## Research Program 1

# Societal Transformation under Environmental Change

This program aims at providing realistic perspectives and options to facilitate the transformation towards a society that can flexibly respond to environmental changes caused by human activities such as global warming and air pollution, as well as to natural disasters. To demonstrate the significance of global environmental sustainability for human society, we need to make intellectually explicit the links between environmental change on the one hand, and social issues such as livelihood, inequality, social security and conflict on the other, and reinforce understanding of these links in the real world.

The Program follows two lines of inquiry. The first conducts research on Asia's long-term paths of social and economic development in relation to climate change and environmental history. Such studies offer historical understandings of the human-nature interface. For example, postwar development of the industrial complex along Asia's Pacific coast was made possible by the combination of imported fossil fuels and utilization of rich local resources of land, water and biomass. Urban and industrial development in the region produced both rapid economic growth and severe environmental pollution and degradation (see Figure 1). By the beginning of this century the more global set of issues such as global warming, loss of biodiversity as a result of tropical deforestation and marine plastic waste were added (see Figure 2). It is important to recognize the causes and consequences of these historical processes in their own light, as well as for their significance to future societal change and policy deliberations.

The Program's second line of inquiry examines the kinds of motivations that affect peoples' livelihoods and seeks social transformation of norms and institutions by working closely with various stakeholders in local society.
The peatland project in Sumatra identified four principal kinds of motivations—local livelihood, profit of local farmers and agricultural and industrial enterprises, local and centrally-based governance, and conservation measures implemented by governments, NGOs and international institutions—and examines how they can be best coordinated to promote sustainability at the village level. Photo 1 captures the peatland fire, a source of severe environmental problems and health hazards. Meanwhile, the ecosystem-based disaster risk reduction project investigates the potentiality of ecosystem services to address natural disaster risks in Japan, where population decline creates additional dimensions to this issue, which are becoming relevant in other Asian countries. Photo 2 shows a traditional Japanese device which serves for flood control and preservation of ecosystem services.
Another project on Punjab, India, studies how to prevent stubble burning, a result of the introduction of a compressed double cropping calendar after the Green Revolution, which caused pressure on water and land, as well as air pollution and health hazards. Air pollution travels far and wide, and exhibits multiple connections of environmental issues on a large scale. Figure 3 reveals the remarkable impact of near nation-wide lockdowns as a result of the COVID-19 on atmospheric nitrogen dioxide concentrations.

As a whole, Program 1 attempts to capture the temporal and spatial depths of such research projects, and to create a framework and vision for their analysis.

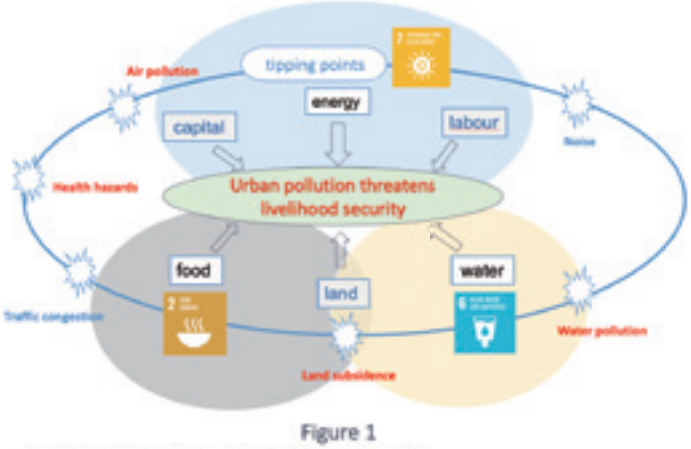


Figure 1
The environmental burden imposed by the high-speed growth model
Urban pollution in Japanese (and later Asian) cities

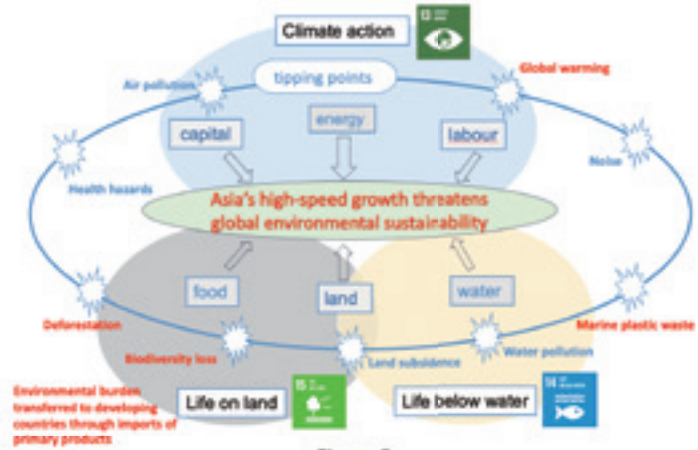


Figure 2
The environmental burden imposed by the high-speed growth model
From urban pollution to global environmental problems

Photo 1 :
A drone view of tropical peat fires, Pelalawan district, Riau Province, Indonesia. Photo taken on September 13th, 2019.

Photo 2 :
Kasumi-tei (open levee), a traditional measure against riverine flood, remaining in the Kitagawa River (Fukui Prefecture). Many open levees still exist in this river and perform multiple functions including flood control and supporting biodiversity and ecosystem services in the watershed. Photo taken in September 2020.

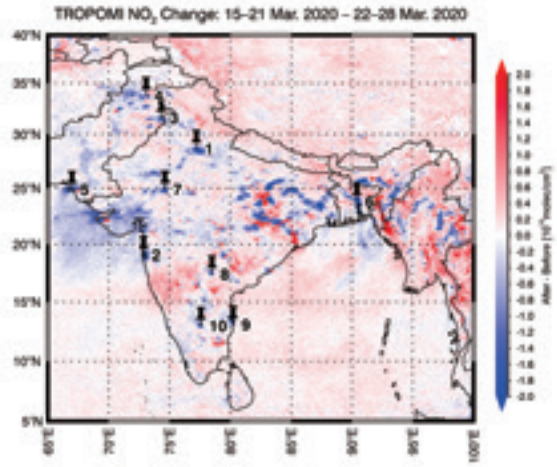


Figure 3 :
Changes in nitrogen dioxide concentrations before and after lockdown in India, observed with satellite sensor (TROPOMI). Areas marked blue show a decrease, those marked red an increase. Pinned spots indicate major cities: 1. Delhi; 2. Mumbai; 3. Lahore; 4. Islamabad; 5. Karachi; 6. Dhaka; 7. Chittorgarh; 8. Hyderabad; 9. Chenna; and 10. Bangalore. See also pages 16-17.

Program Director **SUGIHARA Kaoru** RIHN

Trained in Japan (Doctorate at the University of Tokyo), I have held positions at the Faculty of Economics of Osaka City University, the History Department of the School of Oriental and African Studies, University of London, the Graduate School of Economics of Osaka University, the Center for Southeast Asian Studies, Kyoto University, the Graduate School of Economics of the University of Tokyo, and the National Graduate Institute for Policy Studies (Japan). My research concerns the history of intra-Asian trade, labour-intensive industrialization and the economic and environmental history of Monsoon Asia in long-term perspective. I am currently working on the historical interpretation of decarbonization.

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# Toward the Regeneration of Tropical Peatland Societies:
## Building International Research Network on Paludiculture and Sustainable Peatland Management

Project Leader **KOZAN Osamu** RIHN/Kyoto University

Osamu Kozan has conducted hydro-meteorological observation and hydrological modelling in Asia. Based on field observation data, he developed hydrological land surface models considering actual water management in the Huai River basin in China and the Aral Sea Basin in Central Asia and developed a forecasting model of snowmelt-flood in the Lake Biwa basin, Japan. He has been conducting integrated natural and social science research on peatland society in Riau province and action research on peatland rehabilitation since 2008. He is continuing research on the effects of peatland fires and the accompanying air pollution on the local community.

## Necessity of the study

Peat swamp forests are found throughout Southeast Asia, especially Indonesia, and contain massive stores of carbon and water. Over the last two decades, these swamps have been intensively exploited in order to create commercial acacia and oil palm plantations. As these commercial tree species cannot grow in swamps, peatlands have been drained, creating extensive areas of dried peatlands that are extremely vulnerable to fire.

In 2015, peatland fires burned 2.1 million hectares of forest in Indonesia, affecting 45 million people. A half million people suffered from upper respiratory tract infections, and thousands of people, especially children, were afflicted with asthma. The government responded to this disaster by mobilizing the army, punishing people who set fires, and refusing to issue new peatland development permits. These measures were urgently needed, but provided only short-term relief. The public has demanded longer-term and more sustainable measures, such as rewetting and reforestation of peatlands, activities also promoted by this project since 2012. The government of Indonesia established the Peatland Restoration Agency in January 2016, and declared that two million hectares of degraded peatlands would be restored by 2019.

The objective of this research project is to use action research to generate solutions to peatland degradation and related fire and haze in tropical regions. The project seeks to identify and implement alternative practices in collaboration with local people, academics, governmental offices and officials, NGOs, and international organizations. The project conducts multidisciplinary research in order to clarify the entire process of peatland degradation. We especially focus on three topics: A) History of development; B) Peat environment; and C) Climate change. Each topic sheds light on the cyclical series of social and environmental phenomena related to the process of peatland degradation. We study the vulnerability and transformability of each key subject in order to develop innovative peatland restoration activities that are useful to tropical peatland societies.

## Research methods and objectives

Peatland ecosystems are vulnerable to rapid state-changes. We explore their vulnerability with scientific methods, analyzing the socio-economic history of peatland societies, monitoring greenhouse-gas emissions in various types of peatlands, and tracking historical change in the amount of rainfall and significance of haze. Damage due to human disturbance is not completely reversible, however, and it is also necessary to consider what level of activity is consistent with sustainable development of the local economy.

In order to address this dilemma, we use transdisciplinary approaches to explore the transformability of peatland societies. We promote village participation in peatland restoration activities and suggest effective policies to administrators, arrange effective applications of paludiculture and social forestry, and use weather radar to identify potential fire outbreaks.

**Explaining how to use the GPS logger in Lantau Baru village (Pelalawan District, 30 November 2020)**

This research thus supports the future potential of peatland-based societies, the phasing out of monoculture production activity, the development of paludiculture, and the enlargement of protected peatland areas.

## Achievements to date

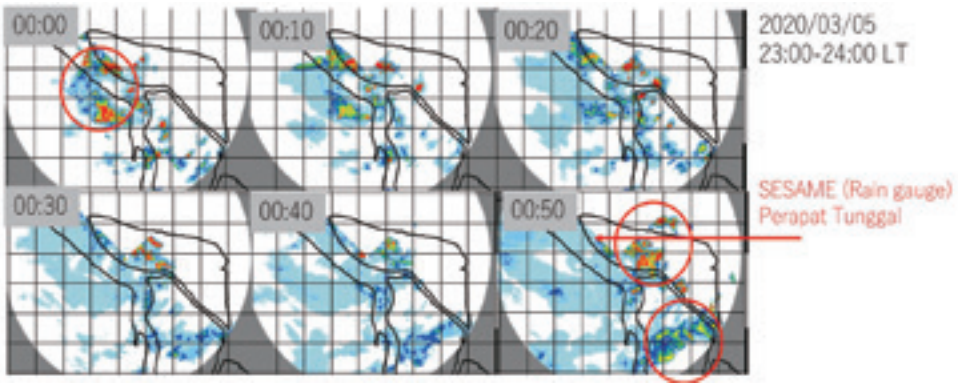
Project researchers first introduced the practice of rewetting and reforestation in peatland areas in Bengkalis District, Riau Province in 2010. This experimental site has attracted significant attention especially since 2015, when fire and haze became very serious in the area. Along with project-led international seminars, the site has significantly enhanced public awareness of rewetting and forestation to promote peatland regeneration.

We signed Memoranda of Understanding with the Peatland Restoration Agency of Indonesia and Riau University to conduct action research on peatland restoration. Our project has created action plans based on these MOUs and begun to implement a restoration program in which social forestry programs are designed to strengthen the land rights of people on degraded state lands. In addition, continuous monitoring of green-house-gas emissions from peatlands, the influence of haze on atmosphere, and seasonal changes of local rainfall, allows us to clarify the influences on, and processes of, peatland degradation.

## Publications

*Catastrophe and Regeneration in Indonesia's Peatlands: Ecology, Economy and Society* was published by the National University of Singapore Press in 2016. This volume provides interdisciplinary field-based and historical analyses of peatland degradation through examination of the survival motives of local people, the profit motives of companies, and the conservation motives of government and NGOs. The book showcases the potential solution of rewetting and reforesting "the people's forest". The book has been reviewed in various media, including leading international academic journals. Our project will continue to build on this research in order to develop new insights on tropical peatland management.


**Fish survey in the village of Lantau Baru (Pelalawan District, January 2020)**




**Movement of rainfall area analyzed by small weather radar (Bengkalis District, 5 March 2020)**

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# Research and Social Implementation of Ecosystem-based Disaster Risk Reduction as Climate Change Adaptation in Shrinking Societies

Project Leader **YOSHIDA Takehito** RIHN/The University of Tokyo

Takehito Yoshida is an ecologist and limnologist who studies diversity and complexity of organisms and ecosystems from the viewpoints of adaptation and system dynamics, and explores human-nature interactions and sustainability in local communities in Japan. Trained in Kyoto University (PhD) and Cornell University (postdoc), he was a member of the faculty at the University of Tokyo at Komaba before assuming joint appointments at RIHN and the University of Tokyo.

## Outline of the project

Globally, the rate of natural disaster occurrence has been increasing, partly due to contemporary climate change, and adaptation to natural disaster risks is increasingly important to the sustainability of human societies. At the same time, many societies are experiencing shrinking populations. Ecosystem-based Disaster Risk Reduction (Eco-DRR) takes advantage of the multi-functionality of ecosystems and biodiversity, including their capacity to mitigate natural disasters while providing multiple ecosystem services, and population decline provides ample opportunity for implementing Eco-DRR. Our project will develop practical solutions for implementation of Eco-DRR by visualizing natural disaster risks, evaluating multi-functionality of Eco-DRR solutions, conducting transdisciplinary scenario analysis, examining traditional and local knowledge of disaster risk reduction, and collaborating with the insurance industry and other sectors.

## Background and goals

Climate change impacts natural and human systems, and these impacts are projected to intensify in the future. Our project focuses on reducing risk and developing management strategies related to natural disasters. The risk of natural disasters results from the interaction between a climate-related hazard, and the exposure and vulnerability of human activities (Fig. 1), so that adaptation to natural disaster risk can be realized by reducing exposure (e.g. by improving land use) and vulnerability to hazards.

Hard-engineering natural disaster countermeasures have target safety levels below which natural disasters can be prevented. Although these countermeasures are effective if the hazard level of natural disaster is below the target safety level, societies increasingly face situations in which hazards exceed safety levels, resulting in devastating natural disasters. Eco-DRR approaches focus on lowering the exposure of human activities to natural hazards, so reducing, if not preventing, associated losses and damages. Eco-DRR approaches, meanwhile, take advantage of the multi-functionality of ecosystems, complementing conventional approaches to natural disaster management, even though the effectiveness and multi-functionality of Eco- DRR is not yet clearly and quantitatively understood.

The population of Japan increased substantially over the last century, increasing the risk of and public exposure to natural disasters. Recently, however, the population is aging and shrinking, leading to the abandonment of farmlands, houses and decreases in other intensive land uses, a challenging circumstance that nevertheless provides an opportunity for improving land use. Evaluating past natural disaster risks in both expanding and shrinking population contexts therefore provides valuable

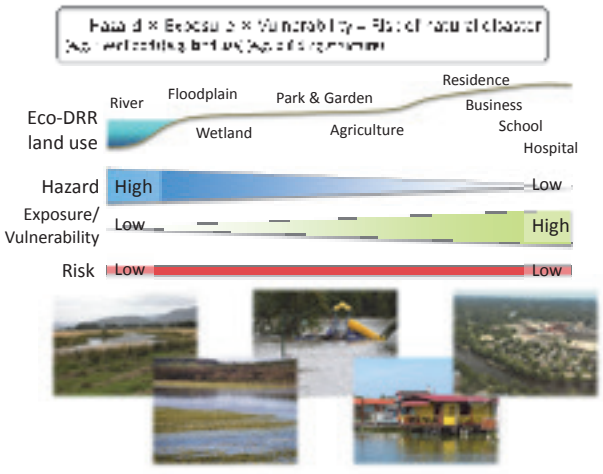


**Figure 1 Ecosystem-based disaster risk reduction not only lowers disaster risks but also enhances benefits of ecosystem services by reducing the exposure of human activities in high-hazard locations and supporting human activities in low-hazard locations.**

information of adaptation strategies considered in Japan as well as in other countries.

Given this background, the ECO-DRR project sets two main goals. First, it develops methodologies to evaluate Eco-DRR multi-functionality and assess Eco-DRR by comparing multi-functionality in the past, present and future. Secondly, the project supports Eco-DRR implementation through transdisciplinary collaborations with local communities, governments, insurance industry and other stakeholders.

## Research objectives

Three research components contribute to achieve the above two goals.

(1) Visualizing risks of natural disasters in present and past

Exposure and vulnerability to different natural disasters is analyzed, and societal risk is evaluated and visualized with risk maps of the present and past. Modeling risk for different exposure scenarios will contribute to future Eco-DRR assessments and plans.

(2) Evaluating and modeling multi-functionality of Eco-DRR

Provisioning, regulating, and cultural ecosystem services will be evaluated, and their spatial distribution will be modeled in relation to population and land use. The model will be used to evaluate the ecosystem services associated with different land use scenarios.

(3) Transdisciplinary approaches for implementing Eco-DRR in society

Together with local stakeholders, transdisciplinary platforms will be formed at each of the local research sites by taking advantage of existing platforms. Transdisciplinary platforms will deepen mutual understanding, promote discussion of future options, and build consensus regarding the use of Eco-DRR. Multi-functionality of Eco-DRR at each local site will be evaluated and research outcomes will be shared with local stakeholders using our transdisciplinary platform. In addition, traditional and local knowledge of Eco-DRR will be inventoried and evaluated for multifunctionality so that the benefits of traditional and local knowledge can be shared with the general public.

In collaboration with insurance industry, a research forum will be formed to discuss the possibility and feasibility of insurance industry contributions to economic incentives of Eco-DRR. Various laws and institutions in national and local governments related to disaster risk reduction and land use will be assessed in the research forum as well.

## Recent results

As the project turns the halfway point, we have been working on disseminating the results of the research and actions we have conducted in collaboration with diverse stakeholders. Traditional and local knowledge in the Matsuura River in Saga Prefecture was compiled as a booklet. We have compiled a technical report on Eco-DRR and green infrastructure in collaboration with practitioners from six consulting companies. In addition, a booklet introducing advanced overseas examples of finance and insurance for implementing Eco-DRR, a guide to the management of the Yatsu landscape, which exists in many places in the Lake Inba watershed (Chiba Prefecture) and has a variety of functions, and a film and booklet introducing the relationship between nature and people at the foot of Hira Mountains (Shiga Prefecture) were published. All of these materials are available free of charge through the RIHN website.

**Figure 2 Booklets published in 2020 summarize the results of our research and actions. E-books and PDFs are available for free from the RIHN website.**

**Photo 1 Mikatagoko area in Fukui Prefecture, one of the research sites.**

**Photo 2 Hira mountains and their base area in Shiga Prefecture, one of the research sites. Photo courtesy of MATSUI Kimiaki.**

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| **HASHIMOTO Shizuka** | The University of Tokyo | **SHOUJI Tarou** | Pacific Consultants Co., Ltd. |
| **ICHINOSE Tomohiro** | Keio University | **TAKI Kentaro** | The University of Shiga Prefecture |
| **MIYOSHI Iwao** | Kyoto Prefectural University | **UEHARA Misato** | Shinshu University |
| **NISHIDA Takaaki** | Kyoto Sangyo University | **URASHIMA Hiroko** | MS&AD Insurance Group Holdings, Inc. |

# An Interdisciplinary Study toward Clean Air, Public Health and Sustainable Agriculture:
## The Case of Crop Residue Burning in North India

Project Leader **HAYASHIDA Sachiko** RIHN/Nara Women's University

Dr. Sachiko Hayashida is an atmospheric scientist who has many achievements of research on stratospheric ozone depletion, air pollution and greenhouse gases. She received the Horiuchi Award from the Japan Meteorological Society in 2002. From 2005-2008 she was a member of the Science Steering Group of the Stratospheric Processes And their Role in Climate (SPARC) within the World Climate Research Programme (WCRP). From 2010-2018 she was a committee member of the International Commission on Atmospheric Chemistry and Global Pollution (iCACGP), a special commission within the International Association of Meteorology and Atmospheric Sciences (IAMAS). She is currently a president of the Remote Sensing Society Japan (RSSJ).

## Problem

This study addresses air pollution caused by large-scale post-harvest burning of rice-straw in October and November in the states of Punjab and Haryana in North-West India (Figure 1). The burning causes severe air pollution in the surrounding areas, most notably in the Delhi-National Capital Region. Some evidence suggests that crop-residue burning negatively affects air quality over the entire Indo-Gangetic Plain (IGP), demonstrating the potential negative impact of changing agricultural practices on regional air quality, affecting public health and well-being of hundreds of millions of people.

## Background

Historically the Indian Punjab region, a semi-arid zone with low precipitation, was not suitable for intensive cultivation. Traditional agriculture in the region consisted of a combination of cultivating wheat and raising livestock (cattle). Development of irrigation canals during the British colonial period transformed the region into a granary. In the 1960s, the area became the seat of the so-called "Green Revolution", and played a central role in producing food for the populous nation. In the 1970s, most of the region adopted a double-cropping system of wheat and rice. However, this cultivation practice required farmers to sow wheat seeds immediately after the rice harvest. While traditional hand-harvest allowed cropping of rice stalks near ground-level, recently increasing use of combine harvesters leaves large quantities of stubble in field. Farmers are forced to quickly burn this crop residue (stubble and stalk) in order to prepare for wheat seeding in the short period between late October and early November. Winds in this season shift to the northwest, often blowing smoke from stubble burning to Delhi-NCR, markedly affecting air quality there. Actually, however, the cause and effect relationship between stubble burning in the Punjab region and worsening air pollution in Delhi has not yet been established quantitatively. This lack of definitive quantitative evaluation is principally due to the poor state of the air pollution monitoring network in the region. Unfortunately, many farmers of the Punjab region are reluctant to acknowledge their own actions as the cause of air pollution in Delhi, and there is also some disagreement among academic researchers as well.

## Project Structure & Research Plan

This project utilizes observational data and model simulations in order to provide a scientific examination of the connection between stubble burning in Punjab and severe air pollution in Delhi. Based on this scientific understanding, we will pursue a pathway of social transformation toward clean air, public health and sustainable agriculture. We will organize three working groups to approach stakeholders; all working groups will examine various measures to raise awareness regarding farmer/community behavior relevant to air pollution, as well as that of other stakeholders and government.

## Project progress in 2020
## Questionnaire survey in all districts in the state of Punjab

We carried out the questionnaire survey in all 22 districts of the state of Punjab, under the contract with the Center for International Projects Trust (CIPT), a non-profit organization in India. Two villages per district and 50 households per village were selected, representing a total of 2,200 households. Surveys gathered information on household financial status, agricultural practices, health awareness, and so on. Even in the midst of the spread of COVID-19, the CIPT was able to carry out surveys of all 2,200 households in FY2020. The questionnaire also included information on rice stubble burning. Because individual farmers may fear punishment for certain agricultural practices, in order to gain further information we also conducted direct interviews with village representatives.

**Figure 1 Map of India with marks of the states of Punjab and Haryana.**

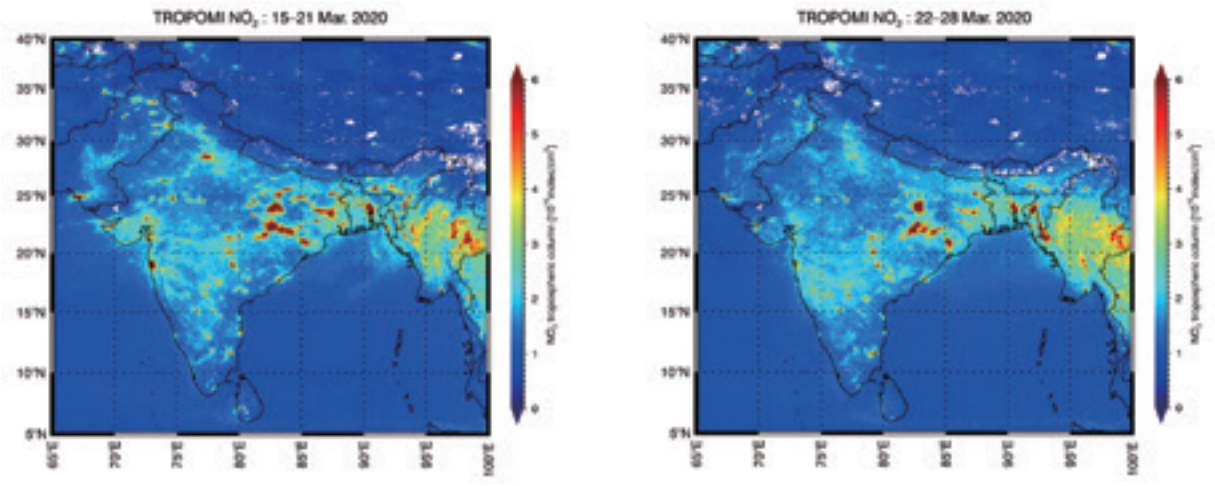
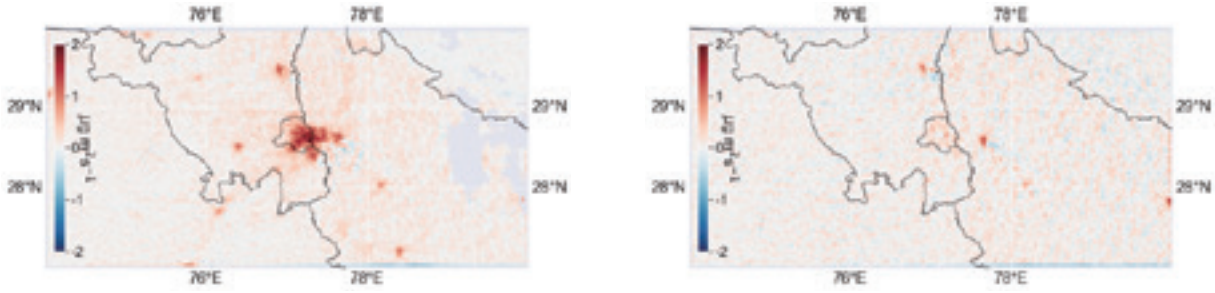



**Figure 2** Nitrogen dioxide concentrations observed with satellite sensor (TROPOMI) just before lockdown (left) and after lockdown (right) in India.




(a) BAU (b) Phase 1

**Figure 3** Estimated NOx emission in 2020 during (a) BAU (business-as-usual), and subsequent lockdown-phase (Mar. 22-Apr.14). Emissions from urban areas with dense roads and buildings and from power plants are shown in red.

## Temporary improvements in air pollution in Delhi as a result of COVID-19 lockdown

On March 25, 2020, a nationwide lockdown was implemented in India. As a result, the skies above Delhi-NCR, which has been cited as the most heavily-polluted city in the world, turned blue (See Aakash Newsletter: "Clean Air and Imagined Sustainability: The case of India" https://www.chikyu.ac.jp/rihn_e/covid-19/topics.html#topics1). An urgent and intensive research mission named "DELHIS (Detection of Emission change of air poLlutants: Human Impact Studies)" was therefore initiated on 1 April 2020, with the help of WG2 to investigate this abrupt change in air pollution. Semi-weekly meetings were held for four months, resulting in the publication of three peer-reviewed papers as of March 2021. Figure 2 shows the changes in the $NO_2$ concentrations observed by TROPOMI, during the periods of 15–21 March 2020 (before the lockdown: left) and 22–28 March 2020 (after the lockdown: right). By comparing $NO_2$ concentrations before and after the lockdown, anthropogenic nitric dioxide ($NO_2$) emissions were also quantitatively estimated (Misra et al., 2021, Figure 3).

**A scene of burning rice straw captured in Ludhiana district, Punjab, on Nov. 2, 2018.**

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## Research Program 2

# Fair Use and Management of Diverse Resources

Global environmental problems are inter-related. Studies concentrating on single issues are therefore often not effective and consideration of the links between multiple resources involving stakeholders is essential. Recently, the nexus structure linking energy, water and food production has become a prominent area of study, but truly sustainable societies require more comprehensive understandings of the ecological resources that provide ecosystem services and cultural resources. The production, circulation and consumption of resources should be discussed in relation to a range of spatial scales, and stakeholders should be involved in these discussions. Sustainable use of resources requires fair and wise management systems as well as indices capable of managing these processes.

Many existing socio-economic or human behavioral systems must be converted or transformed into new systems capable of addressing the special qualities of renewable natural resources, as these qualities have sometimes been externalized from conventional economics. Asia is experiencing rapid change in economy, urbanization and population, though traditional techniques for sustainable resource management, associated with the relatively rich human sphere and cultural background in this region also survive. Study of this long-standing Asian experience of resource use may offer important observations about sustainability in general.

RIHN research projects have accumulated information and suggestions necessary to this transformation in resource management, though gaps remain. Program Two therefore explores wise and fair management systems capable of addressing multiple resource-uses by multiple stakeholders, in multi-spatial scales. We encourage new project proposals including those by innovative young scientists addressing such novel and under-examined subjects. Program research should also address the social conditions that support transformation of values and human behavior, as they should also inform new indices and institutions for fair resource management.

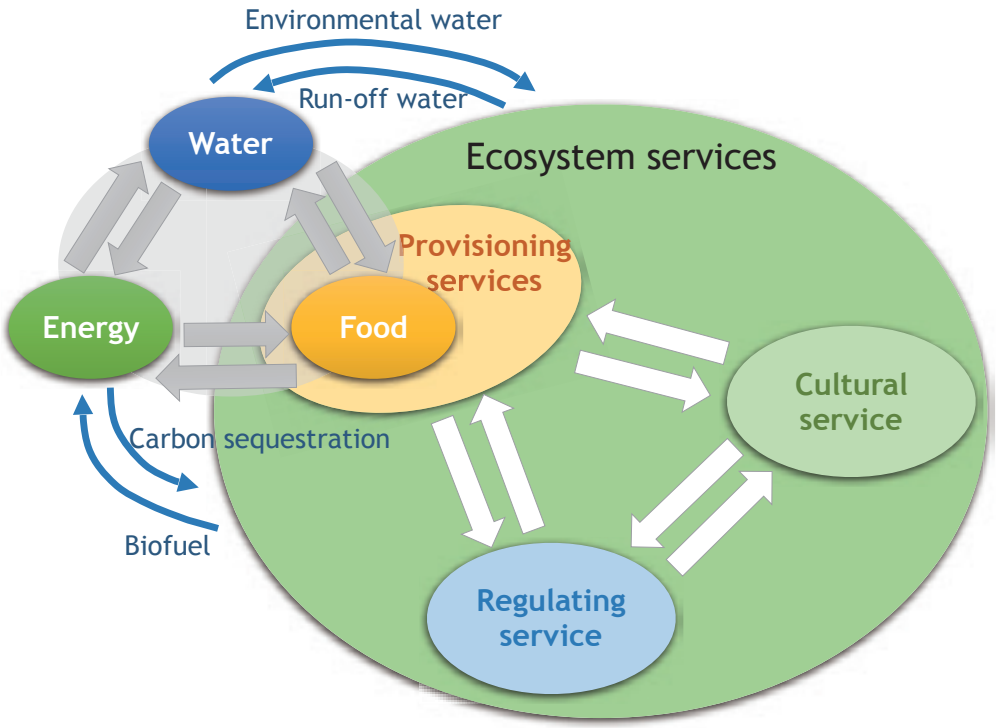
In 2019, we enlarged our database of resource supply and demand in Japan to the municipality level, with particular emphasis on ecosystem services. The database could be utilized to assist comparative and integrative analyses of research sites. One initial analysis of this database indicated that prefectural sustainability is related to population density. Some of these results were presented in the chapter "Evaluating local sustainability, including ecosystem services provided by rural areas to cities to promote bioeconomy" (The Bioeconomy Approach, Routledge 2020). It is also useful to consider the inter linkages among the resource use sustainability, which could be developed to address SDG targets.

Traditional agricultural landscape in Hanamaki, Iwate Prefecture, Japan

Land-use pattern in mountain area in Thailand

Water flow in upstream of Iwaki River, Japan

Solar power generation in Chiba Prefecture, Japan




Nexus structure among water, energy, food, and ecosystem services

Acting Program Director **Hein MALLEE** RIHN

Hein MALLEE is a social scientist with a Ph.D. from Leiden University, the Netherlands. His work was initially concerned with migration and related policies in China, but as he started working in international development, he became involved in projects on rural development, natural resources management and poverty alleviation in China and Southeast Asia. The dominant theme in this work was local people's involvement in and rights to resources. He has been a professor at RIHN since March 2013 and a deputy director-general since April 2018. He is also the director of the Regional Center for Future Earth in Asia.

Researchers

**KOBAYASHI Kunihiko** Researcher

**KARATSU Fukiko** Research Associate

# Mapping the Environmental Impact Footprint of Cities, Companies, and Households

Project Leader **KANEMOTO Keiichiro** RIHN

I am an Associate Professor of Research Institute for Humanity and Nature. Before that, I was a Lecturer of Institute of Decision Science for a Sustainable Society at Kyushu University and Faculty of Economics and Law at Shinshu University. From 2009 - 2011, I was a visiting research fellow at Integrated Sustainability Analysis, the University of Sydney. I received my Ph.D. in 2014 from Tohoku University. In 2018, 2019, and 2020, I was named a Highly Cited Researcher in the field of Cross-Field by Clarivate Analytics.

## Abstract:

A recent study in Nature showed that up to a third of biodiversity loss is driven by trade, and a body of other studies have identified the same pattern for GHG emissions, air pollution, and other environmental ills. Many environmental impacts worldwide are ultimately driven by consumption in developed countries. Considerations of remote responsibility, ecological footprint, and scope 3 emissions are now a standard part of the environmental policy discussion at many levels, from the UNFCC to individual businesses and households.

Providing better information to buyers and decisionmakers can be a powerful way to reduce environmental pressures worldwide. The life-cycle analysis (LCA) and supply chain analysis tools (multi-regional input-output (MRIO) models) used to analyze these remote effects in detail have benefited from significant advances in the past years, with improving models and, more recently, the link of economic models to spatial (GIS) maps that locate more precisely how global supply chains link to particular emissions and biodiversity hotspots.

However, while existing work sketches out the broad picture, it still falls short of being detailed enough to help with many specific decisions. Existing supply chain analyses operate at the resolution of countries and broad economic sectors. In practice decision-makers at these levels often only have limited effective economic and judicial power. Many individuals, businesses, and local governments are seeking to reduce their total environmental footprint, but existing models are either too coarse resolution to be truly useful or require expensive and time-consuming modifications to be useful for informing specific decisions.

Unlike most studies, which focus on environmental emissions and international trade, this is the first study to clarify the effect of global supply chains on environmental impacts. Further, in addition to countries and regions, we will estimate the environmental footprint of cities, companies, and households. The proposed project would be a major contribution and can be expected to be of high interest to businesses, policymakers, NGOs, sustainability consultants, and researchers around the world. The project team has deep experience in supply chain analysis and environmental impact assessment.

## Results:

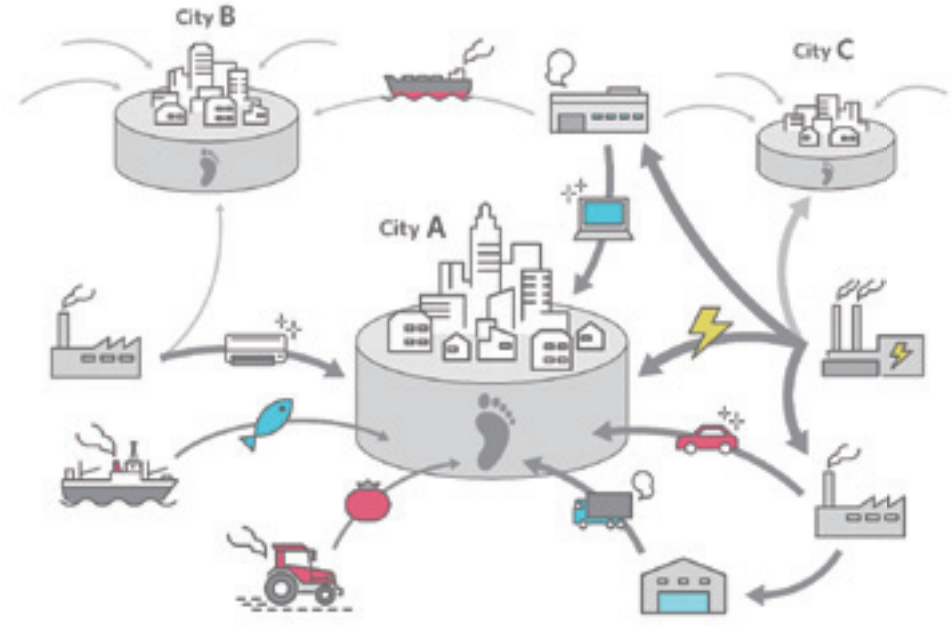
In 2018, we estimated the carbon footprint of 13,000 cities. Globally, we find carbon footprints are highly concentrated in a small number of dense, high-income cities and affluent suburbs. 100 cities drive 18% of global emissions. In most countries (98 of 187 assessed), the top three urban areas are responsible for more than one-quarter of national emissions.

In 2019, we identified five key results about Japanese food diet from the Japanese carbon footprint (CF) household study. First, differences in household demographics (age and sex) do not explain variation in household food CF. Second, regional differences in food-related CF exist, but these are not the main explanatory factor of household differences. Third, household income and savings are weakly correlated with food-related CF. Fourth, there is 1.9 times higher in food CF between the mean household in the lowest and highest quartile. Finally, meat consumption is almost identical across the four quartiles, and it is rather consumption of fish, vegetables, confectionary, alcohol, and restaurants that differentiates high and low CF households.

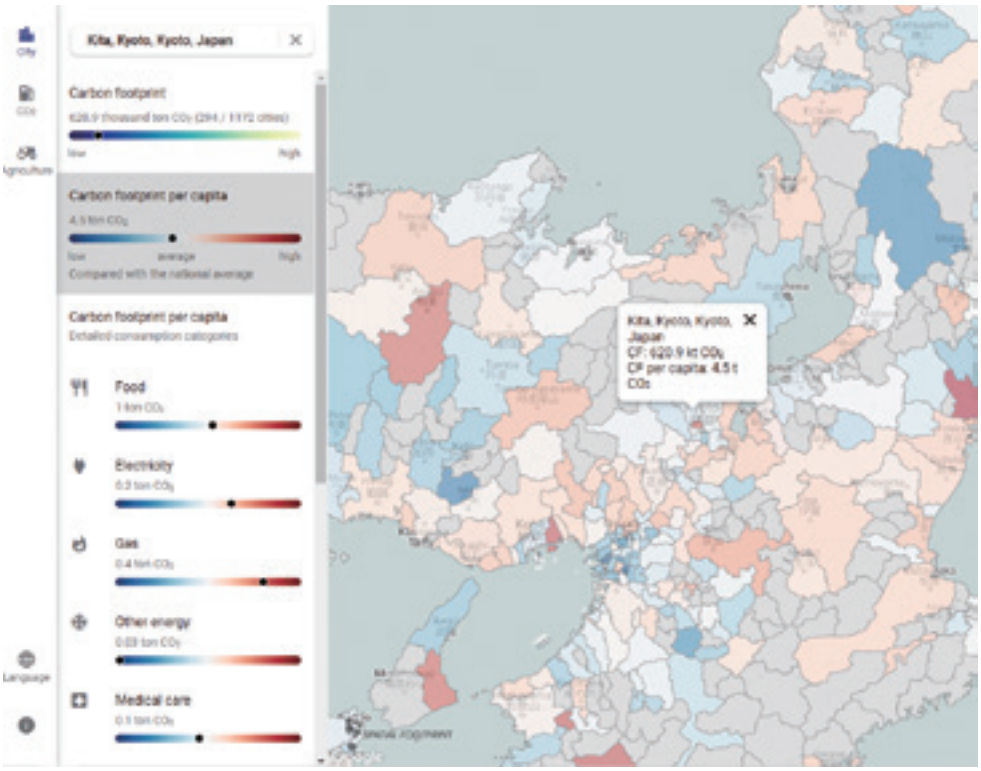
In 2020, we estimated carbon footprint of Japanese and Indian cities. In the Indian study, we show the eradication of extreme poverty does not conflict with ambitious climate change mitigation in India. However, our analysis suggests CF reduction policies within India need to target high-expenditure households, as they are responsible for nearly seven times more carbon emissions than low-expenditure households (living on $1.9 consumption a day). In the Japanese study, we construct household CF inventories for 1172 Japanese cities using detailed consumer expenditure data and a Japanese domestic multi-regional input-output (MRIO) model. We identify the consumption activities which city policymakers can target to reduce CF. We observe a strong concentration of household CF in a few cities in Japan: 40% of the total Japanese CF is driven by 143 cities.



https://www.chikyu.ac.jp/rihn_e/project/2019-01.html




**The concept figure of the environmental footprint of cities.**




**The webpage screenshot of the carbon footprint cities**

Main Members

| | |
|---|---|
| **NGUYEN, Tien Hoang** | Senior Researcher |
| **TAHERZADEH, Oliver Ahrash** | Senior Researcher |
| **LEE, Jemyung** | Senior Researcher |
| **FAHMI, Muhamad** | Researcher |
| **FARABI-ASL, Hadi** | Researcher |
| **KATAFUCHI Yuya** | Researcher |
| **TAKATA Shoko** | Research Associate |

# Fair for whom? Politics, Power and Precarity in Transformations of Tropical Forest-agriculture Frontiers



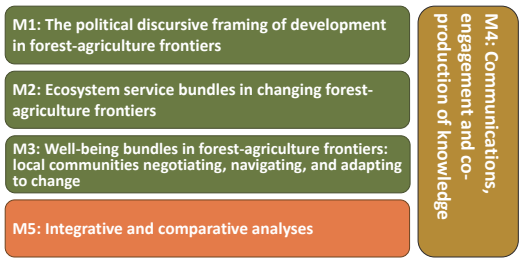
Project Leader **Grace WONG** RIHN

Grace Wong is a natural resource economist. Over the past two decades, her research has largely converged on assessing social, economic and ecological trade-offs in changing tropical environments at the interface of development and conservation processes. She has worked extensively throughout Southeast Asia and Latin America, and more recently in Sub-Saharan Africa. Her current research is on the politics and governance of forest and ecosystem services in dynamic social-ecological systems, with particular focus on issues of power, gender, intersectionality and equity.

Throughout the tropics, forest-agriculture frontiers dominated by diverse swidden mosaics are being converted to homogenous landscapes of commodity agriculture. Despite being labeled as "development", smallholders in these landscapes often benefit less than local elites and external investors in frontier transformations, reflecting underlying politics, institutional and power structures around forests and land-use tenures.

FairFrontiers applies inter- and transdisciplinary approaches to ask: *whose interests drive transformations of forest-agriculture frontiers, who benefits and who is made precarious? What are possible policy options that can deliver ecologically sustainable and socially equitable outcomes?*

To address these research questions, the project is organized into 5 modules. The first will carry out critical discursive analyses of the different framings of development in forest-agriculture frontiers; the second and third modules will examine how bundles of ecosystem services and well-being are changing in frontiers; the fourth module will apply transdisciplinary approaches with co-production of knowledge on, and inclusion of diverse and local narratives of sustainable futures; and the fifth module will carry out integrative and comparative analyses across modules, scales and countries (see Project Structure). The analytical framework is built on theories of power and everyday politics, social and environmental justice and ecosystem services. Together, these approaches support the advancement of theory and methods for assessing equity, ecosystem services and wellbeing, and identification of the enabling and hindering conditions for more equitable and sustainable development pathways for the millions of people who still depend on these diverse landscapes for their wellbeing.




**FairFrontiers project structure**

**Forest-agriculture frontier in Laos**

Above: KONDO Yasuhisa, Reading the height, Wadi Tanuf, Oman

Bottom: YOSHIDA Takehito, The Inokuchi cylindrical diversion tank for irrigation, Shiga, Japan

## Research Program 3

# Designing Lifeworlds of Sustainability and Wellbeing

More than 60% of the world's population resides in Asia and over a third of global economic activity occurs there. Asia is comprised of an incredible diversity of cultures, histories, societies, economies, livelihoods, and ecologies. Asia is also affected by myriad global and local environmental issues, such as population increase, air, water, soil, and coastal pollution, increasing greenhouse gas emissions, and biodiversity loss. The region is also affected by growing wealth disparity, social isolation, rising levels of poverty, and the disappearance of traditional cultures and knowledge. The combination of migration between the countryside and cities, rural depopulation, and urban concentration is accompanied by rapid socio-cultural change, over-exploitation of resources, and deterioration of natural environments. Both urban and rural lifeworlds are disintegrating rapidly.

In reconstructing the lifeworld concept and highlighting the reciprocal linkages between rural and urban spaces, Program 3 designs lifeworlds of sustainability and wellbeing and co-creates concrete pathways for their realization. Program research is based on the diverse world-views and accumulation of experience of human-nature co-existence. Latent socio-cultural elements such as livelihood styles, lay knowledge, conflict resolution strategies, and the vitality of the people themselves, can be called upon to address contemporary problems and to help chart a course toward possible future societies. Program 3 builds upon such experience and knowledge of human-nature interaction to propose concrete changes needed to achieve a sustainable society.

The transformations and frameworks leading to sustainable urban and rural lifeworld design will also entail fundamental shifts in existing economic systems, markets, and political decision-making systems. Rather than investigating top-down approaches to system change, Program 3 works with local residents, government officials, companies, citizen groups and other stakeholders to propose sustainable alternatives and gauge their feasibility. In order to avoid the risk of developing proposals that are only applicable to specific regions or sites, Program 3 will aim for research results that are generalizable while also retaining the diversity at the heart of local lifeworlds and wellbeing.

Intergenerational and intragenerational equity is an important issue in designing a sustainable society. Shibly Shahirier, a new researcher in the program, has found in a field experiment in Bangladesh that inequality can be greatly improved if people with power in the current generation think about current and future issues as imaginary future people. Stimulated by these results, at the Think 20 Summit, a preparatory meeting for the G20, the Program Director proposed that current world leaders be asked to act as imaginary future presidents and prime ministers of the world concerned to control carbon and nitrogen emissions, for example, which will place a heavy burden on future generations. Unfortunately, this proposal was not adopted, but the idea still stimulates Program research, including in the forthcoming volume Future Design x Philosophy (Keiso Shobo Publishers).

The diversity of fruits and vegetables for sale at the market in Kanchanaburi reflect Thailand's changing society


An activities of transdisciplinary community of practice in Hayahaya village of Gorontalo Province, Indonesia

Action research in Zambia. The Vice-President of Zambia visited the Sanitation Project's booth at the Zambia Water Forum and Exhibition (ZAWAFE) 2018.
Photo by NYMBE, Sikopo P.

Program Director **SAIJO Tatsuyoshi** RIHN

Tatsuyoshi Saijo specializes in designing social systems that promote sustainability and equity without inhibiting individual incentive. His interest is in developing the field of "Future Design", one that links the happiness and wellbeing of current generations to that of future generations.

Researchers

**SHAHIRIER, Shibly** Researcher



# The Sanitation Value Chain: Designing Sanitation Systems as Eco-Community-Value System

Project Leader **YAMAUCHI Taro** RIHN/Hokkaido University

Taro Yamauchi is a professor at the Faculty of Health Sciences, Hokkaido University. He has a B.S., a M.S. and a Ph.D. in health sciences from the University of Tokyo. He does intensive fieldwork in hunter-gatherer societies, rural villages, and urban slums in developing counties to understand the lifestyle and health of local populations and adaptation to living environments. His research interests also include sanitation and participatory action research involving local children, youth and adults. He is vice president of the International Association of Physiological Anthropology (IAPA) and an executive member of the International Society for the Study of Human Growth and Clinical Auxology (ISGA).

Sanitation generally refers to facilities and services for the safe disposal of human urine and feces. Sanitation systems are essential for promoting public health, preventing environmental pollution, conserving ecosystem functions, and recycling resources. The question of how to handle the waste of 10 billion people is therefore highly relevant to the global environment. The UN Millennium Development Goals Report 2015 reported that 2.4 billion people are still using unimproved sanitation facilities, including 946 million people who practice open defecation. Sanitation in the developing world has not been improved dramatically, and it still has high under-five mortality and poverty rates.

The world's population is estimated to reach approximately 10 billion in 2050, and this population growth will happen mostly in developing countries. At the same time, depopulation and aging are increasing, especially in the rural areas of the developed world, and the financial capability of many local governments—which are key agents in the management of sanitation systems—is getting weaker. The conventional approach based on technology and building toilets is not sufficient to address sanitation issues. A holistic model that includes collaboration with local communities in sanitation is necessary.

## How we think about sanitation

Sanitation has three components: health and wellbeing, materials (technology and economy), and socio-culture. Inadequate sanitation is harmful to physical and mental health, and sanitation is based on technology that promotes an appropriate material cycle. Sanitation technologies entail costs of introduction and maintenance, but they can create benefits by turning human waste into compost or other useful materials. Sanitation is also based on cultural assessments of what is "clean" or "dirty", so the operation of a sanitation system requires a social framework. As a complex of health and wellbeing, materials, and socio-culture, we propose the Sanitation Triangle as a holistic model (Figure 1).

Based on the Sanitation Triangle, project research will uncover the values embedded in societies and cultures and co-create the Sanitation Value Chain by cooperating with various actors related to the sanitation system. We envisage that the Sanitation Value Chain system will improve the health and wellbeing within the community.


**Figure 1 The Sanitation Triangle Model.**

## Goals of the project

The goals of this research project are to: 1) propose the concept of Sanitation Value Chain in relation to both developing and developed countries; 2) design several pilot studies demonstrating the significance of societal, academic, and professional involvement in the co-creation of this value chain; and 3) contribute to the establishment of a new interdisciplinary academic foundation on sanitation.

## Research topics for achieving the goals

Topic–1 Life: Field surveys examine cultural values and norms regarding human excreta, and reevaluates the sanitation system in relation to residents' lives.

Topic–2 Technology: We identify prerequisites of sanitation technologies and reevaluate the value that sanitation will bring. In addition, based on the sanitation value chain we develop new sanitary technologies relevant to local values and conditions.

Topic–3 Co-creation: We identify key stakeholders and describe the value structures of people and communities, and analyze the hierarchy and structure of stakeholders' value chains and evaluate their affinities. We demonstrate the co-creation process of the sanitation value chain.

Topic–4 Visualization: In order to co-create the value chain, it is necessary to communicate research results to actors and stakeholders. Utilizing resources and institutional collaborations of RIHN, we will develop methods and communicate research outcomes using various media.

## Research sites

The project is performing field studies at four sites: 1) Rural areas in Ishikari River Basin, Hokkaido; 2) Rural areas of Burkina Faso; 3) Urban areas in Indonesia; and 4) Peri-urban areas in Zambia.

## Achievements in FR studies

(1) Toilet for recycling resources. We have developed functioning toilet technologies necessary for the sanitation value chain by making urine in the urban area valuable as fertilizer. These are the "Toilet that can concentrate urine" and "Toilet that can make phosphorus fertilizer".

(2) Tracking propagation of pathogens. Pathogenic bacteria propagate through various routes. We have developed a molecular biological method of tracking this propagation. In the case of Bangladesh, we found that the most important route of pollution is bathing, and the contamination of drinking cups is more important than of the water itself (Figure 2).

(3) Detecting the risk factors relating to WASH (water, sanitation, and hygiene). We surveyed handwashing and health of elementary school students in the "slum" area of Bandung, Indonesia. Risk factors of stunting and diarrhea are gender (boy), drinking tap water rather than tank water, using an open storage container of drinking water, low household income, and not using towels after hand washing. The risk factors for fecal *E. coli* attached to children's hands are gender (boy), inadequate hand-washing and use of soap, and other inhygenic practices.

(4) In Zambia, we organized two workshops with local children and youth groups to promote good sanitation and hygiene. Group members measured fecal contamination around their living environments and then created visualizations of this invisible contamination, improving awareness of the problem and facilitating discussion of improvement (Photo 1). Second, participants took pictures of the places thought to be a problem for community sanitation. These images were recomposed into videos that facilitated community communication.

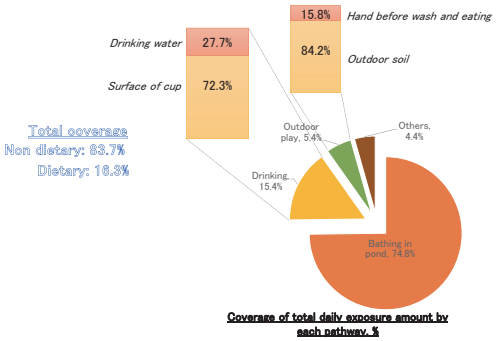



**Figure 2** ***E. coli*** **exposure pathways. Example of measurement in Bangladesh from Harada et al. (2017) Fecal exposure analysis and *E. coli* pathotyping: a case study of a Bangladeshi slum, International Symposium on Green Technology for Value Chains 23-24 October, 2017, Balai Kartini, Jakarta.**

**Photo 1 Workshop in Zambia: Collecting samples and processing (photo by KATAOKA Yoshimi)**

(5) Meta-research of our project were conducted. We published a paper describing and analyzing the embarrassment and trial of a cultural anthropologist who entered our inter-disciplinary project. We also recorded and analyzed how interdisciplinary communication is performed at the intersection of the humanities and sciences, such as in our project meeting discussions. We use these recordings to promote interdisciplinary communication in our project.

## Notable achievements in FY2020

1. We edited and published the international journal "Sanitation Value Chain" (ISSN: 2432-5066). We have revised the Aims & Scope of the journal to provide young researchers in developing countries with opportunities to publish their research results, and in FY2020, we published Volume 4, Numbers 1, 2, 3, and the proceedings of an international online symposium (Volume 5, Number 1) (Figure 3).
2. We held frequent webinars with overseas counterparts and conducted an international online symposium (SVC2020) and remote field surveys.
3. We organized our field practices and methodologies such as visualization and meta-research to theorize inter- and trans-disciplinary research.


**Figure 3 International academic journal Sanitation Value Chain, 4 (1, 2, 3) and 5 (1).**

Sub Leader

| | | | |
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| **FUNAMIZU Naoyuki** | Muroran Institute of Technology | **NAKAO Seiji** | Kyoto University |

Researchers at RIHN

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| **SHIRAI Yuko** | Researcher | **HONMA Saki** | Research Associate |

Main Members

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| **INOUE Takashi** | Hokkaido University | **HARADA Hidenori** | Kyoto University |
| **USHIJIMA Ken** | Hokkaido Research Organization | **FUJIWARA Taku** | Kyoto University |
| **KATAOKA Yoshimi** | Hokkaido University | **LOPEZ ZAVALA, Miguel Angel** | Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico |
| **SANO Daisuke** | Tohoku University | **NYAMBE, Imasiku Anayawa** | University of Zambia, Zambia |
| **SHIMIZU Takao** | Kyoto Seika University | **SINTAWARDANI, Neni** | Indonesian Institute of Sciences (LIPI), Indonesia |

# Co-creation of Sustainable Regional Innovation for Reducing Risk of High-impact Environmental Pollution

Project Leader **SAKAKIBARA Masayuki** RIHN/Ehime University

Professor Masayuki Sakakibara is an earth scientist with multidisciplinary backgrounds: Geology, Petrology, Astrobiology, Geochemistry, Medical Geology, Geoengineering, and Remediation Engineering. He is currently also working at the Faculty of Collaborative Regional Innovation and Graduate School of Science and Engineering, Ehime University. His interest in environmental pollution led him to conduct intensive fieldworks and activities to reduce mercury pollution and poverty problems in artisanal and small-scale gold mining (ASGM) areas in Indonesia and Myanmar. He takes responsibilities of international conferences and seminars such as Transdisciplinary Research on Environmental Problems in Southeast Asia (TREPSEA) and Transdisciplinary Research and Practice for Reducing Environmental Problems (TRPNEP), which focus on transdisciplinary research and practice, as well as development of various regional innovations for the reduction of environmental pollutions in ASEAN countries.

## Research Background

Mercury (Hg) is an extremely toxic metal and a particular threat to human embryonic and early-childhood development. Recent investigation by the United Nations Environment Programme (UNEP) has highlighted the enormity of Hg pollution in developing countries. ASGM produces 15-20% of the global gold market and is responsible for 37% of global Hg emissions, as mercury amalgamation is a cost-effective and widely used method to extract gold from ore. Around 15 million people, including 4-5 million women and children, participate in ASGM activities in more than 70 countries. Even though the Minamata Convention was established to protect human health and the environment from the adverse effects of Hg, ASGM activities are often associated with poverty and cannot be solved by ratification of international treaties or NGO activities alone.

## Research Objectives

The objectives of our project are to: 1) understand the link between poverty reduction and environmental management in ASGM areas; 2) establish a process for constructing sustainable societies through regional innovations in ASGM areas; and 3) strengthen environmental governance in ASEAN countries.

## Methodology and research process

We have been conducting transdisciplinary research and practice in collaboration with mining communities, key stakeholders (SHs) of public and private organizations, and researchers of local universities, etc. (Figure 1). This work emphasizes:

a) Case studies on reduction of Hg pollution using a future scenario of ASGM in Indonesia and Myanmar. Case studies include: 1) studies of living conditions, culture and history; 2) environmental and health impact assessments, and socioeconomic assessment; 3) co-creation of future scenarios with key stakeholders; 4) identification of transformative boundary objects (TBOs); 5) organization of transdisciplinary communities of practice (TDCOPs) using TBOs; 6) co-design and co-production of transformative learning and practice; 7) social implementation research; and 8) evaluation of the progress of regional innovation (Figure 2).

b) Study of interregional networks that aim to generate Hg-free societies in Indonesia and Myanmar.

c) Study of improvements in environmental governance to address Hg pollution in ASEAN countries.

d) Theoretical and practical studies of the design, practical use, and evaluation of TBOs and TDCOPs in study areas.

## Expected goals of the project

Regional innovation will arise as a consequence of environmental and industrial innovations introduced with a transdisciplinary approach, including the development of a future scenario for a Hg-free society, transformative learning and practice, and developments of TDCOPs. By strengthening environmental governance, which consists of multiple layers of co-operative organizations, we will also develop a route through which the problem of global environmental Hg pollution can be resolved.

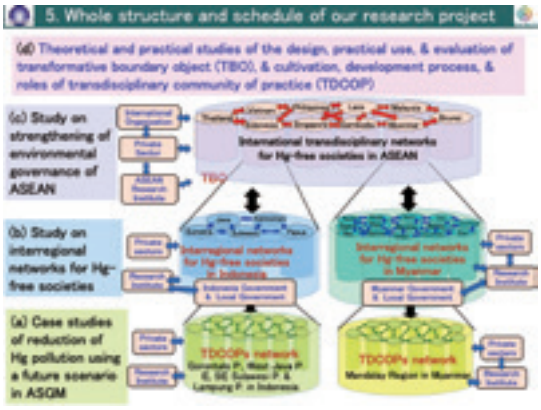


**Figure 1 Structure of SRIREP project**

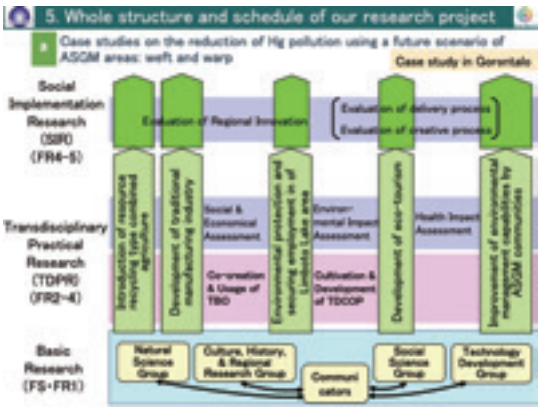


**Figure 2 Structure and schedule of the case studies in Gorontalo, Indonesia.**

## Progress and Achievements

a) Case studies have been completed in Gorontalo, West Java, Southeast Sulawesi, and Lampung in Indonesia in collaboration with Gorontalo State University, Lampung University, and Mandalay Region in Myanmar in collaboration with the Environmental Conservation Department of the Ministry of Natural Resources and Environmental Conservation (MONREC) and a local NGO. In Gorontalo, in August 2019 and February 2020 we examined social-economic conditions in the ASGM areas and rural livelihoods of fishermen and farmers in non-ASGM areas. We found that poverty is a major issue in both areas. We organized four TDCOPs: "KTK (Kampung Tangguh Kesehatan; Healthy village)", "Karawo Research Group", "Natural Fiber Research Group", and "Geo Cafe Gorontalo" to conduct co-design and co-production of transformative learning and practice according to the future scenarios (Figure 3).

In Thabeikkyin Township, Mandalay Region, preliminary environmental and health impact assessments were conducted in ASGM areas in February 2020 (Photo 1). ASGM miners with a longer duration of mining activity demonstrated decreased lung capacity. Remote medical examination of the mining community has been established since December 2020.

b) In the study on interregional networks, we held the 1st and 2nd Japan - ASEAN medical seminars in Indonesia, in 2019 and then we also held the 3rd and 4th medical seminars (webinars) in October 2020 and January 2021. In total, these seminars included 600 attendees from both Indonesia and Myanmar, and were conducted in collaboration with private and public organizations, and the Japan Association for the United Nations Environmental Programme (JAU) (Figure 4. Flyer of the 4th medical seminar held in January 2021).

c) In the study on improvements in environmental governance in ASEAN countries, the UNEP Global Environment Information Exhibition and the 2nd TRPNEP (ASEAN-Japan Meeting Point of Collaboration by Stakeholders and Researchers for Reducing Environmental Problems in ASEAN Countries) were held in Myanmar in December 2019.

d) Reflecting on our research processes to date, our theoretical analyses indicate that environmental problems require a comprehensive problem-solving approach that includes the creation of new knowledge through the integration of local and scientific knowledge. We note that enthusiastic participants in the TDCOPs can become catalysts for initiating dialogue among stakeholders. Finally, we find that well-designed TDCOP activities can stimulate stakeholders to practice interactive and transformative learning.

**Photo 1 Health impact assessment of ASGM miners in Mandalay Region, Myanmar in February 2020; assessment of the lung capacity in ASGM miners using a portable spirometry.**


**Figure 3 Availability and progress of TDCOPs established in the case study of Gorontalo, Indonesia.**


**Figure 4 Flyer of the 4th Japan - ASEAN Medical Seminar on the Human Health Impact of Heavy Metals**


Researchers at RIHN

| | |
|---|---|
| **KIMIJIMA Satomi** | Researcher |
| **KUANG Xiaoxu** | Researcher |
| **WIN THIRI KYAW** | Researcher |
| **MYO HAN HTUN** | Research Associate |
| **TAKEHARA Mari** | Research Associate |

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| **MATSUDA Hiroyuki** | Yokohama National University |
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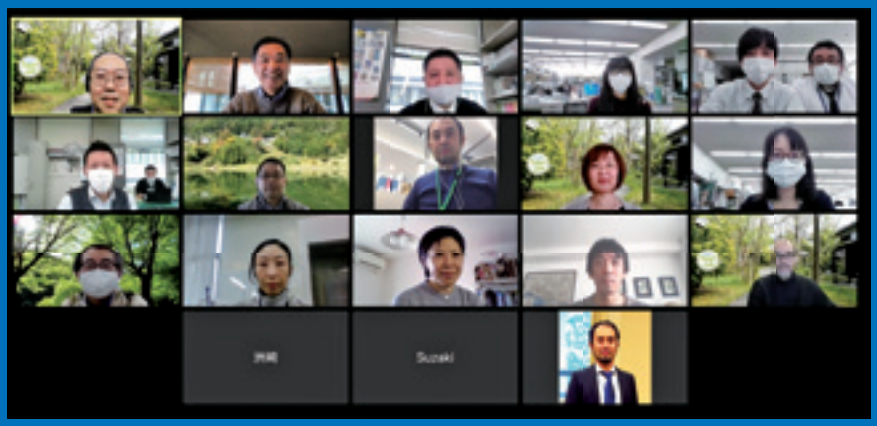
| **SHIMAGAMI Motoko** | Ehime University |
| **MIYAKITA Takashi** | Kumamoto Gakuen University |
| **MATSUMOTO Yuichi** | Kwansei Gakuin University |
| **KOMATSU Satoru** | Nagasaki University |
| **ISA, Ishak** | State University of Gorontalo |
| **JAHJA, Mohamad** | State University of Gorontalo |
| **ABDURRACHMAN, Mirzam** | Institut Teknologi Bandung |
| **KURNIAWAN, A. Idham** | Institut Teknologi Bandung |
| **ARIFIN, Bustanul** | Lampung University |
| **ISOMONO, Hanung** | Lampung University |
| **BASRI** | College of Health Sciences Makassar |
| **BOBBY** | Network Activities Groups |

# Core Program

The Core Program develops concepts and methodologies for transdisciplinary research to solve global environmental problems in collaboration with society. Core projects develop comprehensive and systematic concepts and methodologies for transdisciplinary research, which are widely applicable to global environmental issues, and accessible to related stakeholders.
Core projects produce conceptual and methodological frameworks together with RIHN research projects, based on individual methods, techniques, and tools from the divisions in the RIHN Center. Core projects collaborate with research projects, building on the case studies developed by these projects, and develop comprehensive and systematic methodologies beyond an individual research program or project. Core projects also deliver completed concepts and methodology to research programs and projects, the RIHN center, and related stakeholders.



Core Program online meeting (Feb. 2, 2021)

Program Director **TANIGUCHI Makoto** RIHN

Professor Makoto Taniguchi is a hydrologist and a deputy Director-General at RIHN. He received a Ph.D. from Tsukuba University, Japan, in 1987. He is currently a steering committee member of Future Earth Nexus Knowledge Action Network. He has worked on water-related projects around the world, especially in Asia, authoring or co-authoring over 170 peer reviewed articles and eight books, including Groundwater and Subsurface Environment, The Dilemma of Boundaries, and Groundwater as a Key for Adaptation to the Changing Climate and Society (all from Springer Press).

Researcher
**MIURA Tomoko** Research Associate

# Methods and Tactics to Foster Knowledge Co-creation: A Practical Framework for Implementing Transdisciplinary Research

Project Leader **ONISHI Yuko** RIHN

Yuko Onishi holds a Ph.D. in environmental science from the University of Oxford (UK). Before joining RIHN, she worked for the Food and Agricultural Organization of the United Nations (FAO) and later worked for the National Institute for Environmental Studies (Japan). She is a member of the Regional Centre for Future Earth Asia.

It is increasingly acknowledged that transdisciplinary research methods (TD) are useful in research projects on global environmental problems for which science alone cannot provide a definite solution. However, many researchers have pointed out that the theoretical concepts on ideal TD processes are extremely difficult to apply in practice. This project aims to identify a practical framework for TD research. The practical framework consists of methods and tactics for fostering knowledge co-creation, identified from the current TD practices implemented throughout the world, as well as from knowledge and perspectives of experienced TD researchers and stakeholders. In order to make sure that the proposed framework is useful, the project uses the above results for capacity building and will revise our framework as necessary.

The project consists of the following three components:
1) TD Landscape (literature reviews, collection and analysis of case studies)
2) Lessons learned (researcher and stakeholder experiences)
3) Capacity/network building (lectures and website)

Under a component of TD landscape, this project analyses the international research landscape surrounding TD research. It examines similar research approaches, such as participatory approach and action research, and seeks to establish a new definition of TD research and project design (methods, tools and approaches) for fostering knowledge co-creation in relation to different types of environmental issues.

In addition to this survey of international TD literature, the project carries out in-depth studies with researchers and stakeholders in TD projects at RIHN and other institutes. The project carries out in-house workshops as well as interviews and workshops at existing project field sites. Focused study with researchers seeks to develop a novel and unique methodology for knowledge generation based on personal experiences and to identify tips and tactics to enhance stakeholder engagement in TD research. Investigation with stakeholders seeks to reveal the effects of TD projects on stakeholders and communities, which are the premise of TD projects, but largely overlooked in current project evaluation. With this combination of global and focused investigations, the project seeks to synthesize the TD research experiences so far and share the information to the next generation researchers and practitioners of co-creation project.

**TERRA School 2019 (TD School Co-organized by RIHN and Regional Centre for Future Earth in Asia)**

Researchers at RIHN

| | | | |
|---|---|---|---|
| **KOO, Bonjun** | Researcher | **LAMBINO, Ria** | Specially Appointed Associate Professor |
| **KUIPERS, Rob** | Research Associate | **OKAMOTO Takako** | Research Associate |

Main Members

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| **OH Tomohiro** | | **GASPARATOS, Alexandros** | The University of Tokyo |
| **NISHIMURA Takeshi** | Sanyo Gakuen University | | |