Long-term Sustainability through 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 Economies Project and a Professor at RIHN as well as 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 production system and its associated community more vulnerable in the long-run. In particular, this project proposes that high levels of diversity, networks, and local autonomy, all of which are strongly correlated with the scale of the system, are the keys to long-term sustainability of socioeconomic systems. Archaeological, historical and paleoenvironmental studies are used to test this hypothesis (*Longue-Durée* Group). Ethnographic and ecological studies of contemporary small-scale food systems and communities engage ongoing academic and popular discussion of the scale and methods of alternative food systems (Contemporary Society Group). In combination, these studies of the past and present point to the future, as the research process also involves the development of implementation and public outreach programs that promote place-based, small-scale, and diversified food production (Implementation, Outreach and Policy Proposal Group).

We realize that there are many additional factors that affect the dynamics of subsistence/food diversity, the scale of a food production system, and its long-term sustainability (see Figure 1). Correlations among these factors will also be examined when testing the main hypothesis.

Small-scale economies and global environmental challenges

For the purposes of this project, a "small-scale economy" is defined not solely on the basis of the absolute size of the economic unit, but rather in terms of the relative scale of food production within a given socioeconomic context. Our definition of small-scale economy addresses the range of networks that enable food production, distribution, and consumption in a given locality without precluding links to the outside economy. We are particularly interested in relatively small-scale food production with the following characteristics: 1) goals not limited to the pursuit of short-term efficiency and profits; 2) production for local markets rather than domination of the world market; and 3) readily available information about the producers.

Geographic focus: North Pacific Rim

Geographically, our project focuses on the North Pacific Rim. In particular, we have identified northern Japan, with its solid archaeological record and its importance to contemporary food production in Japan, as the core area of our field research. The west coast of North America, with its rich traditions of ethnographic and ecological investigation among native populations, as well as active contemporary food/agriculture movements, will provide our main comparative case studies. The two regions share a number of biogeographical characteristics, including climate, vegetation, fauna, and high levels of seismic and volcanic activity. There are also cultural ties with significant historical depth as a result of the eastward migration of anatomically modern humans from Asia after the late Pleistocene. Historically, many of the residents of the North Pacific Rim depended on rich marine and terrestrial resources, including salmon, herring, acorns and other wild food resources.

Research activities and findings

***Longue-Durée* Group:** Results of our analyses of prehistoric Jomon Period data from northern Japan are consistent with our hypothesis that over-specialization leads to vulnerability in a socioeconomic system. New data from Jomon sites also aid in the development of a new understanding of Early-Middle Jomon chronology and vegetation, which is important in determining the role of climate change in the long-term shifts in past

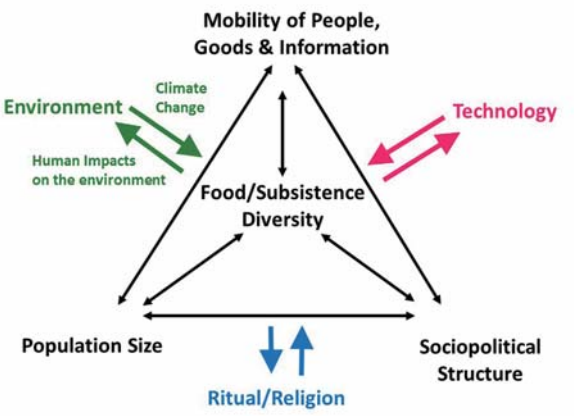

Figure 1 Mechanisms of Long-term Culture Change

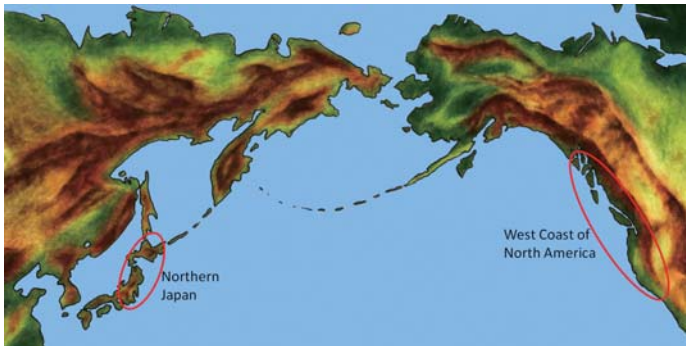

Figure 2 Main Research Areas

Photo1 Archaeological Excavation, Triquet Island in British Columbia, Canada

Photo 2 Acorn Processing Workshop with Wukchumni Yokuts people in California

subsistence-settlement systems. Contrary to the Jomon data from the Japanese archipelago, comparative studies from California and the Northwest Coast of North America suggest that increased subsistence diversity positively correlates with long-term sustainability of complex hunter-gatherer societies. The role of social networks in system resilience is also being explored across multiple regions.

Contemporary Society Group: As corollaries of our main hypothesis, this group investigates: 1) the positive role of small-scale and diversified production systems in relation to the environment and its changes through time; and 2) whether social networks associated with small-scale and diversified production increase the resilience of local communities, especially in times of disaster. Fieldwork has been conducted with traditional communities, including rural farming/fishing communities in Japan and indigenous communities in North America, and alternative food producers, including organic farmers. Results of our research so far indicate the importance of traditional subsistence practices in maintaining resilient socioeconomic systems within local landscapes/seascapes along the North Pacific Rim. Our studies have also revealed critical historical differences between Japan and North America. For example, Japanese contemporary small-scale food production systems tend to be rooted in rural communities that have never fully accepted large-scale operations, while small-scale food production movements in North America have emerged either as a resurgence of indigenous movements or in response to dominant large-scale operations.

Implementation, Outreach and Policy Proposal Group: On the basis of the research results of the *Longue-Durée* Group and Contemporary Society Group, this group conducts action research to convey the importance of long-term perspectives to various stakeholders through public lectures and popular books, to promote sustainable fisheries, agriculture and forestry through seminars and classes, and to work together with local and indigenous communities to find the intersection of traditional environmental knowledge (TEK) and scientific knowledge. Activities of this group include eco-literacy programs with both children and adults, seminars to develop community gardens, university classes about urban organic farming, and workshops to promote the use of traditional environmental knowledge and food processing methods.

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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 the 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 failure of adaptation.

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 the last several millennia, using up-to-date palaeoclimatological methods to identify outstanding periods of climate variations. Then we use historical and archaeological approaches to investigate how local societies reacted to climate variation 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 based on various proxies, such as tree rings (Photo 1, 3 and 4), historical weather records (Photo 2), lake and marine sediments, coral rings and speleothem, and compared with human responses recorded in 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 rice paddy 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 allowed for precise archaeological excavations at numerous sites all over Japan. In addition, a palaeoclimatological tool (tree-ring cellulose oxygen isotope ratio) particularly useful in the Asian monsoon region has recently been developed to reconstruct summer precipitation on which rice paddy cultivation in Japan depends and provides archaeologists with a reliable tool for annual resolved dating of numerous excavated woods.

Significant Results

So far, we have been using many tree-ring samples from around Japan in order to analyze tree-ring oxygen isotope ratios during the last 4.3 thousand years in annual time resolution. Besides, we have collected many tree-ring width datasets all over Asia in the framework of an international palaeo-climatological project (PAGES) and reconstructed inter-annual variations of averaged summer temperature in East Asia. Comparison of annual records of past climate with paleographic information such as yearly tax accounts in early modern villages (Fig. 1) and administrative documents on water control in medieval manors, as well as archaeological information on prehistorical and ancient societies excavated from farmland and habitat remains, coupled with the newest isotopic dendrochronological data allow us to investigate how variations in temperature or precipitation influenced agricultural production, human livelihoods, and water management. Figure 2 illustrates that, with the exception of the 14th century, multi-decadal (20-50 year) summer temperature variability might have often underlain major famines during the medieval upheaval period in Japan. Using various historical documents and archaeological archives, we are now investigating how people in the Jomon to Early Modern eras reacted to those large climate fluctuations.

Final goal

As our concerns about on-going global warming are clearly illustrating, large climate variations in the past might have had serious impacts on our ancestors. However, some past societies continued making efforts to overcome the influence of climate variations, while other societies collapsed at once due to abrupt climate variations. For example, there were many volunteers in Early Modern Japan who tried to rescue people from starvation by anticipating famine due to cold weather. They sometime succeeded but often failed to do so. Their actual roles in history give us various insights on our present lifestyles and strategies against global environmental problems. Therefore, the final goal of this project is to construct our fundamental adaptation strategies in relation to global environmental problems by conducting detailed examinations and comparisons of past struggles against climate variations beyond ages and regions.

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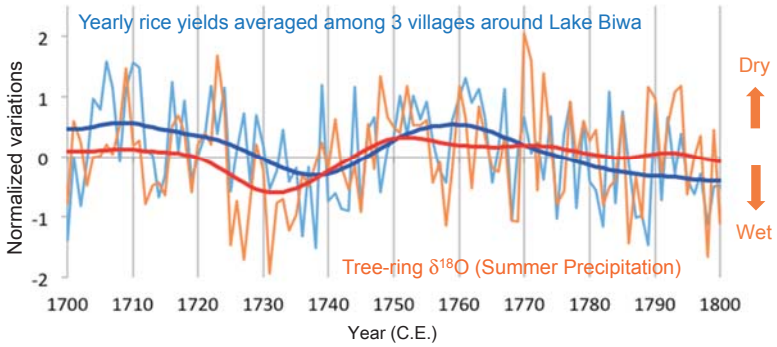

Figure 1 Normalized variations in *Nokoridaka* (estimated rice yields) of yearly tax accounts averaged among three villages around Lake Biwa and the tree-ring cellulose oxygen isotope ratios in central Japan during the18th century. This data demonstrates that flooding was the largest factor damaging rice yields in the area at this time.

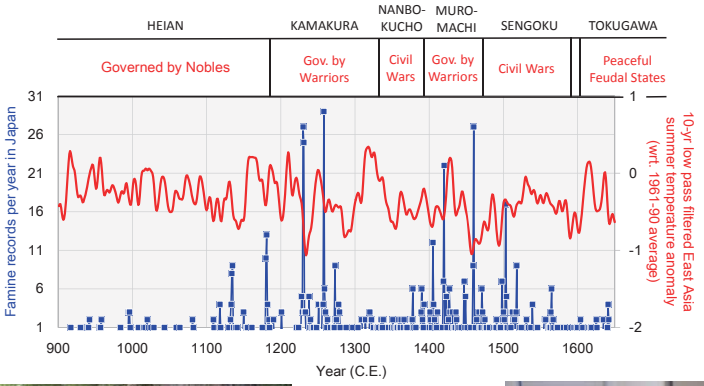

Figure 2 Variations in East Asia summer temperature and annual numbers of famine reports in Japan during the 10-16th centuries.

Photo 1 Collection of tree-ring cores using an increment borer

Photo 3 Separation of annual rings from wood cellulose in the laboratory

Photo 2 Creation of a weather database based on documentation and decoding of old diaries

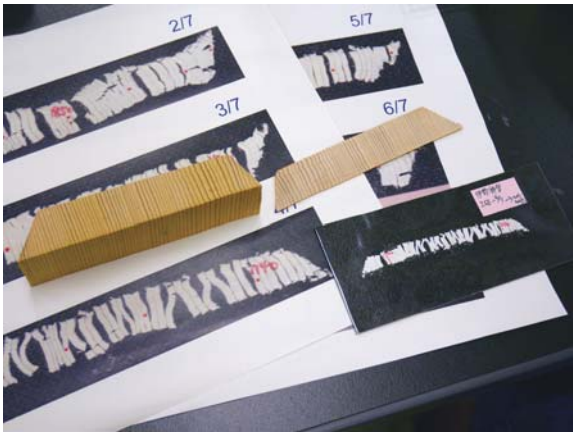

Photo 4 Extracted wood cellulose plates

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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

Associate professor Naoki Kikuchi had been working at the Hyogo Prefectural Homeland for Oriental White Stork as a residential researcher with his academic background on environmental sociology, collaborating with diverse stakeholders in restoration processes of the Oriental White Stork. His transdisciplinary research focuses on seeking 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 are 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 transformations toward sustainability of local communities.

Our project aims to clarify mechanisms to facilitate production and circulation of ILEK and dynamic transformations of social systems to propose ILEK-based adaptive governance mechanisms of local communities. We also seek mechanisms for cross-scale governance of global environment problems, primarily by analyzing formation of cross-scale knowledge bases 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.

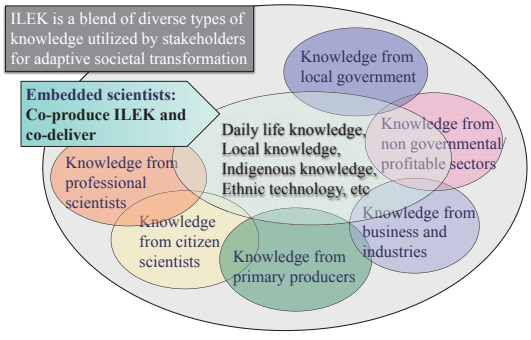

Figure 1 Structure of ILEK
Production and circulation of ILEK is not exclusively performed by professional scientists. Rather, it is usually produced and circulated by diverse actors in local communities, including skilled workers in primary industries, local government officials, local companies and 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 and local knowledge in daily livelihood and practices among local stakeholders. In this process of ILEK production, scientists and experts are assuming new roles to reorganize and integrate various knowledge systems from the viewpoints of knowledge users and co-deliver ILEK to promote collaboration among diverse stakeholders for solutions of local environmental problems

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 group and various task forces to understand ILEK production and adaptive governance mechanisms leveraged by ILEK. Sixteen cases of Action-based Verification have been selected among case study sites and cases of cross-scale translators to verify focused hypotheses concerning ILEK-based adaptive governance, including the Shiraho community in Ishigaki Island (Japan), Nishibetsu River Watershed (Japan), Sarasota Bay in Florida (USA), Karapinar area (Turkey), Lake Malawi National Park (Malawi), and the Japan Biosphere Reserve Network.

Residential researchers live in local communities, and in contrast to visiting researchers from outside the communities, they conduct transdisciplinary research as local stakeholders and community members. Bilateral knowledge translators promote circulation of knowledge among scientists and diverse knowledge users by evaluating

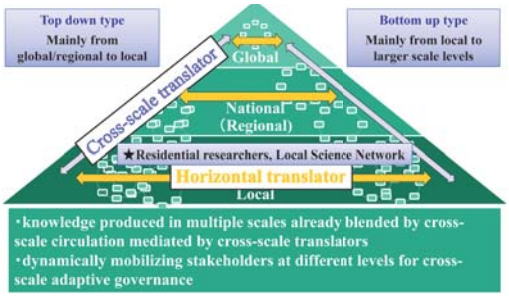

Figure 2 Roles of bilateral knowledge translators
Bilateral knowledge translators connecting scale levels from local to global promote knowledge flows across different scales and levels. Diversity and multiplicity of bilateral translators were found to play crucial roles in promoting cross-scale knowledge circulations. We aim to understand and utilize this processes to clarify mechanisms of cross-scale adaptive governance supported by knowledge bases emerging from integration of various knowledge types at different scale levels.

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 residential/visiting researchers or bilateral knowledge translators 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.

and transforming scientific knowledge from the viewpoints of knowledge users, and by translating 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 five hypothetical categories of important enablers of adaptive societal transformations promoted by ILEK production and circulation, namely "create and visualize values", "create new linkages (local and cross-scale)", "provide options and opportunities", "create collaborative actions" and "appropriate translation". Participatory observations in case studies from the world and in-depth interviews with various actors playing important roles in knowledge production, circulation and utilization opened a new research approach to understand interactive functions of these enabler categories in the ILEK Triangle, resulted in identification of diversity and multiplicity of bilateral knowledge translations as an important factor of cross-scale governance. The findings will be integrated in the theoretical models together with outcomes from the action-based verification processes to understand elaborate mechanisms of ILEK-based adaptive governance.

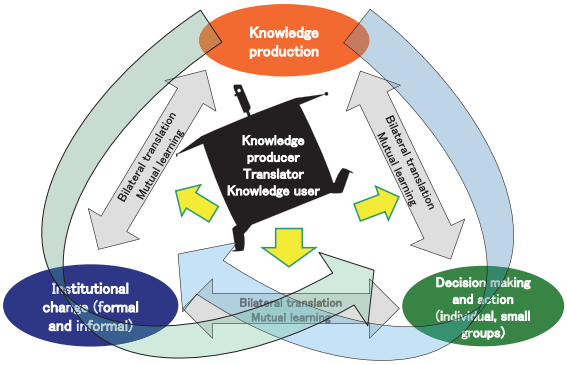

Figure 4 Conceptual model of adaptive governance (ILEK Triangle)
The ILEK Triangle model is composed of an interactive system of three important elements of ILEK-based adaptive governance (knowledge production, decision making and action, and formal/informal institutional change), driven by knowledge 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 institutional changes via changes in individual decisions and actions, or directly influencing formal and informal institutions and human networks to transform individual behavior.

Future research plan

We are moving forward to elaborate the analytical framework of ILEK-based adaptive governance using the ILEK Triangle and the action-based verification processes 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 transformation processes 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 other diverse stakeholders is the core of the ILEK project. We will further strengthen the transdisciplinary approach both in local case studies and abstract meta-analysis processes by designing stakeholder workshops. Action-based verification processes and further development of meta-analyses and modeling methodologies will contribute to production of solution-oriented research outputs to support ILEK-based societal transformations to tackle the challenges of diverse global environmental problems.

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

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 generating 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 causing increased pressure on water, energy and food resources, presenting communities with increased levels of 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 the governance and management within these inter-connected needs, it is desirable to increase human-environmental security by improving social management for the water-energy-food nexus. In this research project, we intend to establish a method to manage and optimize the 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 to address these global environmental problems. The geological and geomorphological conditions in our proposed study area are heavily influenced by the so-called "Ring of Fire," around the Pacific Ocean. Within this area, 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 as negative impacts, 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.

Questionnaire survey in Otsuchi

The objective of this project is to maximize human-environmental security (ie. minimize vulnerability) by choosing management structures and policies that optimize both the water-food and water-energy connections in Asia-Pacific coastal regions. We define a 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

Five different interdisciplinary approaches, scales and clusters will be used in this investigation: (1) Environmental governance, science in/for society, and co-design/co-production approaches, in particular those emphasizing integration of local-national scale stakeholders, and regional scale stakeholders such as GEC (Global Environmental Change) Asia/ Future Earth in Asia-Pacific Platform; (2) Biophysical measurements/ analyses of the water-energy nexus by using state-of-the-art space satellite, geothermic, and hydrogeological techniques to evaluate linkages between water and energy; (3) Biophysical measurements/analyses within the water-food (e.g., fisheries resources) nexus by using state-of-the-art geochemical, coastal oceanographic, geophysical, hydrologic, and ecological techniques including isotopic tracers to evaluate the linkages between land and ocean; (4) Social measurements/analyses of water-energy-food relationships by use of stakeholder analyses, social network analyses, and community surveys, based on sociology, economics, anthropology, psychology, and behaviour science methodologies; and (5) Development of methods for interdisciplinary approaches, such as integrated indices and indicators determined by feedback from stakeholder meeting/workshops, integrated physical models including water, nutrients for fishery resources, and temperature related to energy and food developments for understanding the complexity of nexus systems, integrated maps for sharing actual conditions at a spatial scale among stakeholders, ontology engineering for designing the common platform among stakeholders, and benefit-cost analysis and optimization management models for identifying tradeoffs and making policy options.

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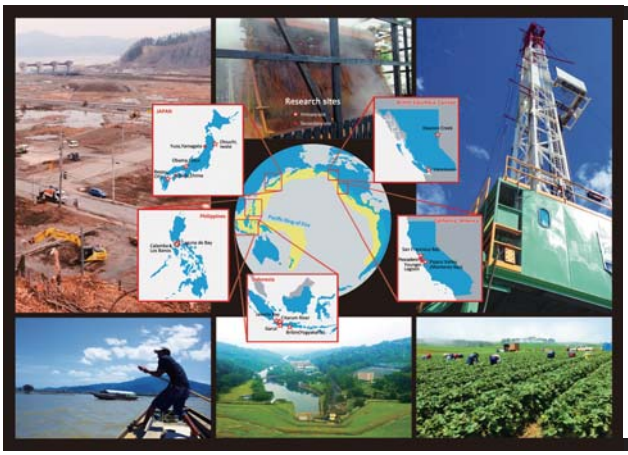
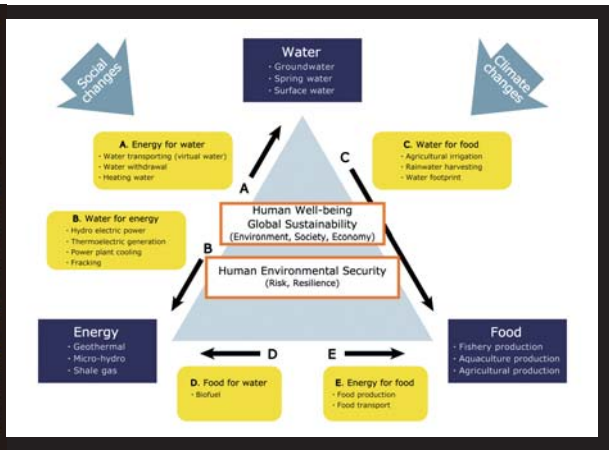


Target research sites



Dynamics of the WEF nexus under RIHN WEFN project

Research activities and findings

At the local level of the water-energy nexus, as a result of collecting groundwater samples by depth, it turns out that aquifer levels declined following construction of seawalls and a water gate in Otsuchi, which is a tsunami-affected area. Installing observation wells and long-term monitoring groundwater level would be needed. Regarding the ground heat exchange system, soil temperature readings in Obama and Otsuchi revealed that the soil temperature in Obama is higher than in Otsuchi. As previous studies show ground warming, further research of the interaction between soil temperature and potential energy of soil is needed. In Beppu, examination of the water-energy nexus show that changes in the heat environment caused by drainage water from hot spring resorts and hot spring power generation affect river ecosystems, including Tilapia habitat. We will continue our research into the potential for producing energy, water consumption, and diversification of renewable energy sources.

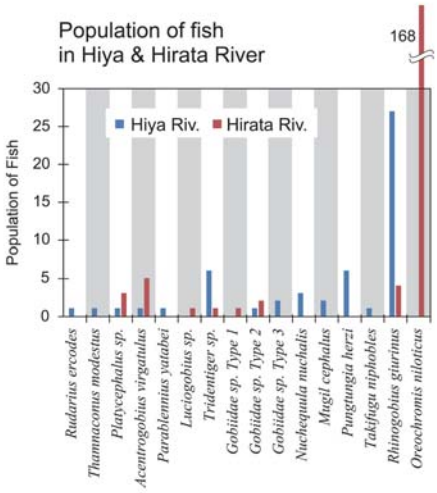
As for the water-food nexus, physical, chemical and biological surveys were conducted at four sites in Japan. The ratio of submarine groundwater discharge (SGD) to fresh water inflow, and the amount of nutrient supply derived from SGD along the coast of Hiji town in Beppu Bay were estimated. Furthermore, it turns out that the ratio of SGD to freshwater inflow is higher in Otsuchi Bay. We will examine the interlinkages between groundwater and fishery production in light of the hypothesis that the flow of nutrients from the land to the ocean affects the coastal ecosystem.

At regional scale, an online survey of perceptions of developing geothermal energy in Japan, the Philippines and Indonesia, revealed that Japanese are not familiar with geothermal energy power plants and are not so interested in promoting local economies through the use of geothermal energy, and that Japanese prefer political referenda rather than trusting scientific evidence.

Further project research will develop understanding of the complexity of the water-energy-food nexus and contribute to policies intended to mitigate tradeoffs among water-energy-resources and reduce the conflicts between resources users through co-design and co-production with stakeholders based on scientific knowledge we discovered.

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.



Population of fish in Hiya & Hirata River

3rd WEFN meeting in Kyoto

Project Researchers at RIHN

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Biodiversity-driven Nutrient Cycling and Human Well-being in Social-Ecological Systems

Project Leader **OKUDA Noboru** RIHN

My specialty is ecology, the field of study concerned with the relationships between biodiversity and ecosystem functioning. One of ecology's central questions is why we should conserve biodiversity. While a member of the Center for Ecological Research at Kyoto University, I have approached this question by integrating different research fields related to biodiversity from gene to ecosystem. At present, I am developing methods for adaptive watershed governance in which new environmental knowledge will be developed to reconcile global and regional issues with local issues. I also should say that I love nature and humanity and how they come together very much!

Research background and objectives

Technological innovations in the use of nutrients, such as nitrogen and phosphorus, to produce food are related to the great global increase in population, life expectancy, and economic prosperity experienced in the twentieth century. Overexploitation of nutrient resources, however, leads to disturbance of natural biogeochemical cycles, contributing to serious eutrophication in many watersheds around the world. Such nutrient imbalances are a main driver of biodiversity loss at a global scale. It is now recognized that nutrient imbalances and biodiversity loss are prevalent throughout the planet, posing a risk to sustainable human development. In order to solve problems related to nutrient imbalances and to ultimately ensure sustainable social-ecological systems, we have to enhance nutrient recycling at watershed scales.

This project therefore aims to facilitate cross-linkage of multi-level governance, in which governments and researchers with a systemic view intend to solve nutrient imbalance-derived issues at the regional and global scales, while civilians want to solve social and environmental issues in the context of their life and livelihood. For such watershed governance to be successful, local and scientific knowledge must be shared and integrated by a variety of stakeholders in order to reconcile conflicts at different scales. Here we will develop a framework for the adaptive watershed governance, in which civilians are empowered for nature conservation, resulting in enhancement of their well-being, while scientists make visible how biodiversity enhances nutrient recycling through their conservation activities (Fig. 1).

Research methods

Our hypothesis is that human activities affect biodiversity through alteration of nutrient balances, while biodiversity affects human well-being through alteration of natural and social capitals. A working hypothesis is proposed to explain how well-being is enhanced through community-based governance of natural resources (Fig. 2). First, local communities will be empowered for nature conservation when they value natural resources (or biodiversity) whose wise and sustainable use has been fostered by local or indigenous cultural knowledge (Fig. 2-1). If bonding social capitals are accumulated through sharing of these cultural values by community members (Fig. 2-2), well-being will be enhanced (Fig. 2-3). If scientific knowledge showing that community activities contribute to enhancement of biodiversity-driven nutrient recycling is shared among a variety of stakeholders in a watershed-based society (Fig. 2-4), community activities will be supported by non-community members directly or indirectly through social evaluation of public values from the biodiversity (Fig. 2-5). A shift from bonding to bridging social capitals will reinforce well-being (Fig. 2-6). These processes will be driven by transdisciplinary science (Fig. 2-7).

To test this hypothesis, we will practice adaptive watershed governance in two extreme systems in Asia, the

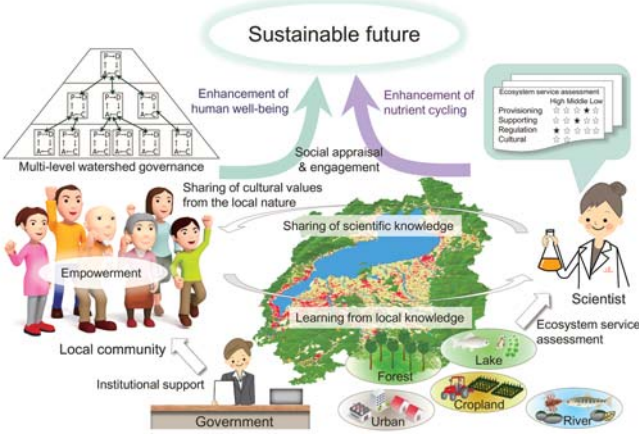

Figure 1 A conceptual schema of adaptive watershed governance

Figure 2 A working hypothesis of how human well-being is enhanced through community-based governance

http://www.chikyu.ac.jp/rihn_e/project/D-06.html

Photos 1 A well-managed communal spring (left) and one recently abandoned (right).

Photos 2 Social engagement in biodiversity monitoring. Housewives are key stakeholders in management of communal springs and reduction of domestic loadings.

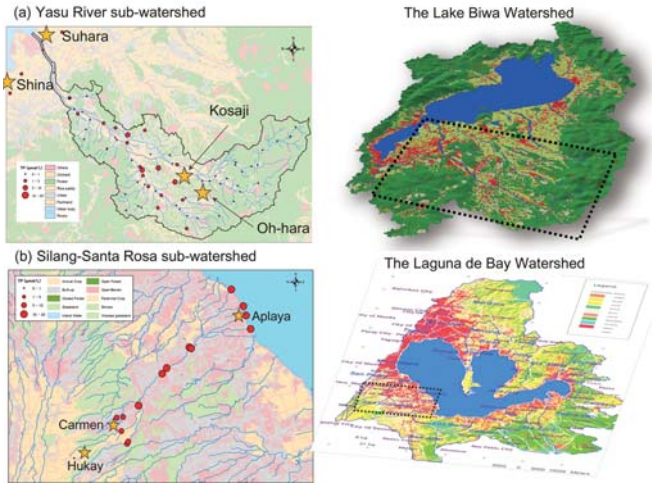

Figure 3 Maps of phosphate concentrations indicated by circle size in the upper Yasu River sub-watershed and lower Silang-Santa Rosa sub-watershed.

Lake Biwa Watershed and the Laguna de Bay Watershed. The former is an infrastructure-oriented society and the latter a high-loading society.

Research progress

In the Yasu River sub-watershed of Lake Biwa, downstream areas have low phosphate concentration even though they are urbanized (Fig. 3a), suggesting that the extensive sewage treatment system is effective in nutrient removal. Counter-intuitively, phosphate concentrations were among the highest in less populated middle-stream areas where agricultural land uses are dominated.

In the Silang-Santa Rosa sub-watershed of Laguna de Bay, by contrast, the phosphate concentration was much higher than that in the Yasu River sub-watershed, except for its most upstream reaches (Fig. 3b). With recent economic development in this sub-watershed, new residential areas have expanded up into the middle-stream areas. Incomplete sewage treatment systems may be a possible cause of phosphorus loading, resulting in an extreme nutrient imbalance. The loading has caused harmful algal blooms in coastal waters as well as biodiversity loss in the middle- and downstream areas.

In this sub-watershed, until recently local communities managed communal springs wisely as common pool resources (Photos 1 Left). After establishment of a tap water system, however, most of these springs were abandoned (Photos 1 Right). Our project will therefore soon begin action research together with a local community to conserve stream and spring environments (Photos 2).

Perspectives

Infrastructure in developed societies, such as sewage treatment and tap water systems, has reduced eutrophication and led to greater comfort and convenience. Environmental consciousness, however, has receded, especially that related to the nature of wetlands as a lifeworld. What enhances human well-being? Is it enhanced by infrastructure? We want to seek answers to these questions together with a variety of stakeholders.

Sub Leader

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Coastal Area-capability Enhancement in Southeast Asia

Project Leader **ISHIKAWA Satoshi** RIHN

Satoshi Ishikawa investigates population genetics and population dynamics of aquatic animals, and has participated in several rural development programs focused on improving fisheries and human capacity building in Southeast Asia. His current interest is how to harmonize conservation of coastal ecosystems and community-based management of fisheries resources. He received his baccalaureate from the National Fisheries University Japan, M.A. from Hiroshima University, and doctoral degree 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. Conservation and resource management strategies, however, are often derived from those of temperate regions, and usually target particular species or commercial resources with little consideration of how multiple ecologies and livelihood strategies overlap in culturally diverse contexts. In addition, in many cases, resource management and conservation activity are individually conducted by several different actors.

Ecosystem services have different significance for different peoples, depending on their interests and contexts. Although overuse and/or abuse of ecosystem services should be avoided, conservation actions should take careful account of the close relationship of local livelihoods and culture to local ecosystems, especially in rural areas lacking other livelihood opportunities. Addressing solutions to environmental problems in such contexts therefore requires linking people and policies engaged in both conservation and resource utilization.

This project attempts to examine several good ecosystem management practices based on local community participation in order to assess the conditions and functions of each actor in creating "Area-capability". We expect that an action contributing to Area-capability can link utilization and conservation and facilitate appropriate ecosystem utilizations, improve local life, cultivate ecosystem health, and foster hope for local society.

Project framework

In Nishio City and Ishigaki Island in Japan, environmental education links several actors having different jobs and interests in new utilization and conservation activities. Around Hamana Lake (Japan), stock enhancement of Kuruma shrimp enhanced social capital among seven villages, facilitated smart fishery management, and stimulated fishermen to care for ecosystems. In Rayong, Thailand, a new community of fishermen was created based on set-net fishery installation, and they collected detailed fishery data and promoted zoning of fishing ground. In Batan Bay, Philippines, shrimp stock enhancement increased local peoples' interest in ecosystem health. Project research conducts field surveys in these areas to collect detailed data and information about social and environmental changes regarding each event. Scientific and social analyses are conducted in order to examine the impacts of each event on both ecosystem health and quality of life. Further, we collaborate with key stakeholders, including local communities, governments and scientists,

Figure 1 Research sites and characters of each area

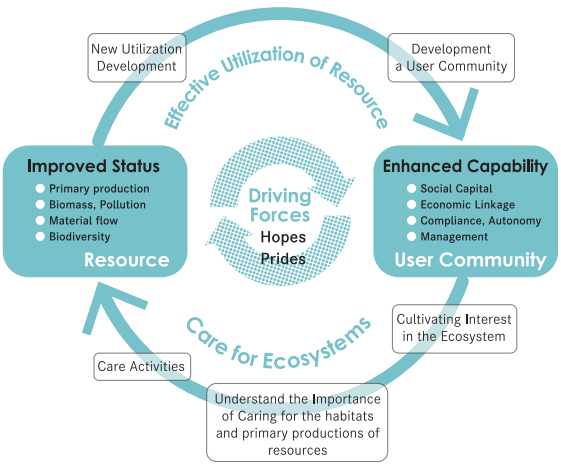

Figure 2 Conceptual model of the "Area-capability Cycle"

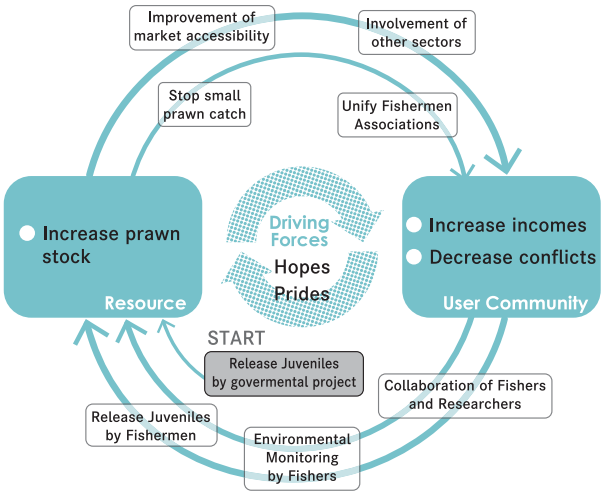

Figure 3 AC Cycle for shrimp stock enhancement in Hamana Lake, Japan

Figure 4 AC Cycle for a set-net fishery in Rayong, Thailand.
The AC Cycle suggests there is weakness in the impact survey on environments. Researchers should therefore try to conduct an impact survey with the local community, and its results taken into account by the set-net fishery operation. The AC Cycle should further clarify other improvements as well.

in order to identify key factors and conditions for local community-based ecosystem management and rural development, examining the functions of each actor in the transformation of society.

This project is based on the joint research efforts of Southeast Asian Fisheries Development Center (SEAFDEC), Eastern Marine Fisheries Research and Development Center of Department Fishery, Thailand, Faculty of Fisheries of Kasetsart University, the University of the Philippines, Visayas (UPV), Aklan State University, and researchers from ten universities and one research organization in Japan.

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

Photo 2 Group photo of International Area-capability Workshop held at RIHN in December 2015

Future tasks

The Area-capability (AC) Cycle was proposed as one model of sequential change in harmonization of natural resource conservation and management. The AC Cycle would be comprised of: (1) Local community use of resources unique to the region; (2) Resource users understanding of the importance of, and care for, the environment that supports the resources used; and (3) A balance is struck between using and caring for resources and the supporting environment, which is evaluated by outside entities.

Project research will apply the AC Cycle model to many cases in order to examine its validity and refine understanding of how to harmonize conservation and management of natural resources. We believe that the set of factors included in AC and the AC Cycle will be useful as a checklist when developing proposals for regional development and revitalization activities, assessing the balance between use and care, and clarifying the standpoint and role of each stakeholder when evaluating projects. As each AC Cycle corresponds to a resource used by a local community, we believe the number of AC Cycles can be an indicator of the abundance of local resources in a given region and, at the same time, an indicator of the potential for various types of cooperation. As such, we suggest that the number of AC Cycles could be used as an index for regional development.

Sub Leader

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EBATA Keigo	Kagoshima University		

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

Desertification is a global concern. The international community ratified the United Nations Convention to Combat Desertification (UNCCD), with a special focus on Africa, in 1994. Despite great effort, the problem of desertification has not been solved. Under conditions of increasing population, desertification is primarily caused by daily subsistence livelihood activities, especially in semi-arid Africa. This is a difficult aspect, since local people have to combat desertification without addressing its underlying causes. Following the UNCCD framework, we focus on the knowledge, experiences and innovations at the field level (Figure 1)

Objectives and study sites

Our project set three objectives: 1) to deepen understanding of the areas experiencing deseritification, and its causes and local strategies for adaptation; 2) to design and verify some practical techniques and approaches for desertification control; and 3) to disseminate the results and experiences.

Study sites are located in semi-arid areas of Africa and Asia (Figure 2), where demographic pressure, uncertain social and economic conditions, and extreme weather degrade ecological conditions and land resources. Major study sites are in the Sahel of West Africa (Burkina Faso, Niger and Senegal), Southern Africa (Namibia and Zambia) and South Asia (India), and some satellite sites are in North Africa (Algeria), Northeast Africa (Sudan), East Africa (Tanzania), and East Asia (Mongolia and China).

Research activities and progress

Together with local people, we developed some practical techniques especially relevant to semi-arid West Africa that enable livelihood improvement and control of desertification.

The 'fallow-band system' is a technique that reduces wind erosion and improves crop yield without any additional cost of labor or materials (Figure 3). It has already entered to the dissemination phase, but in collaborating with a local NGO we can only diffuse the technique slowly at present due to deteriorating security conditions since 2013.

The 'Contour-lines of Andropogon' technique combines *Zai* (planting pit with manure) and *Kukokse* (line planting), which is an indigenous technique originated in Burkina Faso (Figure 4). It is effective in reducing water-related soil erosion, trapping nutrients and harvesting rain water. It also contributes to household economy, as the harvest of Andropogon from three rows, each 100 meter long and with a total width of 5 meters, is sometimes equivalent to millet grains consumed in one to two months. One of the remarkable features of the technique is its benefit to vulnerable people, such as elders and widows, who cannot collect as much wild Andropogon as others.

Shallow tillage using an animal-driven harrow, an indigenous farming tool in India, encourages infiltration of rain water to soil (Figure 5). It may improve retention of soil moisture and therefore the growth of crops, grasses and trees.

By adding a sawing attachment to an animal-driven harrow it is possible to grow cowpea, which is a local variety both for human and animal consumption (Figure 6). Degraded grassland is dominant in the Sahel, West Africa, due to over-grazing for many decades. With this technique, we are able to convert some of the degraded grassland into productive fields.

Afforestation is one of the commonly practiced activities for desertification control. The conventional conceptualization of and techniques for afforestation are, however, not necessarily suitable for local conditions, as they rarely improve local subsistence. As shown in Figure 7, *Zai* (a planting pit with manure) is used to plant tree seedlings. The planting pits collect rainwater, while manure

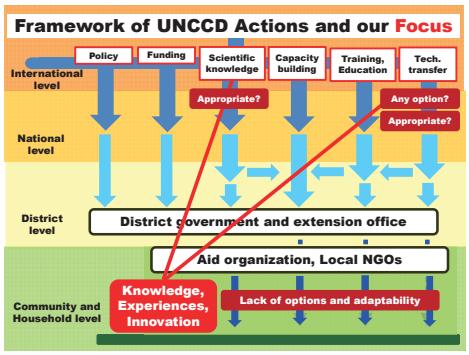

Figure 1 Framework of UNCCD actions and our focus

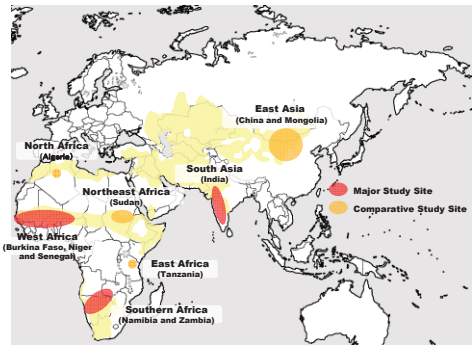

Figure 2 Study sites

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

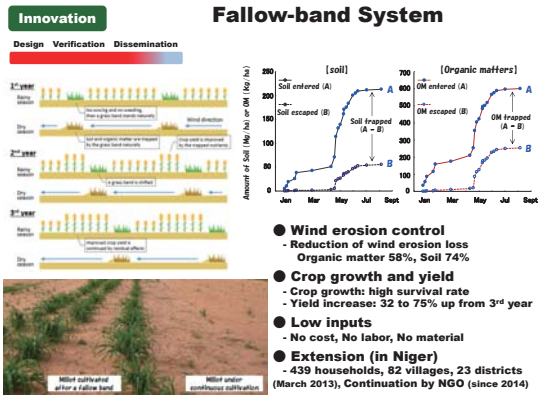

Figure 3 Fallow-band system

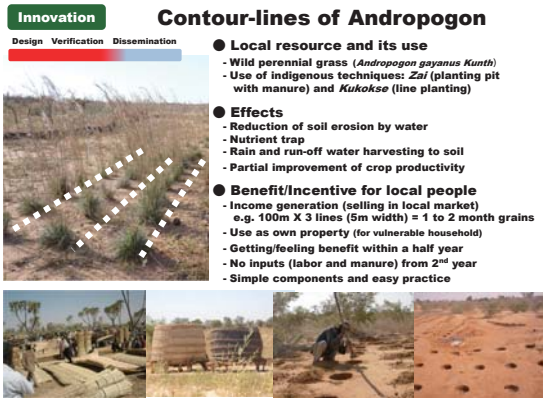

Figure 4 Contour-lines of Andropogon

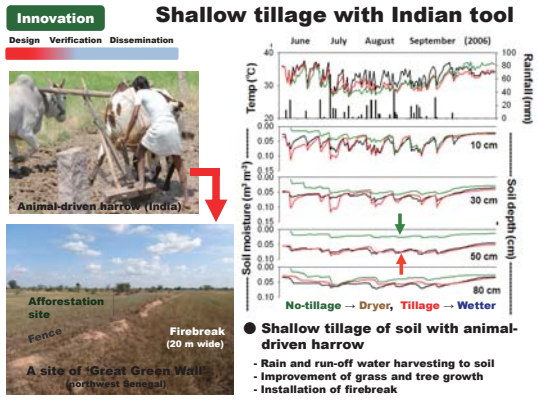

Figure 5 Shallow tillage with animal-driven harrow from India

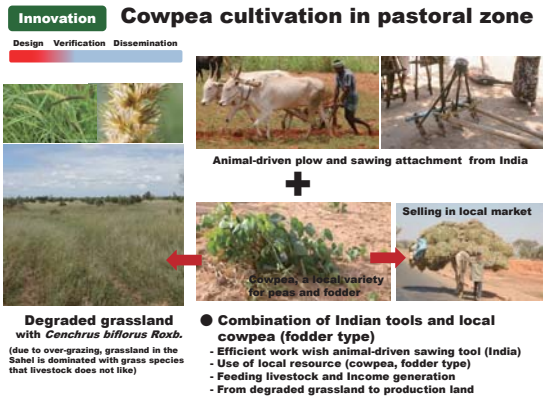

Figure 6 Cowpea cultivation to convert degraded grassland into productive fields

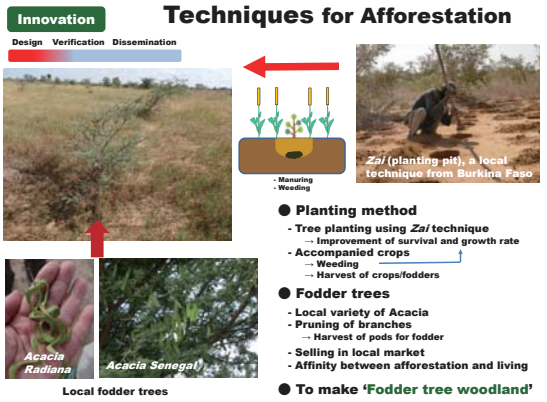

Figure 7 Techniques to improve afforestation

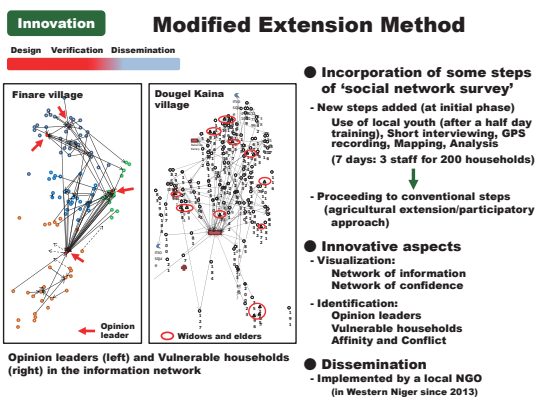

Figure 8 Modified extension method incorporating some steps of our social network survey

encourages plant growth. If a crop, such as pearl millet or cowpea, is planted around each tree seedling, people are encouraged to weed around them in order to improve the potential harvest, and the weeding also encourages growth of the tree seedling. For afforestation, we intentionally choose an acacia species that produces pods. Pruning increases the productivity of acacia pods, which are sold in local market or stocked as a fodder crop. This technique therefore re-casts afforestation as a 'fodder tree woodland', and not simply as a tree plantation. This kind of design is very important, because local people consider such woodlands as their own work, rather than that of foreigners or the government.

We modified the participatory approach conventionally used in rural development activities by incorporating some steps of 'social network survey' (Figure 8). The innovative aspects of this modification are the visualization of networks and the identification of key persons and vulnerable people.

Future tasks

Since our project is entering its final year, we are accelerating the dissemination of our research results through publications, and international and domestic workshops. For social implementation, we are providing some of the practical techniques developed in the project to the 'Great Green Wall for the Sahara and the Sahel Initiative', an international desertification project initiated by the African Union and other entities. We are also preparing proposals which should be helpful in linking our academic results to specific future social implementations.

Sub Leader

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Lifeworlds of Sustainable Food Consumption and Production: Agrifood Systems in Transition (FEAST Project)

Project Leader **Steven R. McGREEVY** RIHN

Steven R. McGreevy is an environmental sociologist (Kyoto University Ph.D. 2012) and associate professor at RIHN. He has a background in agriculture, rural sustainable development, and environmental education. His research focuses on novel approaches to rural revitalization that utilize local natural resources, sustainable knowledge dynamics, sustainable agrifood and energy transition, and the relinking of patterns of food consumption and production in local communities.

Background and objectives

Agrifood systems in Asia face a myriad of sustainability challenges related to declining environmental quality (GHG, resource overuse, pollution, soil fertility), loss of diversity (biological, cultural, knowledge), and the deterioration of small-scale farming due to globalizing market forces. On the consumption side, over-reliance on globalized food chains limits consumer agency and decreases food security and sovereignty, while diets composed of heavily processed food create public health impacts (rise in diabetes, obesity). The ways in which food is provided, consumed, and governed need urgent change.

In order to realize these changes, the FEAST project will partner with key stakeholders to envision plausible futures and initiate democracy-oriented food experiments and actions. FEAST will co-design and co-produce knowledge and societal mechanisms that challenge the predominant logic of the market by valorizing the non-economic qualities of food and agriculture that improve quality of life. The project will engage society in a public debate on its relationship with food and nature, a discussion in which shared beliefs are re-examined so that consumers are re-positioned as citizens and co-producers in the foodscapes around them.

The FEAST project takes an action research approach to explore the realities and potential for sustainable agrifood transition at sites in Japan, Thailand, Bhutan, and China, while also exploring their general significance in Asia. We will analyze patterns of food consumption, food-related social practices and their socio-cultural meanings, and the potential of consumer-based agency to change deeply-held cultural notions and institutions. The notion of "lifeworld" (See Figure 1) captures the meaning behind the shared everyday lived experience of food consumption and production, and allows us to more deeply investigate and understand the "inner dimensions" that can catalyze socio-cultural change.

Research organization and team descriptions

WG1: Food System Mapping & Modeling

WG1 provides contextual information (statistical, spatial, and qualitative) on existing and potential systems of food provisioning and consumption at the local, regional, and national level for each site in Japan and Thailand. GIS mapping, spatial modeling, fieldwork, and statistical analysis will be employed. In order to judge the relative sustainability of said systems, we need to define how we might conceive of a sustainable food system. Toward those ends, we formulated the notion of "holistic local food security" to include the physical capacities to produce and access food in an environmentally-friendly way, as well as the socio-economic factors of overall well-being, food sovereignty, and producer livelihoods.

WG2: Ethics & Consumption Practices

WG2 leads the action research interventions to create communities of practice and food governance in Japan. Three types of workshops are envisioned: 1) to elicit urgent food related problems and co-design research priorities with selected local food system stakeholders; 2) to envision possible alternative food consumption practices and backcast transition frameworks with selected innovators in the food sector; 3) and food ethics-themed workshops to engage the general public. A stakeholder forum at each site will allow participants to conduct citizen-science activities and engage in self-monitoring of consumption-related behaviors. For the sake of comparison, research on the evolution of food-related social practices in Beijing and Bangkok is also planned.

WG3: Agro-ecological Food Provisioning Futures

WG3 addresses three problems facing food provisioning: 1) What role will traditional agrifood systems and knowledge play in the future? 2) What are the ways in which new farmers can be supported and encouraged to farm? 3) How can consumers contribute to the sustainable management of sources of wild food? Fieldwork, case studies, and workshops will be employed to bring further clarity to these research questions over the course of the project at designated Globally Important Agricultural Heritage

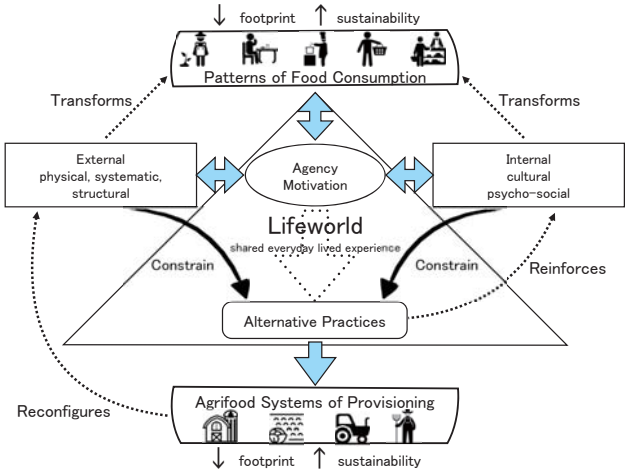

Figure 1 Conceptual framework: a lifeworld perspective on socio-cultural and structural change in agrifood systems of provisioning.

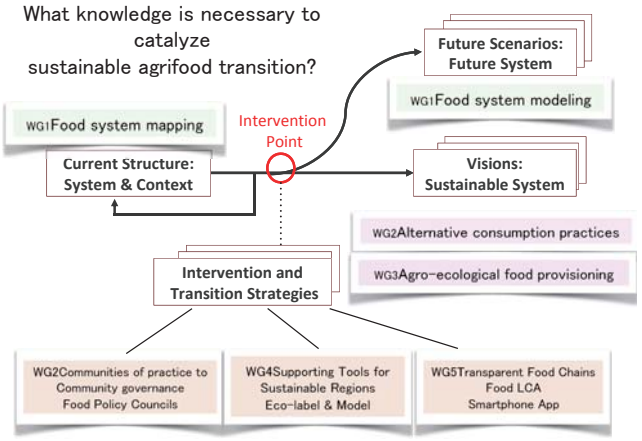

Figure 2 Diagram detailing how each FEAST working group is organized around the question of "What knowledge is necessary to catalyze sustainable agrifood transition?" Four kinds of knowledge are listed: 1) Current system and contextual knowledge; 2) Visions of sustainable future systems knowledge; 3) Future system scenario knowledge; and 4) Knowledge associated with intervention and transition strategies.

Photo Upper left: Bhutanese agricultural landscape; Upper right: Child food literacy education (Japan); Lower left: Consumer food cooperative (Holland); Lower right: Farmers and researcher workshop (China)

Systems (GIAHS) sites in Japan and China, as well as locations in Bhutan.

WG4: Supporting Tools for Sustainable Regions

WG4 explores tools— food labeling, corporate-social responsibility, and carbon valuation— for integrating ecologically sound production practices with unique market support structures that can be used to revitalize rural communities in Japan. Indicator analysis and development, local agro-economic modeling, and marketing surveys will be used to create a regional ecological food label and model case site in Kameoka City, Kyoto.

WG5: Transparent Food Chains

WG5 sets out to develop a smartphone app that tells the backstory of food products using existing and developed LCA data and various sustainability assessment criteria. Ecological, social, and health impacts are the three target factors around which a suite of data sets will be organized for various food categories. Close cooperation with key stakeholders in the food industry will be needed to maximize the impacts of this work and steps are being taken to ensure this is possible.

Sub Leader

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