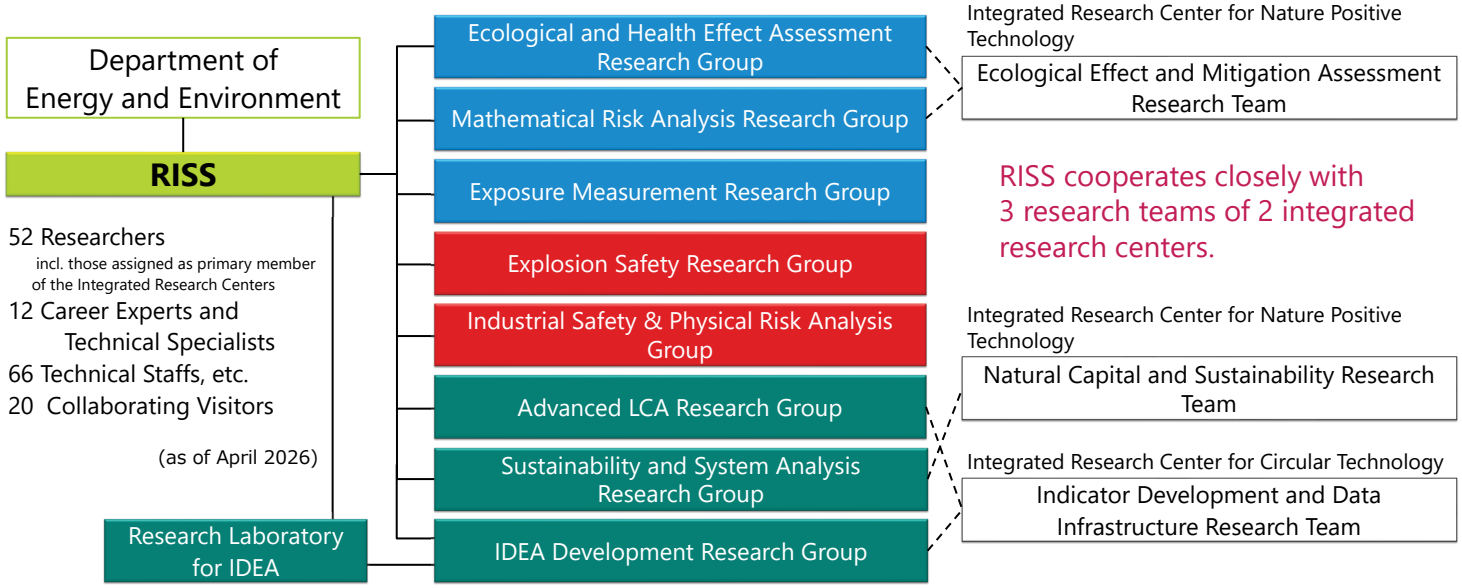




Realization of Safe and Sustainable Society

- Environmental protection and sustainable development
- Maintenance, improvement, and enhancement of industrial competitiveness
- Reduction of risks to the lives and property of people

☐ Organization



Priority Research Issues of RISS

Issue 1: Construction of Assessment Technologies and Methods for Environment, Safety, and Sustainability

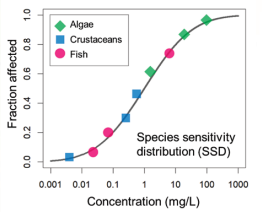
Research Background

Governments and businesses need to conduct assessments by themselves for their decision-making on social issues related to environment, safety, and sustainability. To support this, new assessment technologies and methods based on the latest scientific knowledge must be developed constantly.

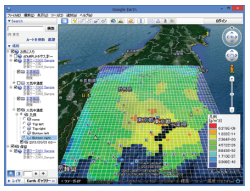
Outline and Target

RISS constructs assessment technologies and methods that governments, businesses, and other entities can use. Specifically, we address issues such as developing a platform for assessing exposure and risk of chemicals in recycled plastics, developing hazard assessment methods that do not use animal testing, promoting DX for the chemical accident information database, contributing to the amendment of the Explosives Control Law, helping corporations assess nature footprint, and developing and disseminating AIST-IDEA (life cycle inventory database).

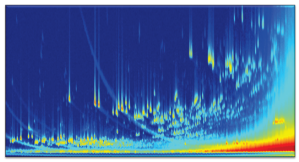
In addition, we also support governments and businesses in their efforts to solve social issues by utilizing the technologies and methods we construct.



Species Sensitivity Distribution used for Ecological Risk Assessment

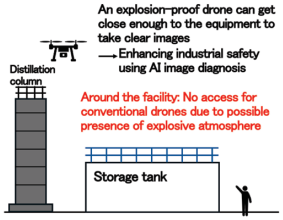


Model for Estimating atmospheric concentrations (ADMER/ADMER-Pro)



Substances from a mixture detected by GC × GC

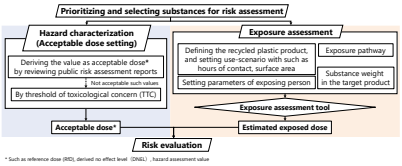
Contributed to the formulation of international standards for the handling of hazardous substances



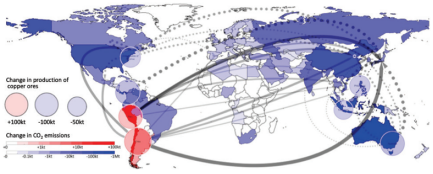
International standardization of explosion-proof structures for unmanned aerial vehicles (drones)

AIST IDEA
Inventory Database for Environmental Analysis

Development of the AIST-IDEA Inventory Database



Development of Risk Assessment Framework for Chemicals in Recycled Plastics



Estimation of CO_2 emission reduction potential through improving global supply chain structures of mineral resources

Issue 2: Practical Assessment of Environment, Safety, and Sustainability for Solving Social Issues

Research Background

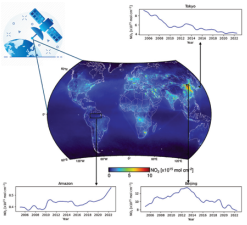
In many cases, solving social issues requires assessments of environment, safety, and sustainability through advanced simulations, data acquisition in various experiments, data processing, and judgments based on expert knowledge.

Outline and Target

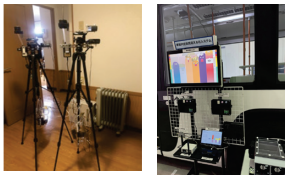
In addition to constructing assessment technologies and methods, RISS conducts environmental, safety, and sustainability assessments and delivers the results to private and public actors in society.

Utilizing expertise in chemical risk assessment, physical risk assessment, and life cycle assessment, RISS conducts practical assessments of alternatives to chemical substances of concern, decarbonization and low-environmental-impact technologies, safety of utilizing drones and IoT devices in industrial plants, safety of hydrogen pipelines, and enhancement of sustainability of supply chains.

Safety Assessment Document of cellulose nanofibers



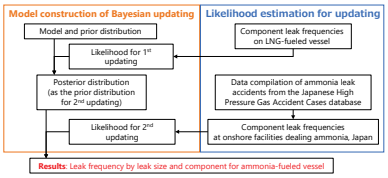
Global distribution of nitrogen dioxide (NO_2) and its long-term trends across three different regions



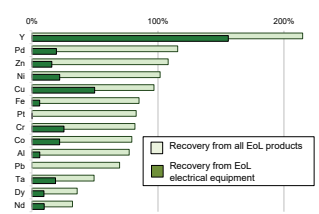
Assessment of the Indoor Environments including Public Transportation Vehicles

Experiments of extinguishing detonating flames that propagate long distances in pipes (the Artificial Photosynthesis Project of NEDO)

Detonation of ANFO Explosive (from report on technical standard for explosion mitigation of explosives (2016))



Leak Frequency Estimation for Ammonia Fuel Ships



The upper limit of resource self-sufficiency achievable through recycling

AIST
Create the Future, Collaborate Together

Ecological and Health Effect Assessment Research Group

Members
6 Researchers:
Akihiro Moriyama, Rie Tai, Hiraku Tanoiri,
Yuichi Iwasaki (concurrent), Masashi Kamo (concurrent)
5 Contract Employees

Group Leader:
Hiroyuki Mano
Tsukuba West

☐ Research Group Outline

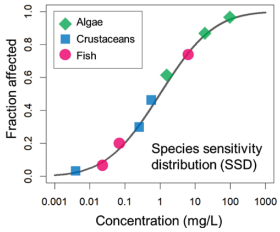
We are conducting hazard and risk assessment research on chemicals (including microplastics) and nanomaterials. Specifically, we develop methods for risk assessment necessary for promoting innovation of new materials such as manufactured nanomaterials, develop methods for obtaining missing data for risk assessment, evaluate risks in actual environments, and promote pragmatic risk assessment for solving social issues. Our goal is to contribute to the realization of a sustainable society where industry and the environment coexist.

☐ Research Highlights

Methods for Risk Assessment and Management of Chemicals

Development of Toxicity Prediction Methods for Rapid and Efficient Risk Assessments

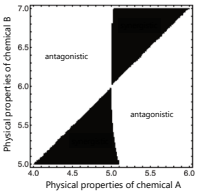
- Development of hazard assessment methods for ecological risk using mathematical and statistical approaches
- Development of methods for quantitative ecological risk assessment using species sensitivity distribution (SSD) and quantification of uncertainties



Fitting a statistical distribution to toxicity data for multiple biological species

Development and Application of Methods for Chemical Mixtures and Population-Level Assessment using Mathematical Models

- Development of models, statistical test theories, and combinatorial optimization methods for assessing the risks of chemical mixtures
- Development of methods for assessing population-level ecological risk of chemicals



An example of the mixture effects of two chemicals (A and B). The mixture effects, which differ depending on the combination of physical properties of the chemicals, are predicted by mathematical models.

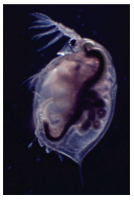
Pragmatic Risk Assessment of Freshwater and Marine Environments

- Assessment of ecological effects and food web-mediated exposure in natural environments based on field bioassessments
- Assessment of practical environmental risk considering regional characteristics using field measurements and modeling techniques

Sampling at river

Risk Assessment and Management Using Bioassays

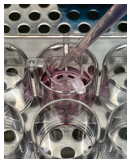
- Evaluation of ecological effects on natural environments from responses of living organisms to environment water pollution
- Investigation of methods for reducing impacts of wastewater from workplaces



Species for bioassay

In-vitro Toxicity Evaluation Methods

- Development of simple and rapid toxicity evaluation methods using cultured human cells
- Development of testing methods for assessing ecotoxicological effects using cultured fish cells
- Investigation of toxicity mechanisms based on gene expression analysis

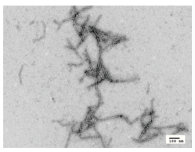


Cell culture

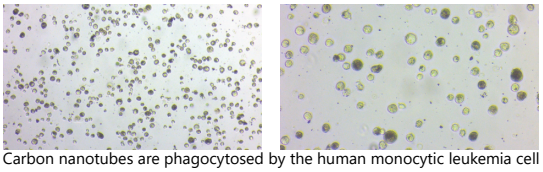
Toxicity Test Methods and Evaluation of Manufactured Nanomaterials

Development of Toxicity Assessment Methods of Cellulose Nanofibers (CNFs)

- Implementation of safety assessments for a variety of CNF slurries
- Development of toxicity test methods (cell test, intratracheal installation test, ecotoxicity test, etc.) that companies can implement on their own
- Publication of a procedure manual and a safety valuation report



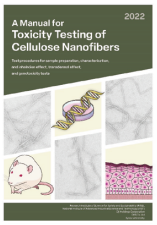
TEM image of CNFs



Carbon nanotubes are phagocytosed by the human monocytic leukemia cell line (THP-1) during the cytotoxicity assay.
The black appearance of cells indicates nanotube internalization.

Dissemination of Testing Methods and Safety Assessments of Manufactured Nanomaterials

- Publication of hazard assessment procedures and safety assessment documents
- Dissemination of information on domestic and international trends through the Nanosafety Web site
- Fundamental research for advancement and standardization of hazard testing methods for manufactured nanomaterials



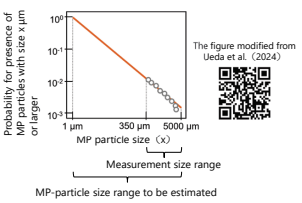
A manual for toxicity testing of CNFs

Practice of Risk Assessment

Ecological Risk Assessment of Microplastic Particles (MPs)

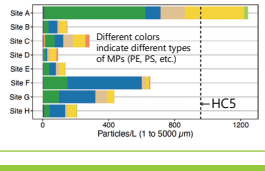
- Surveys measuring MP concentration in environments such as Tokyo Bay
- Estimation of concentrations of small-sized MPs that are difficult to detect or measure
- Estimation of HC5 (the concentration protective of 95% of species) based on species sensitivity distributions and considering MP characteristics such as particle size and polymer type
- Risk assessment practices for MPs based on exposure and hazard assessments

Estimation of MP concentrations using log distribution



The figure modified from Ueda et al. (2024)

Trial Risk Assessment of MPs



AIST
Create the Future, Collaborate Together

Mathematical Risk Analysis Research Group

Members
5 Researchers:
Yuriko Ishikawa, Hiroo Hata,
Jairo Vazquez Santiago, Monami Kondo
6 Contract Employees

Group Leader:
Kazuya Inoue
Tsukuba West

☐ Research Group Outline

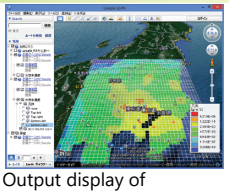
We are developing modeling technologies related to environmental exposure and risk, which are important for assessing the risk of chemical substances to humans and ecosystems. Through these technologies, exposure amounts and risks can be estimated without actual measurement data for proposing effective measures for risk reduction.
In order to address the risk assessment of various chemical substances, including new substances, we are also conducting research that contributes to the speed and efficiency of risk assessment, such as the use of satellite data and the estimation of parameters related to environmental fate based on mathematical methods. Through this work, we aim to contribute to rational decision-making by governments and companies by enabling the evaluation of environmental and energy-related policies and technologies.

☐ Research Highlights

Development of Exposure Models

ADMER (Atmospheric Dispersion Model for Exposure and Risk assessment) & ADMER-PRO

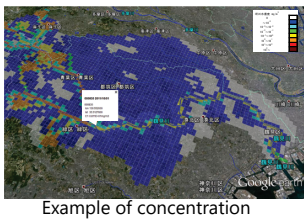
- Estimating atmospheric concentrations and population exposure to chemical substances with high spatial and temporal resolution
- Models contain required input data, so concentration distributions and reduction potentials can be estimated with little time and effort.



Output display of concentration distribution in air

SHANEL
(Standardized Hydrology-based Assessment tool for chemical Exposure Load)

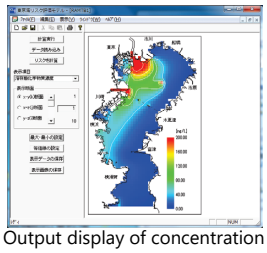
- Estimating spatial distributions and temporal changes of chemical concentrations in rivers nationwide
- Assessing exposure to chemicals in rivers from daily living and industrial activities or leakage accidents
- Incorporating watershed information
- Improving the model to apply to marine biodegradable plastics



Example of concentration distribution in river water

RAM-TB (Risk Assessment Model – Tokyo Bay)

- Spatio-temporal analysis of concentrations of chemical substances in coastal water
- Ecological risk assessment of loads from coast, air and rivers using simple physical properties
- Incorporating ocean currents and nutrients for the target coastal area
- Improving the model to apply to marine biodegradable plastics

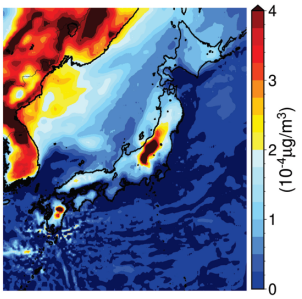


Output display of concentration distribution in Tokyo Bay

Atmospheric Modeling via Chemical Kinetics

Chemical Kinetics and Chemical Transport Model

- Evaluating the rate constants of atmospheric chemical reactions by spectroscopical experiments and quantum chemistry calculation
- Incorporating chemical kinetic parameters into regional and global chemical transport models
- Health risk evaluation for scenarios introducing next generation technologies using chemical transport models

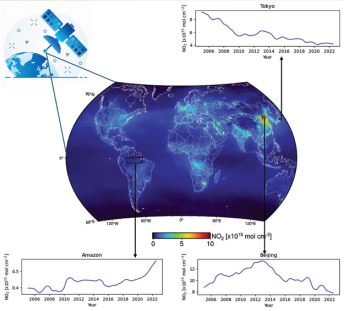


Change of $PM_{2.5}$ concentration by incorporating new kinetic parameters

Data-driven Approaches to Air Quality Assessment

Exploring Air Pollution Dynamics to Support Sustainability

- Integrating satellite and ground-based data to analyze spatial and temporal patterns of air pollutants in diverse environments
- Developing advanced statistical models to identify key drivers of pollutant variability and forecast air quality
- Supporting science-based environmental policy and sustainable development through data-driven insights

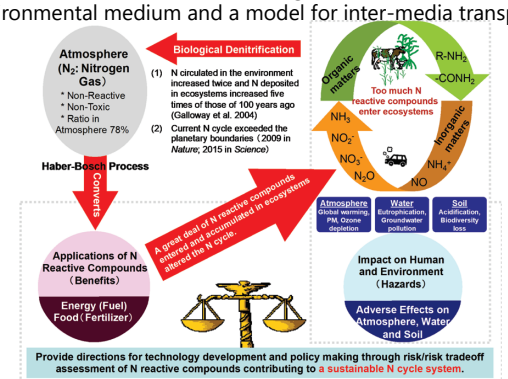


Global distribution of nitrogen dioxide (NO_2) for 2024 and its long-term trends across three different regions.

Environmental risk and risk trade-off assessment

Risk/risk tradeoff assessment of nitrogen (N) and its related technologies

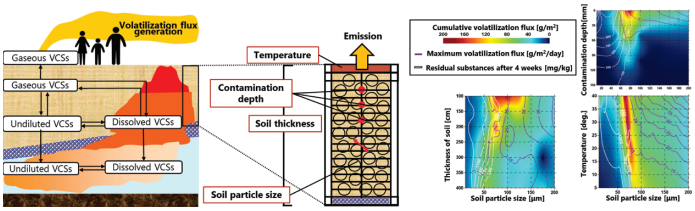
- Modeling the formation and emission of reactive nitrogen associated with biological reactions
- Environmental risk assessment using models of each environmental medium and a model for inter-media transport



Mass Transport at Soil-Atmosphere Boundary

Focus on Volatile Chemical Substances (VCSs)

- Assessing inhalation exposure at ground surface
- Modelling transport of chemicals from contaminated soil into the atmosphere by volatilization
- Analyzing the effects of rainfall and changes in atmospheric pressure and temperature on transport of substances from the soil to the atmosphere



Dependency of volatile emissions on environmental conditions

AIST
Create the Future, Collaborate Together

Exposure Measurement Research Group

Members
4 Researchers:
Naohide Shinohara, Tomoko Oguri, Yasuyuki Zushi
8 Contract Employees

Group Leader:
Isamu Ogura
Tsukuba West

☐ Research Group Outline

Our research focuses on the measurement-based emission and exposure assessment of various chemical substances and fine particles, as well as the elucidation of their environmental occurrence and fate, and the evaluation of associated risks and mitigation strategies. Major efforts include: Evaluation of recycled plastics, microplastics from tire wear, and nanomaterials; Evaluation of indoor environments of homes and public transportation vehicles; Exposure assessment of chemical substances by analysis of house dust, food, consumer products, etc. together with biological samples (urine, blood, etc.); and Exposure and risk assessment of complex mixtures by using comprehensive analysis techniques.

☐ Research Highlights

Evaluation of Plastics and Nanomaterials

Evaluation of Recycled Plastics and Microplastics

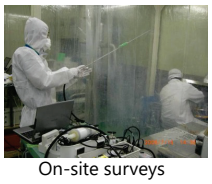
- Evaluation of hazardous substances in recycled plastics
- Evaluation of microplastics in the environment resulting from tire wear

X-ray fluorescence analyzer

Recycled plastic pellets

Safety Evaluation of Nanomaterials

- Emissions and exposure assessment of carbon nanomaterials and cellulose nanofibers
- Publication of documents to support voluntary safety management of nanomaterials



On-site surveys

Documents on safety assessment and management for carbon nanomaterials and cellulose nanofibers

(collaboration with Ecological and Health Effect Assessment Research Group)

Evaluation of Indoor Environments

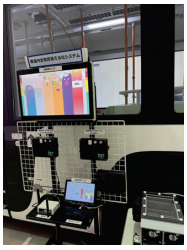
Exposure Assessment in Indoor Environments

- Measurement of emission and adsorption rates of semi-volatile organic compounds (SVOCs), as well as dermal exposure, in the laboratory and actual environment, to elucidate indoor behavior of chemical substances and improve exposure risk assessment
- Investigation of indoor mold, mites, endotoxins, and radioactive cesium

Measurements in indoor environments

Evaluation and Visualization of Indoor Environments in Public Transportation Vehicles

- Investigation of ventilation and particle behavior in indoor environments of buildings and public transportation vehicles
- Measurement and improvement of indoor environments in public transportation vehicles, and development of visualization methods of indoor environmental conditions
- Assessment of sensor performance under various conditions for monitoring the environments both inside and outside of bus vehicles

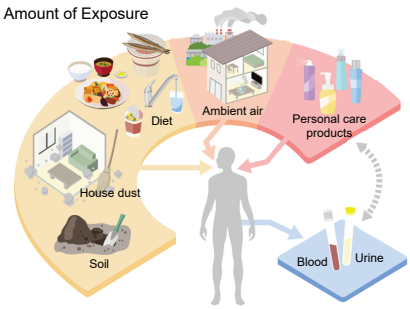


Visualization of the indoor environment of a bus

Assessing Exposure to Chemical Substances

Development of Pharmacokinetic and Exposure Reconstruction Models for Chemical Substances

- Building pharmacokinetic and exposure reconstruction models that link the concentration in biological samples from human biomonitoring and the estimated exposure amount via environmental media
- Analyzing the concentrations of phthalates and other chemicals in house dust, food, consumer products, etc. for exposure assessment
- Development of a system for estimating the effects of exposure on human fertility as health outcome



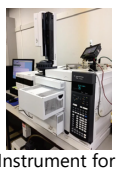
Conceptual diagram of Pharmacokinetic and Exposure Reconstruction Models

Urine samples

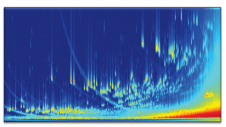
Exposure and Risk Assessment for Complex Mixtures

Comprehensive Analysis of Mixtures by State-of-the-Art Technology

- Development of analytical methods using state-of-the-art instruments (e.g. GC × GC) to comprehensively clarify chemical composition of mixtures occurring in the environment and in commercial/industrial products



Instrument for comprehensive analysis (GC × GC)



Substances from a mixture detected by GC × GC

Web Platform for Assessment of Mixtures of Chemicals

- Development of a web platform that allows users to access mixture data taken by state-of-the-art analytical instruments and directly assess a mixture
- Development of the system to easily and thoroughly assess all of the components in a mixture detected by comprehensive analysis

Mixture Touch: Web platform for assessment of complex mixtures analyzed by GC × GC

Explosion Safety Research Group

Members
7 Researchers:
Shiro Kubota, Yuta Sugiyama, Takahiro Tamba,
Kazuya Nomura, Tomoharu Matsumura, Miyako Akiyoshi
5 Contract Employees

Group Leader:
Ken Okada
Tsukuba Central No.5

☐ Research Group Outline

To advance the understanding of ignition and explosion phenomena of high-energy materials, such as explosives, we are conducting a wide variety of research, from basic to applied. Specific topics include explosion safety, such as safety evaluation methods and visualization techniques, technologies to reduce the effects of explosions, and safety evaluation of batteries.

Also, in response to governmental requirements regarding explosives, we conduct large-scale field experiments. The results obtained are reflected in the creation of standards for technologies to safely handle explosives. We also use these results to help formulate international standards for the handling of hazardous materials, e.g., by making proposals for UN testing. Through these activities, we contribute to the realization of a safe and secure society.

☐ Research Highlights

Development of Methods and Techniques for Evaluating and Mitigating Explosion Effects

Field Explosion Test

- Assessing the effects occurring at the time of explosion (blast wave, fragment characteristics, ground vibration, radiant heat, explosion sound)
- Developing technologies to reduce the explosion effects
- Reducing required safety distance for more effective space utilization, etc.
- Obtaining scientific evidence and basic data for amendment of Explosives Control Act

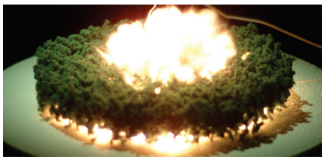
→ Contributing to the formulation of standards for techniques for handling explosives

Detonation of ANFO explosive
Ref: Report on technical standard for explosion mitigation of explosives (2016)

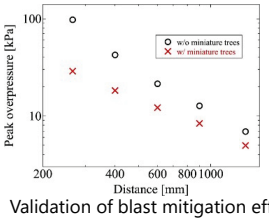
Glass scattering behavior
(Protective effect of film)
Ref: Report on technical standard for explosion mitigation of explosives (2021)

Small-scale Indoor Experiments

- Complementing field experiments with multi-point measurements and optical visualization
- Development of technology to reduce blast effects through buffer materials (vegetation, etc.)



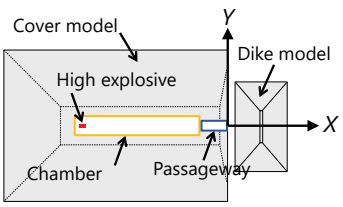
Explosion gas interacting with miniature trees



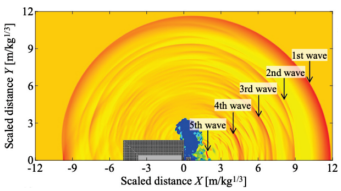
Validation of blast mitigation effect

Numerical Simulation Techniques

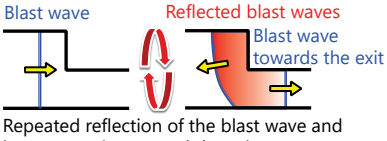
- Developing techniques for predicting explosion effects based on numerical calculations



Modeling of magazines for explosives



Multiple blast waves released from the magazine



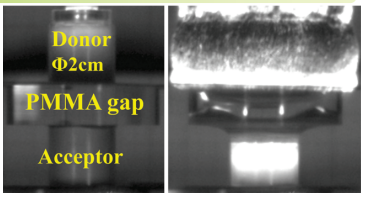
Repeated reflection of the blast wave and its propagation toward the exit

→Understanding of the propagation behavior and mitigation mechanism of the blast wave from the magazine

Techniques for Evaluating Explosion Safety for Energetic Materials

Basic Research on Detonation

- Advancement of Measurement Techniques for High-Speed Phenomena (Application of Magnetic Sensing)
- Development of new energetic materials by co-crystallization
- Investigation of the effects of blasting in the moon's surface
- Performance evaluation of bulk emulsion explosives



High-speed photography of sympathetic detonation phenomena

Combustion and Explosion Evaluation Study

- Safety evaluation for identifying the cause of explosion accidents
- Evaluation of transportation safety of new propellants

Standardization of Explosives

- Addition of a method for highly accurate evaluation of the stability of explosives using BJS test tubes to JIS K 4810:2023
- Creation of a new JIS K 4834:2013, "Method for measuring exothermic decomposition energy as a method for evaluating the explosion hazard of chemical substances," which takes container material into account

BJS test tube

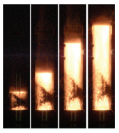
Safety Evaluation of Batteries

- Gas analysis of Lithium-Ion Battery fires
- Investigation of fire suppression strategies

Lithium-Ion Battery fire

Pyrotechnics Research

- Development of low-environmental-impact pyrotechnics
- Pyrotechnics safety research



Acceleration of a small pyrotechnic device in a tube

Combustion of colored firework stars with different compositions

International Contributions for Explosion Safety

Classification of Explosives and Energetic Materials for Safety

- Participated in TDG* and GHS** meetings organized by the United Nations and contributed to international coordination of chemical substance regulations
- Contributed to the formulation of international standards for the handling of hazardous substances by proposing MTC***

*TDG (Transportation of Dangerous Goods), **GHS（Globally Harmonized System of Classification and Labelling of Chemicals）, ***MTC (Manual of Tests and Criteria)

Industrial Safety and Physical Risk Research Group

Members
6 Researchers:
Hiroumi Shiina, Yoshiaki Takahashi, Akira Matsugi, Kaname Sawaguchi, Makoto Asahara*
(* Invited Researcher)

13 Contract Employees

Group Leader:
Ryoji Makino
Tsukuba West

☐ Research Group Outline

In order to utilize the excellent properties of high-energy materials such as hydrogen, which is expected to be a next generation energy carrier, as well as other combustible gases and explosives, it is important to identify the hazards of the materials and technologies to be handled, prevent accidents through control and management technology to handle high energy materials appropriately, and mitigate the severity of harm caused by combustion and explosion accidents through mitigation technology. Furthermore, it is important to learn from accidents to improve safety management. To this end, our group promotes the development of technologies for the safe use of high-energy materials and the advancement of industrial safety, and we aim to meet the needs of government and society related to combustion and explosion safety through research on 1) the safe use of high-pressure gases, 2) explosive safety and its applications and 3) industrial safety.

☐ Research Highlights

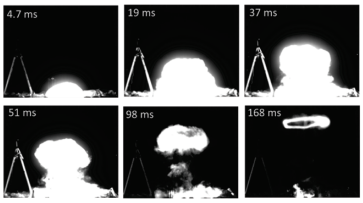
Safe Use of High Pressure Gases, etc.

We develop safety assessment techniques to support new technologies using high pressure gases and flammable gases such as hydrogen and new refrigerants, and we aim to realize a safe and secure society through self-managed industrial safety techniques.

Safety Assessment Studies for Expanding the use of Hydrogen

- **Safety evaluation of hydrogen supply systems**

Evaluation of physical risks and hazards in hydrogen leakage from hydrogen supply systems including pipelines.
- ➢ Leak/diffusion behavior
- ➢ Explosion impact assessment on ignition
- ➢ Evaluation of hazard reduction methods



Flame from ignition of hydrogen leaked to a confined space (Ref: METI Project "Risk evaluation of large damage of hydrogen pipeline")

- **Safety assessment of green hydrogen production systems**

Safety technology assessment of a system that uses solar energy and photocatalysis to split water to produce green hydrogen (artificial photosynthesis)
- ➢ Detonation characteristics in gas transport pipes
- ➢ Evaluation of the performance of deflagration equipment

Experimental equipment for extinguishing detonating flames that propagate long distances in pipes (the Artificial Photosynthesis Project (ARPChem) of the New Energy and Industrial Technology Development Organization (NEDO))

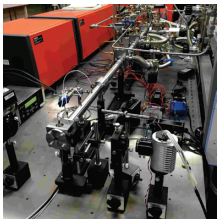
Next Generation Rocket Safety Research

- **Developing safety standards for next-generation rocket fuels**

Assessing the safety of space transportation systems with next-generation rocket fuels
- ➢ Diffusion, combustion and explosion effects of the fuels
- ➢ Establishment of explosion impact estimation and evaluation techniques

Chemistry-Based Evaluation of Combustion Properties

Evaluating combustion properties based on high-temperature kinetic experiments and detailed chemical kinetic mechanism
- ➢ Oxidation and combustion of flammable gases
- ➢ Molecular growth chemistry of hydrocarbons
- ➢ Mechanism of chemiluminescent reactions for combustion visualization



Chemical shock tube for high-temperature reaction studies

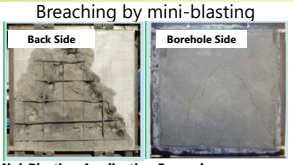
Explosive Safety and its Applications

Development of New Technologies for the Safe Use of Explosives

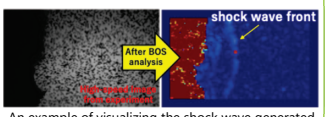
Technology that uses smaller amounts of explosives (gram level) than before to quickly destroy only the target area
→Controlled blasting

Applications
- Development of partial repair techniques for deteriorated building structures in urban areas
- Rescue of people from collapsed buildings in the event of a large-scale disaster

Breaching by mini-blasting



Mini-Blasting Application Examples
To create an opening for rescue team on a collapsed building during a large-scale disaster, so that no flying debris is generated on the rescuer's side.



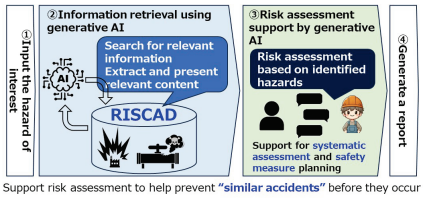
An example of visualizing the shock wave generated by the detonation of explosives using the BOS method

Basic research for the realization of new technologies for the safe use of explosives with low environmental impact (vibration, noise and flying debris)
→ Elucidation of explosion and destruction phenomena of explosives based on optical observation such as DIC (Digital Image Correlation)/BOS (Back Oriented Schlieren) method and numerical simulation technology such as CFD

Industrial Safety

Development of a Risk Assessment Support Tool

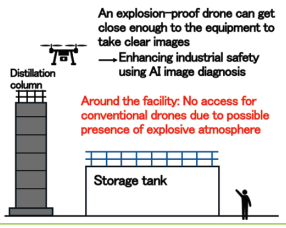
This research aims to develop a system that combines verified data, such as RISCAD, with generative AI to support hazard identification, risk assessment, and the proposal of preventive measures for preventing similar chemical accidents.



Support risk assessment to help prevent **"similar accidents"** before they occur

International Standardization of Explosion-proof Structures for Unmanned Aerial Vehicles (drones)

It is desirable to use drones in chemical plants. However, in many areas inside plants that are restricted as 'hazardous areas (where explosive atmospheres exist)', conventional drones cannot be flown. In order to fly drones in those areas, they must be made "explosion-proof". But current explosion-proof standards do not consider flying electrical equipment. We aim to develop a new international explosion-proof standard that focuses on reducing the risk of explosion and fire caused by falling drones.



Advanced LCA Research Group

Members
5 Researchers:
Sana Mikami, Naoya Kojima (concurrent),
Kyoko Ono (concurrent), Keiichiro Sakurai (concurrent)
8 Contract Employees

Group Leader:
Jun-ichi Takeshita
Tsukuba West

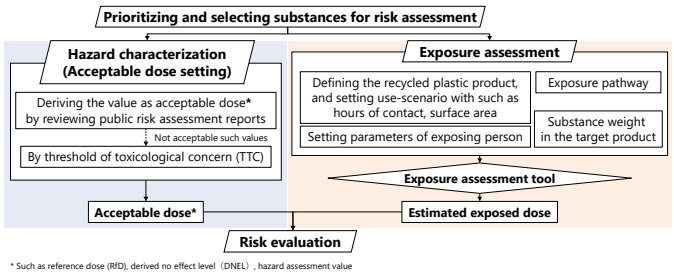
☐ Research Group Outline

We are conducting risk assessments to evaluate the potential issues posed by new technologies, with the aim of providing evidence to support better decision-making for building a sustainable society. Specifically, we are conducting a risk trade-off analysis considering the product life cycle of chemicals, as well as risk assessments related to disasters and accidents. Additionally, we are developing evaluation methods to analyze socio-economic impacts, spillover effects, and social acceptability. Our research covers a wide range of topics, including carbon-neutral and energy-related technologies, nitrogen cycle technologies, and the introduction of marine biodegradable plastics. Furthermore, we are advancing research on mathematical methods for supplementing data gaps in risk assessment, as well as statistical methods that form the foundation of many industries.

☐ Research Highlights

Risk Management of Plastic for the Circular Economy

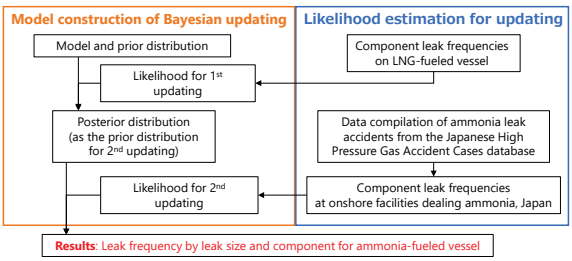
To accelerate the transition to a circular economy for plastic, the health impacts of additives and contaminants specific to recycled plastic must be assessed. Towards the final goal of proposing a management strategy, we aim to understand the entire life cycle of plastic by conducting exposure assessments and risk evaluation of its additives and contaminants.



Risk assessment framework for recycled plastics

Risk Assessment/Management for Ammonia Fuel

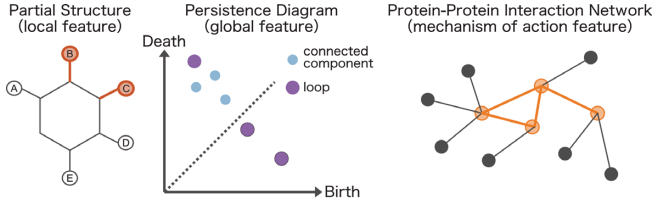
We conduct risk assessments for the leakage of ammonia fuel, the use and storage of which is expected to increase. Notably, we applied the Bayesian theorem to estimate the leak frequency for ammonia-fueled vessels based on data from onshore ammonia handling facilities extracted from the Japanese accident database.



Overview of leak frequency estimation for ammonia-fueled vessels

Data Imputation Methods for Risk Assessment

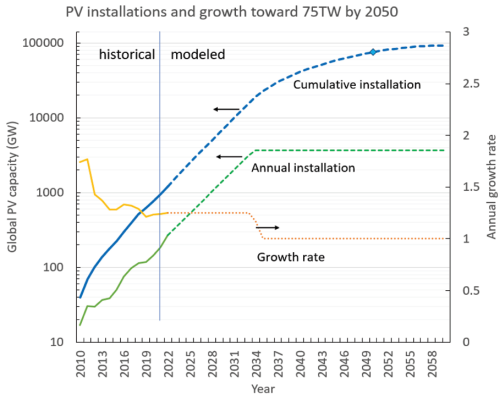
Risk assessment of chemical substances is becoming more difficult as the number of substances increases and regulations on animal testing tighten. Limited time, cost, and access to experimental data make risk assessment challenging. To address this, our research develops data-imputation methods based on statistical modeling and machine learning. To improve data-imputation methods, we explore mathematical approaches, including discrete optimization, topology, and graph theory, to extract multifaceted features of chemical substances. We are also actively involved in ISO/TC 69, where we contribute to international standards on statistical terminology, data interpretation, and methods for evaluating measurement accuracy and precision. Through these efforts, we aim to improve the efficiency and rationality of chemical risk assessment.



Examples of multifaced features of chemical substances

Finding Pathways for the Accelerated Deployment of Decarbonization Technologies

To achieve a sustainable society, it is not enough to just develop new technologies such as energy-efficient buildings, renewables, and electric vehicles. Strategies for smooth deployment are also required. We research these strategies to maximize the societal benefits of new technologies.



A proposed scenario for global deployment of photovoltaics (PV) to achieve 75TW of cumulative capacity by 2050. Historical and projected installation data suggest this scenario is achievable.
(N.M. Haegel et al., *Science* 380, Issue 6640, pp. 39-42, 6 Apr 2023)

Sustainability and System Analysis Research Group

Members
7 Researchers:
Manabu Utagawa, Masaharu Motoshita (concurrent), Ryosuke Yokoi (concurrent), Kamrul Islam (concurrent), Slim Mtibaa (concurrent), Keitaro Maeno (concurrent)
2 Contract Employees

Group Leader:
Hiroki Hatayama
Tsukuba West

☐ Research Group Outline

The aim of our group is to contribute to the achievement of sustainable society through the provision of the two key technologies: 1) models and indicators for sustainability assessment, and 2) system analysis for sustainability.

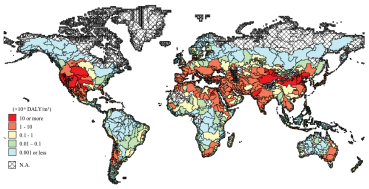
We promote the development of environmental impact assessment models, environmental carrying capacity indicators, risk assessment methods in Environment, Social and Governance (ESG), and assessment methods of individual energy technologies on which to base sustainability assessment. We are also advancing fundamental methods to design sustainable societal systems through system analysis techniques such as Life Cycle Assessment (LCA) and Material Flow Analysis (MFA). Using these methods, we support the practical implementation of promising technologies and systems through studies of actual social implementation.

☐ Research Highlights

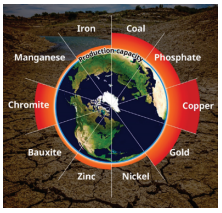
Sustainability Assessment Models and Indicators

Assessment of Environmental Impact and Carrying Capacities

We develop environmental impact assessment models and environmental carrying capacity indicators on which sustainability assessments can be based, and we promote global consensus and world standardization by collaborating with international experts.



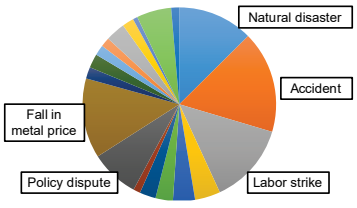
Potential impacts of water consumption in watersheds



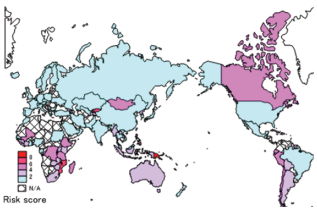
Production capacity of geological resources under water availability constraints

ESG Risk Assessment Methods

We develop methods to assess risks that may impede sustainable resource use from ESG perspectives.



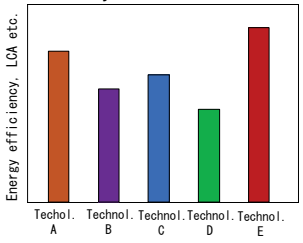
Causes of mineral supply disruptions



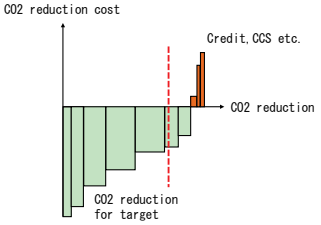
Natural disaster risk for resource exporting countries

Energy Technology Assessment

We assess a variety of energy technologies from environmental and energy efficiency aspects based on Life Cycle Assessment and cost benefit analysis.



Comparison of energy technologies



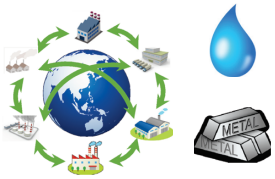
Cost benefit analysis of climate mitigation technologies

System Analysis for Sustainability

Risk Assessment of Resource Supply Chains

We develop and implement methods and databases for the analysis of risks associated with resource supply chains of freshwater and mineral resources.

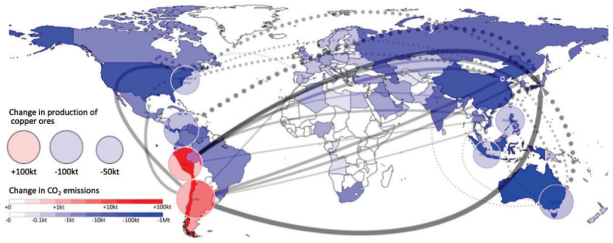
Assessment of the risks to business sustainability and hotspots analysis



- Natural disaster risks
- Future changes (supply and demand)
- Diversity of supply sources
- Exceedance of environmental carrying capacity etc.

Risk management toward business value creation

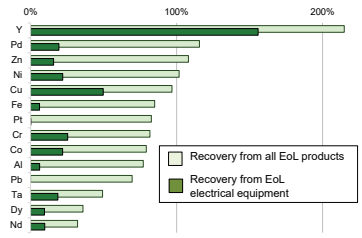
We also develop methods for designing sustainable global supply chains that can reduce the risks associated with use of sustainable natural resources.



Estimation of CO_2 emission reduction potential through improving global supply chain structures of mineral resources

System Analysis on Resource Management and Strategy

We aim to construct systems and strategies for achieving a stable resource supply to domestic industry, through the assessment of supply risks and recycling potentials of various materials.



Some upper limits of resource self-sufficiency achievable through recycling

Research Laboratory for IDEA/IDEA Development Research Group

Members

18 Regular Staff Members:
Steven Kraines, Tetsuya Monna, Yoonyoung Chun*, Akifumi Takahashi*, Yu-Jen Lee*, Chiharu Fujii, Yuki Ichisugi*, Takehiro Suzuki, Asako Takada, Emi Tsutsui, Arini Nuran, Binti Zulkifili*, Maki Yokota, Shizu Uchiumi, Invidiado Loria Faian Ferolin*, Midori Yanagawa, Keisuke Sakata*, Yoshikazu Shinohara, Tetsuya Nakajima* (*: Members of the Research Group)

17 Concurrent Staff Members:
Kenichiro Tsukahara, Shinichiro Morimoto, Hiroki Hatayama, Tomonori Honda, Keijiro Masui, Toshiaki Hanaoka, Shinji Fujimoto, Kenta Takagi, Akihide Hosokawa, Mitsutaka Matsumoto, Tomohiko Nakajima, Hirotomo Itagaki, Yusuke Hirayama, Noriyuki Uchida, Soh Takemoto, Kensuke Kobayashi (Guest), Katsuyuki Nakano (Guest)

24 Contract and Dispatched Staff Members

Laboratory Leader: Kiyotaka Tahara
Tsukuba West

Research Group Leader: Kiyotaka Tsunemi
Tsukuba West

☐ Research Laboratory Outline

Established in April 2017, IDEA Lab is not an organizational unit but rather a collaborative framework that promotes cross-organizational research activities centered on members of research projects. Its primary missions include the development, maintenance, and management of AIST-IDEA (Inventory Database for Environmental Analysis), collaboration with domestic and international partners, and the implementation of technology assessments and the establishment of related methodologies. To fulfill these missions, IDEA Lab operates through a structure consisting of a team responsible for the maintenance and management of AIST-IDEA and the IDEA Development Research Group, which focuses on the development of new inventory databases and technology assessment methods. AIST-IDEA is one of the largest inventory databases in Japan, comprising processes for more than 5,500 products and services that comprehensively cover domestic economic activities. By continuously providing this database to industry and research and development communities, IDEA Lab aims to contribute to the realization of a sustainable society through the reduction of environmental impacts using life cycle assessment (LCA).

☐ Research Highlights

Development of the AIST-IDEA Inventory Database

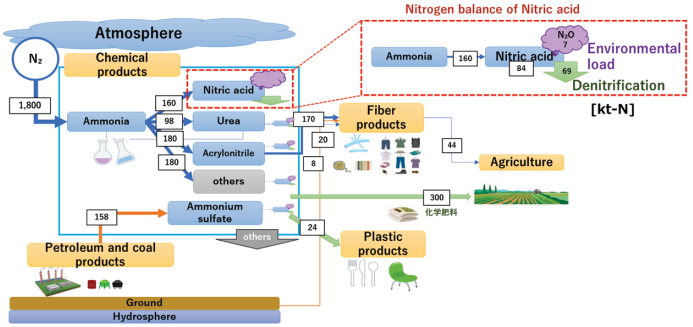
AIST-IDEA is being developed to guarantee comprehensiveness, reliability, completeness, and transparency. Particularly regarding comprehensiveness, AIST-IDEA covers almost all the economic activities of businesses in Japan. Representativeness is assured by using statistical averages for the data on manufacturing processes and services of Japan.

Development of Overseas Data for the AIST-IDEA

Environmental impact values for the same product can vary significantly between Japan and other countries, making country-specific databases essential. Based on AIST-IDEA, which comprehensively covers all products manufactured in Japan, we develop versions for other countries to enable more accurate international assessments.

Development of Nitrogen Inventory Database

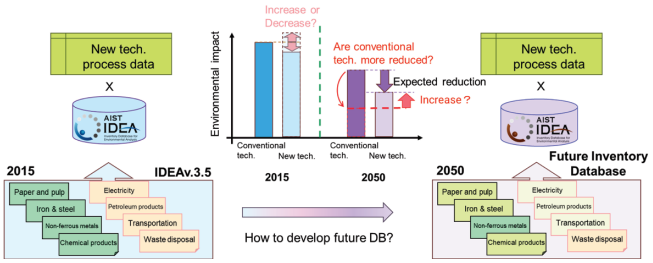
From the perspective of planetary boundaries, emissions of nitrogen compounds from agriculture and manufacturing industries have been identified as a serious threat to the global environment. In response, nitrogen circulation technologies that synthesize and effectively utilize ammonia from nitrogen compounds are being developed. Technology assessment in this field requires databases that account not only for nitrogen emissions but also for nitrogen inputs. To meet this need, AIST-IDEA is being enhanced to develop an inventory in which nitrogen inputs and outputs are consistently balanced. At present, we are building a framework that enables the estimation of nitrogen flows across the manufacturing sector, with a particular focus on chemical industries that utilize recovered and resource-circulated ammonia.



Nitrogen Flow in the manufacturing industry of Japan (2015)

Future Inventory Database

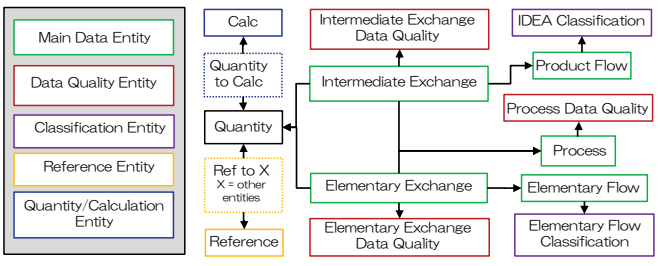
New technologies are being developed with the aim of achieving carbon neutrality in 2050. It is necessary to quantitatively evaluate how much greenhouse gas emissions can be reduced by using these technologies. We are creating a temporal and spatial expansion of AIST-IDEA to provide the inventory database needed for this calculation. We are building this database up to the year 2050 using various future scenarios.



Concept for future evaluation of new technologies

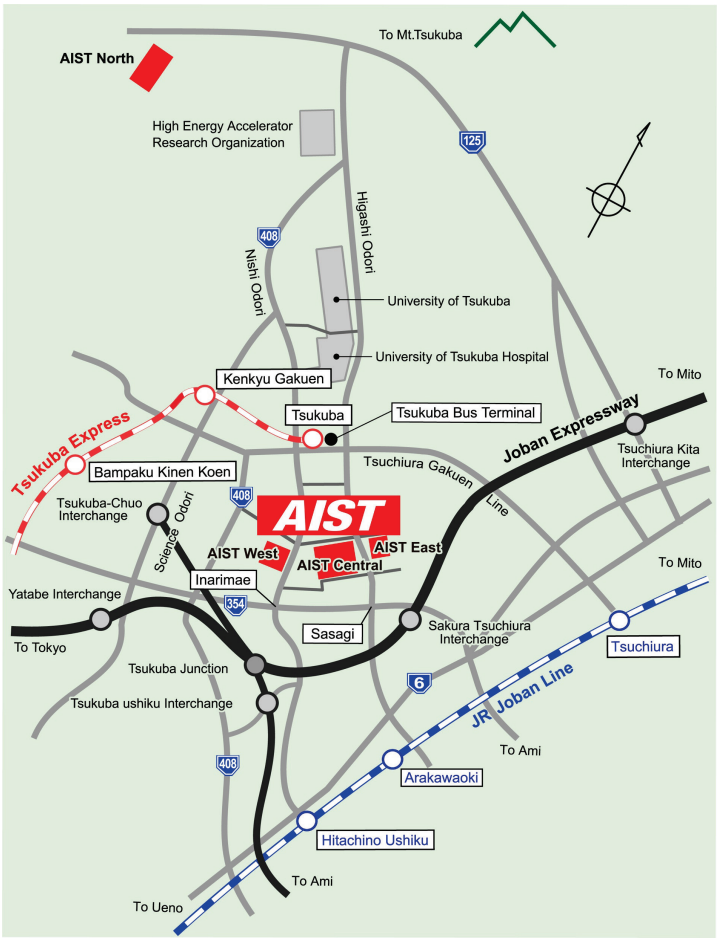
AIST-IDEA Data Model Development

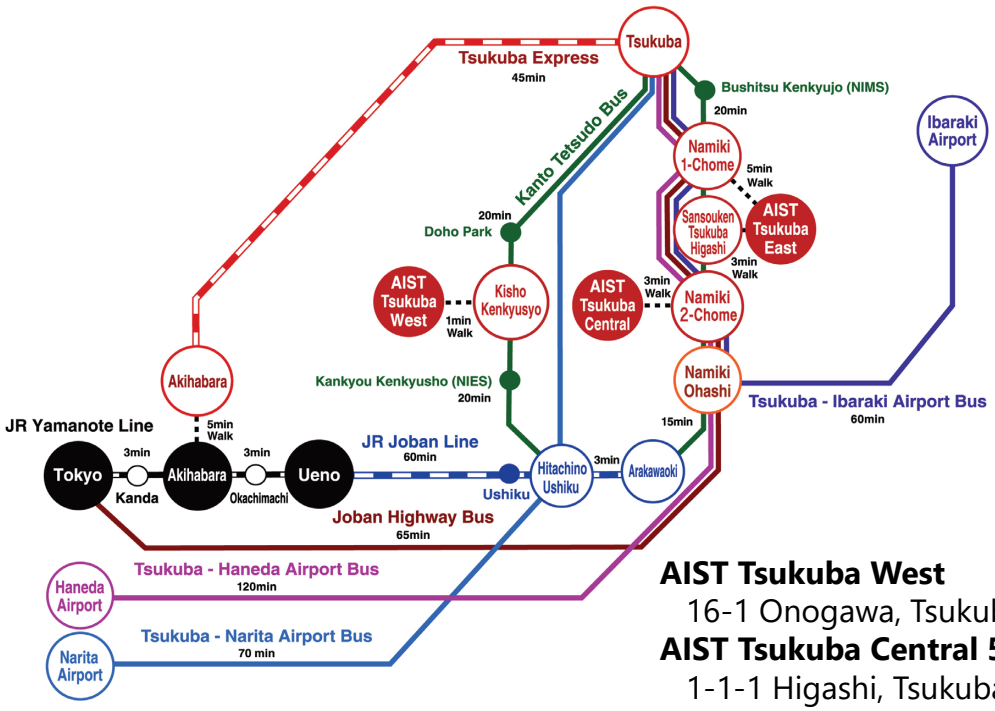
In coordination with the transfer of AIST-IDEA to a large-scale data management system, we are developing a more robust data model for IDEA unit process datasets.



AIST-IDEA Data Model Development

Access





AIST Tsukuba West
16-1 Onogawa, Tsukuba, Ibaraki, 305-8569
AIST Tsukuba Central 5
1-1-1 Higashi, Tsukuba, Ibaraki, 305-8565

Research Institute of Science for Safety and Sustainability (RISS),
Department of Energy and Environment,
National Institute of Advanced Industrial Science and Technology (AIST)

RSS Research Institute of Science for Safety and Sustainability

E-mail: webmaster_riss-ml@aist.go.jp
URL: https://riss.aist.go.jp/en/