Megacities and the Global Environment

Project Leader **MURAMATSU Shin** RIHN

After engaging in research on the history of Asian architecture and urban history at the Institute of Industrial Science, the University of Tokyo, I came to the Research Institute for Humanity and Nature. It is my aspiration to contribute to the improvement of the global environment through perspectives I have developed from a macro viewpoint of the world history of cities, which compares and analyzes cities throughout the world, and a micro viewpoint on the latent potential of urban and architectural ("naka-naka") heritage that will lead to improvement in general architectural practices at the local environment level.

Why are we doing this research?

When we consider global environmental problems, cities are often deemed to be "perpetrators" that consume massive amounts of resources and generate various forms of waste. At present a large number of megacities with populations in excess of 10 million have emerged in non-Western tropical regions of the world. Poverty and environmental deterioration are conspicuously evident in these enormous cities, which are also extremely susceptible to the effects of global environmental problems. At the same time, however, people living in cities have been among the first people in society to express concern about the local environment and global environment. As a person whose study of the history of architecture and cities spans decades, I commenced this project with researchers hailing from a wide array of academic fields including landscape, urban history, history, environmental economics, ecology and urban planning in efforts to find answers to questions such as '*Are cities friends of the environment?*' and '*Is pursuit of the environment and economics incompatible with the pursuit of happiness?*'

What are we doing, and where?

As the main field of our research, we chose greater Jakarta, the capital of Indonesia, where economic growth is robust at present. Like Japan, it is situated in the East-Asian monsoon region. Moreover, the people there make a living by cultivating rice, and the way of life and customs have similarities to those in Japan. On the other hand, the kinds of phenomena occurring in this enormous megacity that stretches out over more than 100 kilometers in all four directions are quite diverse. Moreover, it is not clear what kind of impact these phenomena are having not only on the local environment and global environment but also on the lives of people (Figure 1). Against this backdrop, we have been conducting cooperative research on the natural environment (heat, biodiversity, floods, etc.), the artificial environment (various types of buildings), and people's awareness and lifestyle, etc. from various viewpoints. In our local activities, we have been mutually sharing knowledge not only with researchers from the University of Indonesia, Bogor Agricultural University, and the Indonesian Institute of Sciences but also with local architects and residents mainly through dialog. At the same time, we have also been attempting to mutually apply knowledge gained in Jakarta and results obtained from observations of other megacities based on comparison of 18 megacities in regions throughout the world.

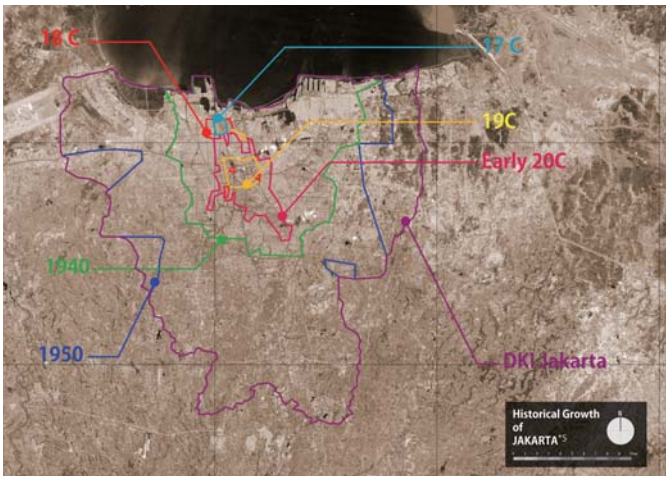

Figure 1 Expansion of Greater Jakarta
Greater Jakarta has grown from the 17th century Dutch colony of Batavia to a megacity with a current population of 27 million.

What we have learned thus far

Using a city sustainable index (CSI) that simultaneously compares a city's impact on the environment, its social impact, and the benefits derived from that city, we analyzed 18 megacities throughout the world and determined that not one of the 18 megacities qualifies as "a friend of the earth" at present (Photo 1). Of these cities, however, Jakarta has a relatively mild impact on the environment, and if it makes some adjustments to avoid the pitfalls of other megacities, it has the potential to pave the way for a brighter future.

To enable megacities of the least developed countries to achieve a soft landing in the future, the megacities in those countries must endeavor to achieve economic growth commensurate with their needs. If they fail to do this, the growing awareness of the environment in those cities will be extinguished.

Envisioning Jakarta in the future in the year 2050, we needed to make a proposal for urban living that would have little impact on the environment and improve the comfort and convenience of the people living there. To do

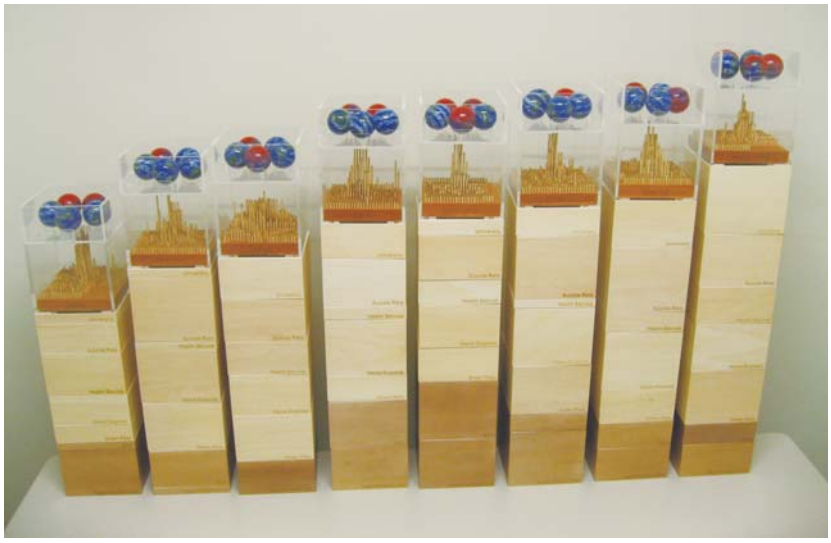

Photo 1 City Sustainable Indicator (CSI)
Production of a model for exploring sustainable cities targeting 18 megacities (Tokyo, Jakarta, Seoul, Mumbai, Sao Paulo, Mexico City, Manila, Delhi, Cairo, Kolkata, Osaka-Kobe, Shanghai, Buenos Aires, New York, Los Angeles, Karachi, Dhaka, Moscow). When the city's impact on the environment is excessive, the globe above the model turns red. The rectangular-shaped wooden tube below indicates benefits from cities, and at present it shows 12 indicators. The thicker the tube, the greater the benefits.

this, we first had to take into consideration the tropical monsoon climate and characteristics of the land where the city is located with its expanding rice-producing areas, and carefully examine the history of the city that has changed over the years. A look at the expansion of Jakarta, a city that began developing during the colonial period of the 20th century, shows that there are many high-density residential areas on the outer fringes where many people of low income live. In the outer fringes where the city is also expanding, rice paddies and storage reservoirs are being filled in to make way for development. We are currently proposing dwellings suitable for the characteristics of areas there (Photo 2).
As the city grew, the rice paddies and reservoirs that had been developed until then were filled in. The effects of cool breezes generated by rice paddies that were once in those places and the functions performed by living creatures such as dragonflies and the existing ecology there have been incorporated into our proposal for new residential areas (Photo 3).

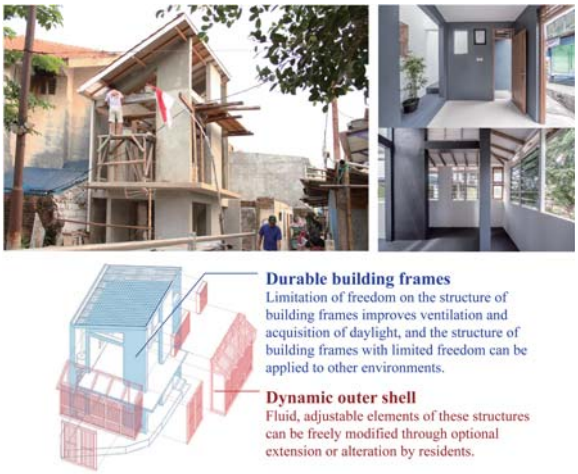

Photo 2 Design Proposal for High-density Settlement in Jakarta
Working in cooperation with local residents, we actually proposed very comfortable living arrangements with little impact on the local environment.

The message we wish to convey

Understanding how cities are connected to the global environment and determining how to propose methods that will be of benefit are both difficult and challenging propositions in our research. Nevertheless, cities are already home to half of the world's population and are set to expand further in the future. Therefore, if we fail to make a contribution to the global environment, we will be forced to pay a hefty price later. Our aspiration is to present the results of our research in a manner that is easy for all people to understand so that not only specialists and urban administrators but also all people will fully understand and own these issues. Likewise, we want to present the results of our research in a way that people will see the advantages to be gained for themselves and we also want to involve them in efforts to improve their environment.

Photo 3 Proposal for a Rural Residential Area at the Front Line of Urban Expansion
We have been proposing pleasant, comfortable residential areas with heat island control, preservation of biodiversity, and flood mitigation effects previously provided by rice paddies.

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Designing Local Frameworks for Integrated Water Resources Management

Project Leader **KUBOTA Jumpei** RIHN

Professor Kubota earned a doctorate in forest hydrology from Kyoto University (1987). He has served as assistant professor at Kyoto University (1987-1989), and assistant professor (1989-1996) and associate professor (1997-2002) at Tokyo University of Agriculture and Technology. He joined RIHN in 2002, and now directs the Center for Research Development and the RIHN-China initiative. His major research fields are hydrology, water issues in arid regions, and human adaptation to societal and environmental changes.

Co-Project Leader **Dorotea RAMPISELA** RIHN

Dorotea Rampisela earned a doctorate in forest hydrology from Kyoto University (1992). She was previously senior lecturer at Hasanuddin University (1982-2013). She joined RIHN in Jan 2014. Her major research fields are hydrology, focusing on watershed management and relocation of people related to dam construction. She established an NGO and for the last ten years has conducted participatory research with water users association for irrigation water management.

Background and objectives

The concept of Integrated Water Resources Management (IWRM) was first proposed in the 1990s in order to recognize and coordinate the many stakeholders and sectors involved in effective water resources management. Despite several decades of development, there are still difficulties implementing IWRM in local communities and in effectively assessing the influence of human activities on water resources. While IWRM has focused on integrating the sectors and organizations governing water resources, it has not typically been able to incorporate demands from local water users or taken account of their cultural or historical backgrounds. This has resulted in a lack of flexibility from the supply side. As a consequence, new frameworks or guidelines have been requested in the field of local-to-regional water resources management.

The objective of this project is to propose knowledge structures and functions of water resources management to local-level stakeholders who play the essential role in adapting IWRM into society. The project also assesses the influence of local patterns of water use and systems of water resources management on the dynamics of global water resources. The research therefore involves considerable exchange between the scientific evidence of water cycles in particular places and the wide range of stakeholders involved in water management and use. The project's goals are to develop cooperation between science and society in order to stimulate the co-creation of desirable local water resource management.

Research areas and methods

In order to accomplish the goals of the project, we have established several study sites in Indonesia, Turkey, Egypt and Japan. Cases in Indonesia and Turkey give us a geographical and hydrological contrast between humid and semiarid to arid regions experiencing increasing demand of water resources associated with rapid economic growth. The Japanese case presents interesting contrast as it shows steady or decreasing demand for water resources. Project researchers have surveyed the management structures reflecting the relationship between water users in each area and observed important background hydrological and socio-economic dynamics.

Project research puts special emphasis on the sites in Indonesia and Turkey as they present a simple hydrological contrast between humid and arid regions, while their historical and cultural differences offer comparative examples of water management structures. We have been developing a GIS system to analyze land-use change indicated by satellite observations in relation to other important conditions such as areas affected by flooding and drought. At the same time, we conduct uncertainty assessment and parameter sensitivity analysis on the global water resources prediction using a global-scale hydrological model. We held stakeholder meetings in field study areas in order to promote mutual understanding of how different actors perceive water-related problems and seek new ways of establishing proper water resources management. Both the hydrological model and GIS system are utilized as information-sharing tools in stakeholder workshops.

Progress to date

In Indonesia, field surveys in Subak, Bali have indicated a recent organizational transition as public policies have shifted water management from autonomous to cooperative unions. Stakeholder meetings were held in Bali and South Sulawesi in 2013. Most of the participants reported problems that have recently arisen between Subak members and outsiders, such as water pollution caused by illegal waste dumping and illegal constructions on irrigation canals. Because the Subak population is made up of farmers, it is difficult to handle these problems and participants realized the necessity of communication beyond the normal scale of Subak governance. In South Sulawesi, a lack of communication among water managers was clearly identified in the stakeholders meeting in which almost a hundred of leaders of farmers, water managers, governmental supervisors participated. After this meeting, we have supported further autonomous discussion among water managers.

In Turkey, we have identified similar problems in water management, such as information disparities and unclear responsibilities in spite of privatization. At the

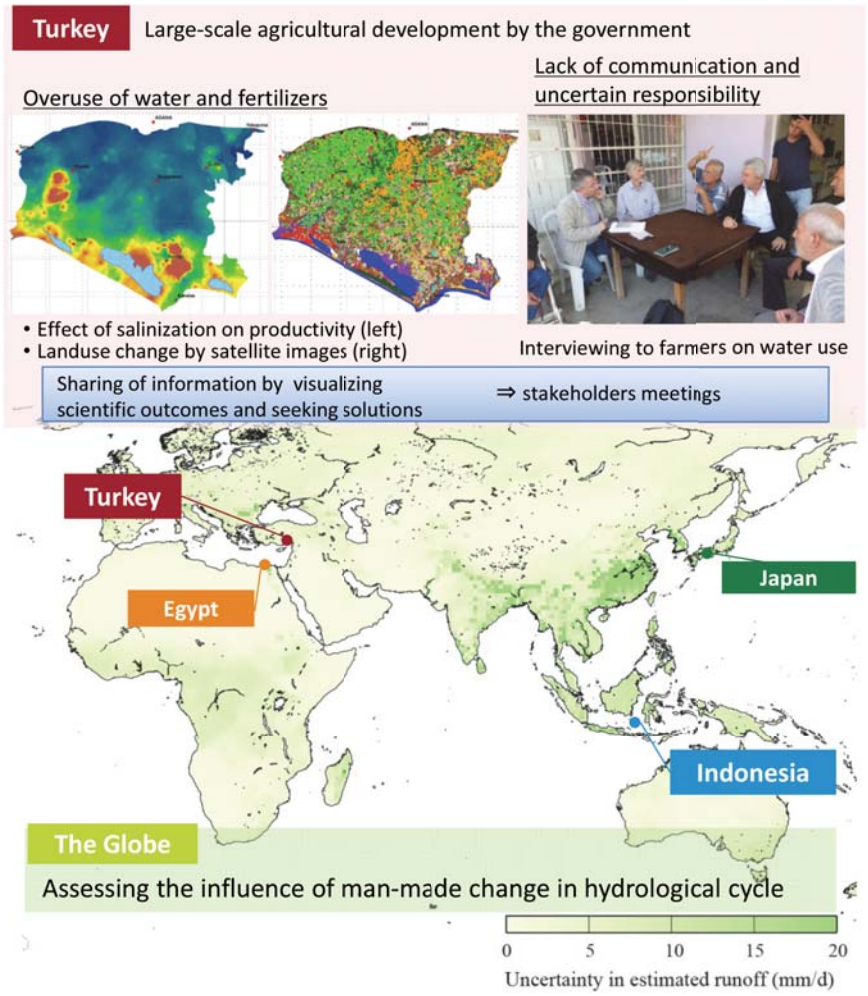

Figure 1 Progress of the project at a glance. The map in the center features indicates the uncertainty indicated by a model predicting water runoff, on which the key elements of research problems and findings in the case study sites on water resources management are featured. Deeper green color signifies higher uncertainty, i.e. difficultly in estimating water resources. We hereby figure out the significance to develop the model considering uncertainties of estimation. Local-level co-creation of knowledge between science and society in the context of global freshwater use will be realized so as to develop transdisciplinary integration of water resources management.

same time, surveys on river flow status, drainage water quality, and land use have revealed that excessive use of irrigation water and chemical fertilizer was responsible for degradation of watershed environment and land productivity. Two stakeholder meetings are planned for enhancing communication and mutual understanding among stakeholders. These meetings, in addition to providing important opportunities for stakeholders to jointly address key problems in local water management, also allow project researchers to analyze changes in stakeholder behavior and decision-making processes as we further develop the methodologies of transdisciplinary investigation.

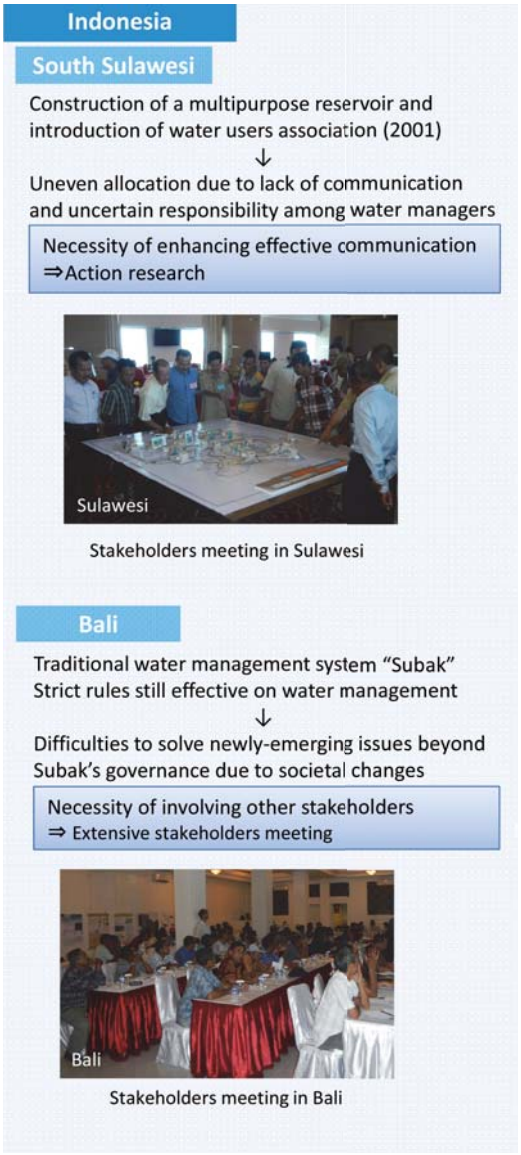

Figure 2 The results of stakeholders meetings in Indonesia areas

Core Members

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NAKAMURA Kimihito	Graduate school of Kyoto University
TAKARA Kaoru	Kyoto University
TAMURA Ulara	Japan Society for Promotion of Science (Kyoto University)

Coastal Area Capability Enhancement in Southeast Asia

Project Leader **ISHIKAWA Satoshi** RIHN

Satoshi Ishikawa has researched population genetics of aquatic animals and conservation, and rural development through fisheries improvements and human capacity building in Asia and Pacific areas. He conducted surveys in Southeast Asian countries, PNG and Pacific Islands. He got bachelorship on Fisheries Science from National Fisheries University Japan, Master of Arts and Science from Hiroshima University, and Dr. of Agriculture from the University of Tokyo.

Background

Coastal area ecosystem services are indispensable for rural people, but are also easily damaged by human use. Many coastal areas with high biodiversity and biological productivity are located in tropical zones of developing countries, as is the case in Southeast Asia. In such areas, ecosystem services, local livelihood and culture are closely related, but no clear research methods have been established to evaluate coastal ecosystem health in relation to human uses and needs. Conservation actions usually target particular resources, and resource management methods commonly used in temperate regions tend to target single ecologies and commercial resources, with little consideration of how multiple ecologies and livelihood strategies overlap in culturally diverse contexts, and so they cannot be easily applied to tropical coastal areas. This project aims to create new interdisciplinary and transdisciplinary research methods that clarify the potentials for harmonization between conservation and rural development in tropical coastal zones.

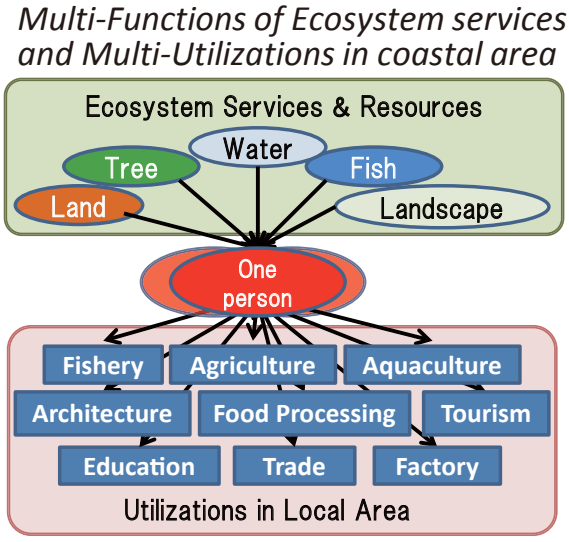

Figure 1 Complicated utilization of coastal resources and ecosystem services in tropical zone

Project Framework

This project develops a holistic concept of "Area-Capability" to permit consideration of socio-ecological dynamics and tradeoffs in rural coastal development. The concept is designed to allow transdisciplinary approaches to the study of the relationships between human and nature as a target for sustainability in order to facilitate transdisciplinary approach. Interdisciplinary field surveys are conducted in order to assess the value of each. Natural science methods identify key factors maintaining ecosystem health and services, or what we call ecosystem capability. Social and anthropological methods are used to describe patterns of resource use and how they may be linked to improvements in local livelihoods, or social and human capability. Action research is based on collaboration with local people and governmental institutions. In combination, such considerations can serve as a guide for sustaining biocultural diversity in tropical coastal area development.

This project is based on the joint research efforts of Southeast Asian Fisheries Development Center (SEAFDEC), Faculty of Fisheries of Kasetsart University, the University of the Philippines Visayas (UPV), and Japanese researchers who are members of the RIHN project. Aklan State University and Eastern Marine Fisheries Research and Development Center of Department Fishery, Thailand, are active participants as well.

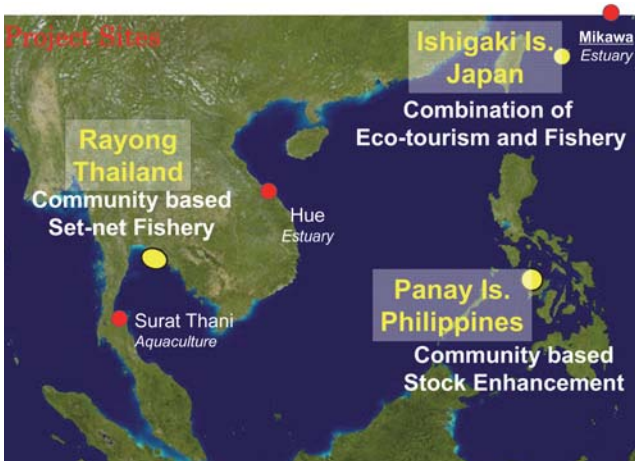

Figure 2 Main research sites

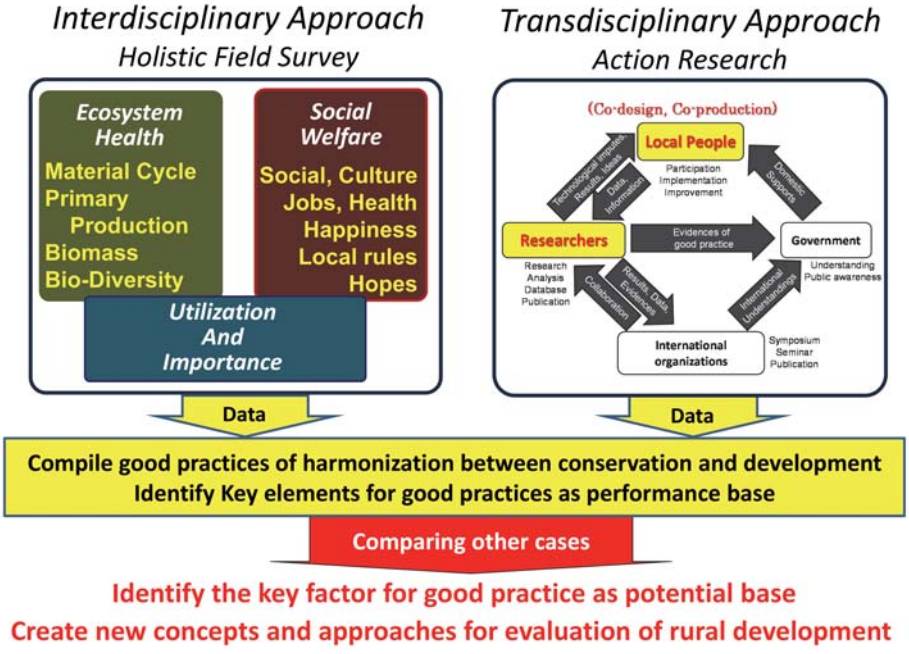

Figure3 Framework of the Area-capability project

Photo 1 Community-based set-net fishery in Rayong, Thailand

Photo 2 Community market managed by set-net fishery group

Future tasks

With full research underway since 2012, we are examining coastal area resources, ecosystem services and communities in the Rayong area of Thailand, Panay Island in the Philippines, and Ishigaki Island and Mikawa Bay in Japan. Local ecosystem primary productivity, material cycles, and food webs will be analyzed. The project will also examine the present state, fluctuation, and migration of important biotic resources, developing equipment for such measurement as necessary.

Social research will investigate related economic activities, including distribution and pricing mechanisms, working conditions, local culture and customs as they inform livelihood strategies, and health and disaster measures and resilience. A set-net fishery and the sale of seafood by local fishery groups will be researched in the Rayong area of Thailand, as will a fish farming enterprise in Batan Bay, Philippines, in order to describe the full effect of such endeavors on local environments and livelihoods, and to better inform effective resource management in these areas.

In total, this project aims to clarify the most salient local issues and constraints and opportunities that define the area capability of the coastal tropical regions under study. Continual feedback of such data within the project will deepen dialogue with local people and governmental institutions and is expected to improve project research and support ecologically sound local and regional development.

Photo 3 Group photo from a project joint seminar held in Thailand 2013

Core Members

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ARIMOTO Takafumi	Tokyo University of Marine Science and Technology
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Desertification and Livelihood in Semi-Arid Afro-Eurasia

Project Leader **TANAKA Ueru** RIHN

Ueru TANAKA obtained a Doctorate in Agriculture from Kyoto University (1997). He has previously worked as lecturer of Jomo Kenyatta Collage of Agriculture and Technology, Kenya (1983–1987), assistant professor in the Faculty of Agriculture, Kyoto University (1990–1999), associate professor in the Graduate School of Agriculture, Kyoto University (1999–2002), associate professor in the Graduate School of Global Environmental Studies, Kyoto University (2002–2011), and since 2012 is honorary professor of Hue University (Vietnam). His major fields of interests are agronomy, indigenous livelihood systems, desertification, and rural development support in West Africa, Southern Africa, India and Southeast Asia.

Research backgrounds, objectives and study areas

Desertification is a complex phenomena related to land degradation and poverty, especially in sub-humid, semi-arid and arid areas. As shown in Figure 1 (a case in the Sahel, West Africa), population and human activities increased, resulting in the exploitation of land resources. Desertification is primarily caused by activities related to basic human survival and daily livelihood, such as cropping, animal husbandry, and gathering of fuel wood (Fig. 2). Efforts to mitigate or solve desertification do not often take account of such causes. This may be one of the major reasons why desertification remains a serious problem despite commitments from the international community, including the United Nations Convention to Combat Desertification (1994), to address it.

This project's objectives are: 1) to deepen understanding of the socio-ecological characteristics of targeted areas in Semi-Arid Afro-Eurasia ; 2) to design and verify some practical techniques or approaches effective for desertification control in the context of rural development support; and 3) to propose and implement some techniques and approaches to desertification control and rural development, paying special attention to vulnerable people.

Project research takes place in the Sahel of West Africa (Burkina Faso, Niger and Senegal), Northeast Africa (Sudan), Southern Africa (Namibia and Zambia), South Asia (India) and East Asia (Mongolia and, hopefully, China), as shown in Figure 3, where socio-ecological condition and land resources are degraded due to demographic pressure and uncertain socio-economic conditions happened under extreme weathers.

Research activities

Major research activities are 1) Innovation of practical techniques for desertification control and improvement of household economy, 2) Extension of verified techniques, e.g. fallow-bans system, contour lines of Andropogon and extension method incorporated with social network survey, and 3) Studies on vulnerable people, as well as 4) local livelihood systems, e.g. agro-pastoral system, adaptation strategy to climatic and economic fluctuation, Islam in rural development context in West Africa. In Southern Africa, studies on 1) Monitoring of soil degradation and recovery processes, e.g. changes of nutrient status and organic matters under different farming practices and 2) Resilience of agro-pastoral system, e.g. behavior of grazed animals and its impact on land resources, conflict between cultivators and pastoralists, and socio-ecological adaptation are implemented. In South Asia and East Asia, 1) Resilience of agro-pastoral systems, e.g. coping behavior of local people in the years of crisis and 2) Inventory of indigenous farming techniques, knowledge and tools and 3) Re-appraisal of traditional dry-farming techniques are focused.

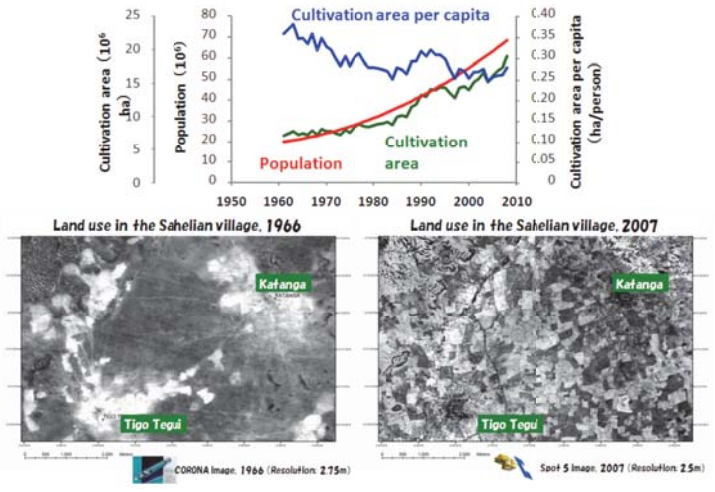

Figure 1 Increase of human impact in the Sahel, West Africa

Figure 2 Causes of desertification

http://www.chikyu.ac.jp/rihn_e/project/R-07.html
http://www.kazehitotsuchi.com/ (in Japanese)

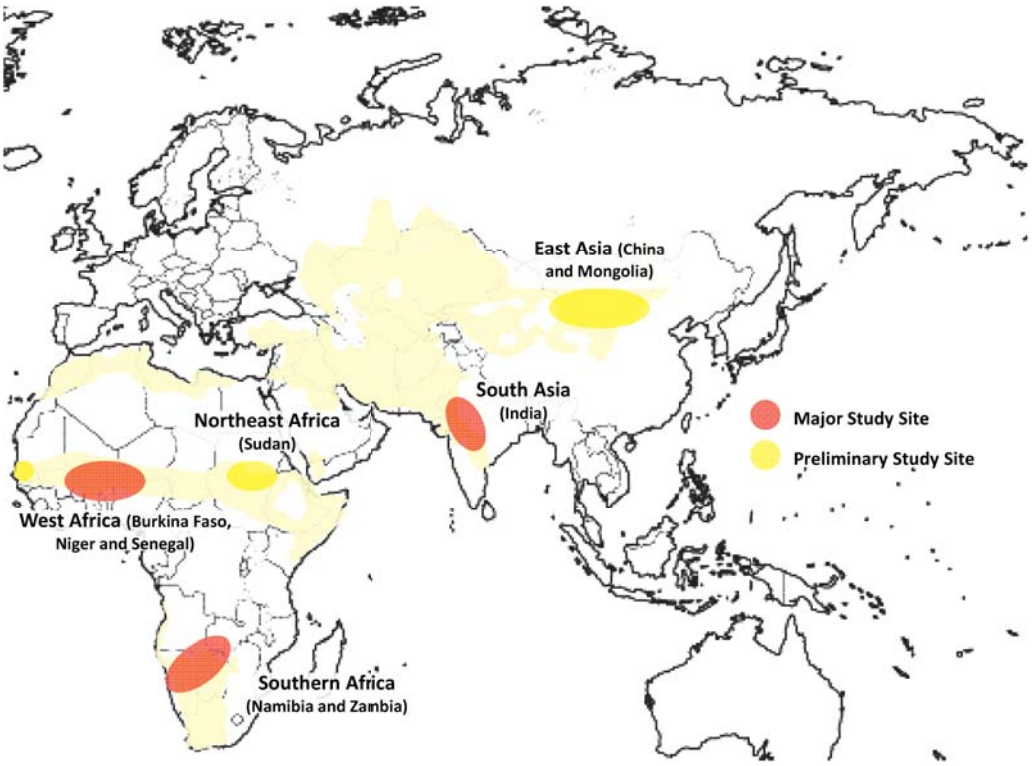

Figure 3 Study sites in Semi-Arid Afro-Eurasia

Progress to date

Design of practical technique with local people

Many techniques have been introduced to control desertification to date, but unfortunately most are not adopted by local people. New techniques, however scientifically sound and rational, may not match the needs and situation of local people if they are too expensive or require too much time or labor. Some techniques are highly dependent on materials and machinery from outside that may not be locally available.

Together with volunteer villagers in Niger and Burkina Faso, we designed an alternative technique using local materials and indigenous knowledge to control soil erosion and increase household income. The technique is called "Contour lines of Andropogon" as shown in Figure 4. Andropogon (Andropogon gayanus Kunth) is a wild perennial grass found everywhere in the Sahel and utilized as a material to construct granaries and housing. The plant stalk and woven mats are sold in local markets, and the income is sometimes equivalent to the price of 1 to 2 months of grain for consumption. When used to control soil erosion, the plant is transplanted to a pit with manure, an indigenous technique known as "Zai". Manure application to the wild grass, a newly adopted practice, increases plant productivity and harvest of stalk. Planting along the contour line reduces soil erosion by intercepting surface run-off water. This technique is also helpful for vulnerable people, such as elders and widows, who have no land or compete with the others to collect wild Andropogon. This is a typical example of designing a practical technique, which satisfies desertification control and improvement of local livelihood, combined with indigenous knowledge, locally available materials and experiences of outsiders.

Figure 4 Contour lines of Andropogon designed with local people

Future tasks

We make comparative studies on 1) Adaptation strategies in agro-pastoral systems between high/low population areas, tropical/temperate climate regions, and cultivation/pastoral system" and 2) Possibility of technology transfer, e.g. land use systems, restoration of degraded land, farming tools and soil management practices in Africa and Asia.

Sub Leader

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SASAKI Yuko RIHN
TESHIROGI Koki RIHN
ENDO Hitoshi RIHN

Creation and Sustainable Governance of New Commons through Formation of Integrated Local Environmental Knowledge (ILEK project)

Project Leader **SATO Tetsu** RIHN

Professor Tetsu Sato studied the ecology of cichlid fishes of African lakes for 20 years. Throughout his career, including as Conservation Director of WWF Japan and professor of Nagano University, he focused on creating knowledge bases for community-based management of natural resources. He also led a project to create a network of local scientists producing Integrated Local Environmental Knowledge.

Co-Project Leader **KIKUCHI Naoki** RIHN

Professor Naoki Kikuchi has been working at the Hyogo Prefectural Homeland for Oriental White Stork as a residential researcher on environmental sociology regarding restoration of the Oriental White Stork. His transdisciplinary research focuses on solutions of environmental problems from the perspectives of local stakeholders.

Research objectives

Local ecosystem services have deteriorated all over the world for various reasons. Ecosystem services should be managed as new commons by collaboration of various stakeholders, both within and from outside the communities. In order to create and sustainably manage such commons, the formation and circulation of local knowledge systems deeply embedded in real local settings is desperately needed. Integrated Local Environmental Knowledge (ILEK, Fig. 1), a novel concept of local knowledge blending scientific as well as various types of knowledge systems among stakeholders, is produced, circulated and utilized in diverse cases of local research and actions to support adaptive changes toward sustainability of local communities.

Our project aims to clarify mechanisms to facilitate production and circulation of ILEK and dynamic changes of social systems to propose ILEK-based adaptive governance mechanisms of local communities. We also seek mechanisms for multi-scale governance of global environment problems, primarily by analyzing formation of multi-scale knowledge bases created as knowledge flows and is mediated by bilateral translators who promote the circulation of knowledge between knowledge producers and users, both within local communities and across global, regional and local scales (Fig. 2). Through the transdisciplinary integration of these research results, we aim to design "science for/with society" and "society making full use of science" for bottom-up solutions of global environmental problems.

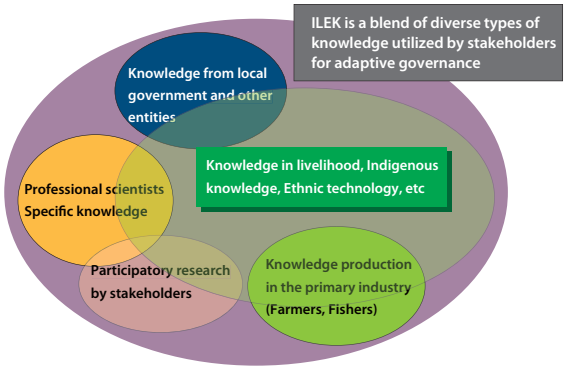

Figure 1 Structure of ILEK
Production and circulation of ILEK is not exclusively performed by professional scientists. Rather, it is often produced and circulated by diverse actors in local communities, including skilled workers in primary industries, local government officials, local companies and NGOs, most of them being knowledge users at the same time. ILEK is formed and utilized through dynamic interactions among different actors/stakeholders in local communities, integrating scientific research and local knowledge production in daily livelihood and culture among local stakeholders.

Main results to date

We have selected 61 case study sites from past and ongoing RIHN projects as well as other examples of diverse production of local knowledge in order to accumulate and analyze ILEK production mechanisms (Fig. 3). Project members belonging to the case study group are deeply involved in each local community and conduct participatory research. These researchers also conduct meta-analysis in order to integrate diverse case study results in collaboration with the Theory and Modeling and Multi-scale Analysis groups to understand ILEK production and sustainable adaptive governance mechanisms leveraged by ILEK. Nine case study sites and two cases of multi-scale translators have been selected to conduct social experiments so far, including the Shiraho community in Ishigaki Island (Japan), Sarasota Bay in Florida (USA), Karapinar area (Turkey), Lake Malawi National Park (Malawi), and the Japan Biosphere Reserve Network as a multi-scale translator case. Initial design of social experiments for these cases has been completed to verify focused hypotheses.

Residential researchers live in local communities, and in contrast to visiting researchers from outside the communities, they conduct transdisciplinary research as local stakeholders and so also are involved in producing ILEK. Bilateral knowledge translators promote circulation of ILEK among scientists and diverse knowledge users by evaluating and transforming scientific knowledge from the viewpoints of knowledge users, and by translating

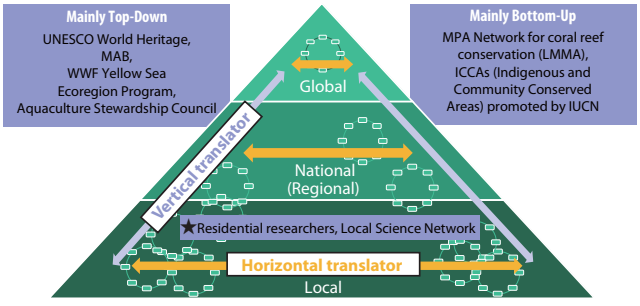

Figure 2 Hypothetical framework of multi-scale analysis
This framework is used to analyze the role of bilateral knowledge translators in supporting knowledge flow and adaptive governance across different scales, from local to global.

Figure 3 Case study sites of the ILEK project
Sixty one project case study sites are grouped into East Asia (32), EU and North America (12), and Developing Countries (17) teams. Project members are embedded in each case study site as a residential/visiting researcher or a bilateral translator to collaborate with various local stakeholders in producing and utilizing ILEK. Web GIS and other techniques are currently developed to categorize case study sites using natural and social-ecological indices for meta-analysis and integration.

knowledge among stakeholders into scientific language.

We constructed a conceptual model of ILEK-based adaptive governance focusing on functions of these important actors of local communities (ILEK Triangle, Fig. 4), and identified four hypothetical categories of important drivers of adaptive societal changes promoted by ILEK production and circulation, namely "create and visualize values", "collaborate with diverse actors (local and multi-scale)", "provide options and opportunities", and "appropriate translation". In-depth interview protocols and questionnaire were developed in 2013, and preliminary analyses of interviews with various actors playing important roles in knowledge production, circulation and utilization (32 cases, 37 interviewees) suggested drivers categorized to "collaborate with diverse actors" playing significant roles especially in Japanese cases. The Theory and Modeling Group researchers are making efforts to integrate various outputs of case studies, and conduct multi-scale analyses in collaboration with empirical scientists and stakeholders using mathematical modeling and computer-assisted discourse analysis to understand ILEK-based adaptive governance mechanisms.

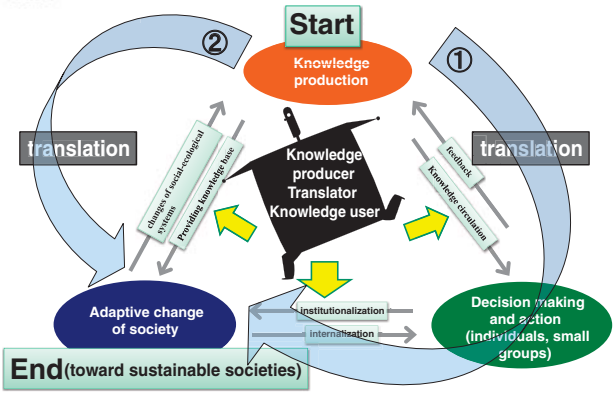

Figure 4 Conceptual model of adaptive governance (ILEK Triangle)
The ILEK Triangle model is composed of an interactive system of three important elements of ILEK-based adaptive governance (knowledge production, decision making and action, and adaptive societal change), driven by knowledge producers, knowledge users and translators. The pathways to achieve ILEK-based adaptive governance are postulated in this model with two different processes starting from knowledge production resulting in adaptive societal changes via changes in individual decisions and actions, or directly influencing formal and informal institutions and human networks.

Future research plan

We are currently moving forward to elaborate the analytical framework of ILEK-based adaptive governance using the ILEK Triangle and social experiment protocols to verify focused hypotheses derived from meta-analyses of diverse case studies from the world. In order to understand ILEK functions in the real-life adaptive governance systems in local communities, interactions between science and various types of local knowledge production must be incorporated to the research processes by co-design of research and co-production of knowledge with stakeholders. This transdisciplinary approach to promote intensive interactions, feedbacks and mutual learning among residential/visiting researchers, bilateral translators, and diverse stakeholders is the core of case studies, social experiments, meta-analyses and integration in the ILEK project. We will strengthen the transdisciplinary approach both in local case studies and abstract meta-analysis processes by designing stakeholder workshops to take place in 2014 and 2015. Social experiments starting in 2014 and further development of meta-analyses and modeling methodologies will contribute to production of solution-oriented research outputs to support ILEK-based bottom-up solutions of diverse global environmental problems.

Core Members

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Human-Environmental Security in Asia-Pacific Ring of Fire: Water-Energy-Food Nexus

Project Leader **TANIGUCHI Makoto** RIHN

Professor Makoto Taniguchi is a hydrologist. He has worked on global studies of groundwater as a leader of the UNESCO GRAPHIC Project "Groundwater Resources Assessment under the Pressures of Humanity and Climate Change", as Vice President (2007-2011) of the International Committee of Groundwater of IAHS under IUGG, and as national representative (2007-present) of IAHS. He is also an editor of the books "Subsurface Hydrological Responses to Land Cover/Use Changes", "Land and Marine Hydrogeology", "The Dilemma of Boundaries" and "Groundwater and Subsurface Environments".

Co-Project Leader **ENDO Aiko** RIHN

Associate professor Aiko Endo studies the economics of fisheries as well as coastal and marine policy. She has taken interdisciplinary and multi-sectoral approaches to Integrated Coastal Management (ICM) in coastal areas in Japan and has experience in projects which made national policy proposals. Her research theme is to find the proper governance structure linking local, national, regional, and global to solve the environmental issues through interdisciplinary and transdisciplinary research with co-design and co-production.

Research objectives and background

Climate change and economic development are increasing pressure on water, energy and food resources, presenting communities with difficult tradeoffs and potential conflicts among these resources. Therefore, the water-energy-food nexus is one of the most important and fundamental global environmental issues facing the world. As water is the central matter within this cluster, we will focus on the inherent tradeoffs between water and food, and water and energy. For the purposes of this project, we define human-environmental security as the joint optimization between human and environmental security as well as the water-energy and water-food connections. To optimize governance and management within these inter-connected needs, it is desirable to increase human-environmental security by improving social management of the water-energy-food nexus. In this research project, we intend to establish a method to manage and optimize human-environmental security of the water-energy-food nexus. We base our approach on the viewpoint that it is important for a sustainable society to increase human-environmental security and decrease vulnerability by optimizing the connections within the critical water-energy and water-food clusters.

We will take a regional perspective on these global environmental problems. The geological and geomorphological conditions in our proposed study area are heavily influenced by the so-called Pacific Ocean "Ring of Fire". Within these areas, including Japan and Southeast Asia, the hydro-meteorological conditions are dominated by the Asia monsoon. The populations that live under these natural conditions face elevated risk and potential disaster, while also benefitting from positive ecological goods and services. There are therefore tradeoffs and conflicts within the water-energy-food nexus, as well as among various stakeholders in the region.

The objective of this project is to maximize human-environmental security (minimize the risk) by choosing policies and management structures that optimize water-energy-food connections in Asia-Pacific region. We define the joint security approach as optimized policy for both critical water clusters. Optimal policies will develop joint security approaches for human-environmental security in the coastal region of the Ring of Fire, including stakeholders and decision-makers.

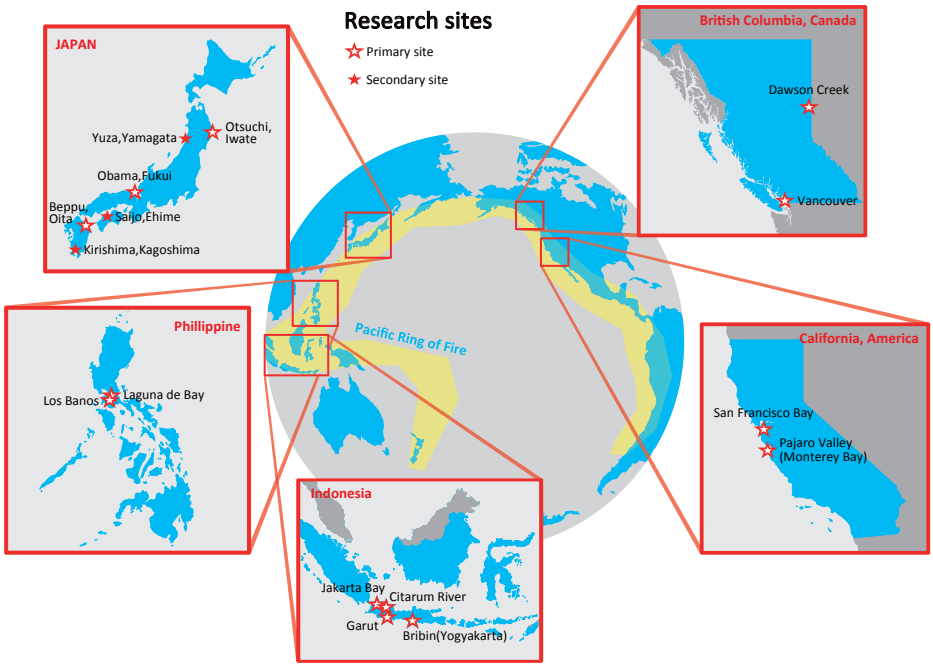
Research methods and structures

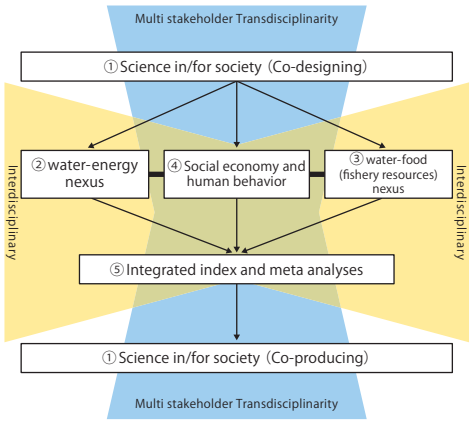
The project integrates interdisciplinary and transdisciplinary research with co-design and co-production (Future Earth, 2013) and science in/for society. Horizontal integration with different issues and sectors, and vertical integration from local, national, regional to global scale are also targeted. Five interdisciplinary approaches will be used: (1) Environmental governance, science in/for society, and co-design/co-production approaches; (2) Biophysical measurements/analyses (water-food nexus) using geochemical, coastal oceanographic, geophysical, hydrologic, and ecological techniques to evaluate linkages between land and ocean; (3) Biophysical measurements/analyses (water-energy nexus) using satellite, geophysical, geochemical, and hydrogeological techniques to evaluate linkages between water and energy; (4) Social measurements/analyses (water-energy-food nexus) using community surveys, cost-benefit/efficiency analysis, and environmental valuation from socioeconomic, anthropology, psychology, and behavioral-science methodologies; and (5) Development of integrated indicators/indices and network analyses of feedback from stakeholder meeting/workshops.

Research activities and findings

In the first year of the research at local scale, stakeholder analyses have been conducted through four stakeholder meetings and interviewing for establishing co-design framework in Obama city of Fukui prefecture. Regarding the water-food nexus, the new parameter such as thoron isotope has been identified to examine the spatial distribution of submarine groundwater discharge (SGD) in Beppu Bay of Oita prefecture, which is a habitat of the Shiroshita flatfish. This establishes thoron isotope as one of the potential indicators for the environmental flow of nutrients from land to the ocean in coastal ecosystems.

As for the water-energy nexus, research to solve potential conflicts and tradeoffs between (1) geothermal energy developments/hot spring power generations and hot spring water, (2) geothermal energy and groundwater, and (3) small hydropower generation and environmental flow, have been implemented. The framework construction and selection of indicators to create an integrated index for human environmental security of the water-energy-food



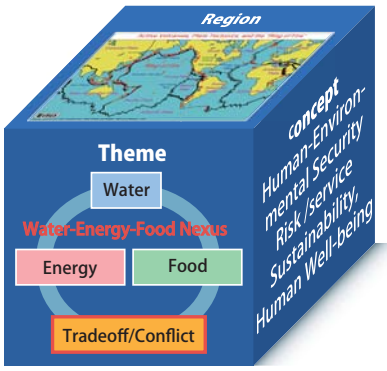


Project structure

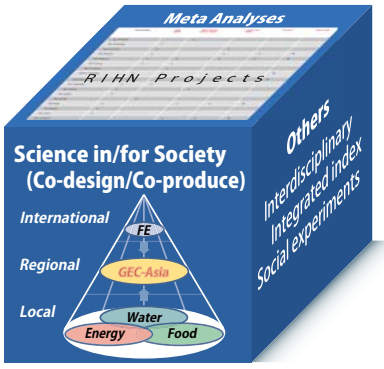
RIHN initiative project

(1) Integration of RIHN projects results
(2) Co-design / co-production (design science)

Contents of integration



Methods for integration



nexus have been also developed.

On the other hand, at the regional scale, stakeholders for water-energy-food nexus have been identified following the Future Earth category for co-production. Horizontal and vertical integration between stakeholders from local, national, and regional to global scale is also a future target.

Expected results

1. Suggested guidelines to increase environmental security and reduce conflicts related to the water-energy-food nexus.
2. Recommendations for decreasing coastal vulnerability related to the separate governance of land and oceans.
3. Policy and governance structure recommendations for improved water management.
4. Suggestions for sustainable environmental management of the water-energy-food nexus in the Asia-Pacific region.

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Long-term Sustainability thorough Place-Based, Small-scale Economies: Approaches from Historical Ecology

Project Leader **HABU Junko** RIHN

Born in Kawasaki City, Japan, Junko Habu received her BA (1982) and MA (1984) from Keio University in Tokyo and PhD (1996) from McGill University in Montreal. She is the project leader of the Small-Scale Societies Project and a Professor at RIHN, and also a Professor of Anthropology at the University of California, Berkeley. As an environmental archaeologist, she has excavated a number of prehistoric Jomon sites and historic Edo period sites in Japan and conducted fieldwork in North America. Her books include *Ancient Jomon of Japan* (Cambridge University Press, 2004) and *Evaluating Multiple Narratives* (Springer 2008, co-edited with Fawcett and Matsunaga).

Objectives and Background

This project examines the importance of place-based, small-scale and diversified economies for the long-term sustainability of human societies. Our working hypothesis is that a highly specialized subsistence strategy can support a larger community for a short period, but a decrease in subsistence and food diversity makes the subsistence system and its associated community more vulnerable in the long-run. Archaeological, historical and paleoenvironmental studies will be used to test this hypothesis. To link these studies with the present discussion of the scale and methods of alternative food systems, ethnographic and ecological studies of contemporary small-scale food systems and communities will be conducted. In combination, studies of the past and present will point to the future, as research process also involves collaborative design of ecologically sound and equitable food systems.

We realize that there are many additional factors that affect the dynamics among subsistence/food diversity, the scale of a food production system, and its long-term sustainability. Some of the key factors include the mobility of people, goods and information, sociopolitical inequality and technological developments (see Figure). Climate change is another important factor when considering the mechanisms of long-term culture change. Accordingly, correlations among these factors will also be examined when testing the main hypothesis listed above.

Global environmental problems addressed by this project

Global environmental problems addressed by this project include soil and water contamination, loss of biodiversity and long-lasting damage to ecosystems. The development of large-scale monoculture with a large amount of chemical pesticide and fertilizer has resulted in serious soil and water contamination and the destruction of ecosystems. Meanwhile, the prevalence of aquaculture by large corporates has caused water pollution as a result of the overuse of chemicals. In addition, overharvesting small fish for feeding farm fish has caused serious damage to marine ecosystems. To mitigate these problems, local and national governments and international organizations typically impose regulations, but they do not always provide fundamental solutions. As an alternative bottom-up approach, this project examines the past and present practice of place-based, smaller-scale food production systems, evaluates their advantages and limitations and explores their future potentials.

Geographic focus

Our regional focus is the North Pacific Rim. In particular, we have identified northern Japan, with its solid archaeological record and its importance in contemporary food production, as the core area of our field research. The west coast of North America, with rich traditions of ethnographic and ecological investigation as well as active contemporary food/agriculture movements, will provide comparative case studies. These two regions share a number of characteristics in common, including climate, vegetation, fauna, and a high level of seismic activity. There are also cultural ties with historical depth as a result of the migration of anatomically modern humans after the late Pleistocene. Historically, the abundance of small-scale economies supported by marine food exploitation (e.g. salmon and herring) and intensive nut-collecting also characterize these two regions.

Research methods

The project consists of three research groups, each with several sub-projects.

***Longue-Durée* Group:** Archaeological, historical, and paleoenvironmental studies will be used to test project

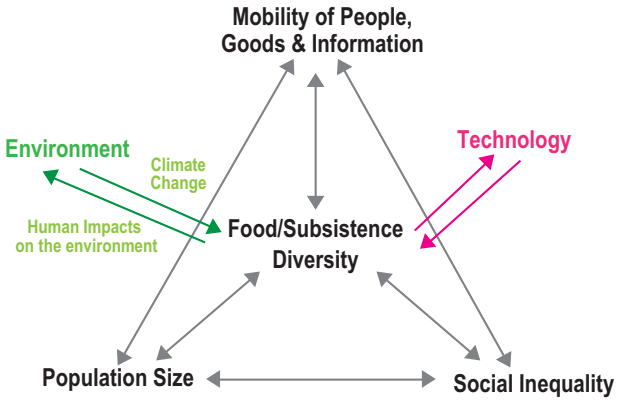
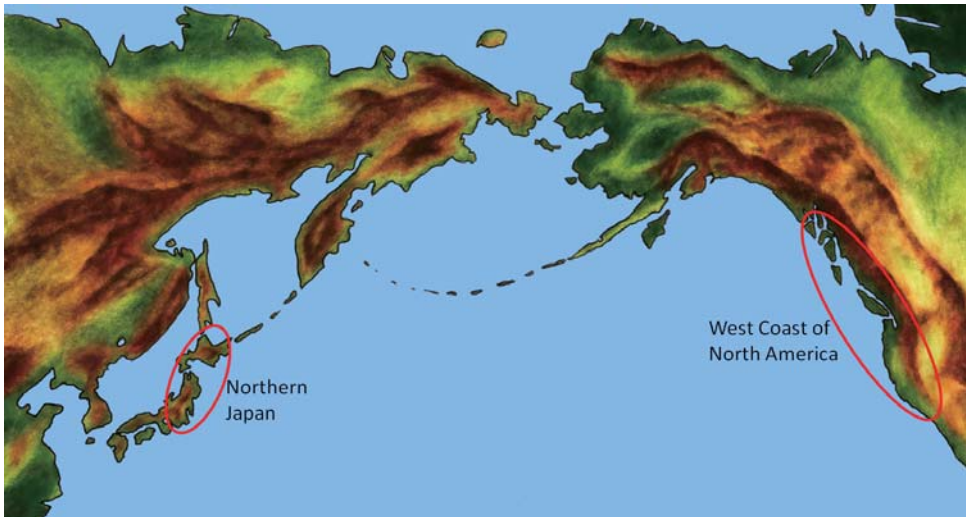


Figure Mechanisms of Long-term Culture Change



Map Main Research Areas

hypotheses. Correlations between subsistence/food diversity, scale of production, community size, and other key factors (see Figure) will be examined.

Contemporary Society Group: Ethnographic and sociological studies of small-scale communities and small-scale food production systems will be conducted to understand the complex inter-relationships among cultural and natural contributors in contemporary urban and rural settings. Chemical and scientific studies of the human impacts on the environment will also be conducted.

Implementation, Outreach and Policy Proposal Group: Insights obtained from our research will be used to develop programs for promoting place-based, small-scale and diversified food production and public outreach programs, and to make policy suggestions.

Achievements during the FS phase

***Longue-Durée* Group:** Preliminary analysis of prehistoric Jomon data in northern Japan indicates a significant decrease in subsistence diversity and a rapid population increase at around 5000 years ago, followed by a drastic population decrease at around 4500 years ago or slightly later. In order to examine causes, conditions and consequences of these changes, paleobotanical and zooarchaeological analyses, GIS analysis of regional settlement patterns, lithic analysis, residue analysis of pottery, and climate change studies are currently in progress. Research plans for comparative studies include archaeological analysis of prehistoric and historic hunter-gatherers in northern California and the Northwest Coast area.

Contemporary Society Group: As a pilot study, ethnohistorical and ethnographic research of small-scale fishing communities in the Miyako Bay and Hei River drainage (Iwate Prefecture) in northern Japan was conducted. In addition, ethnographic studies of small-scale farmers in Fukushima and Miyagi Prefectures have been conducted to collect first-person, primary data about the challenges faced by families and small-scale communities in the areas affected by the 3.11 triple disasters. For Coastal North America, archival and preliminary field research of small-scale farmers, fishing industries and indigenous communities were conducted.

Photo Archaeological Excavation of a Middle Jomon Site in Aomori Prefecture

Implementation, Outreach and Policy Proposal Group: Preparations for this research group are still at their nascent stage. Discussions for the following sub-projects are in progress: 1) Eco-literacy project with a focus on cherry salmon at the Hei-River area, 2) collaboration with small-scale farmers in the 3.11 disaster area, including vegetable oil producers in Tochigi and Fukushima, and 3) urban farmer field schools in collaboration with educational programs in UC Berkeley.

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Societal Adaptation to Climate Change: Integrating Palaeoclimatological Data with Historical and Archaeological Evidences

Project Leader **NAKATSUKA Takeshi** RIHN

Professor Nakatsuka's specialties are palaeoclimatology and isotope biogeochemistry. Since his early career as a graduate student, he has been using nitrogen isotopes to study long-term variations of climate and its impacts on oceanic biogeochemical cycles. Recently, he changed his main research area from oceans to land and focused on using tree-ring oxygen isotopes to examine the relationship between climate change and human history. Investigating periodicity of climate during last two millennia in Japan and the world, he now hypothesizes that past human societies were often damaged by multi-decadal climate variations as they were caught in a cycle of over-adaptation and subsequent collapse.

Background and objectives

When global warming causes many difficulties in our society, how can we adapt to the change? Remarkable recent progress in palaeoclimatology has elucidated the fact that large climate variations often underlay epochs of human history. How did our ancestors address such change in the past? Human history must include many examples from which we can extract common lessons relevant to contemporary global environmental change. The research target of this project is Japanese history from the prehistorical Jomon era to the present. First, we reconstruct past climate variations in Japan and Asia at annual or seasonal time resolutions for last three millennia, using up-to-date palaeoclimatological methods to identify outstanding periods of climate changes. Then we use historical and archaeological approaches to investigate how local societies reacted to the climate change in order to clarify common sociocultural characteristics of societies that are tolerant or vulnerable to changes in climate.

Research methods

In this project, past climate variations are reconstructed by various proxies, such as tree rings (Photo 1), coral rings, ice cores, lake and marine sediments, and historical weather records, and compared with historical documents and archaeological archives. There are three reasons why we have chosen Japan as the main research area in this project. First, Japan is located at northeastern rim of the Asian summer monsoon, where small changes in monsoon dynamics might have significantly affected paddy rice cultivation on which Japanese sustenance has historically depended. Second, due to the historically high literacy rate and long-lasting family system in Japan, innumerable historical documents dating back to the 8th century are preserved in both private and governmental sectors. Third, rapid land developments during last several decades have provided us of precise archaeological records at numerous excavated sites all over Japan. In addition, a palaeoclimatological tool (tree-ring cellulose oxygen isotope ratio) particularly useful in the Asian monsoon region has been developed recently to reconstruct summer precipitation important for rice paddy cultivation.

Remarkable results

So far, we have been using many living trees, buried logs, old architectural wood and archaeological wooden artefacts from around Japan in order to analyze tree-ring oxygen isotope ratios during the last four thousand years in annual time resolution. Figure 1 shows the time-series obtained in central Japan using Hinoki cypress trees. Annual resolution of past climate data enable us to confirm whether there are direct relations between extreme climate conditions and special paleographic events, and to discuss how periodicity of climate variations influences people's livelihood. Figure 1 illustrates that multi-decadal (20-50 years) hydroclimate variability enhanced at about 400 year intervals might have underlain major political regime shifts in Japanese history, such as the ends of Yayoi and Kohun era, and the medieval upheaval period. We are now investigating how people in the past reacted to those large climate fluctuations, using various historical documents and archaeological archives.

Final goal

Because the relationship between climate and society is one of the most mysterious subjects remaining in history and archaeology, this project must have the potential to substantially improve our understanding of Japanese history. The most important hypothesis in this project is that society, vulnerable to climate changes, must be vulnerable to environmental changes, too. Although the sources of "past climate change" are completely different from those of "present global environmental problems", both kinds of change might have the same structure in the context of social adaptation. Therefore, the final goal of this project is to conduct detailed examinations of societal adaptation to past large-scale climate change in order to propose adaptation strategies to environmental change in the present.

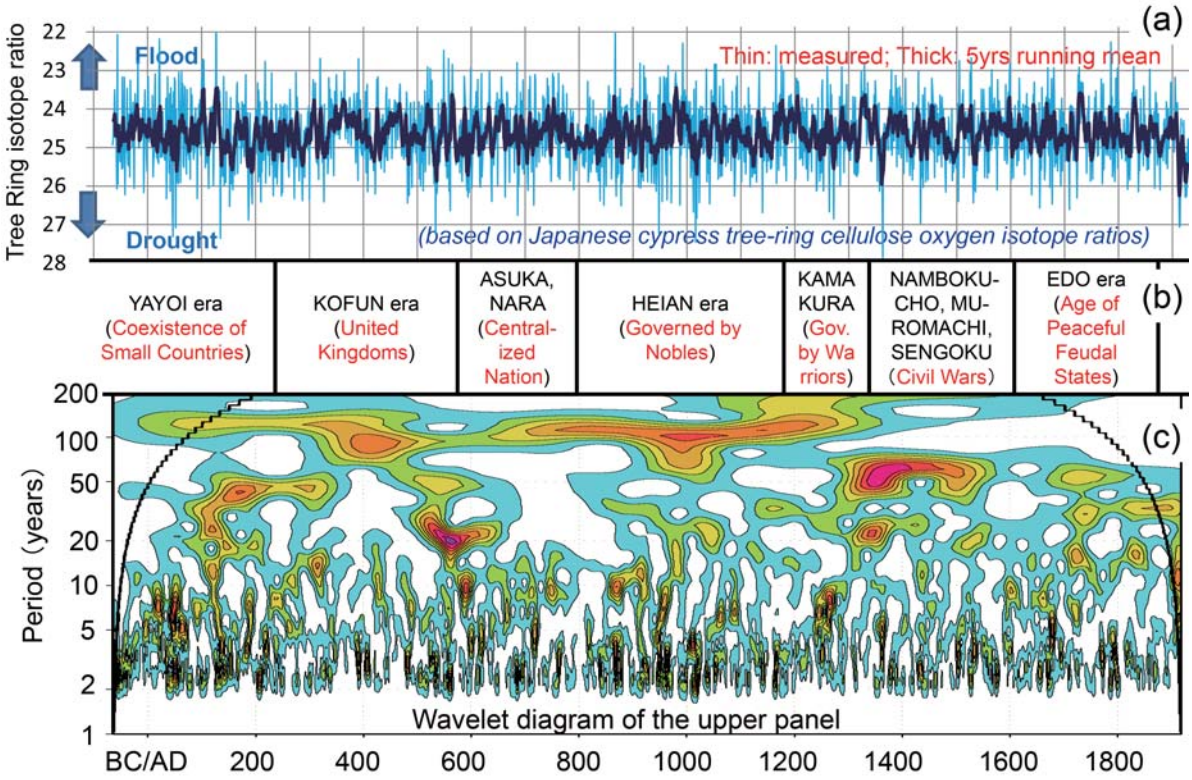

Fig.1: Historical variation of summer precipitation in central Japan recorded by tree-ring cellulose oxygen isotope ratios of Hinoki cypress trees (a), Division of Japanese history (b) and wavelet diagram of the upper panel (c), where warm color indicates larger fluctuations.

Photo 1 Collection of tree-ring cores from giant Hinoki cypress trees in Taiwan

Photo 2 Various tree-ring disks applied to reconstruct past climate variations

Sub Leader

SANO Masaki RIHN

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