Diversity Program

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Program Director **YUMOTO Takakazu**

The diversity program addresses the loss or degradation of biological diversity—from single species to entire ecosystems— and 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 and 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. These are 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 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 well-being and ecological integrity.

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

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

Professor Takakazu Yumoto is Program Director of the RIHN 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. At RIHN 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
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SUKA Takeshi	Nagano Environmental Conservation Research Institute
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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 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, knowledge and skills regarding nature in general, and the human effect on key plant and animal species. This combination of biophysical and human cultural history will enrich appreciation of human-environmental history in the archipelago.

Study area and methods

Six regions and seven sites (in parentheses) 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

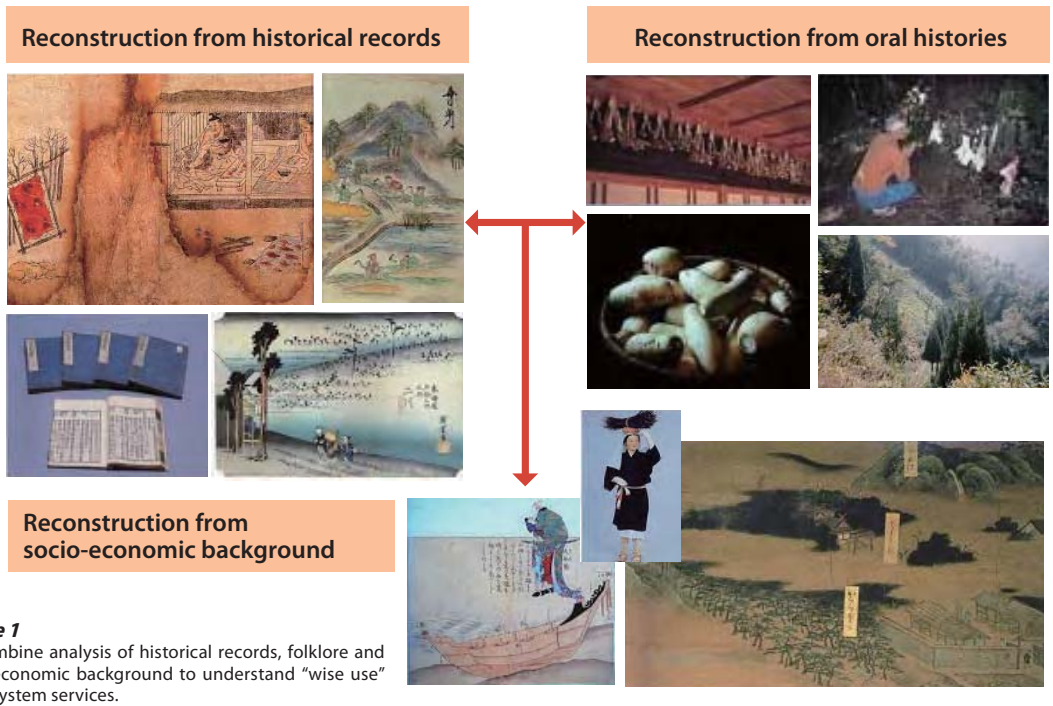

Figure 1
We combine analysis of historical records, folklore and socio-economic background to understand "wise use" of ecosystem services.

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 (pollen, DNA and stable isotope analysis), will enable comparative analysis of the driving causes and effects of changing human-nature relations in different places and epochs.

Results

For each study region we are compiling a series of environmental history charts that indicates major environmental issues and resource management policy changes. 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 in such as way as to utilize (or otherwise take benefit from) renewable natural resources and ecosystem services without exhausting them. Examples of "wise use" and "unwise use" from each district are being distinguished and categorized 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 try to understand 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 contribute to human wellbeing and ecological integrity.

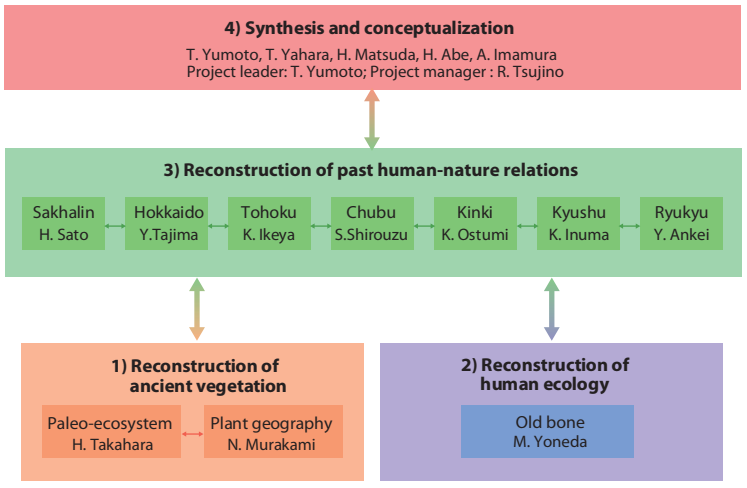

Figure 2
Our project structure is based on 7 area-based working groups, 3 method-based working groups and an integrating working group.

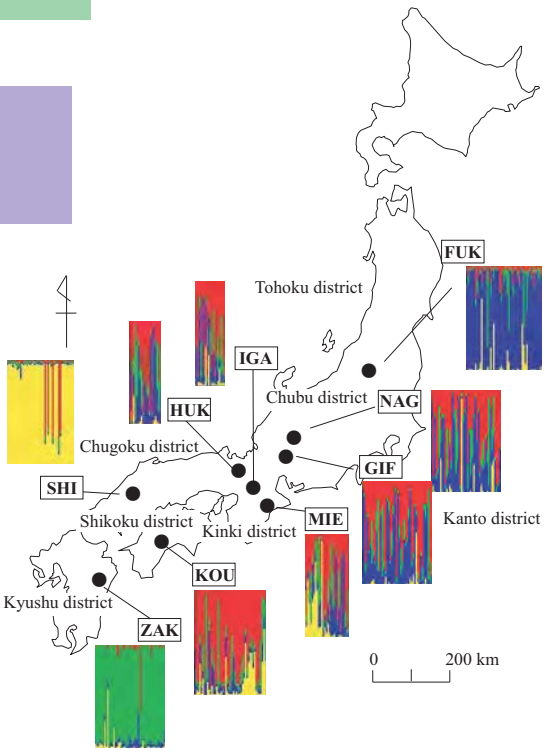

Figure 3
Genetic structure of an endemic tree species, *Sciadopitys verticillata*. *S. verticillata* has been used to make coffins and pillars for more than 2000 years. The species' low genetic variation in several localities indicates overuse in the past.

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

This project examines how humans have adapted to high-altitude environments physiologically, ecologically and culturally. Project researchers document the health status of elderly highlanders, and explore possible factors associated with lifestyle-related diseases in this population. Finally, we investigate the impact of modern development over the past 50 years on high altitude lifestyles and environments, and assess how these changes affect the quality of life (QOL) of elderly highlanders. Study sites have been selected from three areas in the Himalaya-Tibet region, the Ladakh region in India, the Arunachal Pradesh State in India, and the Qinghai Province in China, each of which has distinct ecological and socioeconomic conditions. Findings from the Himalaya-Tibet region will also be compared with medical research conducted in Bhutan and Nepal.

Project Leader
OKUMIYA Kiyohito
RIHN

Dr. Okumiya is a medical doctor with a degree 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

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MATSUBAYASHI Kozo	Center for Southeast Asian Studies, Kyoto University

Project Objectives

We intend to explore new perspectives regarding how people live in high-altitude environments where oxygen levels are low and natural resources are limited. We focus on aging problems and lifestyle-related diseases because we regard these as manifestations of global environmental issues in the human body. We aim to clarify "highland civilization", as defined by ecological and cultural adaptations to high-altitude environments, physiological adaptations, and how recent changes in lifestyle have affected quality of life (QOL) amongst the elderly.

Progress to Date

Research findings indicate the following.

1) High altitude environments speed up the senescence process of the human body.
2) Recent lifestyle changes have brought about increases in the prevalence of lifestyle-related diseases and change of aging phenomena.
3) Incidence of lifestyle-related diseases is strongly influenced by adaptation methods to high altitude environments.
4) High subjective QOL assessments were found in Tibetan people, even though they experience a higher prevalence of disabling conditions compared with Japanese populations.

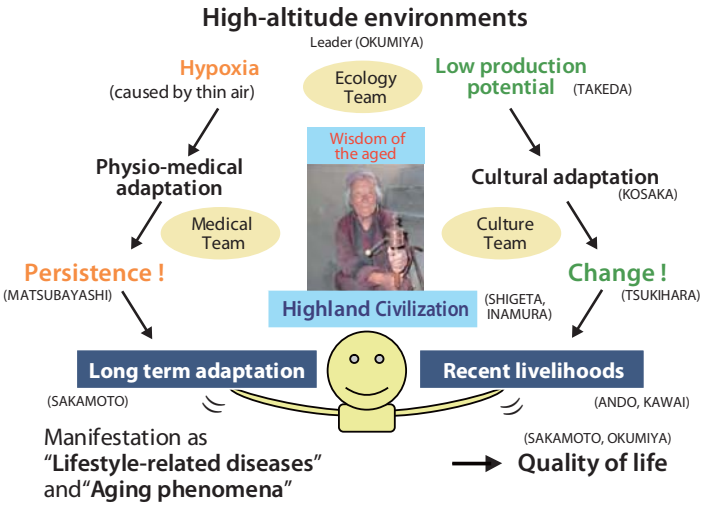

Figure 1 **Framework of the project**
How does recent livelihood change affect long-term cultural and physio-medical adaptation to highland environments?

The three study agenda streams
Human physiological, ecological and cultural adaptation to high-altitude environments

We examined oxygen saturation, hemoglobin concentration (the primary conveyer of oxygen in the blood), Cardio Ankle Vascular Index (atherosclerosis), pulmonary blood pressures (as indicators of dilatation and blood flow to promote oxygen circulation), respiratory functions (intake of oxygen) and oxidative stress in elderly residents in the study areas. Han people had higher hemoglobin concentration compared with Tibetans in Qinghai. Increasing prevalence of diabetes mellitus was strongly associated with increases in hemoglobin levels related to adaptation to hypoxia in Ladakh (Fig. 3).

The following five variables are identified for consideration in cultural adaptation and they will be intensively studied in Ladakh and Arunachal. First, the form of agricultural activity and the land-holding system have been described in terms of wise use of limited natural resources. Second, household attributes will be recorded through a household survey on population, sex ratio and marriage system, labor distribution, and economic conditions. Third, dietary habits have been identified and the amount of nutrition intake will be evaluated. Fourth, local knowledge on traditional medicine will be recorded. Fifth, the role of religious beliefs will also be considered as an important factor that supports daily life by promoting mental well-being.

Figure 2
We set up weather monitoring stations at Domkhar village and installed five temperature/humidity sensors in the Ladakh area beginning in June 2009. We developed a fine resolution climatological profile in the region using a combination of local meteorological and satellite data (Yatagai *et al.* 2008. SPIE).

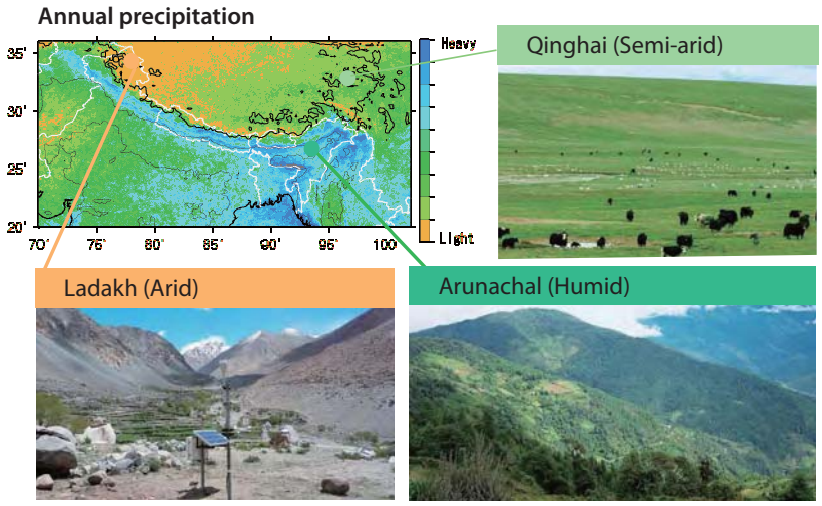

Photo 1 **Ladakh, Domkhar January 2009 (3800 m)**
We explore the physiological and cultural adaptations of people living in low-oxygen and limited-natural resource high-altitude areas.

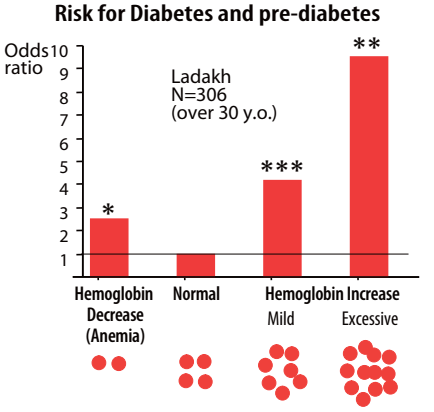

Figure 3
Increase in the prevalence of diabetes mellitus was strongly associated with increases in hemoglobin levels caused by adaptation to hypoxia (Okumiya *et al.* 2010. J Am Geriat Soc).

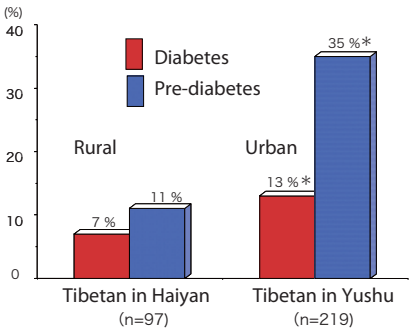

Figure 4 **High prevalence of diabetes and pre-diabetes in Yushu (urban) and Haiyan (rural), Tibet.**
Changes in lifestyle patterns associated with settlement and urbanization may accelerate prevalence of lifestyle-related diseases (Okumiya *et al.*, 2010. J Am Geriat Soc., in press).

Health status of elderly highlanders and possible factors associated with lifestyle-related diseases

Han people had greater rates of hypertension and obesity than Tibetan people. The conditions are associated with higher hemoglobin concentrations in Han populations, which in turn is regarded as an adaptation to hypoxia. Even within the Tibetan population, there was a strong association between glucose intolerance (diabetes/pre-diabetes), obesity, and polycythemia (increased hemoglobin), an indicator of hypoxic maladaptation (Fig. 3). Obesity, hypertension, atherosclerosis and high pulmonary blood pressure were more prevalent in people with higher hemoglobin in both Ladakh and Yushu.

The prevalence of glucose intolerance and hypertension were much higher in Yushu than Haiyan, Qinghai. Changes in lifestyle patterns associated with settlement and urbanization may be associated with the increased prevalence of the two conditions (Fig.4).

The prevalence of diabetes mellitus (DM) in Ladakh was as low as in Haiyan, but pre-diabetes was as high as in Yushu and higher than in Haiyan. The "thrifty gene/phenotype" hypothesis may help to explain some of the observed difference. In Ladakh, we found that there were higher rates of diabetes in people with high economic status and non-traditional food habits. In high altitude Himalaya regions, after rapid changes in lifestyle, adaptation mechanisms to hypoxia and low nutrition may have accelerated the onset and aggravation of diabetes. This is "the Himalaya model of lifestyle-related diseases" -"diabetes acceleration hypothesis"-.

Impact of modern developments on lifestyle and environment at high-altitudes and their relation to elderly QOL

People with glucose intolerance had high risk of losing independence of daily activity, which is a very important contributor to subjective QOL scores. Subjective QOL was higher in Tibetan people in rural Haiyan people than in people in urban Yushu. Even elderly people in Yushu had higher QOL scores notwithstanding higher prevalence of disabling conditions than their counterparts in Japan. High subjective QOL scores seemed to be associated with Tibetan Buddhism, family relationships and living conditions in the community. The healer of Tibetan medicine took responsibility for primary care of sick people especially in Arunachal. Social networks and Tibetan Buddhism may support high QOLs in the Highland Civilizations. Such mechanisms should be further explored.

Schedule in 2010/2011

In linking medical problems with cultural and ecological backgrounds in each study site, we will be able to evaluate the "Himalaya model of lifestyle-related diseases" hypothesis of diabetes acceleration not only in Himalaya/Tibet, but also in the Andes and the Ethiopian highlands. The "Himalaya" model of lifestyle may be renamed as the "Highland" model if our hypothesis holds true in multiple highland environments.

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 ecosystem degradation has focused only on its direct cause and effect in a particular place. This project applies new network sciences to the problem of ecosystem deterioration and collapse, and to the prospects of ecosystem restoration. The project examines social-environmental interactions in two distinct ecosystems where humans are dramatically altering ecosystems, 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

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ITIOKA Takao	Graduate School of Human and Environmental Studies, Kyoto University
MATSUOKA Masayuki	Graduate School of Agriculture, Kochi University
HYODO Fujio	Center for New Technology, Okayama 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 network-based analytical frameworks capable of describing the 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 occur as a consequence 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 ecosystems in Asia. Recent advances in computer science and in theoretical studies on networks (i.e. complex system sciences, complex adaptive systems) have dramatically increased our ability to describe interactions between ecosystems and human societies. Complex system science 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 restoration.

Research sites

Field research takes place in tropical rainforests in Sarawak, Indonesia, and the grasslands of Mongolia (Photo 1). 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 relation 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 affects their practices and prospects.

Research methods

The most important concept of this project is the "ecosystem network"; it describes a nested series of interactions among and within subsystems, including human societies, as shown in Figure 1. In both Sarawak and the grasslands of Mongolia, we are conducting research in three core steps: (1) identification of area-specific problems and the possible ecosystem network structures that can be related with them; (2) use of field survey, remote sensing and literature surveys to hypothesize and evalu-

Photo 1 **Recent environmental problems in Mongolia and Sarawak**
A. The number of livestock, especially goats, is increasing rapidly, leading to degradation of pastures (photo by A. Maekawa).
B. The number of oil-palm plantations is increasing all around Sarawak, and palm oil products are increasingly available (photo by S. Sakai).

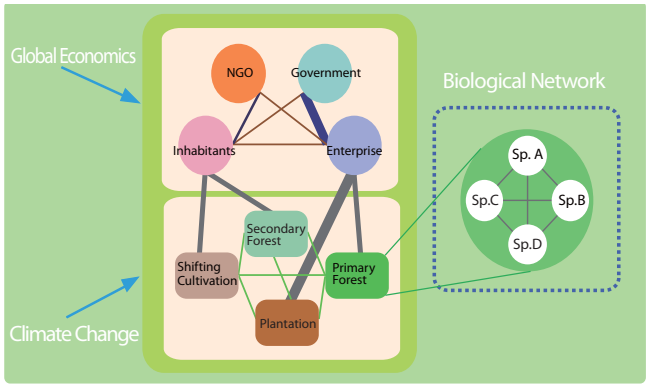


Figure 1 **Example of an ecosystem network in Sarawak**

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.

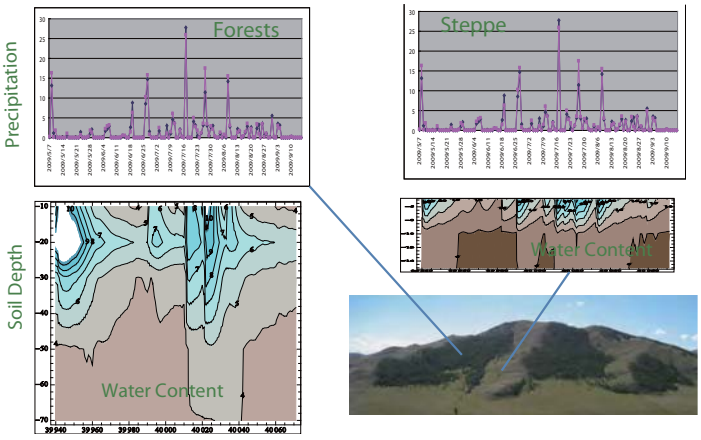
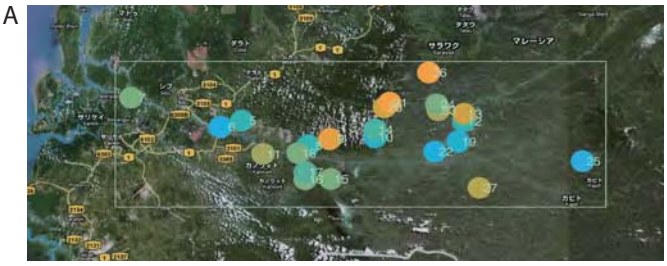
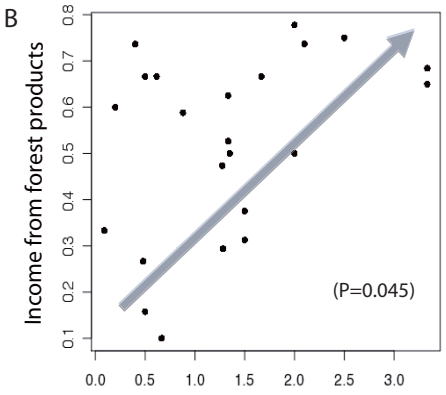


Figure 2 **Data from automated weather systems set at intensive research sites in Mongolia**

Precipitation and soil water levels in forests and grasslands in the forest-steppe area. Forest soils are deeper than those in the grasslands, and hold more water for a longer period of time. We believe that forests contribute to the growth and maintenance of grasses.





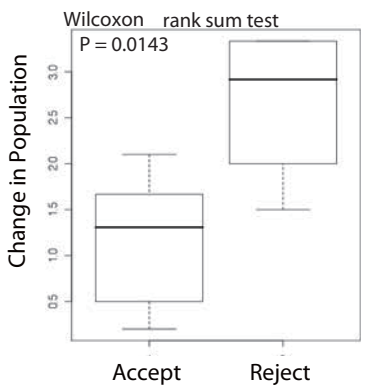


Figure 3 **Preliminary results of a survey conducted in 23 villages along Rajang River, Sarawak**

A. Orange (blue) circles represent villages with population increase (decrease)
B. Population is increasing in the areas where income from forest products is significant
C. In those villages, local governments tend not to allow plantations

ate network links; and (3) scenario analysis of constructed networks, in which ecosystem and social outcomes are evaluated according to several indices. In integrating these results, we use the concept of ecosystem networks to establish a general theory of conservation. The core of the theory will indicate which network structures are likely to lead to environmental problems and how they can be mitigated.

Progress to date

In Mongolia, we: (1) found the most serious environmental problem to be increased degradation of pastures, especially near Ulan Bator, caused by overgrazing by an increasing number of livestock, especially goats (Photo 1A); (2) studied the social patterns leading to concentrations of livestock to urban areas; (3) analyzed climate data in order to clarify the roles of forests and shrubs in maintaining sustainable pastures (Fig. 2); and (4) conducted scenario analysis of the effects of several variables, such as improvement of transportation and protected areas, on pasture degradation.

C

In Sarawak, we: (1) found the most serious environmental issues to be the expansion of palm plantations and their negative effect on biodiversity and forest resources available to inhabitants; (Photo 1B); (2) conducted questionnaire surveys along the Rajang and Baram rivers, two main rivers in Sarawak, in order to identify the reasons (Fig. 3); (3) analyzed the effectiveness of, and problems with, institutions and systems such as forest certification and bioprospecting in regulating rapid plantation developments.

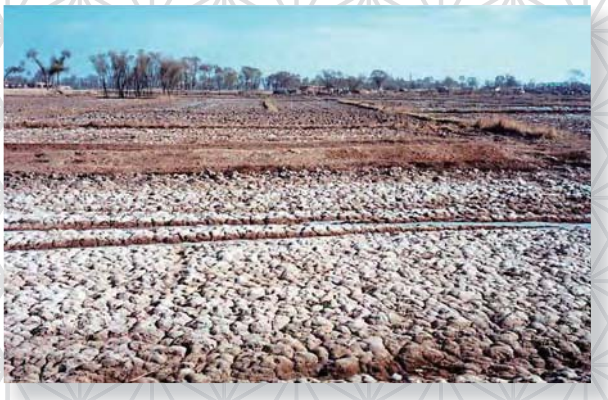
Finally, on the basis of the Mongolia and Sarawak case studies, we have begun to develop a general theory of conservation of ecosystem networks. In this process we have identified two important network effects: ripple effects that spread through the spatial structure, and positive feedback interactions between ecosystems and human behaviors.

Future issues to be addressed

The scenario approach has become popular in recent years. Well-known examples include those proposed by the Intergovernmental Panel on Climate Change (IPCC) to describe the significance of different levels of CO_2 emissions, and those of the Millennium Ecosystem Assessment. In both cases, the scenarios assume a set of conditions according to a particular story line. We will use a similar approach. In the next two years, we will identify several plausible scenarios and evaluate them with several indices. Three provisional scenarios are: (1) business as usual; (2) infrastructure investment and development; and (3) changes in institutions.

Desert wisdom: long-term use of oasis waters in the Sahara
Photo by ISHIYAMA Shun

Fields under the influence of climate change, Zambia
Photo by MIYAZAKI Hidetoshi



Arid land damaged by seawater intrusion, Inner Mongolia
Photo by KUME Takashi

The scene of a camel race in Riyadh, Saudi Arabia
Photo by NAWATA Hiroshi