Flood-Damaged Town
Leh, India
Massive flood struck this area on Aug. 6, 2010, killing around 600 people. Many bodies were never recovered and remain buried in this area. The Dalai Lama visited the area immediately after the disaster
NARAMA Chiyuki

Alone in the Andes Misti volcano
Arequipa, Peru
Carlos Renzo Zeballos Valarde

Moon in Ladakh
Leh Castle
View from Leh Castle. With no vegetation, Ladakh seems like a city on the moon
HAMADA Atsushi

Continuation of a Dream
Ankara, Turkey
The old typical houses, or gecekondus, are being demolished and replaced with new buildings
MATSUNAGA Kohei

Circulation Program

C

Program Director **NAKANO Takanori**

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
C-05	TANIGUCHI Makoto	Human Impacts on Urban Subsurface Environments
Full Research	**Leader**	**Title**
C-06	KAWABATA Zen'ichiro	Effects of Environmental Change on the Interactions between Pathogens and Humans
C-07	HIYAMA Tetsuya	Global Warming and the Human-Nature Dimension in Siberia
C-08	MURAMATSU Shin	Megacities and the Global Environment
C-09-Init	WATANABE Tsugihiro	Designing Local Frameworks for Integrated Water Resources Management

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

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.

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

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.

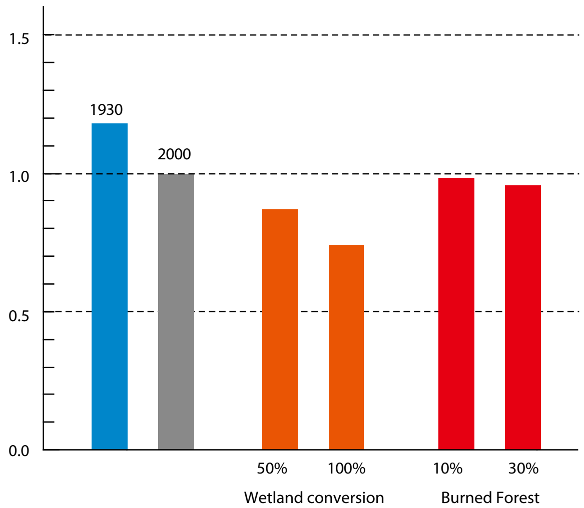


Figure 1 **Simulated results of land cover conversion in the Amur River Basin on iron flux**

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 assessed 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 were 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

The great coastal cities of Asia place substantial burdens on subsurface environments, but little is known of the impact or its environmental or potential social significance. This project was therefore designed to reveal the groundwater recharge rate, storage, redox and other natural subsurface capacities in Tokyo, Osaka, Seoul, Taipei, Bangkok, Jakarta and Manila, and to measure the pace and scale of human disturbance of subsurface environments in these cities in the past century.

Summary of research findings

Cumulative human impacts on subsurface environments were documented at depths of up to 200-300 meters. Groundwater circulation was accelerated by more than 10 times in the past century. Subsurface thermal storage due to surface warming, such as by the urban 'heat island effect', is two to six times that attributable to global warming. Numerical modelling of the subsurface environment in Tokyo, Osaka, Bangkok, and Jakarta allowed evaluation of groundwater recharge rate and area, residence time, and exchange of fresh/salt water between land and ocean. GRACE satelite data was scaled down to the Chaopraya basin, Thailand, allowing comparison with basin models. Creation of a 0.5 km grid GIS database based on nine categories of land cover/use in three different historical periods (1930s, 1970s, and 2000s) allowed evaluation of water, materials, and heat exchange between surface and subsurface environments in each city.

Research significance

Natural resource capacity and social and environmental development indices allowed integration of findings. In total, the indices in our five-stage urban development and DPSIR (Driving force, Pressure, State, Impact, and Response) models described patterns of land subidence, groundwater contamination, and subsurface thermal anomaly, and allowed us to suggest a range of suitable policy approaches, taking account of latecomer's benefits, patterns of development, and natural resource capacities.

In total, project findings highlight the importance of careful public cross-boundary surface-suburface environmental management. We conclude that subsurface environmental processes can be sucessfully managed, especially in their critical capacity in providing water, if policies correspond to actual material flows across surface-subsurface and land-marine boundaries. In regard to water quality, human societies should pay closer attention to the subsurface accumulation of contaminats and heat, especially as these loads can often be controled or managed from the surface. Designing such policies, however, depends on accurate assessment of the stage of urban growth in relation to natural capacities and social capabilities.

Research communication

Project research findings have been disseminated widely in a variety of fora. The project has convened five international symposia, the third as a side event of COP13 and the fifth in colaboration with UNESCO-International Hydrological Programme. Project researchers have published more than 120 peer-reviewed scientific papers, five books (three in Japanese and two in English), a special issue of the journal STOTEN, and a CD-Book with multilayer contents for beginners to experts. Feedback seminars were organized to discuss project findings with local administrators and policy makers in Manila, Jakarta, and Bangkok. The utility of such seminars, and perceived value of comparative discussion of subsuface urban issues, now inspires the creation of a consortium concerned with urban water management in Asia.

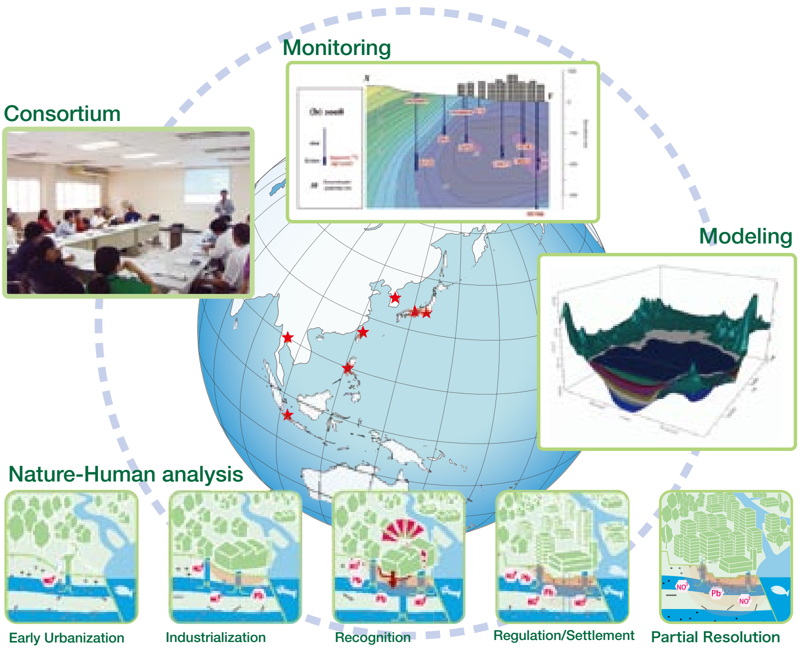
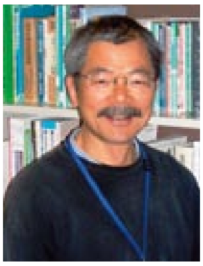


Figure
The project's major components

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 humans that may create or alleviate 'fertile' disease environments – is necessary for prediction and prevention of new disease outbreaks. This project develops a model of environment-pathogen-human interactions based on our intensive examination of the ecological and social causes and effects of Koi Herpes Virus disease in Lake Biwa, Japan. This model will allow us to 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.

Sub-Leader
MINAMOTO Toshifumi RIHN

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YAMANAKA Hiroki Department of Environmental Solution Technology, Ryukoku University

Objectives

The rapid spread of emerging infectious diseases is threatening humans, wildlife, and livestock worldwide. Koi Herpes Virus (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). To predict outbreaks of infectious disease and to prevent epidemics, it is essential to conduct pathological studies and to understand the environment-pathogen-human interactions that cause and spread infectious disease.

This study has three main objectives. It first describes KHV disease ecology, including: the specific links between anthropogenically-caused 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 mitigation or adaptation (Fig. 1). Based on this description of the human and non-human factors affecting KHV disease ecology, it then describes a general model of environment-pathogen-human interaction (Fig. 2). Finally, it will suggest how these interactions may be modified in order to mitigate the damages associated with infectious diseases.

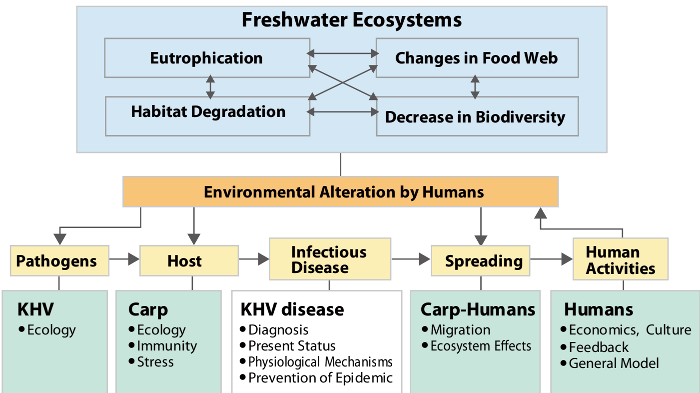

Figure 1 **Interactions between KHV disease and humans**

Research methods and organization

Fields survey is conducted at Lake Biwa, Japan. 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 carp.

The Pathogen and Host Ecology Group defines carp and KHV ecology, 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 genetic diversity.

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

The Feedback Group examines the environmental changes associated with human response to loses caused by KHV disease.

The Executive Group develops the model of pathogen-human interactions by coordinating the activities of each group.

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 gentle gradient lakeshores provide a wide range of thermal conditions, suggesting that fish can choose tempertures to alleviate stress associated with unfavorable water temperatures, and thus reduce susceptibility to KHV (Yamanaka et al., 2010).
2) We established an innovative method to quantitatively detect KHV in natural environments (Minamoto et al., 2009 (Fig. 3); Honjo et al., 2010). The method revealed that since it was first detected in 2003, KHV is now found throughout the Lake Biwa ecosystem, including in plankton and sediment, lagoons and ponds, and now in almost all the rivers in Japan. We

Photo 1
Carp killed by KHV disease
Lake Biwa, 2004
(Masatomi Matsuoka)

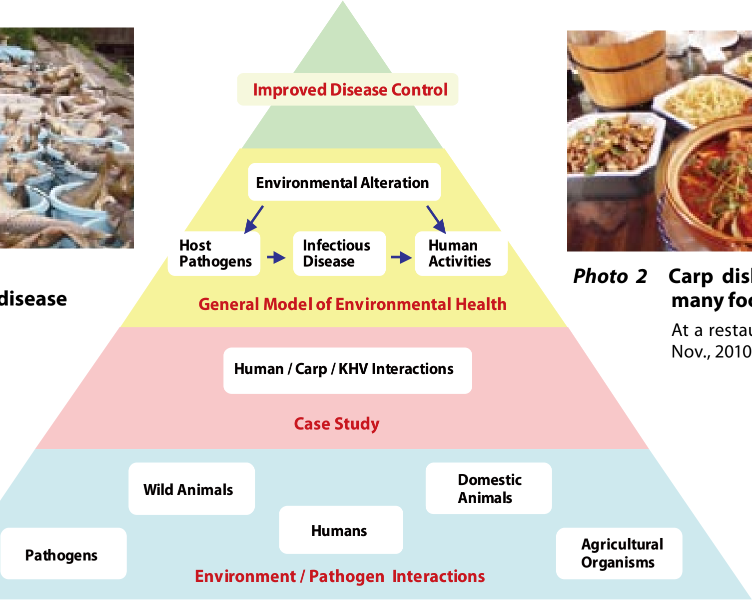

Figure 2 **Relationship of our model to a general human pathogen model**

Photo 2 **Carp dishes: Carp is an important ingredient in many food cultures**
At a restaurant beside Lake Erhai, Dali City, Yunnan, China, Nov., 2010 (Zen'ichiro Kawabata)

Photo 3 **A carp laying eggs on the stems of reed**
Lake Biwa, May 2009 (Kimiko Uchii)

Photo 4 **A survey on a mass death of Tilapia**
The Pin River, Chaing Mai, Thailand, July 2010 (Zen'ichiro Kawabata)

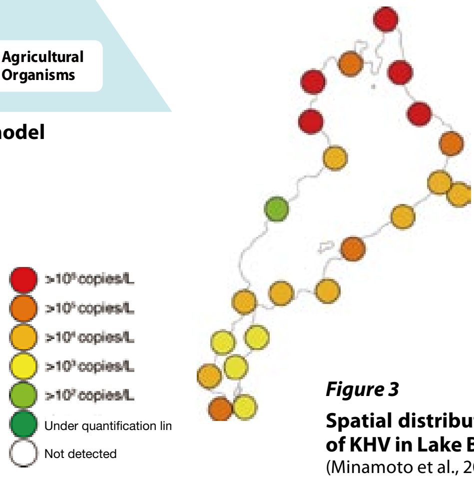

Figure 3
Spatial distribution of KHV in Lake Biwa
(Minamoto et al., 2009)

demonstrated that it is impossible to eliminate KHV, but that precautionary environmental management can eliminate "fertile" disease environments.

3) We have developed a preliminary break-through method allowing determination of the number and location of carp in their natural environments.
4) We found that breeding habitats can become hot spots for transmission of infectious diseases if hosts aggregate for mating and pathogen activation occurs during the host breeding season (Uchii et al., 2011) (Photo 3).
5) We developed a non-invasive method (i.e., a method that does not require handling fish) to quantify how water conditions stress carp. Using this method we found that changes in water temperature do induce stress.
6) We applied a Based on our assessment of KHV disease in Lake Biwa, we applied our conceptual model of linked environment-pathogen-human interactions to Lake Erhai, China, schistosomiasis in Kenya, fish diseases in the Pin River at Chaing Mai, Thailand (Photo 4), and Legionella disease (Yamaguchi et al., 2010), MRSA, Norovirus disease, and nontuberculous mycobacteria disease (Ichijo et al., 2010) in Japan. These applications helped us understand how pathogens interact with humans and suggested environmental conditions that might prevent disease outbreaks and spread as well asstrategies for safe coexistence of humans with pathogens.
7) By combining the results from each work group, ranging from molecular biology to environmental sciences to human society, we are providing evidence to support the hypothesis that anthropogenic environmental changes promote disease outbreaks.
8) We have presented our findings at national and international conferences of the linkages between the environment, pathogens and humans, emphsizing their significance to prevention and control of infectious disease.

Research objectives in 2011

1) Refine a method to quantify carp spatially and temporally and innovative methods to describe our conceptual model of environment-pathogen-human linkages including a development of micro-device capable of *in-situ* measurment of KHV incidence and infectivity.
2) Determine the environmental factors involved in KHV abundance and its infectivity, and in carp population density and its susceptibility.
3) Conduct controlled experiments to reveal the relationship between water temperature, carp stress and susceptibility to KHV.
4) Assess the economic and cultural impacts of carp die-offs.
5) Apply the conceptual model of environment-pathogen-human linkage to other infectious diseases; KHV disease in Lake Erhai, China, Schistosomiasis in Kenya, fish diseases in the Pin River at Chaing Mai, Thailand, and *Legionella* disease, MRSA, Norovirus disease, and nontuberculous mycobacteria disease in Japan, and then describe the common parameters of KHV disease and other infectious diseases.
6) Continue to explore evidence that anthropogenic environmental changes can mediate disease outbreaks.
7) Synthesis of results of the work groups in order to develop a set of recommendations designed to minimize the emergence and spread of infectious diseases and facilitate the safe coexistence of humans with pathogens.
8) Publish our results in international journals and books in order to disseminate the concepts and practical measures that can aid the control of "fertile" disease environments.
9) Organize a national and international symposium on environment-pathogen-human linkage to develop a network for this field of study.

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
HIYAMA Tetsuya RIHN

Professor Hiyama's specialties are ecohydrology and hydrometeorology. He is interested in vulnerability assessment of shallow groundwater, especially in permafrost regions affected by global warming. He is also interested in atmospheric boundary layer meteorology and terrestrial-climate interactions, especially energy/water/carbon exchanges. Eastern Siberia is the most important region for his field research, and he has conducted field observations of the atmospheric boundary layer over several regions including Eastern Siberia for around twenty years.

Sub-Leader
FUJIWARA Junko RIHN
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SASAI Takahiro Nagoya University
YASUNARI Tetsuzo Nagoya University
OHTA Takeshi Nagoya University
SUGIMOTO Atsuko Hokkaido University
YAMAZAKI Takeshi Tohoku University
TAKAKURA Hiroki Tohoku University
OKUMURA Makoto Tohoku University
TATSUZAWA Shiro Hokkaido University

Background and project objectives

The Lena River Basin in Eastern Siberia is covered in larch forest but receives little precipitation. Permafrost provides moisture to the forest. The area is thus an ideal setting in which to study the effects of climate warming, as the forest-permafrost symbiosis is extremely susceptible to abnormal variations in temperature. Abnormally high temperatures have been recorded in the region in recent years, and changes in the ecosystem and cryosphere environment, such as forest degradation and frequent flooding, are evident.

This research project takes natural and social science perspectives on three aspects of climate-associated environmental change. The project is designed to: 1) describe current variation in water and carbon cycles and predict likely variation in the near future; 2) make field observations of the effect of carbon and hydrologic variabilty in Eastern Siberian landscapes, and identify key exchanges or driving forces; and 3) examine the capability of the multi-ethnic Siberian peoples, and their distinct social economies, to adapt to predicted change in their climate and terrestrial ecosystems.

Three research groups are organized in order to realize these goals (Fig.1). The *Siberia bird's-eye group* (Group 1) uses climatic and satellite remote sensing data to describe change in climate and in principal patterns of human adaptation. The *Water cycle and ecosystem interaction group* (Group 2) uses dendrochronology, isotope-analysis, flux monitoring, and hydrological analysis in order to examine interaction between climate and vegetation. The *Human ecology group* (Group 3) elucidates the impact of climate and ecological change described above on the residential life in urban and agricultural districts in Eastern Siberia and the cultural practices and social systems of local minority peoples related to their capacities for adaptation.

Research outcomes

The Siberia bird's eye group

Analytical emphasis is on flood, as flood impacts are significant and climate change increases flood frequency and intensity. Flood frequency and extent are described through remotely sensed and field based data (Fig. 2). Data show a recent gradual increase in upstream air temperature (in the southern part of the Lena River Basin) yet little change in air temperature downstream (northern part of the basin near the Arctic Ocean). River ice-jam floods along the Lena River were detected by satellite each thaw season. In addition, a spatio-temporal survey of flood around the Alazeya River Basin was conducted (Fig. 3).

Field surveys and remote sensing determined that insect damage and forest fires were major causes of forest degradation. A dynamic vegetation model of Eastern Siberia, including forest fire and soil freezing and thawing, predicted that an annual mean air temperature

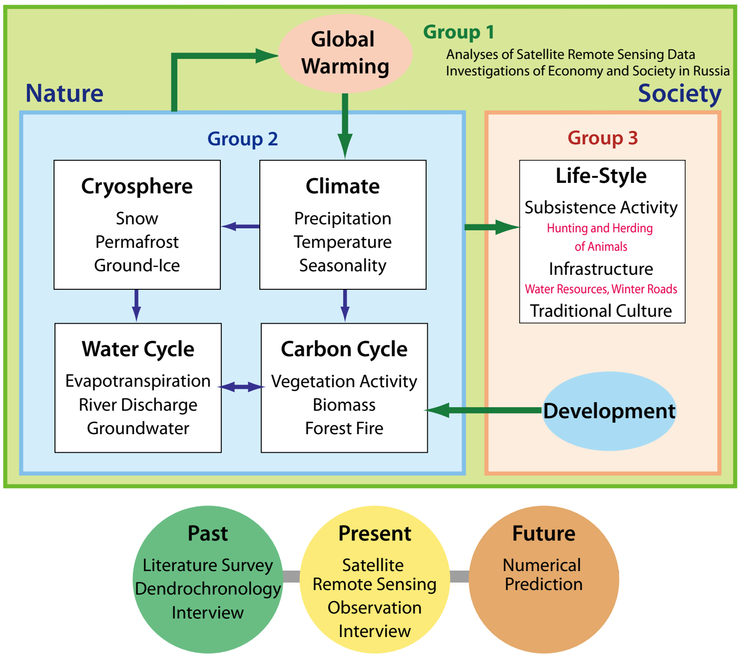

Figure 1 **Project structure and research targets**

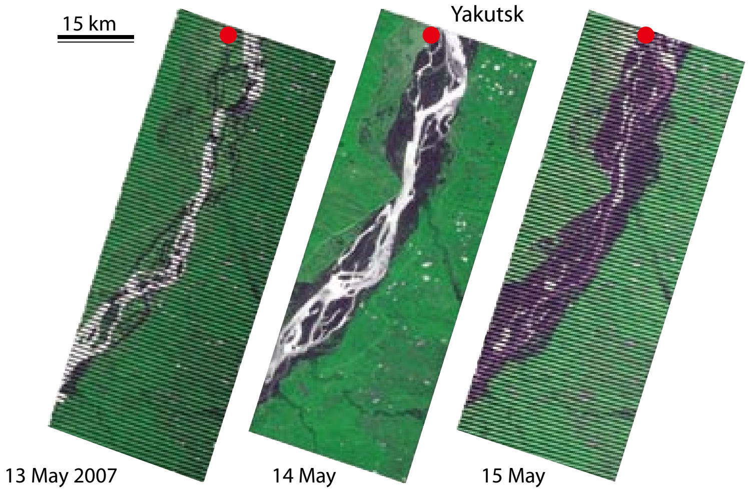

Figure 2 **River ice-jam floods along the Lena River at around Yakutsk city, observed by satellite**

Photo 1 **Permafrost and ground ice around Yakutsk, Eastern Siberia**

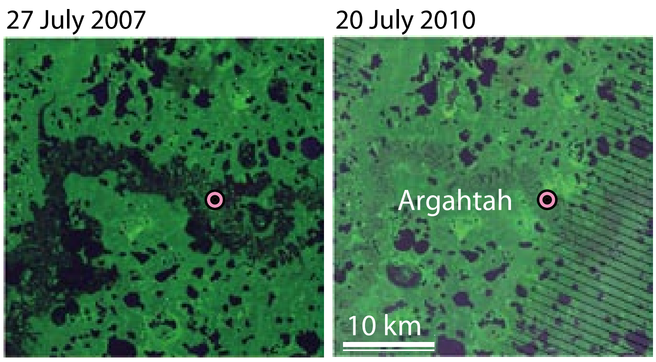

Figure 3 **Variation of water-covered areas at the Alazeya River Basin**

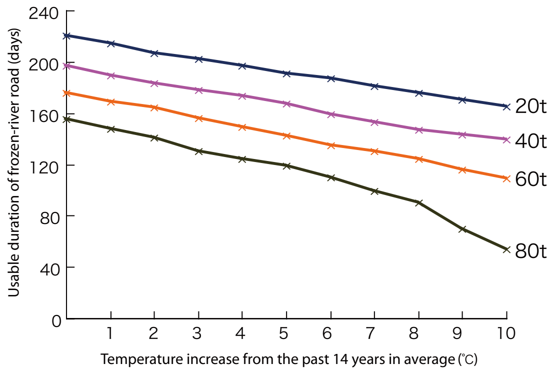

Figure 4 **The predicted effect of increasing annual mean air temperature on availability of frozen-river roads in winter**

rise of more than 2° C will thaw permafrost to a depth prohibiting larch forest growth.

The water cycle and ecosystem interaction group

Cellulose carbon isotope samples taken from larch forest in the Siberian tundra-taiga transition zone described inter-annual variations of precipitation and soil moisture. Changes in the seasonal larch growth pattern are clearly associated with water stress. Based on this analysis, the group made point-scale measurements of inter-annual variations in soil moisture from 1950s to 2000s.

A new monitoring site was established in the middle reaches of the Aldan River (Ust' Maya), where precipitation is high in relation to that at Yakutsk, in order to clarify the precipitation-forest reponse relationships. The new flux-tower (in addition to the one operating at Yakutsk) allowed continuous measurement of hydro-meteorological elements, sensible heat, latent heat (evapotranspiration), and carbon dioxide fluxes. Numerical simulation based on a regional (non-hydrostatic) climate model revealed that increases in surface wetness due to global warming would not significantly increase precipitation through evapotranspiration. Extensive land cover change from taiga forest- to grass-cover or water surface would have a much greater positive impact on precipitation in Eastern Siberia.

A newly established research contract between RIHN and the Melnikov Permafrost Institute, Siberian Branch of the Russian Academy of Sciences, has allowed joint study of permafrost groundwater and ground ice in central Eastern Siberia (Photo 1). As a first step, the age of groundwater found in several natural springs was established as a few tens of years. Researchers from both institutes also made improvements to the conventional water circulation model allowing better prediction of the Lena River Basin water cycle.

The human ecology group

This group documented the folk knowledge of middle Lena River Basin peoples related to river ice-jam floods. Group researchers combined field data and newspaper reports with remotely sensed data in order to develop a graphic display of recent flooding patterns, and so the influence of global warming on the frozen water environment. The group analyzed the traffic density, vehicle type, and quantity of freight travelling over the frozen Lena River in winter. Such frozen-river "roads" are the most important public transport in the region, but access to them will be dramatically decreased with global warming (Fig.4).

Transmitters attached to wild reindeers will reveal their pattern of movement in relation to environmental variables such as vegetation status and snow depth. Direct observation of reindeer herders and investigation of hunting and traffic in furs and of salmon havests will clarify dynamics affecting these three important areas of human-animal interaction. Disaster-driven emigration is a new indicator of adaptation and maladjustment to climate change, and field research is now underway in villages experiencing significant out-migration.

Future research issues

It is necessary to examine local media for environment- and climate-related reports, development plans and policies in Siberia. The apparent path of industrial development, especially in relation to energy and road infrastructure, will likely have a significant effect on Eastern Siberian social life and water environments.

Megacities and the Global Environment

Cities today support half of the Earth's population. This project investigates the causes and effects of rapid urbanization in the megacity of greater Jakarta, and the kinds of governance and everyday human practices that can address, in a unified manner, the urban ecosystem and the key human institutions affecting it. In this context, this project describes megacities as dynamic environments comprised of both human and non-human elements; the challenge is to develop conceptual and practical tools that can support harmonious relations within and between these elements. The project is therefore fundamentally interdisciplinary, historical, spatial, driven by real problems in the world, and solution-oriented.

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.

Sub-Leader
HAYASHI Kengo RIHN

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MURAKAMI Akinobu Graduate School of Systems and Information Engineering, University of Tsukuba
YAMASHITA Yuko Graduate School of Commerce and Management, Hitotsubashi University

Background and objectives

The great amount of human activity concentrated in megacities causes environmental problems at local to global scales. Megacities consume great quantities of material, and produce great quantities of waste; they simultaneously cause some of the most pressing environmental problems and are the sites of significant environmental degradation. Many megacities are emerging in developing countries in the tropical monsoon region characterized by highly dynamic biophysical environments. Social practices and urban management methods are often not adequate to the pressures of megacity systems.

The central study area is Jabodetabek, the metropolitan area surrounding Jakarta, Indonesia, where, despite fast-paced urban development and in-migration, paddy rice cultivation remains a principal source of livelihood. The direct and indirect environmental impact of urban expansion, increasing demand for basic needs and services such as food, water and shelter, and the need to maintain and create viable human livelihoods often involve undesirable trade-offs. As cities continue to increase in size and number; their success depends on humanity's ability to increase and make use of its archive of 'urban knowledge'. Meanwhile, the cumulative wisdom that enabled humankind to coexist with ecosystems through great periods of time, what we here call 'eco-knowledge', has been gradually buried deep within the collective human memory.

In this context, project research will describe the historical conditions associated with megaurbanization in Indonesia, as well as the recent and contemporary factors contributing to Jabodetabek's most significant environmental problems, including frequent flood, heat island effect, loss of biodiversity and social disparity linked to urban vulnerability. The project uses a GIS to describe the spatial growth of the city and its impact on surrounding environment. Project researchers are also interested in the scalar dynamics revealed by examining

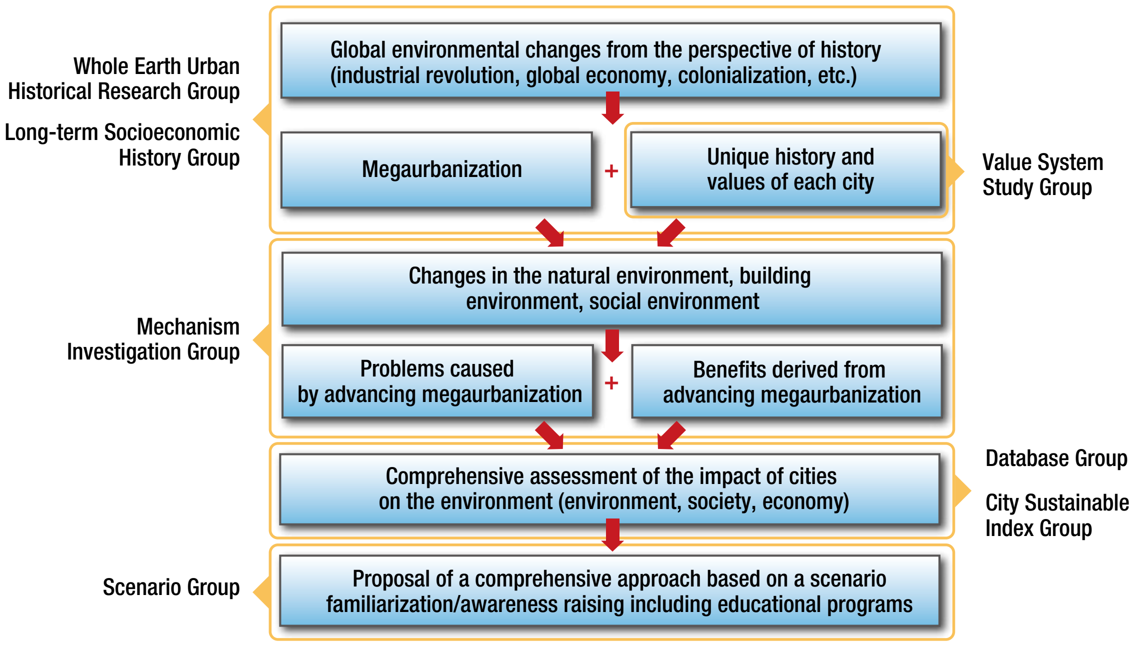


Figure 1 **Organization of the project**

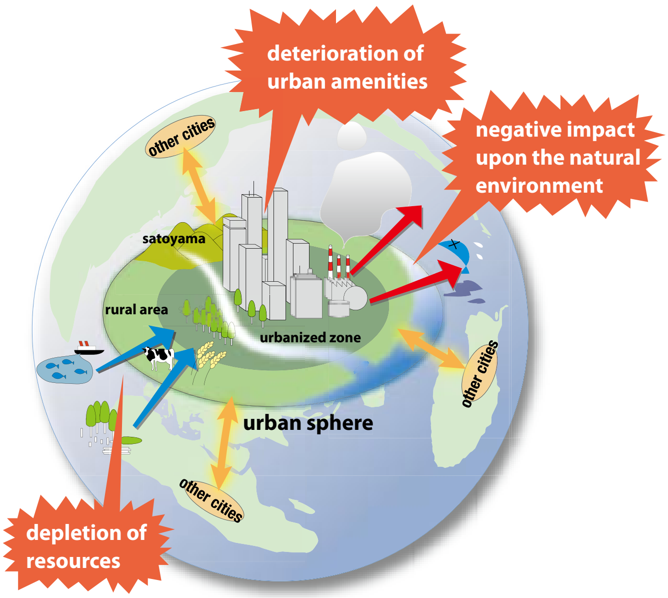


Figure 2 **Environmental problems associated with cities**

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.

environmental problems from the perspectives of several different stakeholders and communities.

Project approach

This project is designed to develop a common understanding of a city beyond the limits of specific disciplines (Fig. 1). Much project research is based in the natural and social sciences, including researchers from ecology, hydraulic engineering, architectural planning, urban history, distributive sociology, fisheries science and urban sociology. And yet, since complex environmental problems cannot be remedied by single solutions, such direct descriptive methods of modern science are combined with fundamental methods linked to social consciousness, such as education and community studies. At the same time, a wide range of local ecological knowledge can also found in cities. If recognized, such knowledge can also be applied to local problems. In eliciting and combining multiple traditions of knowledge, the project seeks to develop flexible methods relevant to the everyday lives of individuals, and that can also scale up to address the livability of the city as a whole (Fig. 2).

Recent achievements and coming tasks

The last academic year saw the following three achievements:

1) Development of methods for analyzing variations in environmental load due to changes in the built environment

Jabodetabek is experiencing a significant amount of building activity. The project's Built Environment Team is calculating the total volume of building material stock in Jakarta, the volume of CO_2 generated in the use of construction materials, and the vulnerability of city buildings to various disasters, including earthquakes.

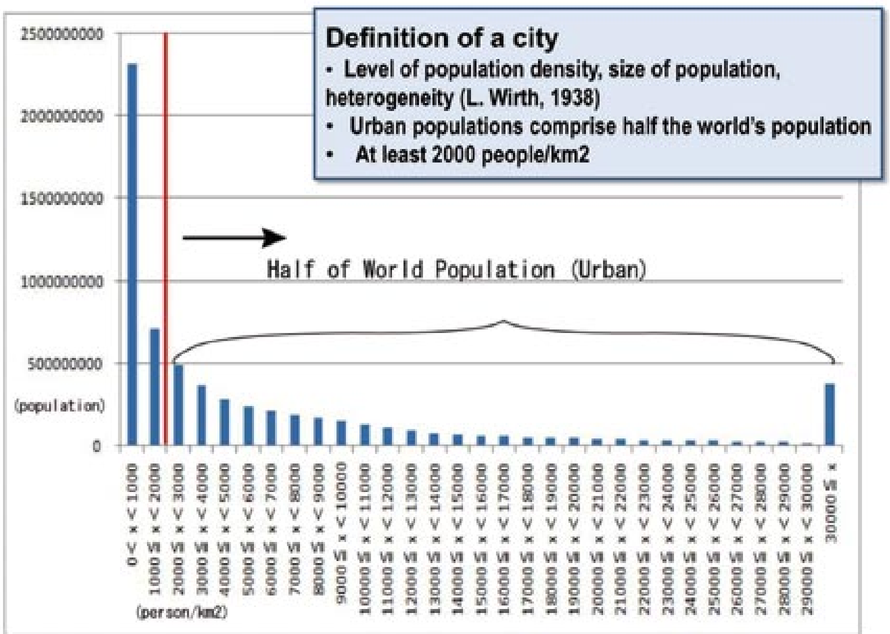
2) Impact assessment of environmental warming due to urbanization

The Natural Environment Group is analyzing the impact of advancing urbanization on the heat island problem, increase in flood risk, and decline in biodiversity. With the Jakarta suburbs as target area, researchers have used interviews, field survey, satellite image analysis, 3D CAD simulation and other methods to describe abandonment of rice paddies, their conversion to housing blocks, and the decrease in wooded areas in the last thirty years.

3) Literature review and analysis for establishing a sustainability index (CSI)

The Urban Assessment Index Team analyzed almost twenty existing urban sustainability indices, including an environmental sustainability index (ESI) and an environmental performance index (EPI), in order to describe the need and goals for a new City Sustainability Index (CSI).

Project researchers have also been preparing to conduct intensive micro-scale field work in Jakarta's high-density, low-income areas. As the CSI advances, it will be possible to begin to build a comparative database with megacities in China, India, and Latin American countries.



Source: LandScan TM Global Population Database. Oak Ridge, TN: Oak Ridge National Laboratory (data for 2007)
UN Population Division, World Urbanization Prospects 2007, Muramatsu FS Project based on 2005 data

Figure 3 **World population distribution by population density (per kilometer)**

Designing Local Frameworks for Integrated Water Resources Management

This project investigates the pressing need for integrated water and land management and improved human-water-land relationships. It is based on the results of several completed RIHN research projects related to basin resources management. Project research entails interdisciplinary investigation of the merits and demerits of distinct water management regimes, especially related to irrigation, in several semi-arid and humid environmental contexts. Main research foci are agricultural productivity, water balance and environment, management institutions and organizations, and human behavior and consciousness. Field and modeling studies are integrated to develop an advanced description of the knowledge systems affecting water management; it will allow comprehensive analysis of the key elements in improved management of basin water resources and in human-water-land relationships more generally.

Project Leader
WATANABE Tsugihiro RIHN

Tsugihiro WATANABE received his doctor's degree in agricultural engineering from Kyoto University. He was the leader of RIHN's Research Project "Impacts of climate change on agricultural production system in arid areas" (2002-2007). He is interested in irrigation as an expression of local wisdom regarding land and water.

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TAKARA Kaoru	Disaster Prevention Research Institute, Kyoto University
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Background and objectives

World water and food resources are under pressure. Population growth and development will increase aggregate demand for freshwater just as climate change is predicted to affect the historical spatial and temporal patterns of water availability. Since hydrologic cycles and agricultural systems are so closely linked, human societies must plan for change in both in relation to increasing demand and predicted increases in water-related disasters such as flood and drought. There is great need for integrated water resources management (IWRM). To date, however, IWRM has not achieved its potential (Fig. 1).

This project conducts extensive historical and contemporary evaluation of several local- and basin-scale agricultural water management regimes, seeking principles that promote, or blockages that hinder, efficient water-use. Combining best quantitative measures of water flow, use and quality, irrigation engineering, historical description and institutional analysis in several case-study sites, it evaluates and describes scenarios for culturally relevant and institutionally and economically feasible re-design of local water management regimes. It seeks to improve the IWRM framework's adaptability to local cultural and economic contexts, as local management performance directly affects local livelihoods and environment, and to highlight linkages between local and higher-scale management practices and contexts. In collaboration with users and authorities, the project then turns to fundamental re-design of local land and water management systems in relation to the combined social, economic and environmental challenges of the future.

Main results to date

Under the aegis of the RIHN GAIA Initiative, project researchers have conducted extensive review and discussion of completed RIHN projects, developing

Figure 1 **Project objectives**

Many water-related global environmental problems can be attributed to unsustainable local level water management. IWRM provides a template for integration of both local- and larger-scale concerns, but it must be refined through in-depth local study and can only be implemented with cooperation from local populations.

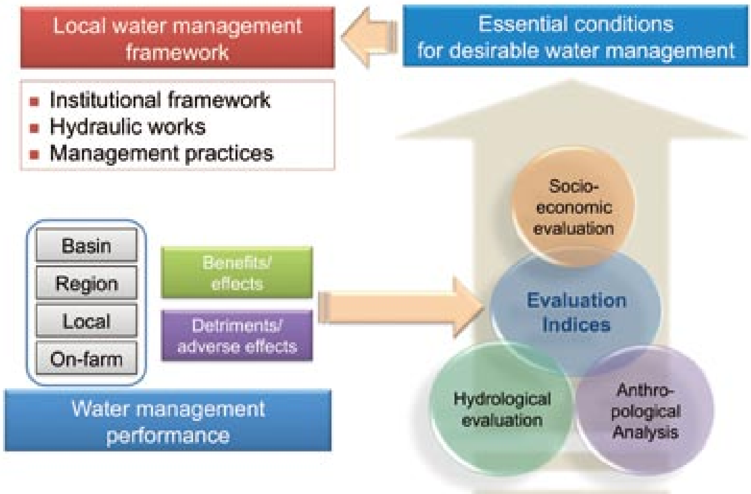

Figure 2 **Research Flow**

The research strategy to examine local water management consists of three frameworks, and integration of these works leads to design of the management system: 1) hydrological evaluation, 2) socio-economic evaluation, and 3) anthropological analysis of the structure and function of local "wisdom" on water management. An emphasis is placed upon the extent to which water management can be designed to reflect the interwoven three main themes in each region of interest.

Figure 3 **Project organization**

Photo 1 **Field application in a large-scale irrigation scheme in Turkey's lower Seihan Plain**

Photo 2 **Diversion works of a small-scale irrigation system in Bali, Indonesia**

Figure 4 **Main case study areas**

analysis allowing for refinement of this project's objectives and methods. Based on this analysis, we have set up the framework research organization and are ready to make rapid progress with researchers from universities, governmental and non-governmental organizations in the case-study areas, as well as several relevant international organizations such as the International Water Management Institute (IWMI) and the International Commission on Irrigation and Drainage (ICID) (Figs. 2, 3).

Research plan

Six major case study areas are selected according to conditions of topography, hydrology, regional meteorology, scale and history of the system, and recent development progress (Fig. 4). Water management systems in each location are to be examined according to the following four main themes; 1) environment (soil and water use, hydrology); 2) economy (agriculture, regional economy); 3) society (organizations, governing institutions); and 4) culture (consciousness, behavior). A dedicated sub-team will investigate each theme at each study site; sub-teams are to share, integrate and communicate their findings, tasks overseen by the Site Research Coordinator. Cross-site integration is overseen by a Central Coordination Committee composed of researchers from each of the study sites as well as representatives of relevant international agencies.

This research project will contribute to the design of place-specific water policies and practices and to the concepts, models and theories that describe the multi-scale and linked nature of human-ecological systems. The case studies are designed to illuminate challenges in specific social and environmental contexts; at the same time the emphasis on scale and place integration should contribute to IWRM wherever it is applied. The project is therefore of relevance to local communities, decision makers, and international donor and aid organizations.