Diversity Program

Program Director **YUMOTO Takakazu**

The diversity program addresses the loss or degradation of biological diversity, from single species to entire ecosystems, and that of human cultural diversity, including language, social structure, religion and cosmology. Biological diversity composes the planet as we know it; it is the foundation of all society; human reliance on it is inestimable. Meanwhile, all contemporary societies are the inheritors of past cultural diversity: ideas, technologies, ways of living and systems of belief have been passed from people to people, and have enriched human quality of life and understanding of the cosmos. In recognizing this role of cultural diversity we recognize the basic human rights to safe, healthy, fulfilling lives and peace of mind: the essential conditions in which the individual can live with hope and pride.

In a historical context, the current loss of cultural diversity should be seen as part of a large-scale process that threatens biological diversity on Earth, and as an expression of humankind's current relationship with nature since the last century. Humanity faces a situation in which the cultures and languages that embrace the thinking that have caused today's global environmental problems are expelling from the world the cultures and languages that have embraced "wise use" and harmony with nature.

The RIHN Diversity Program aims to clarify the formation, maintenance and functions of biological and cultural diversity in various environments. It seeks to identify ways to re-vitalize the idea and practice of "wise use" of nature—to prevent exhaustion of resources and preserve ecosystem services—in order to enhance human wellbeing and ecological integrity.

Completed Research	Leader	Title
D-01	**ICHIKAWA Masahiro**	Sustainability and Biodiversity Assessment on Forest Utilization Options
Full Research	**Leader**	**Title**
D-02	**YUMOTO Takakazu**	A New Cultural and Historical Exploration into Human-Nature Relationships in the Japanese Archipelago
D-03	**OKUMIYA Kiyohito**	Human Life, Aging and Disease in High-Altitude Environments
D-04	**YAMAMURA Norio**	Collapse and Restoration of Ecosystem Networks with Human Activity

Sustainability and Biodiversity Assessment on Forest Utilization Options

Terrestrial biodiversity has decreased mainly because of the loss and/or deterioration of forest ecosystems. A system to utilize forest resources while conserving biodiversity should be developed. This project aims to elucidate the socio-economic factors causing forest decrease, the effect of decreasing forest on biodiversity, and the ecological services that might be lost as a consequence of biodiversity loss. We also evaluate the forest-use options both from ecological and socio-economical perspectives to develop a sustainable utilization system.

Project Leader: **ICHIKAWA Masahiro** Faculty of Agriculture, Kochi University (RIHN until March 2009)

Project Findings

The following subjects were studied at four sites: Sarawak and Sabah in Malaysia, and Yaku Island and Abukuma Mountains in Japan.

1. Changes of forests and their driving forces

- The results were shown as land-use maps and matrices.
- Driving forces of change

2. Effects forest changes on biodiversity

- Biodiversity losses in each utilization option. The results were shown as biodiversity maps.
- Mechanisms of maintenance and loss of biodiversity in natural and disturbed systems

3. Ecosystem functions and services provided by biodiversity and their changes

- The results were shown as ecosystem function and service maps.

4. Social institutions on sustainable use of forest biodiversity

- Environmental economy of each utilization option. Ecological and socio-economic value of each utilization option.

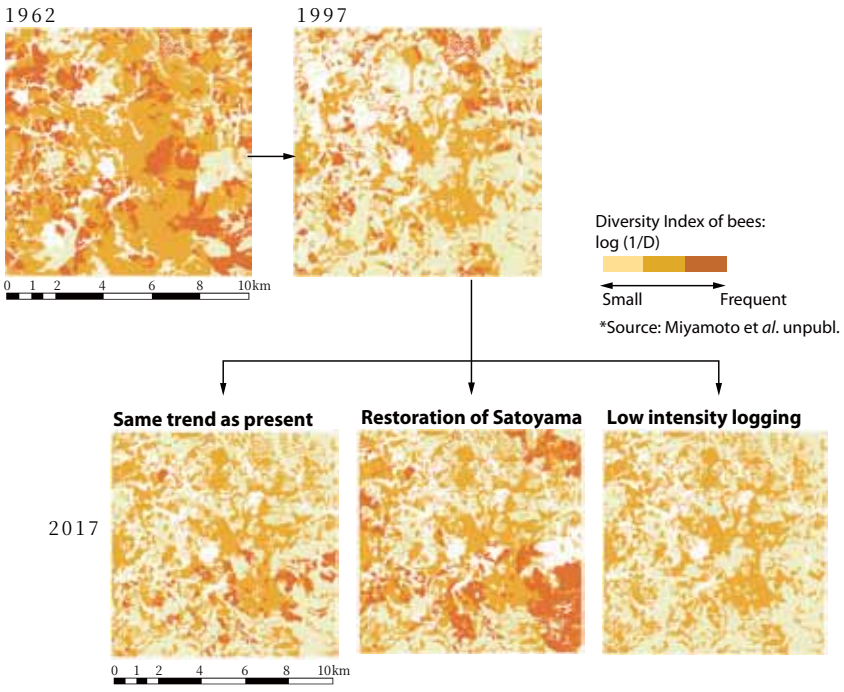
Based on the results of 1 to 4 above, we built an integrated assessment method for sustainable use of forest and biodiversity.

Project Contribution

This project demonstrated how forest changes affect biodiversity. Based on this description we proposed an integrated method to assess sustainable uses of forest and biodiversity. The assessment will be useful as ways are sought to resolve problems on uses of forests and biodiversity in each area. The assessment method could be standardized for use by the public and private sectors.

Published Results

Academic papers with peer review: 203 (English 165, Japanese 38). Papers in books: 67 (English 21, Japanese 46). *For the Future of Biodiversity* (11 chapters), a curriculum for undergraduate students (RIHN and Showa-do in Japanese). *Forest Degradation in the Tropics of Southeast Asia* (Jinbun Shoin, in Japanese), Special issue in *Ecological Research* (2007), *Sustainability and Diversity of Forest Ecosystems* (2007), and others.



An example ecosystem function map

This figure shows change of diversity of bees and projections under three scenarios in Abukuma. Restoration of Satoyama is the best scenario for species richness of bees.

A New Cultural and Historical Exploration into Human-Nature Relationships in the Japanese Archipelago

The Japanese Archipelago has been densely populated since the Neolithic Age and its natural environment has been greatly influenced by human activities. In spite of intensive human intervention in the natural environment, the area is still rich in biota. More recent patterns of interaction between humanity and nature have placed many plants and animals in danger of extinction. This project describes the historical evolution of human-nature relationships in the Japanese Archipelago in order to suggest concrete measures for preventing species extinction in the near future.

Project Leader
YUMOTO Takakazu
RIHN

Takakazu YUMOTO is Professor at RIHN and Program Director of the Diversity research agenda. He is an ecologist with a doctoral degree from Kyoto University, and has been studying plant- animal relations in the tropical regions before starting RIHN project. Now he expands his research field into human-nature relations, including ethnobotany and ethnozoology mainly in the Japanese Archipelago.

Core Members

ABE Hiroshi	Graduate School of Human and Environmental Studies, Kyoto University
ANKEI Yuji	Faculty of International Studies, Yamaguchi Prefectural University
IINUMA Kenji	Faculty of Humanities, Beppu University
IKEYA Kazunobu	National Museum of Ethnology
IMAMURA Akio	Faculty of Bioenvironmental Science, Kyoto Gakuen University
MATSUDA Hiroyuki	Graduate School of Environment and Information Sciences, Yokohama National University
MURAKAMI Noriaki	Graduate School of Sciences and Engineering, Tokyo Metropolitan University
NAKAI Sei'ichi	Faculty of Humanities, Toyama University
NAKANO Takanori	RHIN
OSUMI Katsuhiro	Forestry and Forest Products Research Institute
SATO Hiroyuki	Graduate School of Humanity and Sociology, The University of Tokyo
SHIROUZU Satoshi	The Law Faculty, Chuo-Gakuin University
SUKA Takeshi	Nagano Environmental Conservation Research Institute
TAJIMA Yoshiya	Faculty of Economics, Kanagawa University
TAKAHARA Hikaru	Graduate School of Life and Environmental Sciences, Kyoto Prefectural University
TAYASU Ichiro	Center for Ecological Research, Kyoto University
YAHARA Tetsukazu	Graduate School of Sciences, Kyushu University
YONEDA Minoru	Graduate School of Frontier Sciences, The University of Tokyo

Project Objectives

The main objective of the project is to describe the history of human-nature relationships in the Japanese Archipelago. Project researchers will examine how the area's physical environment and biota have changed since the late Paleolithic Age, when human presence was first established. Archaeological, historical and folkloric materials are used to indicate past human perception and knowledge of, and skills regarding, nature in general, and to describe human effect on key plant and animal species. Combining biophysical history with human cultural history will lead to a richer appreciation of the human-environmental experience in the archipelago.

Study Area and Methods

Six regions and (in parentheses) seven sites have been selected for intensive field study: Hokkaido (Shiribeshi), Tohoku (Kitakami), Chubu (Akiyama), Kinki (Kyoto-Tanba), Kyushu (Kuju-Aso), Ryukyu (Okinawa Island and Amami-oshima Island), with some additional evidence taken in Sakhalin. Each site consists of an area measuring about 100 km^2, and includes agricultural land, forested land, and mountains, as well as the characteristic climate, vegetation, flora and fauna, and human culture of its area. Three method-based working groups focus on investigation of the paleo-ecosystem, plant-geography, and analysis of human remains. Principal data is gathered from pollen samples, and DNA and stable isotope analysis, as well as a range of archaeological artifacts, historical documents and folkloric materials.

The project foci are: 1) analysis of ancient vegetation and changes in the distribution of plants and animals; 2) reconstruction of human ecology based on population estimates and diet; 3) description of principal patterns of human-nature interactions in the past and of the social systems associated with these patterns; and 4) theoretical modeling of human-nature relations.

The above data and analyses will be used to compile an environmental history chart depicting vegetation change, human population, and historical epochs for each site. The use of proxy and tracer analyses, such as of pollen, DNA and stable isotopes, will enable comparative analysis of the driving causes and effects of changing human-nature relations in different places and epochs.

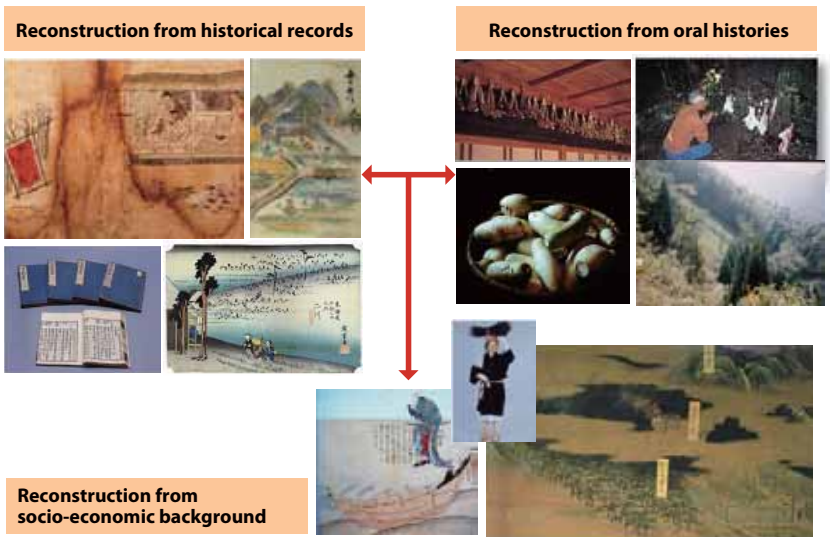


Figure 1
We combine analysis of historical records, folklore and socio-economic background to understand "wise use" of ecosystem services.

Results

For each study region we are compiling a series of environmental history charts that indicate major environmental issues and changes in resource management policy. The charts will be completed by adding data of estimated vegetation and population change. These charts have allowed us to examine the parallel histories of human and environmental change in the archipelago, and to relate changes in environmental knowledge and skill to the disappearance, or new abundance, of particular flora or fauna.

We have also examined the concept of "wise use," which we have defined as the application of environmental knowledge and skills so as to utilize (or otherwise take benefit from) renewable natural resources and ecosystem services without exhausting them. We are distinguishing and categorizing examples of "wise use" and "unwise use" from each district by scale of governance (e.g. household, community, local government, national government, international organization) and system of incentive employed. This analysis will indicate variations in the approach to environmental governance and time-and place-specific perceptions of "wise use" of environmental resources.

Future plans

In integrating and analyzing the findings of the different working groups, we attempt to describe the processes that have led to plant and animal extinction in the Japanese Archipelago, and how the extinction ratio in the future can be reduced. At the same time, we seek to emphasize examples in which culture, religion and governance encouraged wise use of natural environments. In 2010 when the 10th Conference of the Parties of the Convention on Biological Diversity will be held in Nagoya, Japan, we will prepare a strong message of how the preservation of biodiversity and cultural diversity constitute quality social and ecological life.

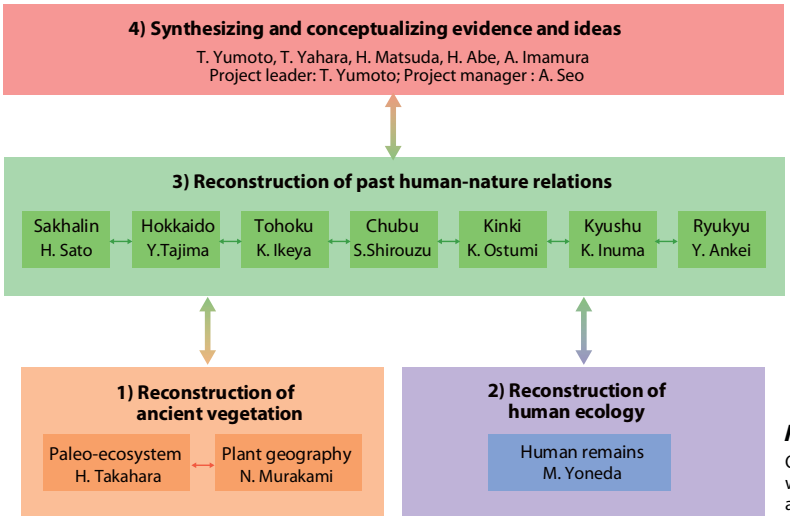


Figure 2

Our project structure is based on 7 district-based working groups, 3 method-based working groups and an integrating working group.

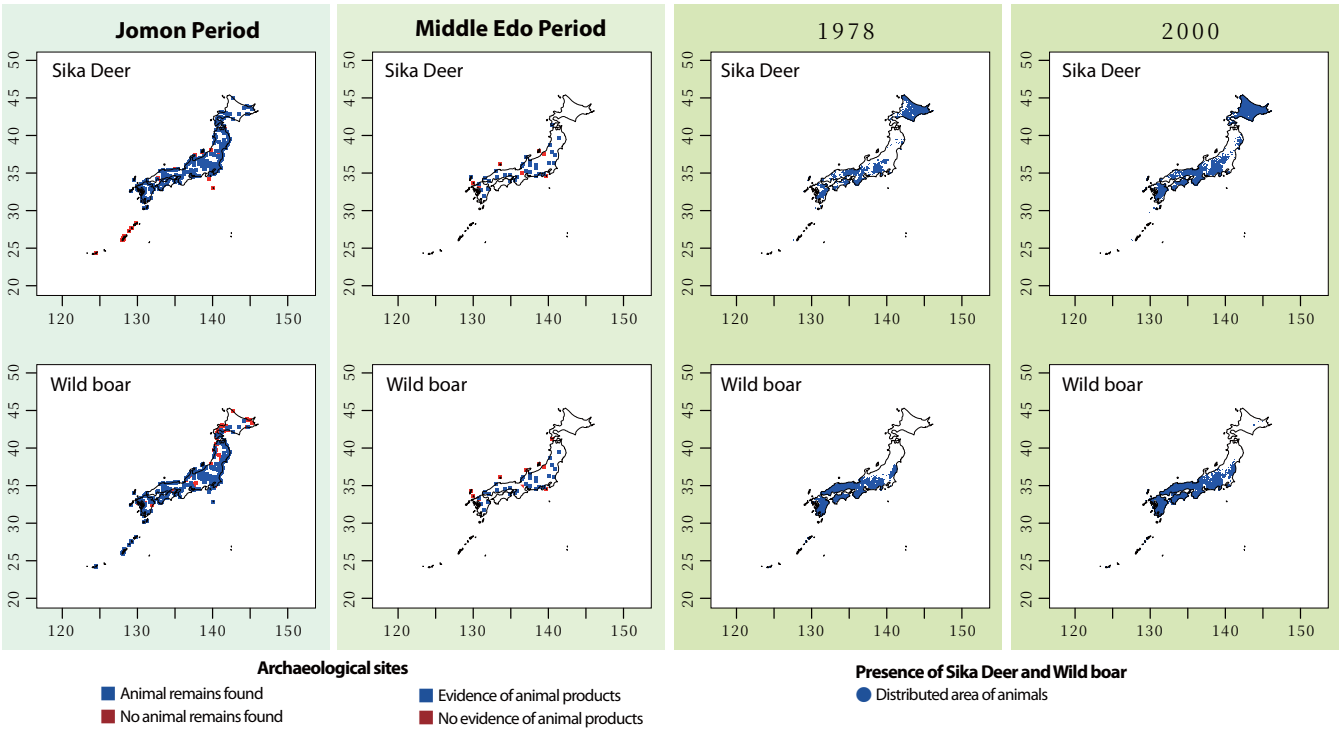


Figure 3 **Distribution maps**

Distribution maps of sika deer and wild boar in Jomon Period, Edo Period, 1978 AD and 2000 AD in Japanese Archipelago. Distribution map of Jomon period was drawn from the data of Kaizuka (Shell mound) database (http://aci.soken.ac.jp/database/kaizuka/index.html). Distribution map of Edo period and 1978 AD and 2000 AD were cited from Japan Integrated Biodiversity Information System (http://biodic.go.jp/kiso/fnd_f.html), Ministry of the Environment Biodiversity Center of Japan.

Human Life, Aging and Disease in High-Altitude Environments: Physio-Medical, Ecological and Cultural Adaptation in "Highland Civilizations"

This project takes new perspectives on the long- and short-term effects of high-altitude environments on human physiology and health. We focus on several common health problems associated with aging and contemporary lifestyle because we regard these as manifestations of global environmental issues in the human body. Focusing on Himalaya-Tibet in comparison with the other "highland civilizations" in the Andes and Ethiopia, we examine ecological, cultural and physiological adaptations to high-altitude environments and how recent changes in lifestyle have affected quality of life amongst the elderly in these places.

Project Leader
OKUMIYA Kiyohito
RIHN

Dr. Okumiya earned a doctorate in medicine from Kochi Medical College. He has adopted a novel approach to field medicine, including cultural and environmental factors in the study of community-dwelling. He has published journal articles on field medicine, geriatrics, and neurology.

Core Members

ANDO Kazuo	Center for Southeast Asian Studies, Kyoto University
INAMURA Tetsuya	School of Foreign Studies, Aichi Prefectural University
KAWAI Akinobu	Faculty of Liberal Arts, The Open University of Japan
KOSAKA Yasuyuki	RIHN
SAKAMOTO Ryota	RIHN
SHIGETA Masayoshi	Graduate School of Asian and African Area Studies, Kyoto University
TAKEDA Shinya	Graduate School of Asian and African Area Studies, Kyoto University
TSUKIHARA Toshihiro	Faculty of Education and Regional Studies, University of Fukui
MATSUBAYASHI Kozo	Center for Southeast Asian Studies, Kyoto University

Project Objectives

Are High-altitude environments harsh? They have little oxygen, cold temperatures and fragile ecosystems; these conditions have caused physiological changes in their inhabitants. Examinations reveal that physiological adaptations to high altitude differ between the populations of Tibet, Andes and the Ethiopian highlands. Andean people, who of the three civilizations have the shortest history of high-altitude inhabitance, show increased number of red blood cells. This adaptation is the same as that found in lowlanders who have migrated to high-altitudes. Tibetan people show a greater blood flow capacity than is commonly found in lowland residents or those of shorter-term highland cultures. Ethiopians, who have the longest history of high-altitude habitation, may have the best physiological adaptation to the challenges of high-altitude environments: their blood shows very high oxygen saturation. Thus this project has described physiological adaptation to high-altitude environments at different time scales.

Our research objectives are as follows: first, to further clarify how humans have adapted to high-altitude environments, physio-medically and culturally; and second, to consider the relation between the human body as the internal environment shaped by long-term adaptation and recent livelihood changes and health problems associated with contemporary globalization. Specifically, we examine incidence of diabetes, obesity, hypertension and other lifestyle-related diseases, and their likely significance for highland populations.

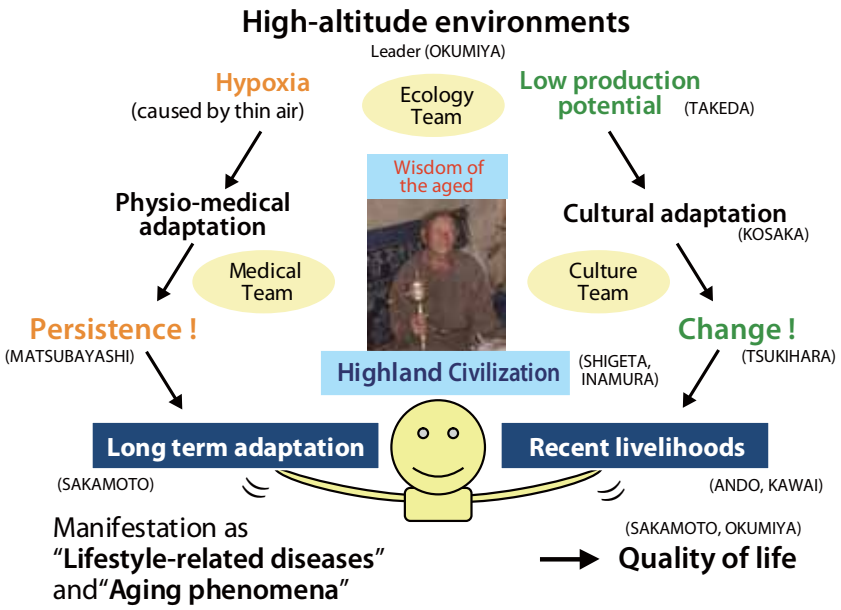


Figure 1 **Framework of the project**
How do recent livelihood changes affect long-term cultural and physio-medical adaptations to highland environments?

Progress to date

We have composed a series of examinations and interviews regarding health, longevity, and quality of life among recent and long-term residents of Tibet, and among a population of Japanese lowlanders for comparison. In Tibet, we found that Han peoples show increased red blood cell counts. Since obesity and hypertension are also associated with increased red blood cells, this process of hypoxic adaptation may expose Han people to greater risk.

We found that the prevalence of diabetes in Han and Tibetan elderly was lower than in Japanese lowlanders. This is compatible with previous reports showing that the lifestyle in highlands may help prevent diabetes. However, diabetes appears to be increasing in highland resident office workers and monks, and follow-up and prevention schemes are needed. The prevention of diabetes is important,

Photo 1 **Tea trade**
Commerce networks between different ecosystems have a history of over a thousand years.

Photo 2 **A contemporary funeral in Tibet**
Modernization reaches into all aspects of life and death.

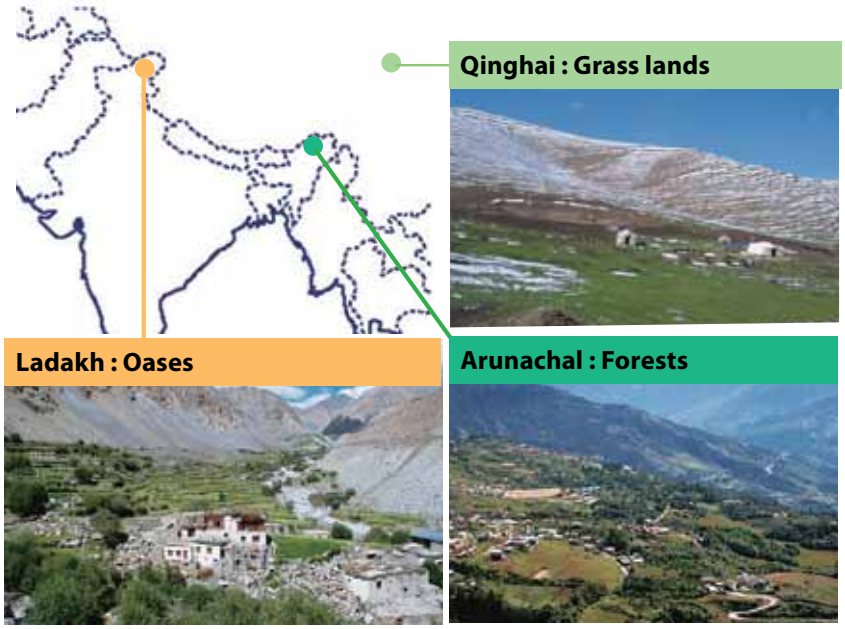


Photo 3 **The main research areas in the Himalaya-Tibet region**
Ladakh, Qinghai and Arunachal are located in distinct oasis, grassland and forest ecological zones.

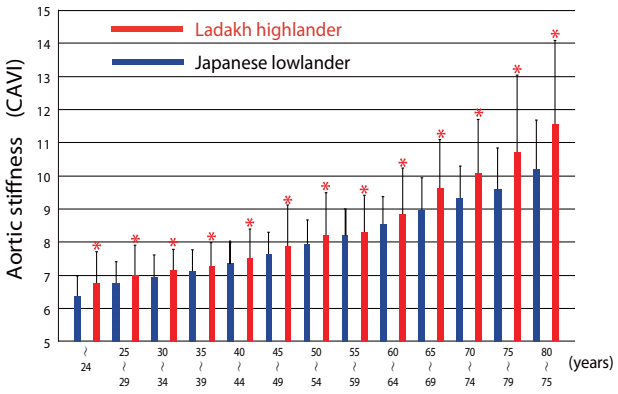


Figure 2 **Accelerated aging of blood vessels in highlanders**
Ladakhi women highlanders had greater aortic stiffness (CAVI: cardio ankle vascular index) than Japanese lowlanders. Aortic stiffness is a marker for arteriosclerosis (Kuniaki Otsuka; Himalayan Study Monograph 10 2009).

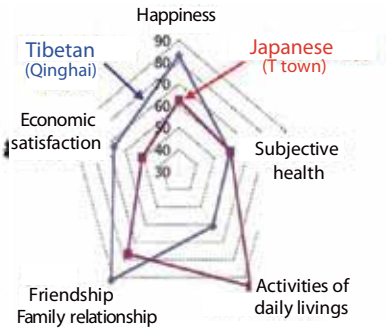


Figure 3 **Subjective quality of life and living abilities**
In spite of low functional abilities and health indicators, Tibetans self-report a higher quality of life than do elderly Japanese. (Matsubayashi K, *Geriat Geront Int*. 2009 in press.)

because diabetes accelerates arteriosclerosis which inhibits the transport of oxygen in the human body.

Rural-urban migration is increasing in Ladakh, with great effect on agro-pastoral traditions and livelihoods of the area. Out-migration has caused a labor shortage; agro-pastoral households are decreasing in number as rural households turn to commercialized agriculture. Such changes in the rural economy will affect community form and dietary habit. We are studying their effect and mapping changes in land use.

Schedule in 2009/2010

Our research will emphasize linkages of medical problems and cultural and ecological factors in each study site, including:

(1) Association between hypoxic adaptation and lifestyle related diseases;
(2) Acceleration of aging at high altitudes;
(3) Low prevalence of diabetes in highlanders, but increasing in office workers;
(4) Rapid increase of off-farm workers at high altitude;
(5) Transformation of the agro-pastoral linkage due to rural-urban migration.

We will concentrate on the Himalayas/Tibet and propose a model of human-nature interactions in Asian highland civilization . We intend to make further comparative study of Himalaya-Tibet with the Andes and Ethiopia in the future.

Collapse and Restoration of Ecosystem Networks with Human Activity

Many ecosystems have been seriously degraded by human activities and are now in critical condition. Nevertheless, most research on the subject has focused only on the direct cause and effect of ecosystem degradation in a particular place. This project applies new network sciences to the problem of ecosystem deterioration and collapse, and to the prospects of their restoration. The project examines interactions between human societies and nature in two distinct ecosystems where humans are dramatically altering the course of ecosystem change, and attempts to identify general properties of productive and destructive ecological change.

Project Leader
YAMAMURA Norio
RIHN

My research field is mathematical ecology. I have studied various theoretical problems in population and evolutionary ecology. I am now trying to construct mathematical models on socio-ecological systems, for example, modeling population migration between urban and rural areas, and differences in the use of private and common lands. I like football, and am still playing on the small RIHN field sometimes.

Core Members

SAKAI Shoko	RHIN
ISHII Reiichiro	Frontier Research Center for Global Change
FUJITA Noboru	Center for Ecological Research, Kyoto University
ICHIKAWA Masahiro	RIHN
MAEKAWA Ai	RIHN
NAKASHIZUKA Tohru	Faculty of Bioscience, Tohoku University
OHGUSHI Takayuki	Center for Ecological Research, Kyoto University

Objectives

Degradation of ecosystems, including loss of biodiversity and ecosystem functions, is widely viewed as a serious global environmental problem. To date, most research on the problem has focused on the direct causes and effects of ecological degradation in a particular place. Few studies have adopted a network-based analytical framework amenable to description of indirect and cascade effects characteristic of human-driven ecosystem change. Still fewer studies incorporate a social science perspective on ecological networks, even though environmental problems are one of the consequences of interactions between nature and human society.

This project uses new network sciences to clarify the social and ecological patterns of exchange that lead to degradation of two endangered Asian ecosystems. Recent advances in computer science and in theoretical studies on complex networks (i.e. complex system sciences, complex adaptive systems) have dramatically increased our ability to describe complex interactions such as those between ecosystems and human societies. Complex system sciences can now lend important insights to the fields of sociology, economics, and ecology, and can offer richer description of the processes of ecological degradation and of the potential for restoration.

Research Sites

Field research takes place in tropical rainforests in Sarawak, Indonesia and the grasslands in Mongolia.

Mongolia, healthy grassland (A) and degraded pasture (B). Sarawak, rainforest (C) and plantation (D).

In Mongolia, livestock have grazed the grasslands intensively for a long time. In recent years, overgrazing by livestock, especially by the increased number of goats used in the production of cashmere for export, has caused a serious problem in the region. In Sarawak, the ecosystem has changed dramatically over the last 100 years; land use has shifted from extensive agriculture in forests by aboriginal people to logging in natural forests as a source of timber for export, and more recently to oil-palm plantations.

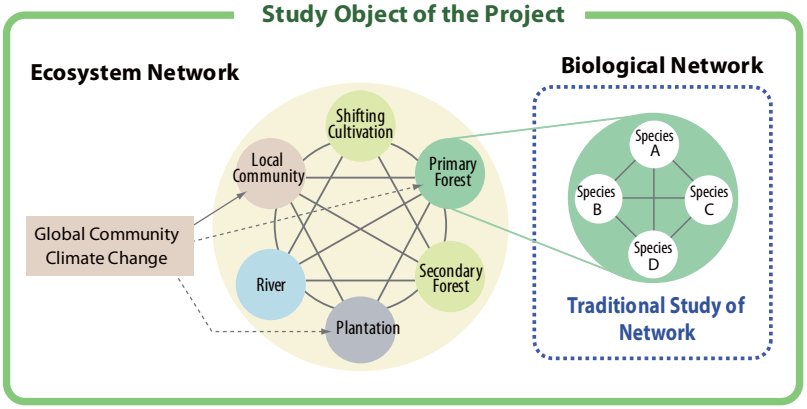


Figure 1 **Example of an ecosystem network in Sarawak**

In the ecosystem network, the subsystems (e.g., primary forests, secondary forests, lands for shifting cultivation), each of which consists of several networks of biological interactions, form an interacting network. We treat human society as a subsystem within the ecosystem network and regard human activities as another field of ecosystem interactions.

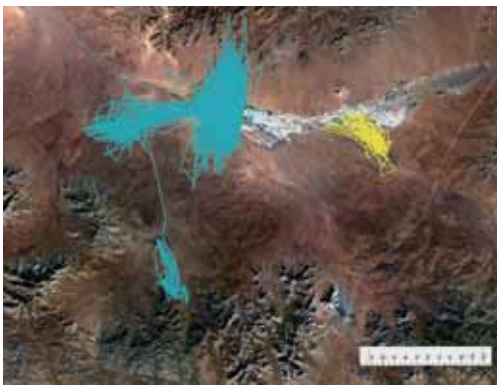


Figure 2 **GPS data for movement of livestock in two families in Bayanunjuul (10 km x 7 km)**

The range of one family's grazing livestock from August to November (shown in blue) and that of another in August (yellow). The former family shifted the location of its house twice in the period of four months. The graph shows that the livestock of both families have a fairly regular daily range of several kilometers from their pens.

Export of raw materials is central to both economies. In the last few decades, social and environmental conditions in both places were profoundly affected by resource extraction, which has recently intensified in response to demand from China. Though their ecological characteristics, such as the regeneration time of vegetation and position of humans in the food web, are quite different, the livelihoods of many inhabitants of these regions are dependent on natural ecosystems, and ecosystem destruction dramatically changes their practices and prospects.

Research Methods

The most important concept of this project is the "ecosystem network," which has a nested structure of interactions among and within network subsystems, including human systems, as shown in Figure 1. Our project will describe the existing ecosystem network structure in both regions. Because biological interactions within ecological subsystems have already been studied extensively, our ecological surveys will focus on material flow and the movements of organisms—especially pollinators, predators and parasitoids—between subsystems, and their role in ecosystem function.

As for the human action relevant to the ecosystem network, we are investigating the ecological effect of specific human actors (e.g. pastoralists), the reasons for their behavior, how it may be subject to that of other actors, and how present social and ecological relationships differ from those of the past. Based on our results, we will construct models that can describe the ecosystem networks in the two regions, and predict their patterns of change. Further, we will generalize the results to determine the critical network characteristics likely to result in environmental problems.

Progress to date

In 2008, our initial year of research, we established our observational infrastructure at several sites in Sarawak and Mongolia and collected satellite data and statistical data with a GIS. We conducted ecological and social surveys on which initial projection models have been based.

In Sarawak, we: (a) established survey plots at primary and secondary forests in Lambir National Park, and surveyed biological species and ecosystem services; (b) conducted intensive social surveys on a few selected villages and extensive questionnaire surveys on many villages over all Sarawak; (c) examined the status and causes of expansion of oil palm plantations, and socio-ecological systems of certified forest biological resources.

In Mongolia, we: (a) set up automating weather systems at three points, Ulaanbaatar in the forest steppe, Mandalgobi in the steppe, and Hanhongor in the desert steppe; (b) examined migration patterns of nomadic people by setting GPS on livestock (Figure 2), and surveyed grass production and livestock grazing pressure; and (c) conducted questionnaire surveys on factors determining the migration patterns of nomadic peoples, with special emphasis at Ulaanbaatar.

For our modeling component, we: (a) started construction of models predicting the biomass in Mongolian grasslands using satellite and climate data; (b) started construction of agent-based models examining relationship between vegetation changes and migration patterns; and (c) constructed a GIS database of population and livestock with SUM (an administrative division) units. We documented a recent rapid increase in the number of goats associated with the production of cashmere, especially near Ulaanbaatar.

Issues to be addressed

Because the land cover in Mongolia is relatively simple, the modeling is easier, and project modeling and surveys are better integrated in Mongolia than in Sarawak. Based on our progress in describing the ecological structure and in identifying appropriate modeling subjects, model construction is now set to proceed in Sarawak. In both areas, where spatial data are available, we will model dynamics of plant biomass and land use. Biodiversity serves as an index of land cover and land use. Modeling the effects of human activities on ecosystems is still a challenging task. In Mongolia, we will abstract the rule of movements of nomadic households and livestock from GPS data and questionnaire surveys. In Sarawak, we have to determine both the unit and rule of decision-making in regard to utilization of ecological resources. As for the final goal of our project, the future projection and evaluation of ecosystem networks under several scenarios, we must also focus our efforts and determine scenario parameters.