Circulation Program

TANIGUCHI Makoto | Program Director

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-06	KAWABATA Zen'ichiro	Effects of Environmental Change on the Interactions between Pathogens and Humans

Full Research	Leader	Title
C-07	HIYAMA Tetsuya	Global Warming and the Human-Nature Dimension in Siberia
C-08	MURAMATSU Shin	Megacities and the Global Environment

Effects of Environmental Change on the Interactions between Pathogens and Humans

Project Leader **KAWABATA Zen'ichiro** RIHN

The rapid spread of emerging infectious diseases is a serious global environmental problem that threatens not only humans, wildlife, and livestock worldwide, but also induces economical loss and collapse of ecosystems. This project aimed to verify the hypothesis that human mediated environmental degradations cause and spread infectious diseases by studying Koi herpesvirus (KHV) disease (Photo) as a model. Based on the analyses of environment–pathogen–human interactions, we also tried to suggest ways to prevent or minimize the emergence and communication of infectious diseases, and to enhance social ability to cope with them.

Project achievements

Analysis of the links between lakeshore degradation, KHV, and human activity in Lake Biwa, Japan allowed partial verification of the hypothesis that anthropogenic alterations of the environment facilitate outbreaks and spread of infectious diseases. A conceptual model we developed of the environment–pathogen–human linkage derived from KHV disease in Lake Biwa helped us to understand the causes of other cases of infectious disease, such as 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.

Contributions to global environmental studies

We discovered that there is an important environmental component to infectious disease. While pathological studies inform effective disease treatment, the study of the interactions between pathogen, host and human actions that may create or alleviate 'fertile' disease environments is necessary for prediction and prevention of new disease outbreaks.

We found that since the outbreak of KHV disease in Lake Biwa was first documented, KHV is now found throughout the lake ecosystem, including in plankton and sediment, in many lagoons and ponds, as well as in almost all the rivers of Japan. This finding indicates that it is impossible to eliminate KHV directly, and that instead it is necessary to practice precautionary environmental management to eliminate 'fertile' disease environments. In order to reduce future outbreaks of infectious disease, it is necessary to understand links between environments, pathogen, host, and humans in addition to the 'natural' behaviors of pathogen and host.

The finding that anthropogenic environmental changes mediate disease outbreaks and spread led us to consider how interactions between pathogens and humans can be modified for long-term societal benefit. From the view point of human ethics, we suggest that humans often have responsibility for outbreaks and spread of infectious disease.

Dissemination of the research results for a worldwide research network

We shared our research methods and results and our concept of infectious diseases as 'environmental disease' with international and national academic communities and society. Project findings were introduced to academic communities in a general paper, more than 30 specific papers on environment–pathogen–human linkages, 10 edited special articles, and six project-organized international conferences, as well as through invited lectures at universities in several Asian countries. These activities formed the base of an international alliance of researchers studying environmental disease while also promoting activities that can help address infectious disease worldwide.

Carp killed by KHV disease, Lake Biwa, 2004
by Masatomi Matsuoka [2010] In: The RIHN Encyclopedia of Global Environmental Studies, Koubundou, p. 284.

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

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 (ABL) 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 ABL over several regions including Eastern Siberia for around twenty years.

Global warming will likely transform Siberian environments. Early evidence indicates that water and carbon 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. The Lena River Basin in Eastern Siberia, which is covered in larch forest but receives little precipitation, is our main research area. The area is 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 and precipitation. This project uses multiple satellite and surface systems to track changes in water and carbon cycles and the cryosphere, and to assess their likely interactions and significance for human inhabitants of the region. The project is jointly conducted by Japanese and Russian universities and research institutes.

This research project takes natural and social science perspectives on three aspects of climate-associated environmental change. It 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 variability 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.

Project research has emphasized four main research areas

1) Permafrost–ecosystem modeling

Flux and hydro-meteorological observations were operated with the help of JAMSTEC and Russian institutes from the beginning of this research project up to now. It was found that high precipitation in the middle part of the Lena River Basin from 2005 to 2008 (Fig. 1) has led to tremendous changes in surface conditions. The changes observed include deepening and moistening of the active layers (Fig. 2), hindrance to tree growth, and the expansion of water surface due to floods. Such over-moistening condition of forest soil made larch trees to wither around the monitoring station. However satellite data analyses revealed that such tree withering was in progress only on a spot-scale.

Based on the field observation data, we have been revising our model of surface soil freezing–thawing processes in order to better represent heat, water, and carbon fluxes in permafrost ecosystems. Here we were particularly concerned with the surface soil layer, in which we now see increased thawing depth and surface soil moisture, and an increase of net primary production. It was detected that annual maximum thawing depth (AMTD) gradually increased (deepened) on a decadal scale.

Such terrestrial water storage increases in the Lena River Basin derived increases in river base flows during the open water season (Fig. 3). It was indicated that over the 1950–2008 period basin-scale AMTD has been increasing at average rates of roughly 1 cm a^{-1}.

2) Adaptation ways of keepers and/or hunters of reindeers to social-environmental changes

Interviews with keepers of domestic reindeer revealed that current climate change has not severely damaged their operations. It appears that so far they have been able to successfully adapt to changes in climate, especially in the Eastern Siberia. This might be related to resilient use of microhabitat of the domesticated reindeers around the camping site of the keepers. While on the contrary, they were severely impacted by social changes following the collapse of the Soviet Union (Fig. 4).

We are also interested in documenting the migration routes of wild reindeer and establishing whether these are

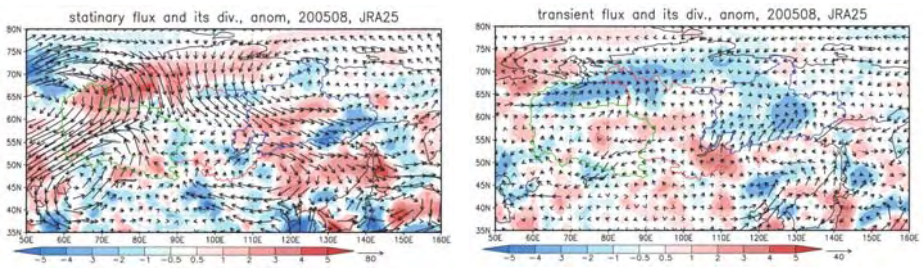

Figure 1 Atmospheric water vapor transport in August 2005 over the Siberia
Arrows in the left figure show stationary flux and those in the right one are the transient flux. Water vapor convergence is indicated in blue and the divergence is in red for both figures.

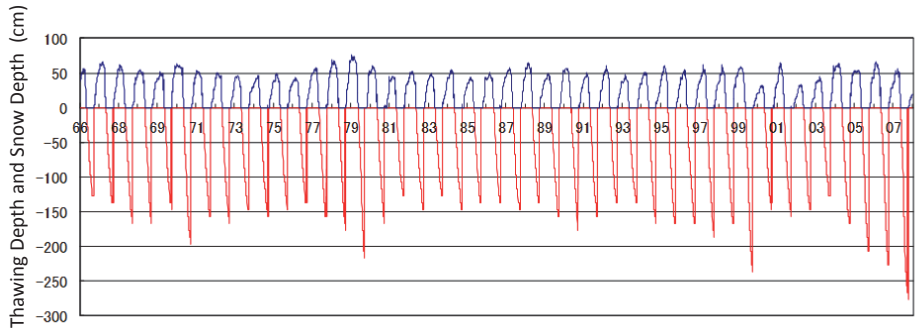

Figure 2 Time series of estimated snow depth (above 0 cm) and soil thawing depth (below 0 cm) at our larch forest site, located at the middle part of the Lena River Basin

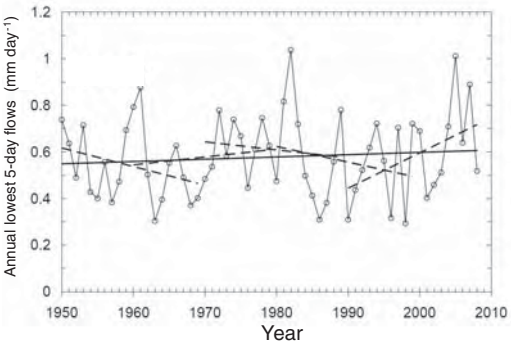

Figure 3 Evolution of the annual lowest river flows of the Aldan River in Eastern Siberia
The long straight line represents the regression over the period of record 1950–2008. The shorter straight line segments are the regressions over the periods 1950-1969, 1960-1979, 1970-1989, 1980-1999, and 1990-2008.

Figure 4 Interannual change in numbers of domestic reindeer in the Sakha Republic (right axis) and the three sub-regions (left axis) from 1980 to 2010

changing in relation to new environmental conditions. We successively tracked routes of eight wild reindeers using an ARGOS satellite system. MODIS satellite data showed that reindeer have moved along rivers and through zones of better vegetation, while avoiding increasingly common forest fires (Fig. 5). Migration distance was similar to those documented in North America and North Europe. We also found similar diurnal change in the migration behavior of wild reindeer.

3) Flood impacts

Using archival sources and remotely sensed data, we were able to make a detailed historical description of changes in annual spring ice-jam floods of the Lena River. Interestingly, spring ice-jam floods have been recognized as beneficial, except in the case of ice-jam floods which can severe damage villages along the Lena River. The benefit of spring flooding is that it delivers nutrient rich water to the river islands on which the farmers cultivate pastures for domesticated horses and cattle. When it occurs, summer river flooding, however, is a hazard as it submerges the pasture for a long duration.

We also found that increased flooding disrupts cold-weather transport via ordinarily frozen rivers and warm-weather transport over land. As result we note that Northern communities are increasingly remote and difficult to access, and have begun to study disaster vulnerability, prevention and adaptation in such areas.

4) Socio-cultural adaptations

We are describing local minority peoples' social-cultural adaptations to environmental and social changes. It became clear that traditional knowledge, social networks, money, and (in the case of North America) technology, were key factors affecting adaptive capacity to climate change. In the case of Eastern Siberia, we found additional adaptations, such as 'working with what's available, and doing without what isn't'. Interestingly, in the case of Siberia, we found that public support systems, remnants of the Soviet era, are increasingly replaced by personal networks.

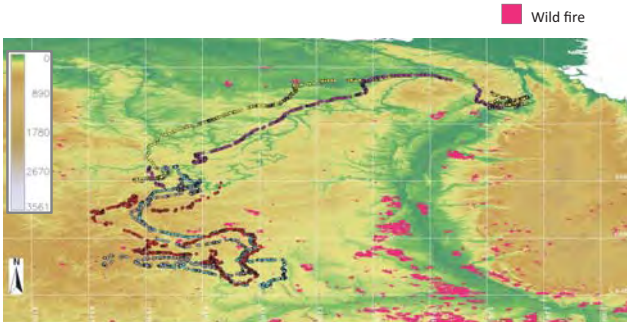

Figure 5 Tracking routes of eight wild reindeer detected using ARGOS satellite system from August 2010 to February 2011
The routes are drawn on a topographical map. Areas of wild fire are also shown.

Sub Leader

FUJIWARA Junko RIHN

Core Member

YAMAGUCHI Yasushi Nagoya University
OHTA Takeshi Nagoya University
TAKAKURA Hiroki Tohoku University
SUGIMOTO Atsuko Hokkaido University
YAMAZAKI Takeshi Tohoku University
OKUMURA Makoto Tohoku University
TATSUZAWA Shirow Hokkaido University
SAKAI Toru RIHN
SHIMIZU Hiromi RIHN

Megacities and the Global Environment

Project Leader **MURAMATSU Shin** RIHN

Professor Muramatsu researches East Asian architectural history and urban history. At the same time, he has turned his attention to historic and urban preservation and to environmental literacy education about children's living environments (Minicity). His books include *Shanghai: The City and Its Architecture, Addicted to China*, and *Keeping an Elephant*. He is editor of *Asian Architectural Studies* and *The Shibuya Heritage.*

Why are we doing this research?

In the 20th century, megacities (cities with a population of more than 10 million people) arose for the first time in human history – a new and amazing phenomenon. Their behavior has produced environmental problems on a global scale (e.g., global warming) as well as local environmental problems (urban vulnerabilities). At the same time, megacities are expected to be greatly affected by such problems. Moreover, many megacities are appearing in developing countries located in non-Western, temperate, tropical, monsoon regions: that is, in places where methods of controlling cities have not necessarily matured. In grappling with these front-line problems related to the global environment, we also hope to be able to obtain some ideas for dealing with the problem of urban shrinkage that is now occurring in Japan and elsewhere.

What are we doing, and where?

As this project's main field of study, we chose the megacity of Jakarta, the capital of Indonesia, where economic growth is currently booming. The phenomena accompanying the city's growth are exceedingly diverse. The area of the capital region is enormous, covering more than 100 km^2. The suburbs are spread out, and high-rise buildings stand one next to the other. Former rural areas have been swallowed up by the city, and high-density, traditional communities within the city have changed form while continuing to exist. Factories and commercial districts have also been constructed one after another. In these, not just artificial environments but also diverse communities have been established, and the natural environment exists in a multiplicity of forms. For this project, our goal is to work together with the University of Indonesia, Bogor Agricultural University, and the Indonesia Institute of Science to observe and measure and thereby deduce the relationships between global and local environments. We also will propose a model for megacities in the year 2050. At the same time, we are thinking about micro-design and everyday experience. In addition, we are doing comparative fieldwork on the living environments in the 17 megacities that exist in various regions of the world.

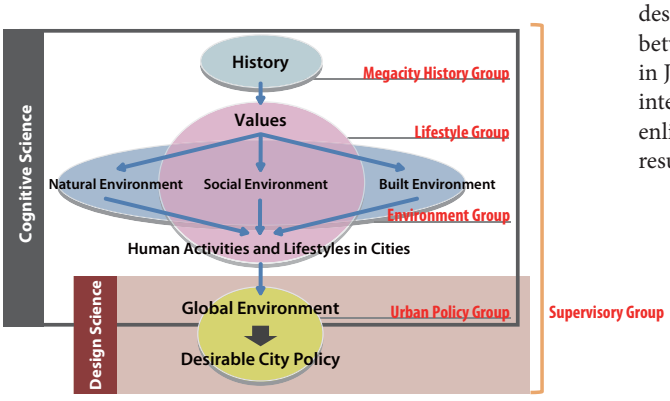

Figure 1 Project flow and research organization

What we want to communicate

Three years have passed since the project began. Counting from the preparatory stage, it is seven years in total. Experts from various academic disciplines—ecology, urban planning, history, environmental economics, environmental climatology, hydrology, and others—are cooperating to research a single giant city, generating a dynamism that is not only exciting but also produces a series of nail-biting worries. The gap between the disciplines in their research attitudes, methods and evaluative standards is much wider than was expected. Nevertheless, we are proud of the fact that even at this intermediate stage, the method (based on certain characteristics of the urban environment) by which we integrate various urban factors while analyzing this giant city "under high magnification" and which we also apply to the other 17 megacities, and the city sustainability index (CSI) which we use to compare and evaluate megacities, have already yielded unprecedented results. Moreover, the design proposals which have resulted from cooperation between the University of Indonesia and Japanese students in Jakarta's high-density communities, and which are intended not only for university education but also to enlighten community residents, have achieved significant results as well.

	Urban village area	Planned residential area	High-rise residential area	Rural village area
				
Block planning	Unplanned	Planned	Planned	Unplanned
Land use	Buildings	Buildings	Buildings	Interspersed rice fields
Dwelling density	High density	Low density	Low density	Low density
Building height	Low height	Low height	High height	Low height

Figure 2 Four characteristics of the urban environment

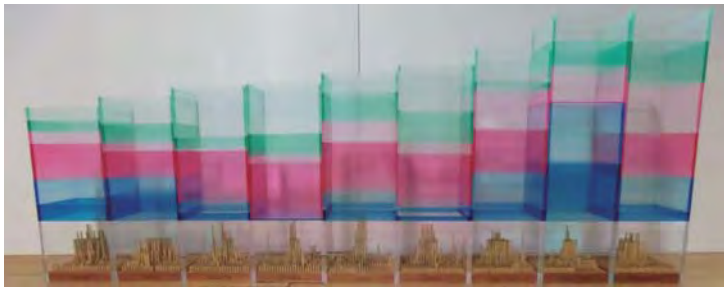

Photo 1 City sustainability index (CSI)
A model constructed to investigate the sustainability of 17 megacities (Tokyo, Jakarta, Seoul, Mumbai, Sao Paulo, Mexico City, Manila, New Delhi, Cairo, Kolkata, Osaka-Kobe, Shanghai, Buenos Aires, New York, Karachi, Dhaka, and Moscow). With blue indicating the city's environment, red its economy and green its society, this model shows how indicators will increase as each element grows. Individual indicators can be removed from the model, allowing a simple comparison and evaluation to be made of the individual elements.

Photo 2 Design intervention in Cikini (a high-density community in the city)

What we want to do from here on

Two years remain in the project. However, unforeseen results, different from those hitherto, are likely to occur. This can also be expected from the fact that the various teams members are endeavoring to integrate their diverse academic disciplines. From the start, this research has focused not only on achieving a Megacity Scenario 2050 and a megacity GIS, but also on understanding the middle-class living environments that are expanding in various cities, on undertaking a novel effort that uses the Internet to offer proposals able to improve people's urban environmental literacy, and on how humanistic knowledge and art can contribute to city, town and village environments (artificial environments, natural environments and social environments). Hereafter we will continue to plant new seeds, and we will do our utmost to reap a full harvest by the end of the project.

Photo 3 An interactive website that recognizes middle-class living environments and offers proposals

Sub Leader
HAYASHI Kengo RIHN

Core Member
OKABE Akiko Chiba University
KAGOTANI Naoto Kyoto University
KATO Hironori The University of Tokyo
SHIMADA Ryuto The University of Tokyo
FUKAMI Naoko Waseda University
MURAKAMI Akinobu University of Tsukuba
MORI Koichiro Shiga University
YAMASHITA Yuko Hitotsubashi University
YAMADA Kyota Kyoto University
MCGEE, Terry University of British Columbia, Canada
ELLISA, Evawani University of Indonesia, Indonesia