C Circulation Program

Program Director **TANIGUCHI Makoto**

What is circulation and how does it relate to global environmental problems? Two concepts of circulation are considered in this program. One is the circulation of energy and matter at the earth's surface. Matter includes air, water, chemical components and the living organisms they contain. Such circulations of energy and matter are caused by solar radiation absorbed by the earth's surface systems. In a broad view, the migration of humans around the planet can be considered as a kind of circulation, as can the great amount of material people move from place to place. Circulation describes large-scale spatial and temporal movements that in small-scale may look like flows. The critical issue in regards to global environmental problems is that current change in the biogeochemical circulations that sustain the biosphere is so sudden; it may be irreversible, though this is difficult to predict, as it depends in part on human thought, action and culture.

The recurrent interaction between humanity and nature can also be considered as a kind of circulation. Through economic and technological development, and through its sheer numbers, humankind has gradually transformed the surface of the planet. It has altered existing environments and created wholly new environments, which have in turn become new sites of human-environmental interaction in which new societies have emerged.

Individual research projects in the RIHN Circulation Program are conceptualized and carried out within the above conceptual framework. They cumulatively improve human understanding of the ceaseless motion that composes the biosphere.

Completed Research	Leader	Title
C-04	**SHIRAIWA Takayuki**	Human Activities in Northeastern Asia and their Impact on Biological Productivity in the North Pacific Ocean
Full Research	Leader	Title
C-05	**TANIGUCHI Makoto**	Human Impacts on Urban Subsurface Environments
C-06	**KAWABATA Zen'ichiro**	Effects of Environmental Change on the Interactions between Pathogens and Humans
C-07	**INOUE Gen**	Global Warming and the Human-Nature Dimension in Siberia
C-08	**MURAMATSU Shin**	Megacities and the Global Environment

Human Activities in Northeastern Asia and their Impact on Biological Productivity in the North Pacific Ocean

How do continental forests and wetlands affect life in the sea? Adapting the traditional Japanese concept *uotsukirin*, or "fish-breeding forest", this project investigated the ecological linkages between the Amur River basin and primary marine productivity in the Sea of Okhotsk and Oyashio region of the northern North Pacific Ocean. In particular, the project documented how dissolved iron from the Amur River supports ocean primary production and how this iron discharge is affected by human activity in the Amur River basin. Finally, by studying the underlying causes behind the land-use changes in the basin, the project proposed how this continental-scale terrestrial-marine linkage—the giant fish-breeding forest—can be sustained.

Project Leader: **SHIRAIWA Takayuki** Institute of Low Temperature Science, Hokkaido University (RIHN until March 2010)

Achievement of the project

The Sea of Okhotsk and the neighboring Oyashio current region compose one of the richest marine environments in the world. This project investigated the source of this productivity. Iron is an essential element for phytoplankton, but iron's insolubility usually limits its availability in open water. In the Sea of Okhotsk region, however, we hypothesized that thermohaline circulation caused by sea ice production would increase the amount of iron available to phytoplankton. We supposed that the original source of this iron was upstream, in the forests and wetlands of the Amur River basin.

In the last five years, our intensive field activities in the Amur River basin and the Sea of Okhotsk/Oyashio region validated these initial ideas. We found that 40% of the annual phytoplankton productivity in the Oyashio region depends on iron from the Amur River; the remaining 60 % depends on iron recycled through a microbial loop.

In the Amur River basin, the highest concentration of iron was recorded in the wetlands extending through the middle reaches of the basin. In the latter half of the 20th century, however, this wetland has often been converted into upland and paddy fields. In order to determine the effect of this land conversion on primary productivity in the Sea of Okhotsk, we reconstructed basin-scale land-use maps for 1930 and 2000 and developed a hydrological model designed to compare the potential iron flux from the Amur River in each period. The results suggest that iron flux in the 1930 was 20% higher than in 2000, and will decrease further as wetland conversion or forest burning continues (Fig. 1). The project results motivated us to establish an epistemic community, the Amur-Okhotsk Consortium, to discuss sustainable use of the Amur-Okhotsk ecosystem.

Photo **The Amur-Okhotsk Consortium was established for the futurability of the Amur-Okhotsk Ecosystem including the giant fish-breeding forest.**

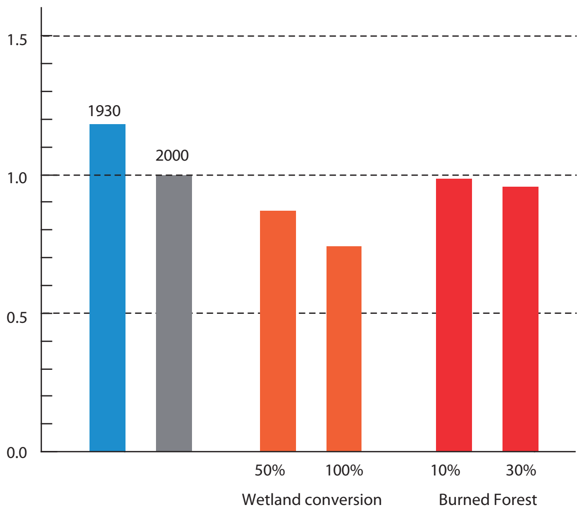
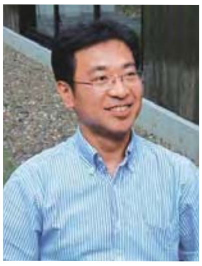


Figure 1 **Simulated results of land cover conversion in the Amur River Basin on iron flux**
Iron flux in 2000 (■grey bar) is compared to that estimated in 1930 (■blue bar) and under several land change scenarios. ■Orange bars show potential decrease with 50% or 100% decrease in wetland area; ■red bars show potential decrease with 10% or 30% increase in forest burning.

Human Impacts on Urban Subsurface Environments

This project assesses the effect of human activities on urban subsurface environments, an important but largely unexamined field of human-environmental interactions. Subsurface conditions merit particular attention in Asian coastal cities where population numbers, urban density and use of subsurface environments have expanded rapidly. The goals of this project are to evaluate the subsurface environments of seven Asian coastal cities for such problems as subsidence, groundwater contamination and thermal anomalies, and to suggest how they can be addressed or avoided.



Project Leader
TANIGUCHI Makoto
RIHN

Professor Taniguchi earned his doctorate in hydrology from the University of Tsukuba. In addition to his work at RIHN he is a leader of the UNESCO-GRAPHIC Project "Groundwater Resources Assessment under the Pressures of Humanity and Climate Change", and vice president of the International Committee of Groundwater of the IAHS/IUGG. He has published several books and journal articles on hydrology, geophysics and environmental science.

Core Members

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YAMANO Makoto	Earthquake Research Institute, The University of Tokyo
KANEKO Shinji	Graduate School for International Development and Cooperation, Hiroshima University
ONODERA Shin-ichi	Graduate School of Integrated Arts and Sciences, Hiroshima University
FUKUDA Yoichi	Graduate School of Science, Kyoto University
SHIMADA Jun	Faculty of Science, Kumamoto University
NAKANO Takanori	RIHN
ENDO Takahiro	University of Tsukuba
SIRINGAN, Fernando	University of the Philippines
DELINOM, Robert	Indonesia Institute of Science
WANG Chung-Ho	Academia Sinica, Taiwan
BUAPENG Somkid	Ministry of Natural Resources and Environment, Thailand
LEE Backjin	KRIHS, Korea

Project background and objectives

Most environmental research focuses on above-ground environments. Subsurface environments, though they are involved in biogeochemical circulations and are critical to overall environmental quality, attract little attention, perhaps because they are invisible and difficult to evaluate. Subsurface environmental problems such as subsidence and groundwater contamination occur repeatedly in major Asian cities, though there is often a time lag between the "stage" of urban development and the point at which negative subsurface conditions are recognized. Improved understanding of the subsurface environmental changes associated with past and present urban growth should improve overall urban environmental quality in the future.

This project investigates subsurface environmental conditions in Tokyo, Osaka, Bangkok, Jakarta, Seoul, Taipei and Manila. It also assesses the degree to which groundwater resources may improve these cities' resilience to increasingly variable sources of surface water. Each city's historical development will be assessed through socio-economical analyses and historical records. Hydrogeochemical and in-situ/satellite-GRACE gravity data will describe groundwater flow and storage systems, and indicate where significant problems in subsurface environments exist. Chemical analyses of subsurface waters, sediments and tracers will allow us to evaluate contaminant accumulation and transport from land to ocean. Finally, we will use urban meteorological analyses to reconstruct surface temperature histories in the seven cities and to examine the impact of the urban "heat island" effect on subsurface thermal contamination.

Progress in 2009

Subsurface environments in the seven cities have been surveyed, and monitoring continues.

Natural and social data have been assessed in each city and compiled into a GIS database. Based on historical maps, land use/cover maps of 0.5 km mesh were composed for each city at three development stages (1930s, 1970s, and 2000s).

RIHN project members organized the 3rd RIHN international symposium, on Urban Subsurface Environments. A volume based on the symposium entitled "Human Impacts on Urban Subsurface Environments" will be published in 2010 (Springer Publishers).

Several cross-cutting themes, such as the relation between groundwater and religious sites and beliefs in Bangkok and Jakarta, have been identified and investigated.

Fifteen indices of urban social and environmental change and six indices of natural capacity were compiled.

Future works and challenges

We must continue analyzing how water use and quality is affected by water rights and regulation of surface and groundwater in each of the cities under study.

We will combine our social and ecological data and our subsurface ennvironmental model in order to analyze the impact of water resources, environmentalloads, economic processes and public policies on subsurface environments.

Land use/cover data taken in the 1930s, 1970s and 2000s will be used to evaluate the rate of groundwater recharge, thermal storage in aquifers, and subsurface contamination. Based on the above, we will develop several scenarios describing how better relationships between subsurface environment and society can be established.

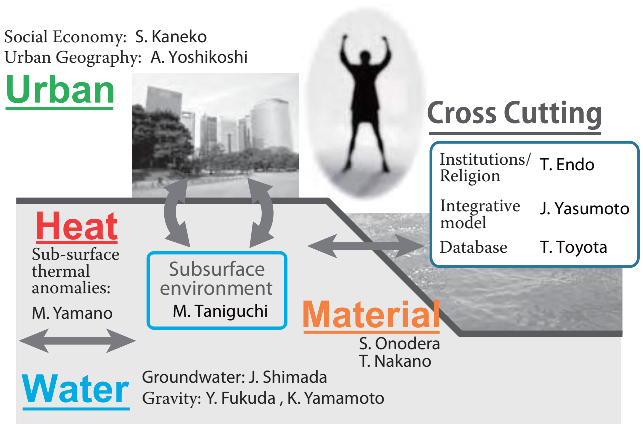


Figure 1 **Research Structure**

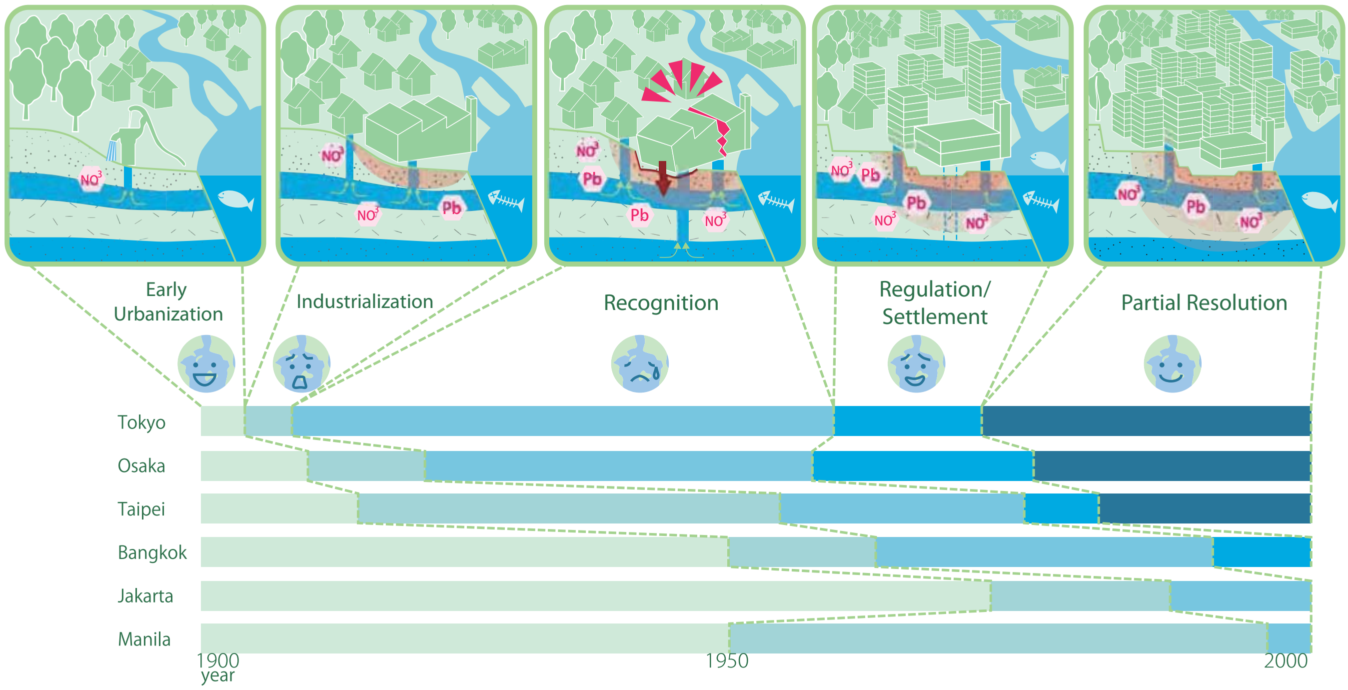
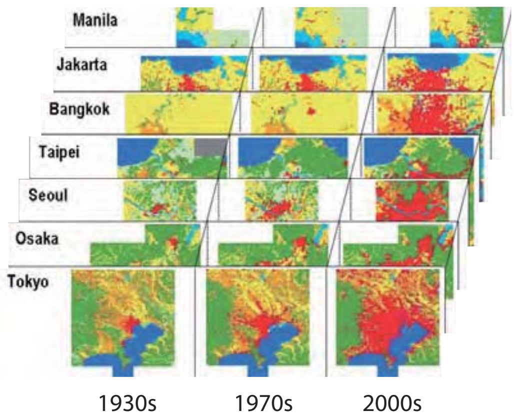


Figure 2 **Cross Cutting : Integrated Model**

Observed and statistical data are compared in seven cities based on five stages of development. The bar figure shows the stages of land subsidence at each city in comparison with Tokyo.



Historical changes in land use/cover in the seven cities. Residential areas have expanded along with urban development.

Groundwater storage and flow patterns are quantitatively modeled.

Groundwater models are used to estimate the total impact of natural and human processes on subsurface environments.

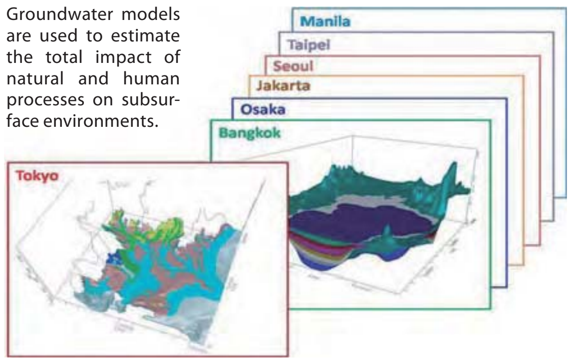


Figure 3 **Cross-cutting analysis: Integrated groundwater models/GIS**

Integrates observed and GIS data and constructs a framework for comparative analysis of the seven cities.

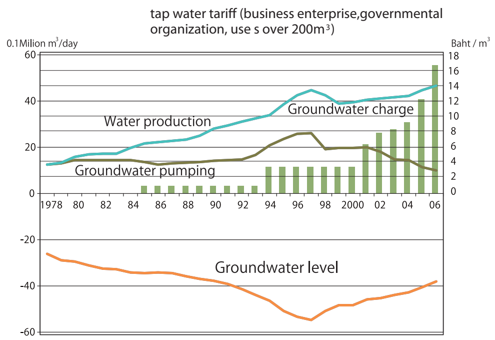


Figure 4 **Cross-cutting themes: Legal institutions**

In Bangkok, excessive groundwater pumping in the late 1970s led to land subsidence. The problem was solved through expansion of surface water infrastructure and the imposition of a charge for use of groundwater, which is now more costly than tap water.
Beyond 200m³/month, a special tariff of 15.81 Baht applies to each unit of water used.

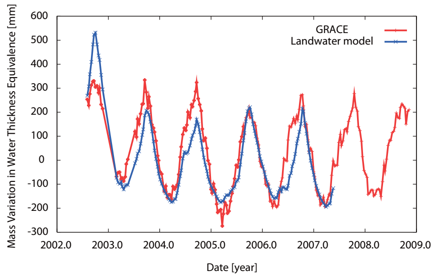
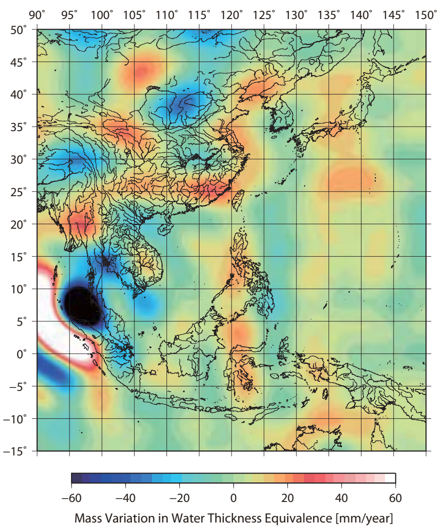


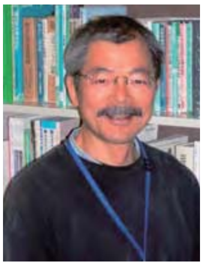
Figure 5 **Gravity GRACE**

Right: Inter-annual Earth mass trend observed by GRACE (2002 to 2009). Variations in mass over the land area correspond to changes in total terrestrial water storage, including groundwater. Mass is decreasing in and around the Bangkok area.
Above: Time series of GRACE-derived mass variation and model-derived terrestrial water storage over the Chao Phraya river basin. The two variables show good correspondence.



Effects of Environmental Change on the Interactions between Pathogens and Humans

There is an important environmental component to infectious disease. While pathological studies inform effective disease treatment, study of disease ecology – the interactions between pathogen, host and human actions that may create or eliminate 'fertile' disease environments – is necessary for prediction and prevention of new disease outbreaks. This project intensively examines the ecological and social causes and effects of Koi Herpes Virus disease in Japan and China in order to develop a model of pathogen-human interactions. Based on our experiments and observations of interactions between pathogen, environments and humans, we will suggest ways to prevent or minimize the emergence and spread of infectious diseases.



Project Leader
KAWABATA Zen' ichiro
RIHN

Zen'ichiro Kawabata previously held professorships at Kyoto University and Ehime University, and an assistant professorship at Tohoku University. His research field is microbial ecology and aquatic ecosystem ecology.

Core Members

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ITAYAMA Tomoaki	RIHN
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KONG Hainan	School of Environmental Science and Engineering, Shanghai Jiao Tong University, China
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MINAMOTO Toshifumi	RIHN
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OKUDA Noboru	Center for Ecological Research, Kyoto University
OMORI Koji	Center for Marine Environmental Studies, Ehime University
WU Deyi	School of Environmental Science and Engineering, Shanghai Jiao Tong University, China
YAMANAKA Hiroki	Department of Environmental Solution Technology, Ryukoku University

Objectives

Infectious disease has become a significant global environmental problem. This study investigates the emergence and spread of Koi Herpes Virus (KHV) in Lake Biwa, Japan. KHV is a pathogen responsible for episodic mass mortality of common carp (*Cyprinus carpio carpio*) (Photo 1) since the late 1990s. The common carp is the original domesticated aquaculture species, and an important source of protein today (Photo 2).

This study has three main objectives: (1) To describe Koi Herpes Virus disease ecology, including: the specific links between anthropogenic changes to freshwater ecosystems and the emergence and spread of KHV disease; the impacts of KHV disease on local ecosystem services; the social and cultural attempts to address KHV disease; and the environmental changes associated with human adaptation (Fig. 1); (2) To describe a general model of linkage between environments, pathogens and humans (Fig. 3); (3) To suggest how interactions between pathogen and humans may be modified in order to mitigate the human and environmental damages associated with infectious diseases.

Research methods and organization

Fields surveys are conducted at Lake Biwa, Japan, and Lake Erhai, China. Laboratory work is undertaken at RIHN. Our project is organized into five research groups, plus executive and advisory groups, as follows:

The Human Alterations Group investigates the effects of anthropogenic environmental alteration on the emergence and spread of KHV and the behavior of its host *Cyprinus carpio carpio.*

The Pathogen and Host Ecology Group defines the biology and ecology of KHV and carp, and so describes the environmental factors involved in KHV infection and transmission.

The Ecosystem Impacts Group examines the process of infection and the effects of KHV disease on ecosystem functions such as material cycling.

The Economics and Culture Group investigates the losses associated with KHV disease, including of ecosystem services or other economic and cultural phenomena, and describes the social attempts to redress those losses.

The Feedback Group examines the human response to losses caused by KHV disease, and the environmental change associated with this response.

Photo 1 ***Carp* killed by KHV disease**

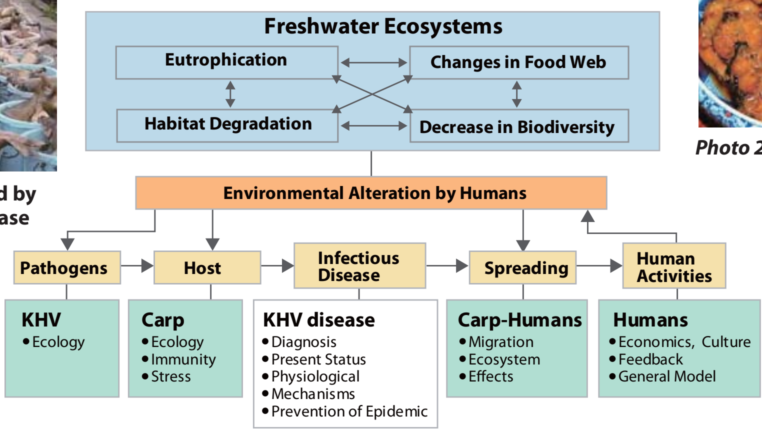

Figure 1 **Case studies: Interactions between KHV disease and humans**

Photo 2 **Carp dishes: Carp is an important ingredient in many food cultures**

Photo 3 **Survey of water temperature in Lake Erhai, China**

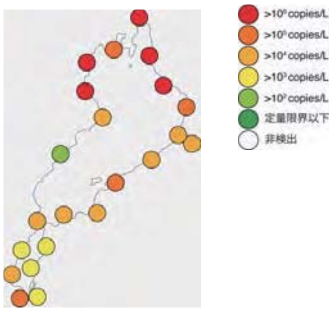

Figure 2 **Spatial distribution of KHV in Lake Biwa (Minamoto et al., 2009b)**

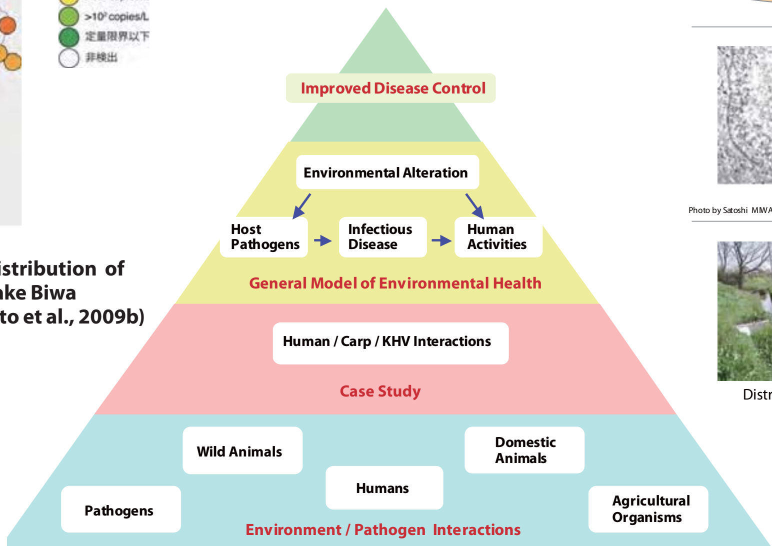

Figure 3 **Relationship of our model to a general human pathogen model**

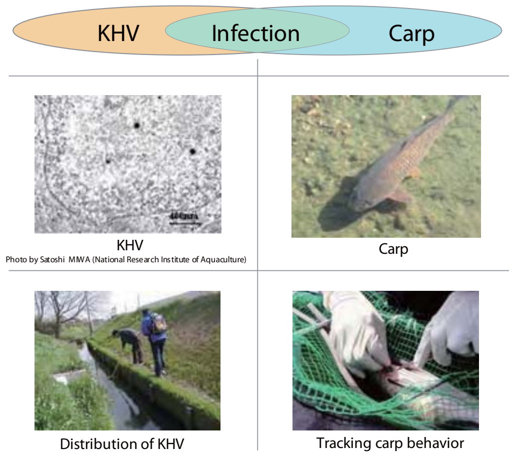

Figure 4

Survey of distribution of KHV and behavioral range of carp to predict the outbreak of infectious diseases.

The Executive Group coordinates the activities of each group and develops the model of pathogen-human interactions.

Finally, an Advisory Group composed of recognized experts in relevant fields makes suggestions in order to improve the research.

Main results to date

1) We found that water temperature on gentle gradient lakeshores is more spatially and temporally variable than on steep banks constructed by humans. This result suggests that gentle shores can provide a wider range of thermal conditions that allows fish to fine-tune their (everyday) thermoregulatory behavior, acclimate efficiently to (longer-term) changes in water temperature, and generally alleviate stresses associated with unfavorable water temperatures and so reduce susceptibility to KHV (Yamanaka et al. 2010).
2) We established a method to measure KHV presence in natural water (Minamoto et al., 2009a; Honjo et al., 2010) and found that in the five years since its presence was first documented, KHV has spread throughout Lake Biwa (Fig. 2) (Minamoto et al., 2009b).
3) Telemetry tracking of carp behavior revealed that carp favor warmer water temperatures. This finding was incorporated into our mathematical model predicting KHV disease outbreaks.
4) We found no evidence of KHV antibodies in carp smaller than 30cm, while 54% of carp larger than 30cm were KHV positive. Of antibody-positive individuals, 44% contracted KHV by polymerase chain reaction (PCR), strongly suggesting that those surviving carp become KHV carriers. A few individuals were positive by PCR but negative for antibodies, indicating recent infection. These results suggest that transmission of KHV is still occurring within the native common carp population in Lake Biwa (Uchii, et al., 2009).
5) We developed a non-invasive method (i.e. a method that does not require handling fish) to quantify how water conditions stress carp. This method indicates that changes in water temperature do stress carp.
6) In Lake Erhai we found gradient and water temperature conditions similar to those of Lake Biwa, indicating that KHV may find an advantageous habitat there.
7) At national and international conferences, we have presented our findings on the linkages between environment, pathogen and humans, and emphasized their importance to the prevention and control of infectious disease.

Scheduled research objectives in 2010

1) Develop a method to quantitatively detect KHV in sediment, organisms and other elements in aquatic ecosystems.
2) Clarify the distribution of infectious KHV in Lake Biwa.
3) Develop a micro-device to measure the quantity and infectivity of KHV in situ.
4) Determine the environmental factors involved in KHV dynamics and infectivity.
5) Use outdoor experimental tanks to define optimum water temperature for carp.
6) Describe the environmental characteristics of the places where KHV and carp interact, and clarify the behavior of the KHV-infected carp in order to reveal the locations where infection likely occurs (Fig. 4).
7) Conduct controlled experiments to reveal the relationship water temperature and carp stress and susceptibility to KHV.
8) Demonstrate the ecological effects of carp on species composition in experimental ponds.
9) Evaluate the cultural and nutritional value of carp as a human food.
10) Assess the economic and cultural impact of carp die-offs.
11) Create a preliminary model of the interactions between environmental change, KHV and humans.
12) Survey the spatial and temporal distribution of water temperature in Lake Erhai in order to establish the applicability of Lake Biwa findings to Lake Erhai (Photo 3).
13) Describe the common parameters of KHV and other infectious diseases.
14) Promote collaboration with the DIVERSITAS program of international biodiversity science.
15) Develop a set of recommendations to prevent or minimize the emergence and spread of infectious diseases.

Global Warming and the Human-Nature Dimension in Siberia: Social Adaptation to the Changes of the Terrestrial Ecosystem, with an Emphasis on Water Environments

Global warming will likely transform Siberian environments. Early evidence indicates that the hydrological, carbon, and methane cycles are undergoing rapid change, with potentially grave impact on Siberian flora and fauna. Human inhabitants, who have adapted to great changes in social structure and environment in the past, will be forced to adapt again, but to a cascading series of environmental changes whose dimensions are understood only in outline. This project uses multiple satellite and surface systems to track changes in the carbon and hydrologic cycles and the cryosphere, and assesses their likely interactions and significance for human inhabitants of the region. The project is jointly conducted by Japanese and Russian universities and research institutes.

Project Leader
INOUE Gen
RIHN

Professor Inoue's specialties are laser spectroscopy of chemical reactions and monitoring of greenhouse gases, mainly CO_2 and CH_4. He is interested in terrestrial ecosystems as sinks for atmospheric carbon and has developed ground-, aircraft- and satellite-based atmospheric observation systems. He proposed and led the Greenhouse gases Observing SATellite (IBUKI/GOSAT) project for five years, and now serves as its Chief Scientist. He has conducted field-based monitoring of greenhouse gases in Siberia for twenty years.

Core Members

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SASAI Takahiro	Nagoya University
OHTA Takeshi	Nagoya University
HIYAMA Tetsuya	RIHN
TAKAKURA Hiroki	Tohoku University
OKUMURA Makoto	Tohoku University

Background and project objectives

Climate models predict that evidence of climate change will appear early in Siberia and, as it is located in the high latitudes and in a continent whose climate is determined by radiative cooling, that its effects will be more significant than in other places. In fact, there is already clear evidence of declining ice-content, forest degradation associated with wet environments, and increasing flood frequency and intensity.

Rising temperatures can trigger drastic change in ice, snow and permafrost environments, increase the incidence and intensity of extreme weather events, including flood and forest fires, and alter the structure of interactions between principal biophysical elements. The immediate effect of these changes is likely to increase the concentrations of carbon dioxide, methane and water vapor in the atmosphere, all of which contribute to further warming (Fig. 2) Warmer environments also present new opportunities for large-scale resource extraction, which in turn increases the risk of environment damage, including natural gas leakage from gas pipelines.

Research takes place in the Lena Basin in East Siberia, an area characterized by a fragile symbiotic relationship between permafrost and forest. Permafrost provides moisture to the forest by preventing soil water from draining into deeper soil, while the forest shadows the permafrost from sunlight. A significant change in this relationship could release into the atmosphere an enormous amount of carbon that is currently stored in trees and soil. Our research in the area is conducted by three interrelated groups.

The Siberia bird's eye group

This group combines "bottom-up" and "top-down" observation of the Siberian carbon cycle. Surface spectral ASTER or MODIS data are combined with a terrestrial carbon-energy-water budget model (BEAMS) developed by our group to examine changes in land cover. This data will be supplemented by monitoring of greenhouse gases in Siberia enabled by Japan's launch of the GOSAT (Greenhouse gases Observing SATellite) in January 2009. GOSAT data should rectify the scarcity of ground-based monitors of greenhouse gases in Siberia. This data will improve our understanding of the CO_2 and CH_4 budget in Siberia and track greenhouse gas emissions due to forest fires and malfunctioning natural gas pipelines. Spectral surface data also allows measurement of flood extent and frequency, area of forest degradation or loss, and change in reindeer habitat, phenomena which are also of relevance to the human ecology group.

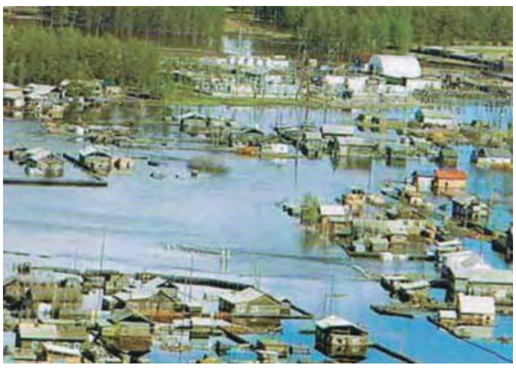

Photo 1 **Flooding of the Lena River in Yakutsk overtakes a village**

Photo 2 **Forest degradation caused by a wet environment**

Figure 1 **Past field research area in Siberia**
Red: natural science, Yellow: socio-ecology

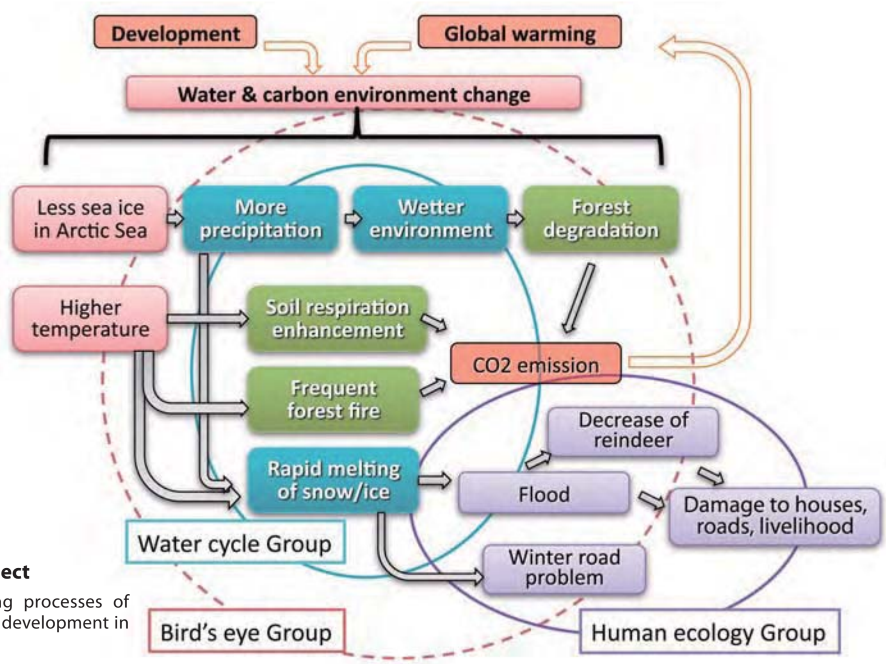

Figure 2 **Flow chart of Project**
Flow chart depicting processes of global warming and development in Siberia

The water cycle and ecosystem interactions study group

Ice cover in the Arctic Sea is decreasing more rapidly than predicted; atmospheric water vapor will be supplied year round and precipitation will increase in Siberia. How will Siberian forests respond to a wetter environment? There is evidence of sudden forest die-off (Photo 2), perhaps due to soil moisture surpassing a critical threshold. Isotope analysis of tree rings provides insight into the past conditions of forest-tundra growth. We have constructed a new monitoring tower at Us'tmaya, located about 500km to the south of the existing monitoring tower at Yakutsk, to measure water vapor, carbon dioxide and heat budget. Precipitation at the new site is 1.5 times greater than at Yakutsk.

The human ecology group

Siberia's human inhabitants have adapted to the cold environment, but current environmental changes affect their life patterns in unprecedented ways. Field studies have revealed that availability of drinking water (stored as ice in winter), availability of bio-fuels (mainly wood), pasture land productivity, and patterns of animal reproduction and hunting are now changing. The number of wild and domestic reindeer has dramatically declined in recent years. Climate warming has led to wetter environments which negatively affect reindeer range and breeding and grazing grounds. There may also be some linkage between decreasing reindeer populations and recent economic conditions. We are going to investigate these changes by interviewing famers and hunters in villages, and by mounting tracking devices on wild reindeer.

Climate change and social change intersect in complex ways and are often difficult to predict. We believe that the human dimension of climate change in Siberia is a very important factor, as human reaction to changing environments has the potential to exacerbate, or perhaps mitigate, negative impacts. We begin by analyzing different actors' perceptions of contemporary change, emphasizing perception of abnormal conditions and of what constitutes a "natural disaster". Analysis of difference in social response to environmental change will improve understanding of social-ecological fragility and vulnerability.

Megacities and the Global Environment

Over half of humanity now lives in cities. By 2020, it is estimated that one in four people will live in *megacities*—cities with a population of more than 10 million—many of which will be located in the developing world. Cities can provide rich sites for individual and community life, but they also impose tremendous burdens on earth environments. This project approaches the great question of how to make megacities earth-friendly while also increasing the present and future welfare of their inhabitants.

Project Leader
MURAMATSU Shin
RIHN

Shin Muramatsu has studied Asian architectural and urban history and is now interested in developing new methods that can shed light on urban futures. His previous publications include “Shanghai: The City and Its Architecture”, “Addicted to China”, “Keeping an Elephant”, and “Asian Architectural Studies”. He is the founder of mAAN (http://www. maan.org), an NPO involved in the evaluation, conservation and revitalization of modern architecture in Asia.

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FUKAMI Naoko Organization for Islamic Area Studies, Waseda University
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YAMASHITA Yuko Graduate School of Commerce and Management, Hitotsubashi University

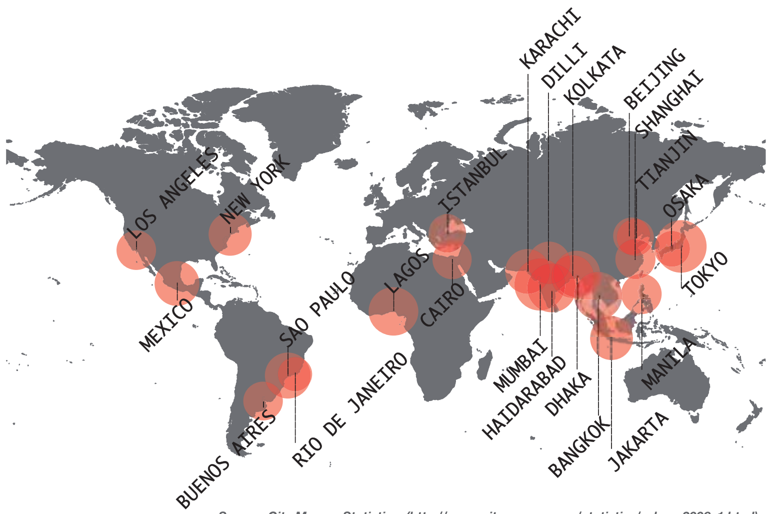
Megacities and “new eco-urbanity”

Population growth and increasing economic wealth is transforming Jakarta, Indonesia (Photo 1), into a megacity of expanding consumption and waste. This project investigates the developmental factors driving this transformation and the kinds of governance that can address, in a unified manner, the urban ecosystem and the key human institutions affecting it. In order to do so, we seek to identify the potential practical advantages in being a “latecomer” megacity (i.e. fast growing and without long-established urban patterns), and the relevance of customary patterns of behavior and urban life to contemporary social processes and ecological problems. Finally, on the basis of the above analyses, we intend to propose specific policies than can support a kind of *eco-urbanity*.

Project methods 1: A diverse but integrative examination of cities

Historically, people have gathered near lakes and rivers, sources of water and life. Early peoples fished, hunted and later cultivated land in these areas. In time, they produced surpluses, developed trade relationships and constructed buildings, industries and infrastructure, and such areas became centers of social organization and political power. In cities people, things, information, and capital have mixed together in unprecedented and unpredictable ways. Cities continue to increase in size and number (Fig. 1, 2); their success depends on humanity’s ability to increase its archive of ‘urban knowledge’. Meanwhile, the cumulative wisdom that enabled humankind to coexist with ecosystems, what we here call ‘eco-knowledge’, has been gradually buried deep within the collective human memory.

In this project, we use the phrase “urban sphere” to describe the entirety of human-made elements, human inhabitants, and natural features (subsurface and surface environments and atmosphere) that create and support cities. We focus our study of the urban sphere on the **3E-ICH** elements: the Environment, social Equity; and Economy, which are examined in relation to Institutions, Culture, and History.



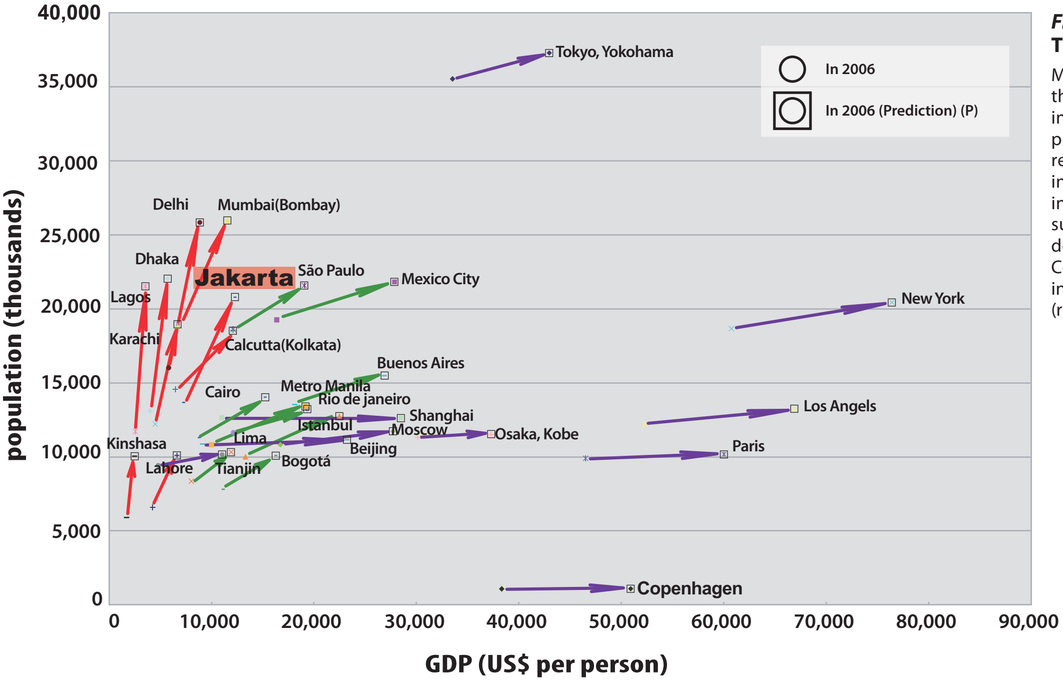
Source: City Mayors Statistics (http://www.citymayors.com/statistics/urban_2006_1.html)

Figure 1 **Megacities of the world (2006)**

Megacities—cities of more than ten million people—are emerging all over the world. They tend to be concentrated in developing countries, and as more of these countries see economic growth, their impact on the global environment has increased.

Photo 1 **Landscape of Jakarta**

Jakarta, the primary megacity of Southeast Asia, where skyscrapers and traditional houses coexist.



Population increase and economic growth forecast in megacities
Source:CITYMAYORS,The world's largest cities and urban areas in 2006. The world's largest cities and urban areas in 2020
Muramatsu FS project baced on http://www.citymayors.com/statistics/urban_2006_1.html,
http://www.citymayors.com/statistics/urban_2020_1.html

Figure 2
Three types of Megacities
Megacities can be classified into the following three types depending on economic growth rate and population growth rate: Mass resource consumption megacities in advanced countries (indicated in purple); Mass resource consumption megacity followers in developing countries (green); and Coexisting poverty megacities in the least developed countries (red).

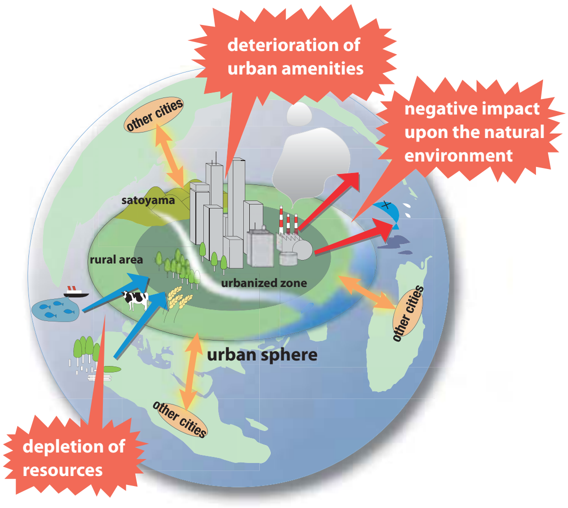


Figure 3 **Environmental problems associated with cities**
Cities have a large impact on the global environment but they also provide great benefits to humanity. They do not simply cause problems, but also contain solutions.

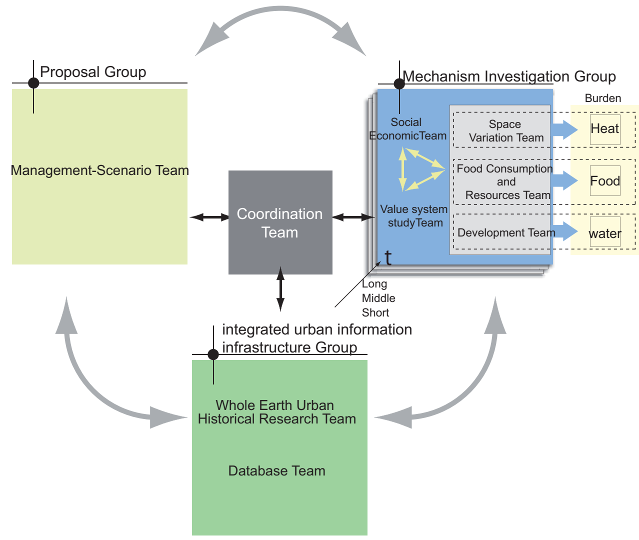


Figure 4 **Organization of the project**
The project consists of three groups to go with our three objectives. Each group is comprised of several teams with specific goals.

Project methods 2: Integration of traditional and contemporary eco- and scientific-knowledge

Addressing the contemporary problems of megacities (Fig. 3) requires scientific and technological measures as well as greater understanding of the local and everyday knowledge, practices and patterns that have historically enabled urban life in particular places and environments. This project seeks solutions to contemporary urban problems through synthesis of urban studies from the social and natural sciences and engineering. It also uses existing literature and social observations to identify the specific customs and patterns of life that have enabled the co-existence of large numbers of people in dense settlements. We will document not only such elements as housing style and local living practices (such as sprinkling water on the streets, and moderating activity in hot parts of the day), but also describe their deeper roots in local philosophical, religious, and aesthetic traditions.

Rich fruit year after year: 2010 objectives

We expect this project to bear rich fruit in each of the coming years. In 2010 we have four main goals: 1) to improve our qualitative description of megacities and to develop a method for graphically representing their principal characteristics; 2) to formalize the specific criteria we will use to assess 3*E*+*ICH* issues; 3) to rapidly collect and organize the 3E data; and 4) to describe and propose explanations of how exhaustion of resources, deterioration of natural environment, and degradation of amenities are related in Jakarta. To achieve these goals, project members need to collaborate closely and deepen their personal knowledge and experience of the study sites (Fig. 4). Each of the project members should walk around the city, observing deeply and thinking flexibly of the pleasures and practical necessities of life in Jakarta, and in urban areas around the world.

“One thousand white rice terraces”, Wajima, Noto Peninsula, Japan
Photo by SHINDO Kenji

Rice terraces in Nepal
Photo by ABE Ken-ichi

Paddy rice cultivation was introduced recently to this area of Arunachal Pradesh, India
Photo by KOSAKA Yasuyuki