Making dried fish
Alazeya River area, Sakha Republic, Russia
Salmon are filleted, sliced and then hung to dry. Fresh salmon caviar is eaten with the day's lunch
FUJIWARA Junko

Tree-lined road
Xiangcheng, Henan, China
Recently planted trees around farms make for beautiful scenery.
At the same time, timber for fuel and construction is in short supply
MAKIBAYASHI Keisuke

Disappearing island
Kiribati, Central Pacific Ocean
Islanders say that this island has been slowly disappearing in the past 30 years. Seabirds now can be seen perched on the exposed coral reefs, appearing almost as a new island
NAKATA Satoshi

Our Father's Cow
South of Zambia
Brothers playing on the back of their father's cow
ISHIMOTO Yudai

Resources Program

Program Director **MOJI Kazuhiko**

The Resources Program examines global environmental issues related to the use and conservation of natural resources. Human beings have always made use of—and changed—the environments in which they lived. Such change occurs as people appraise the qualities of the plants, animals, waters and soils that surround them, and develop the tools that allow them to make use of those qualities. Perception and use of resources is therefore related to a people or society's immediate need for survival and to its knowledge of the natural world. Resource use is also guided by cultural preferences, including favored tastes and forms of social organization, as well as a people's collective sense of its place and role within the larger world.

Human ability to perceive the dormant utility in the natural world has led to the domestication of plants and animals and the control of water and energy. Paradoxically, humanity's great advances in environmental knowledge and resource control have also led to environmental problems of unprecedented scale and magnitude. In aggregate, it appears that humanity is using many resources and taxing ecological services at a pace beyond their capacity for renewal or absorption.

Excessive resource use cannot simply be explained in relation to population or economic growth; instead we must look to the roots of the interactions between humanity and nature for explanation. Identifying solutions to contemporary resource problems will require close attention to specific patterns of human-environmental interaction, for there are great disparities between and within individual societies that prevent equal access to the benefits of the global environment and the solutions devised to address environmental problems.

Research projects in the Resource Program therefore make critical and creative assessment of resource-use processes and problems. Projects put special emphasis on water and food resources, especially as they are so closely linked to human health, daily life and wellbeing, and on the new infrastructures that will enable efficient resource use and improve quality of life.

Full Research	Leader	Title
R-03	**KUBOTA Jumpei**	Historical Interactions between Multi-Cultural Societies and the Natural Environment in a Semi-Arid Region in Central Eurasia
R-04	**MOJI Kazuhiko**	Environmental Change and Infectious Disease in Tropical Asia
R-05	**NAWATA Hiroshi**	A Study of Human Subsistence Ecosystems in Arab Societies
R-06	**KADA Ryohei**	Managing Environmental Risks to Food and Health Security in Asian Watersheds

Historical Interactions between Multi-Cultural Societies and the Natural Environment in a Semi-Arid Region in Central Eurasia

This project examines the historical interactions of humanity and nature in the semi-arid region of Central Eurasia. Textual, archaeological and biophysical evidence is used to examine the effect of human boundaries on environments, ethnic groups, dominant patterns of subsistence, and relations between cities and their surroundings. The findings of this project will improve understanding of how past human activities cumulatively affected ecosystems in Central Eurasia, and how semi-arid regions can best be managed in the future.

Project Leader
KUBOTA Jumpei RIHN

Professor Kubota earned a doctorate in forest hydrology from Kyoto University (1987). He was previously Assistant Professor at Kyoto University (1987-1989), 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 RIHN-China initiative. His major research fields are hydrology, water issues in arid regions and human impacts on the hydrological cycle.

Sub-Leader

WATANABE Mitsuko	RIHN

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CHENGZHI	RIHN

Background and objectives

Nomads were once the principal inhabitants of semi-arid Central Eurasia. Following the rise and fall of various ethnic groups and empires, the Yuan Dynasty took nominal control of much of Eurasia in the 13th and 14th centuries. In the 18th century, however, a national border was drawn across the region, definitely distinguishing Russia from Qing China. The inhabitants of the area subsequently experienced a great change of lifestyle, as the border and national settlement policies forced nomadic peoples out of their traditional patterns of livelihood.

This project combines analysis of historical documents, archaeological remains and natural proxies such as ice cores, lake sediment samples, tree rings and wind-blown deposits in order to describe how nomadic peoples and nation-states affected the natural resources and climatic conditions in the Ili River watershed. Project researchers also investigate human activities on both sides of the Russia/China border in order to describe the likely impact of these activities on contemporary environmental conditions.

Research area and groups

Research centers on the Ili River watershed area extending from China to Kazakhstan, and surrounding areas, including Kyrgyzstan and Uzbekistan. Throughout human history, Central Eurasia has been a key site of the civilizations of East and West. In more recent times, the development policies of modern states have led to severe environmental degradation.

This project consists of two research groups. The first group uses historical documents and natural proxies to describe historical changes in both human and natural systems. The second group investigates current human activities and natural systems in order to interpret the long term significance of past human and environmental change.

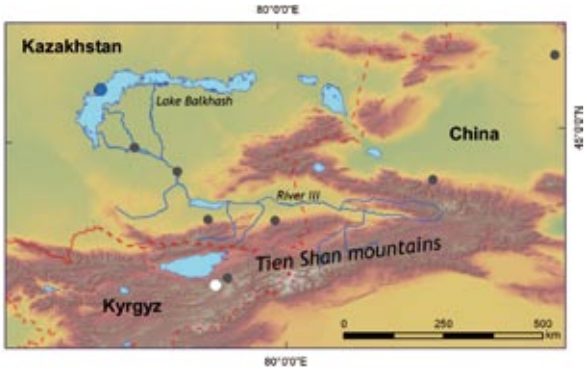


Figure 1 **The Tian Shan Mountains and Ili River**

● Lake sediment core ○ Ice core ● Other study sites

Progress to date

Project researchers have used several proxies to reconstruct climate change in the area in the past 1,000 years. This reconstruction forms the basis of our understanding of historical interaction between human activities and the environment. Reconstructed temperature and precipitation, and estimated river discharge, indicated that the period AD 1000-1500 was warm and dry, while the Little Ice Age (LIA, AD 1500-1850) from 1500 to 1850 was cold and wet. After the LIA, the climate became wet and warm. This long-term trend corresponds well with the reconstructed level of Lake Balkhash, which was determined by analysis of the ratio of saline and planktonic diatoms, indicating a decreasing trend of lake level in the 10th to 13th centuries. After this significant regression, the lake level showed rapid recovery and remained relatively high. Results from other proxies, such as dust and retrieval of glaciers support this description.

A chronological database was developed to describe the rise and fall of settlements. In the northern piedmont of the Tian Shan Mountains, oasis cities, which were agricultural centres, and trading bases in the Syr Darya basin of western Turkestan, flourished from the 7th century; settlements in the Ili River basin were the next to be blessed with prosperity. Most of the settlements were not founded on agricultural bases, but were nomadic and trading posts with military utility. In medieval times, agricultural and nomadic peoples lived separately, making full use of environmental variation. Interactions between the two peoples were complementary in terms of natural resources use. Climate change had both negative and positive effects on agricultural and nomadic production. A

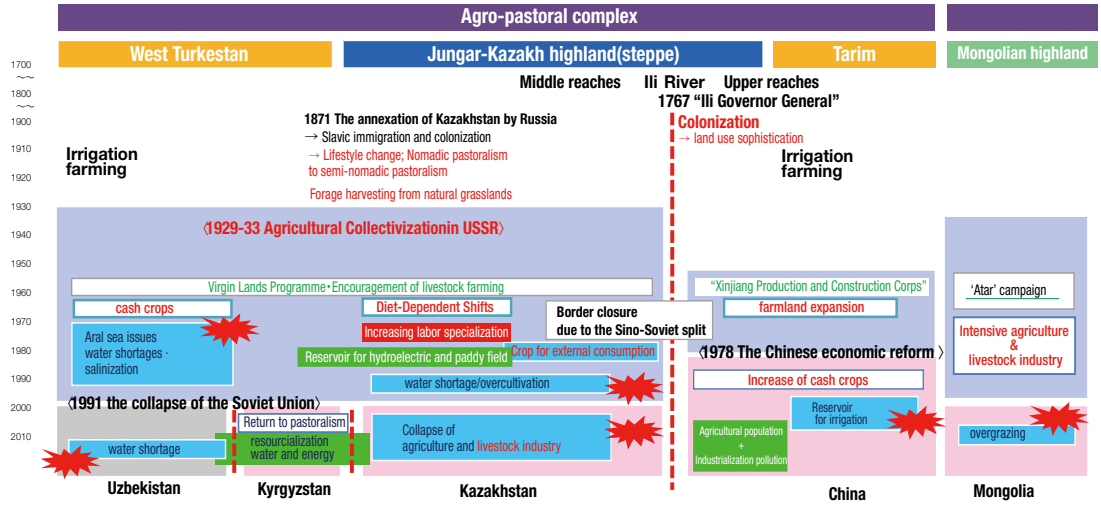
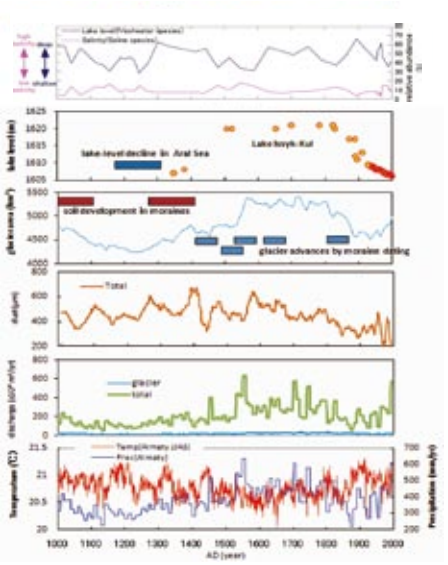


Figure 2 **Transition of social systems, subsisistence and environmental conditionsin Central Eurasia**



Ratio (%) of saline and planktonic diatoms shows that the lake-level in Lake Balkhash declined in the 11th-13th century and increased in the 17th-18th century.

Lake terrace and historical maps show changes of water level in Issyk-Kul Lake was high (around 1620m) in AD 1500-1850. Climate was wet in this period.

Glacier model shows glacier area in Iri river basin expanded in AD 1500-1850 during the Little Ice Age. Based on moraine dating, maximum glacier advances in the Gissar-Alay and Tien Shan occurred in the first period (AD 1450-1650) of the Little Ice Age.

Dust flux from Gregoriev ice core in Tien Shan. Increasing of dust flux in AD 1000-1400 shows a dry climate condition.

Glacial and total river runoff in the Ili river basin. Increased river runoff AD 1500-1850 shows a wet climate in this period.

Reconstructed summer temperature at Almaty from tree-rings (Esper et al., 2003) and precipitation from Guliya ice core (Thompson et al., 1995). Climate conditions were warm/dry in AD 1000-1500, cold/wet in AD 1500-1850, and warm/wet in 1850-2000.

Figure 3 **Long-term reconstructions of climate and environmental change in Central Eurasia**

warm and dry climate in early medieval times might have accelerated the development of agricultural and trading activities, and consequently contributed to the area's flourishing, especially of oasis cities in the Syr Darya basin of western Turkestan. The cold and wet climate in the early LIA might have accelerated the decline of oasis cities and the increase of nomadic activities in the Ili River basin and Dzungaria.

Relocation and change in subsistence patterns were major adaptations of these periods. This adaptive capacity, and so the direct impact of longer term patterns of environmental change, was drastically altered following the division of the area between Russia and Qing China, however.

In Kazakhstan, several stages of subsequent change can be identified. After Russian expansion, there were attempts beginning in the late 19th century to settle pastoral nomadic peoples and make them agriculturalists. Collectivization of the agricultural sector beginning in 1929 triggered serious social confusion in Kazakhstan, resulting in the loss of a large number of nomadic populations. Khrushchev's Virgin Lands Programme determined that Kazakhstan would become one of the Soviet Union's major crop production areas. The policy was conceived and implemented without regard for the area's traditional inhabitants or environmental capacity, and both suffered its successes. The newly adopted production systems were based on strict divisions of labour and required emigration of skilled peoples from other lands to serve as leaders of collective farms. These systems therefore did not promote accumulation of agricultural knowledge, while simultaneously undermining traditional knowledge of pastoralism.

With the collapse of the Soviet Union, the terms of trade in the agricultural sector deteriorated, state subsidies and purchases decreased, and many farmlands developed during the planned economy were abandoned. Abandonment reduced the pressure on natural resources, resulting in ecosystem recovery. At the same time, people labouring in state farms were provided rather small farmlands after privatization, but their experience as agricultural labourers was not adequate to the task of whole farm management. The area suffered general economic crisis, making transition even more difficult.

In China, modern development did not start until the 1950s. While plains grassland was converted to cereals agriculture in a first development period in the 1960s, the traditional nomadic pastoral system and natural grasslands were well preserved in the mountains. A second stage of development emphasized conversion of cereals to other cash crops, again causing no serious damage to natural resources such as land and water. Industrial development since 2000 however, has been very active and is expected to increase demand for natural resources and pollution in the region.

Environmental Change and Infectious Disease in Tropical Asia

The RIHN Ecohealth Project examines the effects of climate/environmental and social change on the ecology of human infectious disease in tropical monsoon Asia. Key drivers of ecological change in this area include climate change, population increase, deforestation, resettlement, urbanization, expansion of wet rice cultivation, changes in water management, economic development and livelihood/lifestyle changes. Prevalent diseases associated with such ecological change include malaria, liver fluke infection, and diarrhea. The study will offer new ecologically-based insights for the evaluation and control of infectious disease in relation to both local and global environmental changes.

Project Leader
MOJI Kazuhiko RIHN

Kazuhiko Moji has been at RIHN since 2007. He received his MA (1978) and Ph.D. (1987) in Health Sciences at the University of Tokyo. He was Research Associate at the Department of Human Ecology at the University of Tokyo (1983-1987). In 1987 he moved to Nagasaki University, where he served as Associate Professor in the Department of Public Health (1987-1999) and Professor in the School of Allied Medical Sciences (1999-2001), Faculty of Health Sciences (2001-2002), and Research Centre for Tropical Infectious Diseases of Institute of Tropical Medicine (2002-2007). He was a visiting Takemi Fellow of International Health at Harvard School of Public Health (1991-1992) and a visiting researcher in the Department of Bio-anthropology, Cambridge University (1998-2000).

Sub-Leader
NISHIMOTO Futoshi RIHN

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TOJO Bunpei	RIHN

Project background

The health profile of a human population can be seen as a product of the human ecosystem—an ecosystem comprised of both biophysical and human elements. The construction and conservation of sound human ecosystems, therefore, is essential to the livelihood, health and survival of human populations. The field of ecohealth considers human livelihood and health in relation to environmental conditions; it can improve attempts to address disease and local and global environmental problems.

Progress to date

The RIHN Ecohealth Project is studying major infectious diseases in tropical monsoon Asia (Table 1).

Several research groups comprise our project. The Lahanam Study Group's research in Savannakhet Province, Laos, examines patterns of liver fluke infection of *Opisthorchis viverrini* (Ov), a parasital infection associated with consumption of raw freshwater fish. In 2011 the principal objectives of this group are to:

1) Maintain and expand the Lahanam Health and Demographic Surveillance System (HDSS) and analyse life expectancy and causes of death;
2) Study the relation between modern irrigation/wet-rice cultivation and liver fluke infection (Fig. 1);
3) Study fish and snail ecology, fishery ecology, and consumption of fish, and;
4) Determine feasible educational, behavioural, and/or environmental control of liver fluke infection.

Studies on young children and school health and nutrition are also underway.

The Sepone Study Group's work in Savannakhet Province, Laos, is developing an integrated ecological and medical approach to malaria control and elimination in Southeast Asia. This group established a mobile phone-based health information network system covering all 158 villages in Sepone. Land-cover studies and satellite image analysis (ALOS) were conducted in Lahanam and Sepone. In 2010 this group found the very high mortality of young children among mountain farmers. The principal objectives of this group in 2011 are to:

1) Maintain the Sepone Health Information Network in order to monitor monthly incidence of malaria and other diseases;
2) Analyze the relation of forest cover change, settlement, subsistence, mosquito population/ecology with malaria endemiology/epidemiology;
3) Analyze the environmental and societal changes within the Banhiang River catchment area (a tributary of the Mekong River), including rainfall, flood, land- cover/use, and water quantity and quality;
4) Analyze the effects of the Vietnam War on the occurrence of malaria (Fig. 2).

The Vietnam Study Group is focusing on transmission of new human malaria, *Plasmodium knowlesi* (Pk) in humans as well as in monkeys. The group found a very high mix-infection of Pk with *P. vivax* in humans. The group therefore has begun to analyse Pk incidence through a multi-disciplinary approach including malariology, entomology, primatology, forestry, epidemiology and social sciences. The team also is assessing the prevalence of Pk near the Sepone border of Laos.

The Bangladesh Study Group is working in collaboration with the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR, B) to study the relationship between the Indian Ocean Dipole and the incidence of cholera in Dhaka. This group is also studying the

Table 1 **Target diseases of the RIHN Ecohealth Project**

Diseases (pathogens)	Vector/Fomites	Reserch field	Environmental factors	Research strategies	Interntional parters
malaria (*P. falciparum*)	mosquito (*A.dirus*)	Lao, Sepone Distirct	forest, swidden cultvation, bomb holes	mobilephone network, malaria-ecological survey	NIOPH, SVKPHD-MS, CIMPE
zoonotic malaria (*P. knowlesi*)	mosquito (*A.dirus*)	Vietnam, Khanh Phu Commune	forest, wild monkey, illegal logging	malaria analisis	Khanh Phu Malaria Station, NIMPE
malaria in the 20th C (*P. falciparum/ P. vivax*)	mosquito (*A.sinensis*)	China, Yunnan	forest retardation, subsistence transition	Chinese historical records	Yunnan University
cholera and other diarrhea	water, food	Bangladesh, Dhaka	climate change, flood, estreme events	climatological data and hospital data	ICDDR,B, London University
diarrhea, chronic diseases, total mortality	water, various	Bangladesh, Matlab	flood in 2004	epidemiological survey in HDSS	ICDDR,B, London University
rotavirul infection	water, food	Sri Lanka	refugee camp, tsunami effects	molecular epidemiology	University of Colombo
filariasis	mosquito (*Curex spp.*)	Bangladesh, Northwest region	poverty, discrimination, living condition	urine antibody analysis, mobidity control, control of mosquitos	Government of Bangladesh, JICA
neglected tropical diseases (NTDs)	dogs (rabies) snake bite etc.	Bangladesh (all country)	hot and humid environment of tropics, poverty, poor health system	health Information system, preparedness of environmental sanitation	Government of Bangladesh
liver fluke infection (Ov.)	snail, carp	Lao, Savannakhet	flood, irrigation, defecation places	parasitological-ecological approach	NIOPH, SVKPHD, Mahidol Univ.
soil transmitted helminsiasis (STH)	water, food	Lao, Savannakhet	defecation, animal husbandary, environmental sanitation	HDSS, stool exam copro-DNA	NIOPH, SVKPHD, Mahidol Univ.
maternal and child/vaccine preventable diseases	various factors	Lao, Savannakhet	nutrition, health services, tradition	HDSS, cause of death analysis	NIOPH, SVKPHD
dengue fever/ dengue haemorrhagic fever	mosquito (*Aides spp.*)	Lao, Savannakhet	urbanization, water containers	nutrition, malaria co-infection	SVKPHD-MC
HIV/AIDS, STI, viral hepatitis	sexual contact, IVDU	China, Yunnan	poverty, TB, mobile population	molecular, social and behaivioral epidemiology	China CDC・YHDRA
schistosomiasis (*Schistosoma japonicum*)	snail (*Oncomelania*)	China (Yunnan and Jiangnan)	aquatic system, irrigation, dams,	historical records & oral history	Shanghai JT Univ.; Yunnan Univ.
health effects of environmental pollutants	occupational exposure	China and Lao (Savannakhet)	livelihood, pesticide, fertilizer,	analysis of bio-samples & water	Univ. of Tokyo ENVRERA project

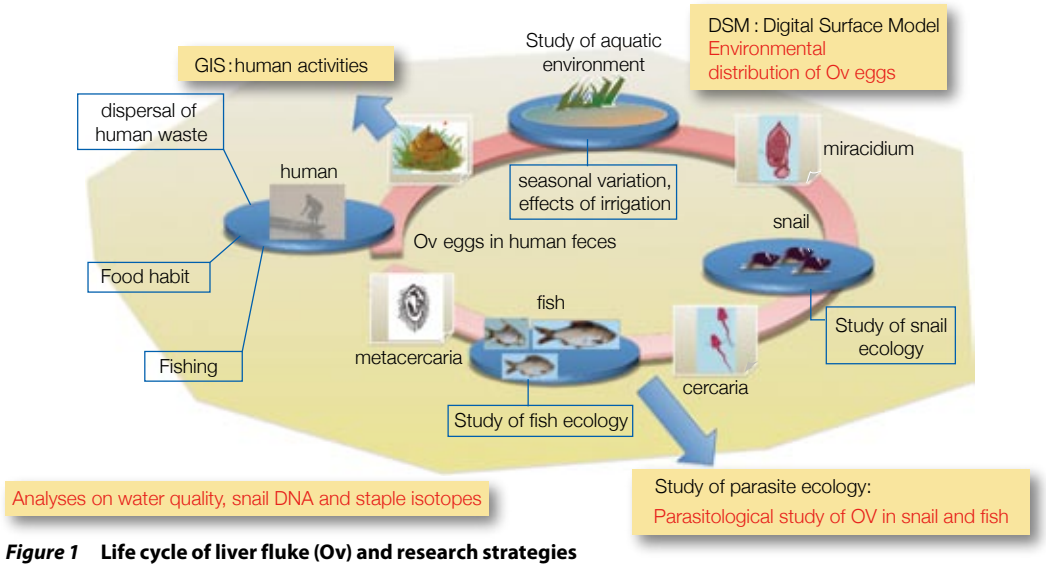

Figure 1 **Life cycle of liver fluke (Ov) and research strategies**

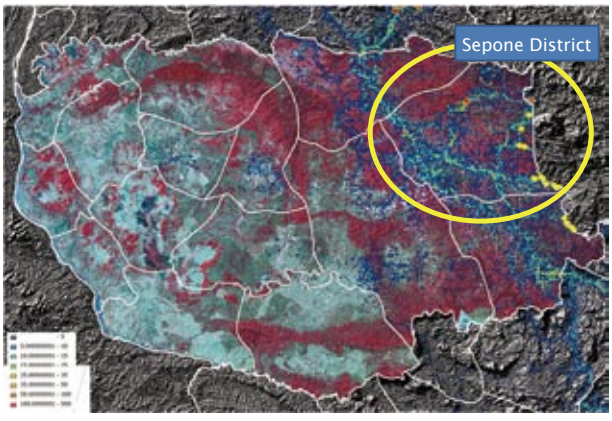

Figure 2 **ALOS image of Savannakhet Province of Lao PDR with density of bombing during the Vietnam War**

Table 2 **Disease profile of Indochina in 1922**

Disease	Inpatients	Deaths
Malaria	16,703	1,451
Tuberculosis	2,360	626
Dysentery	3,157	546
Beriberi	2,018	356
Leprosy	1,090	352
Cholera	479	310
Opium addict	953	135
Syphilis	5,024	107
Plague	118	75
Smallpox	432	74
Influenza	927	62
Total	33,261	4,094

Source: Annuaire statistique de l'Indochine

long-term effects of flood on morbidity and mortality in Matlab. In collaboration with the Ministry of Health and Welfare, a subgroup is studying epidemiology of rabies in the entire nation, and of filariasis in the north-west of the country.

The China Study Group investigates how social and environmental change affects health in the Greater Mekong Subregion. There are many vulnerable populations, including male and female commercial sex workers, IV drug users, migrant urban labourers, poor rural farmers and international migrants. The Yunnan Health and Development Research Association (YHDRA) is conducting research to improve the ecohealth of such vulnerable populations, and Ecohealth Project researchers are also describing the prevalence of HIV/AIDS among vulnerable peoples in the region. The China History Study Group is making a database documenting control of malaria and schistosomiasis in the 20th Century. The disease profile of colonial Indochina is also described (Table 2).

A Study of Human Subsistence Ecosystems in Arab Societies: To Combat Livelihood Degradation for the Post-oil Era

This project examines life support mechanisms and self-sufficient modes of production among Arab peoples who have survived in dryland environments for more than a millennium. Using the research results, we will propose a scientific framework to strengthen subsistence productivity and combat livelihood degradation in local Arab communities in preparation for the post-oil era.

Project Leader
NAWATA Hiroshi RIHN

Hiroshi NAWATA received his Ph.D. in Human and Environmental Studies (Cultural Anthropology) at Kyoto University (2003). He was assistant professor at the Division of Comprehensive Measures to Combat Desertification, Arid Land Research Center, Tottori University (2004-2007). His major fields of interests are camel pastoral systems, Muslim trading networks, and indigenous (traditional) knowledge for rural development in the Middle East and Africa.

Sub-Leader
ISHIYAMA Shun RIHN

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Background

For political, social, economic and environmental reasons, the Middle East now faces a turning point in modern oil-based development. Fossil fuel-based interdependencies must now be transformed into new relations that can support viable future societies.

This research project focuses on human subsistence ecosystems of the region: low energy-intensity life-support mechanisms and modes of production, such as hunting, gathering, fishing, herding, farming, and forestry. In doing so it also reflects on the role of advanced technologies in economic development, and assesses measures adopted thus far to combat desertification. Field research investigates keystone species, ecotones, and traditional knowledge. In sum it examines the sustainability of subsistence economies under site-specific conditions.

Research methods and organization

The study is developed along three principal axes (Fig. 1): 1) botanical and ecological study of the alien invasive species mesquite, with emphasis on comprehensive measures for its control; 2) environmental impact assessment of development programs in coastal zones of the arid tropics; and 3) sharing of research results to support local decision making. Field research examines subsistence ecosystems, focusing on keystone species such as camels, date palm, dugong, mangrove, and coral reefs, and ecotones such as wadi beds, riverbanks, mountainsides, and seashores.

The members of this project include social and natural scientists, members of local NGOs, and project managers, who are divided into four study groups, concerned with the following (Fig. 2):

1. Alien invasive species control
A team of Japanese and Sudanese hydrologists, plant physiologists, weed scientists, remote-sensing specialists, range managers, agricultural economists, nutrient physiologists, and cultural anthropologists conducted field surveys at riverbanks, wadi beds, seashores and mountainsides in arid to semi-arid areas of Sudan. The group has developed a detailed description of the human and ecological factors affecting mesquite growth in several distinct environmental contexts, and suggested several potential measures that may be used for its control.

2. Environmental assessment in coastal zones
Forest structure, morphology, and water use of the keystone mangrove species Avicennia marina in the southern Egyptian Red Sea coast were studied in collaboration with the Nature Conservation Sector of the Egyptian Environmental Affairs Agency. Ten microsatellite markers on DNA analysis were found on collected samples. Parent-child relationship of A. marina may be revealed in further study at the RIHN laboratory. Local environmental researchers and administrators have begun extension courses to promote mangrove re-forestation along the Red Sea coast in Egypt and Saudi Arabia. Anthropological study on maritime societies demonstrates a high level of traditional ecological knowledge, particularly in regard to coral reef environments.

3. Support for local decision making
Three sites have been selected for field surveys: In Belbel, Matriouen and Aoulef. Surveys are to describe the Sahara oasis subsistence ecosystems in light of recent historical change (Fig. 3). Fieldworkers are anthropologists, biologists, geographers and historians; practitioners, consultants and motivated farmers also participate. Researchers from the Centre National de Développement des Ressources Biologiques (CNDRB) are to inventory fauna and flora at the sites and draft conservation projects involving local inhabitants.

Figure 1 **Field survey areas**

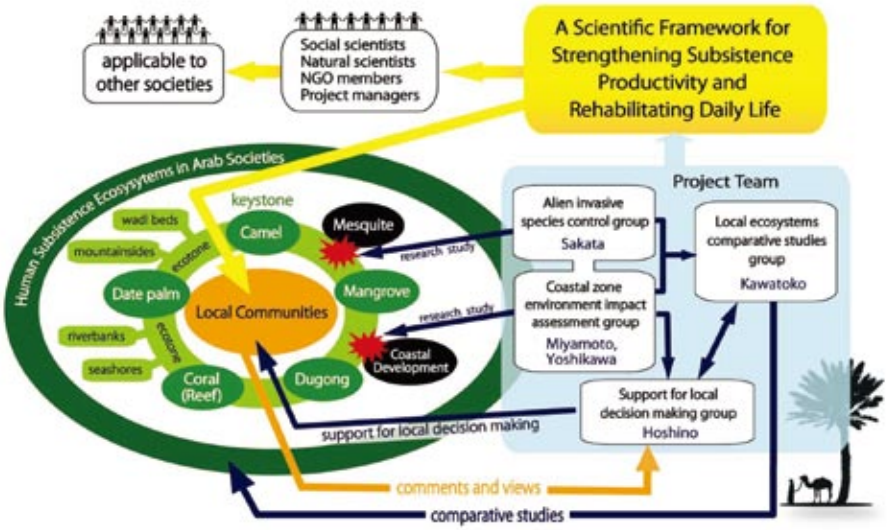

Figure 2 **Research methods, approaches, and organization**

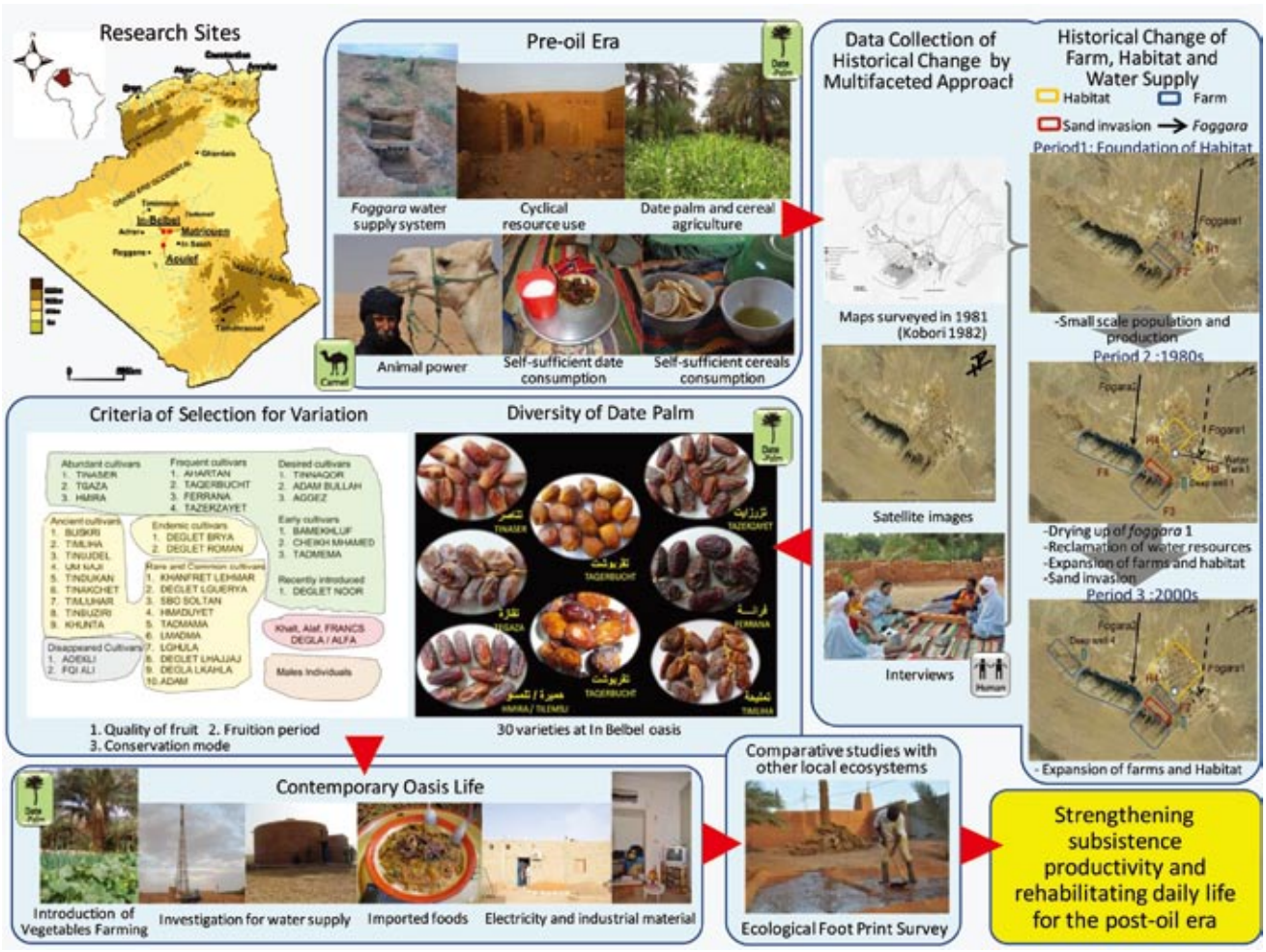

Figure 3 **Design and progress of survey in Algeria**

Research shows that in pre-oil era (more than 50 years ago), human subsistence was based on self-sufficient social-ecological systems. Life depended on oasis resources. Date palm agriculture and groundwater-based irrigation systems, called *foggara*, were indispensable. There were also extensive extra-local networks based on camel transport. This mode of life has changed dramatically since the 1970s. The use of deep-water pumps has allowed oasis agriculture to expand, but new water sources are often not dependable. The use of *foggara* has declined. Date palms have become a commodity for export, not local consumption. Cous-cous, an imported food, is now a staple. Since October 2010 we have analyzed the ecological footprint associated with this conversion at a deep-pump irrigated date palm farm in Aoulef.

Future tasks

Full-scale field surveys are now underway in each research area. In the next year we will begin comparative data analysis and consideration of best ways to disseminate findings. In particular, we are investigating potential alternative uses of uprooted invasive mesquite trees; Sudanese researchers are examining the species potential as fodder and charcoal. Another key task is the design of a coastal mangrove management and afforestation regime based on traditional uses.

Managing Environmental Risks to Food and Health Security in Asian Watersheds

This project combines the social, medical and physical sciences in order to develop strategies of ecological risk management for sustainable food, health security and watershed planning in the Laguna Lake region, the Philippines. In addition to the dense population and urbanization, the continuing deforestation, upsurge in inland fisheries, and unabated abuse of the land uses surrounding the lake have aggravated the deposition of the sediments and resulted in the rapid deterioration of water quality. Organized by Japanese and Filipino researchers, this project aims at critically examining resource degradation and pollution, its origin and effect on aquatic life, food production and quality, and subsequently on public health in the Laguna Lake watershed area.

Project Leader
KADA Ryohei RIHN

Professor Kada joined RIHN as leader of the Food and Health Risk Project in July 2010. He also teaches at the Graduate School of Environment and Information Sciences, Yokohama National University. From 2001-2004 he served as Policy Research Coordinator at the Policy Research Institute, Ministry of Agriculture, Forestry and Fisheries (PRIMAFF), Japan. For nearly 25 years he has been researching and teaching agriculture and food policy at the Graduate School of Kyoto University, and has also held posts at Kasetsart University in Thailand and the University of Wisconsin-Madison. With B.S. and M.S. degrees in agricultural economics from Kyoto University, he received his Ph.D. from the University of Wisconsin-Madison in 1978.

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Background and research objectives

This research project investigates the direct and complex links between environmental change, ecological degradation, food availability and quality, and human health. Research is conducted at three sites in the Laguna Lake region, a highly populated and variegated region in which rich ecological resources are threatened by rapid land use change, urbanization and industrialization. Study sites are representative of the challenges facing many other Asian watersheds.

The project has four principal objectives: 1) to document the current levels and pathways of heavy metals pollution in the aquatic resources of Laguna Lake; 2) to investigate the health condition of local residents and their perception of food risks; 3) to analyse the ecological effects of agrochemical inputs, and their cumulative impact on food production and relation to subsequent ecosystem deterioration; and 4) to describe land use change in the Laguna Lake area and its impact on material cycles directly related to agricultural productivity, such as sedimentation and groundwater level and quality.

Research organization

Five research teams are comprised mainly of researchers at RIHN, Yokohama National University and University of the Philippines; they work in collaboration with government agencies such as the Laguna Lake Development Authorities (LLDA) and local government units. The *Environmental Risk Assessment Team* identifies the exact sources of, and factors responsible for, particular pollutants in the food chain. The team uses stable isotope and other analytical techniques to investigate how land use change is associated with downstream pollution. The *Socio-Economic Evaluation Team* explores how market- and non-market-based instruments can be used to improve water quality, food security and public health. The *Health Risk Evaluation Team* describes human nutrition, history of disease, and life expectancy in the region, especially in relation to socio-economic dynamics. The *Payment for Ecosystem Services Team* (PES) investigates the design of ecosystem service payment programs that may support robust regional agroecologies. The *GIS-based Risk Mapping Team* supports the entire research

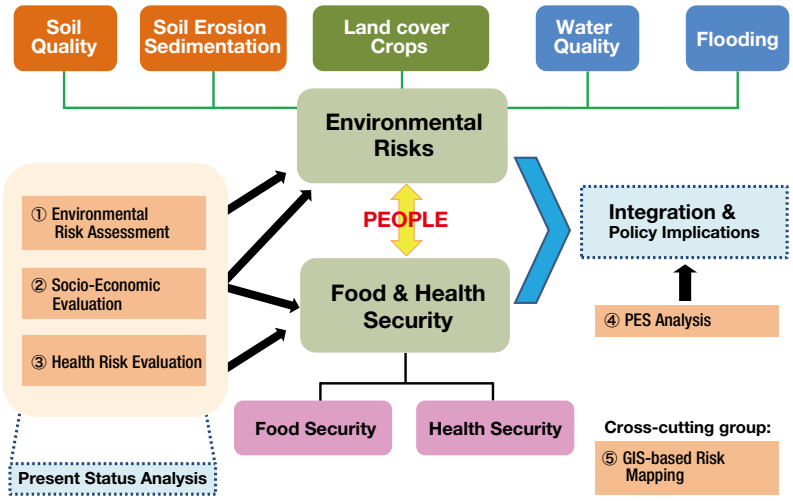

Figure 1 **Basic Research Flow and Organization**

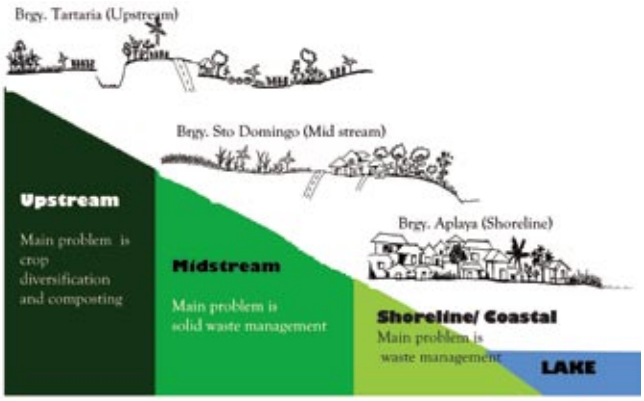

Figure 2 **Transect Map of the Village PRA Sites**

Figure 4 **Extent of flood in the village of Applaya, Santa Rosa, Laguna**

Flood Water Foot Print of Typhoon "Milenyo": Coastal Flooding in Brgy. Aplaya, Sta. Rosa City, Laguna Province

Figure 3 **Participatory Rural Appraisal Activities**

project by creating a spatially-explicit database of key variables associated with risk in the food chain.

Progress to date

Although research is still at an early stage of implementation, initial findings indicate that industrial and agricultural pollution is a major environmental issue in the region. Unsafe concentrations of heavy metals such as lead, chromium, cadmium, arsenic, and mercury have been found in the lake water column. Toxic concentrations of lead are now found in tilapia sampled in markets and caught in open water, as well as in some local crop plants such as *kangkong* (*Ipomoea aquatica*) and *kamote* (*Ipomoea batatas*). In quantity, however, most pollution is associated with untreated human waste; water-borne pathogens thus pose significant human health risk. Environmental degradation throughout the watershed has reduced resource availability to local residents. There is a danger of feedback cycles between resource deterioration and decreasing household income, access to food and public health. As a consequence, many households are exposed to health risks and food insecurity. Survey respondents, especially those dependent on fisheries and upland agriculture, reported significant concern for their ability to improve, protect and expand their current resource base.

The GIS team has begun spatial description of human and environmental health risks. Their database will allow integration and analysis of multivariate data, including resource presence and availability, community health and nutritional status, food availability and quality, and other factors affecting vulnerability to ecological risk. GIS analysis should also aid in identification of unforeseen transboundary risks associated with current and future land use changes in the target areas.

Plans for Full Research

The Environmental Risk Assessment Team takes a geochemical approach to the study of interactions between humans and nature. Using techniques of stable isotope analysis, it describes the pathways of multiple elements through water and soil environments. It also assesses water quality in relation to basic water quality criteria, trophic state parameters and phytoplankton communities, and aquatic macrophyte biosorption in order to address issues of stream turbidity, eutrophication and heavy metal pollution.

Socio-Economic Evaluation Team: (i) characterization of other critical watersheds surrounding Laguna Lake; (ii) food risk assessment; (iii) bio-economic modeling of the effects of land use patterns on lake water quality and commercial fish productivity; (iv) assessment of household and community vulnerability to environmental risks induced by changing land uses in the Dampalit Subwatershed, Los Baños.

The Health Risk Evaluation Team will continue with its baseline evaluation in order to clarify the type and severity of environmental exposure(s) affecting human health. It will describe community exposure to environmental pollutants near Laguna Lake and assess the health risks posed by consumption of fish and other local food products, such as shellfish and duck eggs, contaminated by heavy metals.

The PES Analysis Team will use municipality-level socio-economic statistics and/or interview data in order to examine the value of potential ecosystem services. It will also estimate the impact of different land use and policy options, from no conservation to full conservation, on farmer livelihoods.

The GIS-based Risk Mapping Team will enhance its ability to describe the benefits and risks associated with particular patterns of land use change, especially in relation to transboundary water-related disasters such as flooding, and to support development of comprehensive land use plans in selected municipalities in the region.