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## Diversity

Program Director ■ **YUMOTO Takakazu** RIHN

Diversity program deals with global environmental issues derived from the loss and degradation of biological diversity from genetic-specific to ecosystem, as well as cultural diversity including language, social structure, religion and cosmology. Diversity is significant as an indicator of a harmonious society where people lead safe, healthy lives with peace of mind, where human rights are not violated, and where the individual can live with hope and pride.

In the context of the history of civilization, the loss of cultural diversity should be seen as part of a large-scale process that threatens biological diversity on Earth, in particular, as part of the global breakdown of man's relationship with nature that has become prominent since the last century. We face 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" in harmony with nature.

Diversity program aims to clarify the formation, maintenance and functions of biological and cultural diversity within human-nature interactions in various environments. And it seeks the ways to inherit "wise use" of nature that prevents renewable natural resources from exhausting, and extracts ecosystem services sustainably, for realizing environmentally low-impact but wealthy-in-mind daily life by applying biological and cultural diversity.

Completed Research	Leader	Theme
<b>D-01 (CR1)</b>	ICHIKAWA Masahiro	Sustainability and Biodiversity Assessment on Forest Utilization Options
Full Research		
<b>D-02 (FR3)</b>	YUMOTO Takakazu	A New Cultural and Historical Exploration into Human-Nature Relationships in the Japanese Archipelago
<b>D-03 (FR1)</b>	OKUMIYA Kiyohito	Human Life, Aging, and Disease in High-Altitude Environments: Physio-medical, Ecological and Cultural Adaptation in the Three Great "Highland Civilizations"
<b>D-04 (FR1)</b>	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 background causing forest decrease, its effects on biodiversity, and 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 aspects to develop a sustainable utilization system.

Project Leader ■ ICHIKAWA Masahiro RIHN

### Findings from the project

The following subjects were studied at four sites, Sarawak state and Sabah state 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 of 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.

Finally from the results of 1 to 4 above, we built an integrated method for assessment of sustainable uses of forest and biodiversity.

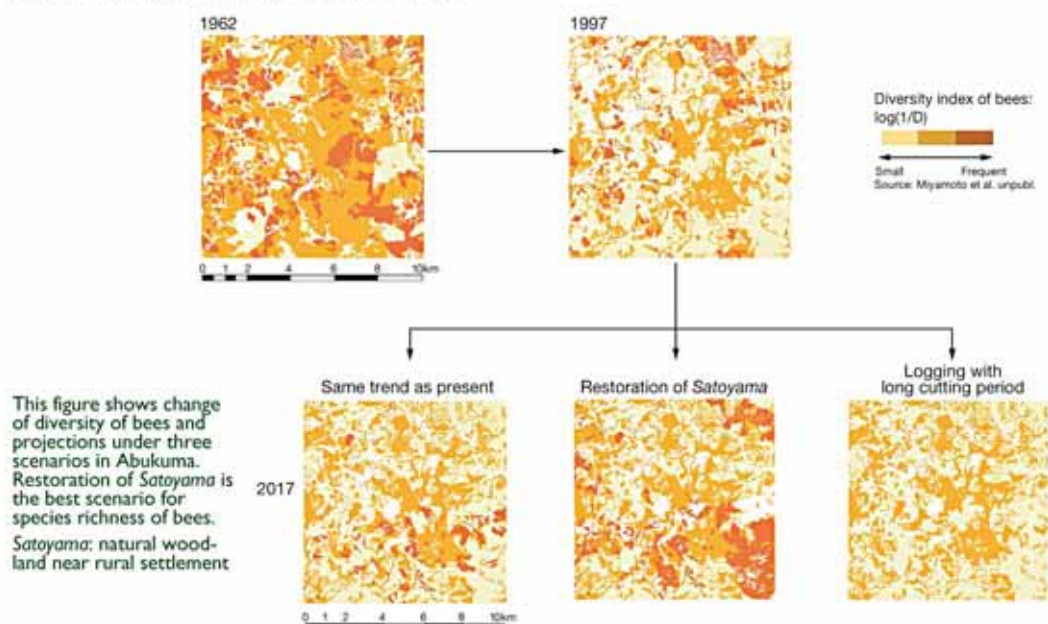
### Contribution of Project Results to Tackling Global Environment Problems

The results of this project showed how forest changes affected the biodiversity, from which an integrated method to assess sustainable uses of forest and biodiversity was proposed. The assessment will be useful to seek ways for resolution of problems on uses of forests and biodiversity in each area. The assessment method could be standardized for use by public and private sectors.

### Published products

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 presentation material 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 Springer), and others.

Figure An example of ecosystem function maps



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

The Japanese Archipelago has been extremely densely populated since the Neolithic Age, and most of the natural environment has been strongly influenced by human activities. However, in spite of the intensive intervention by humans in the natural environment, there is still a rich biota in the Japanese Archipelago, which includes, for example, an abundance of indigenous species of angiosperm and freshwater fish. But recently, many plants and animals are close to extinction because human-nature relations in this Archipelago have changes. This project aims to reconstruct human-nature relationships as historical processes to suggest concrete measures for preventing further extinction of species in the near future.

Project Leader ■ **YUMOTO Takakazu** RHIN

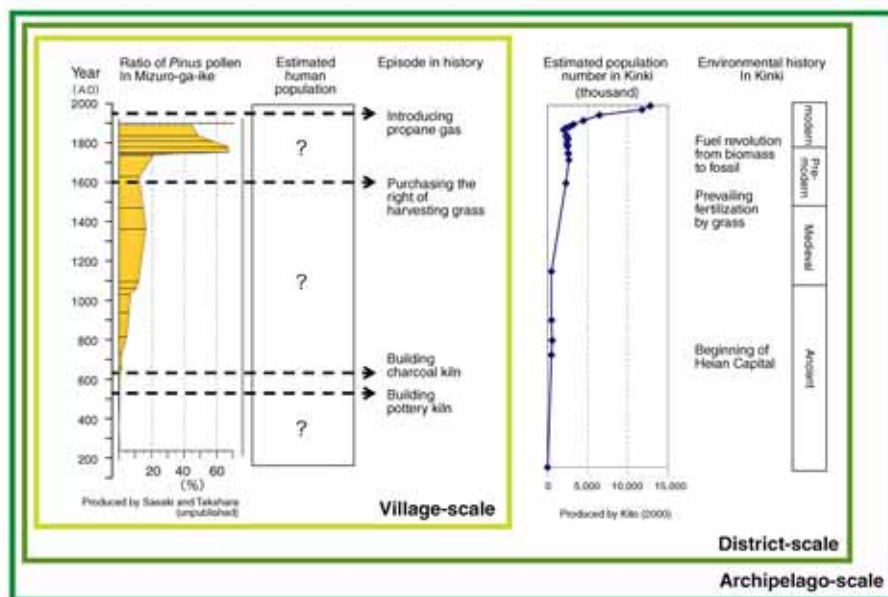
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## Objectives

The objective of the present project is to reconstruct human-nature relationships as historical processes. It will examine, first, how the natural environment has been changed since the late Paleolithic Age, when human beings are first

known to have existed in the Japanese Archipelago; second, how the biota has changed during that process; and third, what kind of perceptions, knowledge and skills the humans possessed, concerning both nature in general, and specific life forms. Our aim is to present a foundation for con-

Figure 1 A prototype of the chronological chart of environmental history (Kyoto Basin as an example)



The chronological chart of the environment consists of three layers: village-scale, district-scale and archipelago-scale, according to multi-layered environment governance. A series of chronological charts of environmental history for each district is being compiled from epoch-making events on environmental issues and policy changes on resource managements. It will be completed by adding data of estimated vegetation changes (pollen analysis) and population change (historical demography).

Figure 2 Scheme of historical dynamics in human-nature relation

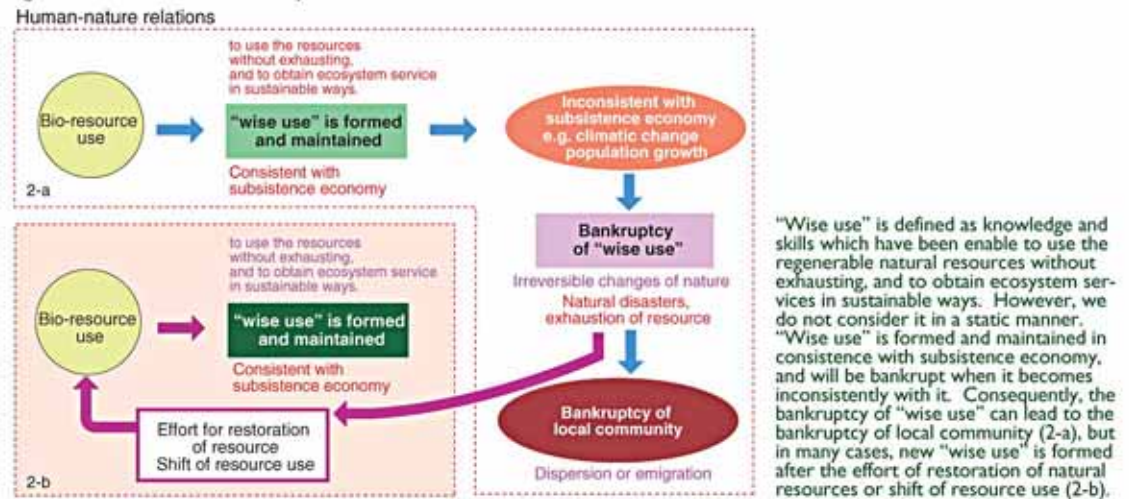
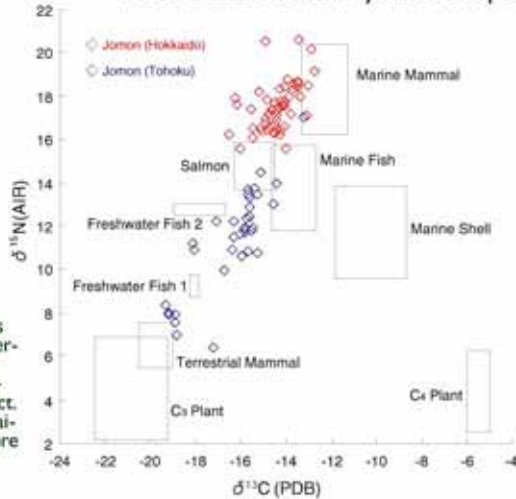


Figure 3 Diet analysis of Jomon people in Hokkaido and Tohoku by stable isotope



A big difference in diets in Jomon people (hunter-gatherer) was found between Hokkaido district and Tohoku district. Jomon people in Hokkaido depended much more on marine mammals.

templating how human-nature relations should be developed, and to suggest concrete measures for preventing further extinction of species in the near future.

### Study Area and Methodology

The project will elucidate the historical process of change in human-nature relationships under the global and/or local climate changes in these six regions: Hokkaido, Tohoku, Chubu, Kinki, Kyushu and Amani-Okinawa, in addition of Sakhalin, using biological remains that contain pollen samples, archaeological remains, old documents and folkloric materials. In addition, we intend to examine the change of the historico-economic background and the knowledge and skills concerning nature and living organisms, with special emphasis on their relation to the disappearance, or thriving, of organisms. Main approaches are: 1) the analysis of ancient vegetation and changes in the distribution of plants and animals; 2) reconstruction of human ecology based on population estimates and the diets; 3) reconstruction of human-nature relations in the past, and the analysis of the social systems behind them; and 4) theoretical modeling of human-nature relations. In the process of compil-

ing the chronological chart of environmental history (vegetation change, human population, episode in history) in each site by comparative methods including proxy and tracer analyses (pollen, DNA, stable isotope), we will analyze the change of human-nature relations and its drivers under the multi-layered environmental governance ("wise use" of whom, by whom, for whom).

### Progresses, Organizing working groups and targeting core sites in seven districts

We have re-organized seven district-based working groups targeting core sites (shown in parentheses), Hokkaido (Shiribeshi), Tohoku (Kitakami), Chubu (Akiyama), Kinki (Kyoto-Tanba), Kyushu (Kuju-Aso), Ryukyu (Okinawa Island and Amami-oshima Island), in addition of Sakhalin, each of which possesses characteristic climate, vegetation, flora and fauna, and traditional life style of people, and includes ca. 100 km X 100 km area of agricultural and forestry villages, and mountains. Also, we organized three method-based working groups targeting paleo-ecosystem, plant-geography, and old human bones.

- 1) A series of chronological charts of environmental history for each district is being compiled from epoch-making events on environmental issues and policy changes on resource managements. It will be completed by adding data of estimated vegetation changes (based on pollen analysis) and population change (based on historical demography).
- 2) The word "wise use" has been examined from various aspects. Consequently, it is defined as knowledge and skills which have been able to use the regenerable natural resources without exhausting, and to obtain ecosystem services (provisioning, regulating, cultural, and supporting, in sensu Millennium Assessment (2005)) in sustainable ways. Examples of "wise use" and "unwise use" from each district are being sorted out and categorized by identifying which governance (e.g. household, community, local government, national government, international organization) took an initiative role, and according to what kind of incentive it concerned.

## Human Life, Aging, and Disease in High-Altitude Environments: Physio-medical, Ecological and Cultural Adaptation in the Three Great “Highland Civilizations”

Highlands are the places where people have been building specific means of livelihood and unique cultures to survive in challenging environment with thin air and limited ecological resources over the years. The Himalaya/Tibet, the Andes and the Ethiopian Highland are three great examples of such highlands. Life, aging, disease and death are closely-linked to lifestyle and environmental condition. Communities in the highlands have kept the interaction with those in lowlands in balance. However, in recent years, the wave of globalization has rushed over highlands, as symbolized by the infiltration of money economy, the acceleration of migration, the change of lifestyle and the extended life spans. The aim of this research is to evaluate the impact of changing natural conditions and lifestyles on life, aging, disease and death. The change of natural ecosystems and cultures has accumulated in the human bodies through lifetimes. Aging and disease can be regarded as the environmental issues that affect the human bodies.

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### Background

Nowadays, urbanization and environment destruction are expanding on a global scale. The effects have also reached living environments of highlanders, such as migration in village communities, decrease in physical activity due to spread of motorbikes and drastic decline in forest and grass cover. As a result of extended life spans and change in lifestyle, the number of so-called civilization diseases such as hypertension and diabetes has increased. There is a possibility that highlanders are vulnerable to aging and lifestyle related diseases because of hypoxic stress, high levels of ultraviolet radiation or other factors. On the other hand, there remains the local knowledge like spirit of cooperation within communities and healing of mind through the network of religious activities in highlands.

### Objectives

The objective of this research is to evaluate the impact of peculiar natural conditions and changing traditional lifestyle on human life, aging, disease and death in the Himalaya/Tibet, the Andes and the Ethiopian Highland. We will learn wisdom of the aged in highlands and also disclose futurity in which highlanders can live in relief in highlands and find ways to adapt to our society.

### Research Content

The effects of globalization on highlander's lifestyle will be examined with special reference to lifestyle-related diseases, chronic mountain sickness, and human aging phenomena through comprehensive geriatric assessment as a health check-up for the elderly, interviews of residents' life histories, and observation of the lives and the envi-

Figure The change of natural ecosystems and cultures has accumulated in the human bodies through lifetimes. Aging and disease can be regarded as the environmental issues that affect the human bodies.

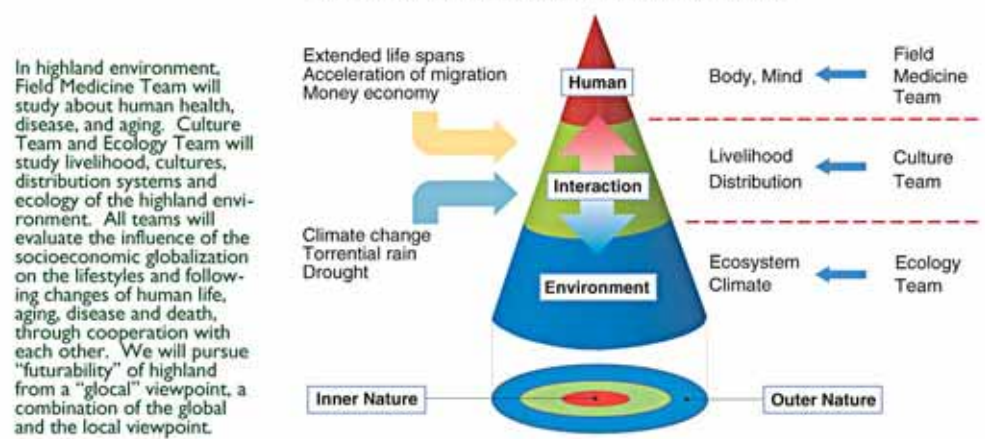


Photo 1 Vicugna, wild race of camelid (wild relative of alpaca). (the Andes , Peru)



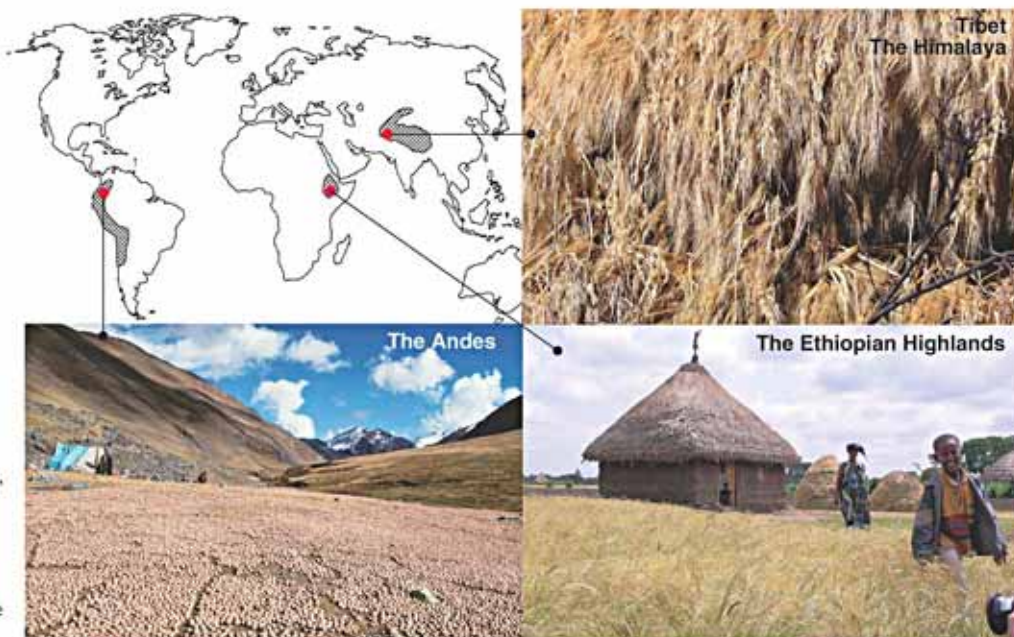
A custom in the time of the Inca Empire of "Chacu" was revived recently. The custom was to release vicugna without killing them after drive-in hunting and shearing. The price of vicugna wool has risen with the globalization of economic activities and the economic profit was brought about in the community. Co-management of vicugna in the community has reduced poaching and has contributed to natural conservation and recovery of confidence in its own cultures.

Photo 2 Highland people in health check-up (Shangri-La, Yunnan, China)



One of the problems among highlanders is an increase in lifestyle-related diseases, including hypertension and obesity, especially in urban area.

Photo 3 Indigenous crops having supported the three major highland's culture



Suitable crops for highland have supported cultures in highland. For example, there are potatoes in Andes, barley in Tibet, teff and enset in Ethiopia. Also, there are suitable domesticated animals for highland like llama and alpaca in Andes, yak in Tibet, and cattle in Ethiopia. There are the issues of zoonotic infections on the other side of the coin.

ronments (Field Medicine Team).

There are common features of environmental exploitation, such as agriculture and animal husbandry, in the livelihoods of the three major highlands. Livelihoods, cultures and ecosystem in the highlands will be clarified that affect human life, aging, disease and death in highlanders. The relationship between people and the high-altitude environments will be investigated through the surveys on local knowledge and techniques. Interaction between highland and lowland in order to maintain highland communities and lifestyles is also examined. The ecosystem in highlands that affect the livelihood and diseases will be studied with special reference to weather, climate change, land use, forest use and vegetation. (Highland's Culture and Ecology Teams).

The actual features of the diseases and human aging phenomena among highlanders will be clarified with special reference to high-altitude ecology and its socio-economic backgrounds. The young researchers from the field medicine team and the highland's culture and environment teams will stay in the fields on a long-term in principle

and conduct the interdisciplinary works in the common study field areas.

#### Annual progress 2007

- 1) The surveys on the relationship between health of highland people and their economic condition in Yunnan Province, China revealed an increase in high-blood pressure and obesity, and also susceptibility to lifestyle-based diseases.
- 2) Preliminary surveys on lifestyle-related diseases, chronic mountain sickness, and zoonotic infection were conducted in Qinghai Province, China, and the Andes Highland, Peru.
- 3) Preliminary surveys on agricultural systems, forest vegetation, trading and lifestyle were conducted in Arunachal Pradesh and Ladakh, India, and Yunnan Province, China.

#### Schedule in 2008

The study will be carried out mainly in Qinghai Province, China in the Himalaya/Tibet, and in the Andes and the Ethiopian Highland.

## Collapse and Restoration of Ecosystem Networks with Human Activity

Most ecosystems on the planet have been seriously degraded by human activities and are now in a critical situation. Nevertheless, most researches on the problem have focused only on the direct consequences. The project aims to clarify the mechanisms resulting in the collapse and deterioration of ecosystems, and then pave the way to restore and maintain healthier ecosystems with high biodiversity and ecological functions while minimizing instability and uncertainty in the long term over a wide area.

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### Objectives

Degradation of ecosystems, which has led to the loss of biodiversity and ecosystem function, is widely accepted as one of the most serious global environmental problems. Nevertheless, most researches on the problem have focused only on

the direct consequences. The collapse and deterioration of ecosystems by human activities via interactions within the ecosystem network, including indirect and cascade effects, have rarely been considered. In addition, few studies take a social science perspective, although environmental problems are one of the consequences of the interactions between nature and human society.

The recent boom in theoretical studies on complex networks (complex system sciences, complex adaptive systems) and the remarkable progress in computer performance have dramatically increased our capacity to deal with complex systems such as ecosystems and social interactions. Complex system sciences are now a practical, important tool in various fields of sociology, economics, and ecology.

This project takes advantage of the interdisciplinary nature of network sciences to consider environ-

mental problems, especially the problem of ecosystem deterioration, by linking sociology, economics, and ecology. The project aims to clarify the mechanisms resulting in the collapse and deterioration of ecosystems, and then pave the way to restore and maintain healthier ecosystems with high biodiversity and ecological functions while minimizing instability and uncertainty in the long term over a wide area.

### Research Sites

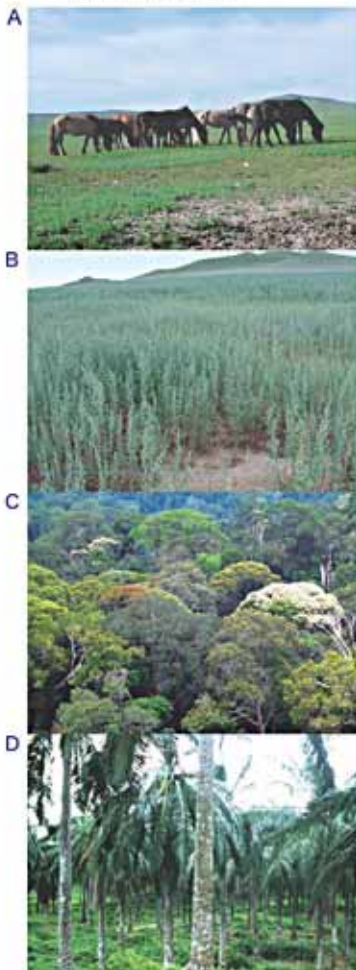
The research areas for this project are tropical rainforests in Southeast Asia and grassland in Central Asia. For a comparative investigation, it is essential to establish more than one research area to obtain general results and discussion. At both sites, the terrestrial ecosystems are being devastated with the surge in the Asian economy associated with the recent dramatic economic growth of China. Nevertheless, the lives of many people depend on natural ecosystems, and the destruction of these ecosystems directly results in dramatic changes in their lives. The economies of both regions have similar frameworks, whereas their ecological characteristics differ, such as the regeneration time of vegetation and position of humans in the food web. Both sites are good research areas because many studies in the social sciences and ecology have been conducted there. In general, it is impossible to go from a description of the ecosystem networks to constructing models for projections at multiple study sites if we start from scratch, considering the time span and research budget of projects at the RIHN. By using such information, we expect to make significant achievements in a period as short as six years.

### Research Methods

The most important concept of this project is the "ecosystem network," which has a nested structure involving interactions among and within subsystems, including human societies, as shown in Figure 1.

We will conduct fieldwork in two regions: trop-

Photo Mongol, Healthy grassland (A) and degraded pasture (B). Sarawak, Rainforest (C) and plantation (D).



In Mongolia, livestock have grazed the grassland intensively for the long time. In recent years, overgrazing by livestock, especially by the increased number of goats for 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 then to oil-palm plantations.

ical rainforests in Southeast Asia and grassland in Central Asia. First, we will describe the existing ecosystem network structure in both regions using information obtained from fieldwork and the literature. Because relatively large amounts of information on biological interactions within subsystems have already accumulated, the ecological surveys will focus mainly on material flow and the movements of organisms between subsystems, especially the movements of pollinators, predators, and parasitoids related to ecosystem function. For the networks of human societies, we will investigate which actors are responsible for the changes in the ecosystems, the intention of the change, how other actors control these activities, and the historical transition of actors driving the ecosystem changes. Based on our results, we will construct models for making projections and evaluating the ecosystem networks in the two regions. Further, we will generalize the results to determine the critical network characteristics likely to result in environmental problems.

In the ecosystem network, the subsystems (e.g., primary forests, secondary forests, lands for shifting cultivation) form an interacting network. In addition, each subsystem consists of networks of biological interactions. Moreover, we place human society as a subsystem within the ecosystem network and regard human activities as part of the interactions within the ecosystem network.

### Progress up to now

We determined the structure of the network model that we will construct during the full research period. We listed available and measurable variables relevant to our subject matter in the two field research sites (Sarawak and Mongolia) and classified them according to their inter-relationships and the potential mechanisms linking them. The model is hierarchically structured, with three spatial scales: i) 200-600 km (large scale), ii) 10-50 km (medium scale), and iii) 50 m to 1 km (small scale). The spatial resolution at each scale is the distance range of the one-step lower scale. The spatial scale of human migration and settlement processes has increased at the nationwide (large) scale owing to the expansion of the transportation and economic networks, whereas these processes for other organisms in nature are mostly limited to a more narrow (medium) scale by climatic, geographical, and biological constraints. The ecological interactions within a landscape do not incorporate spatial structure, which would enable their inclusion in small-scale models.

We are starting to collect quantitative and qualitative data at different spatial scales in the field by combining large-scale surveys and intensive investigations at a small number of sites. The large-scale surveys will involve interviews and simple ecological assessments at several locations. The surveys may elucidate the large-scale correlations between changes in ecological networks and the structures of social and ecological networks. The intensive surveys aim to clarify the mechanisms of patterns revealed by the large-scale surveys.

Figure 1 Ecosystem network studied in this project (an example in Sarawak)

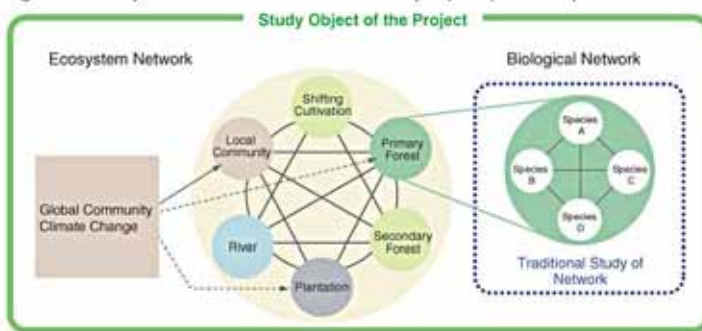
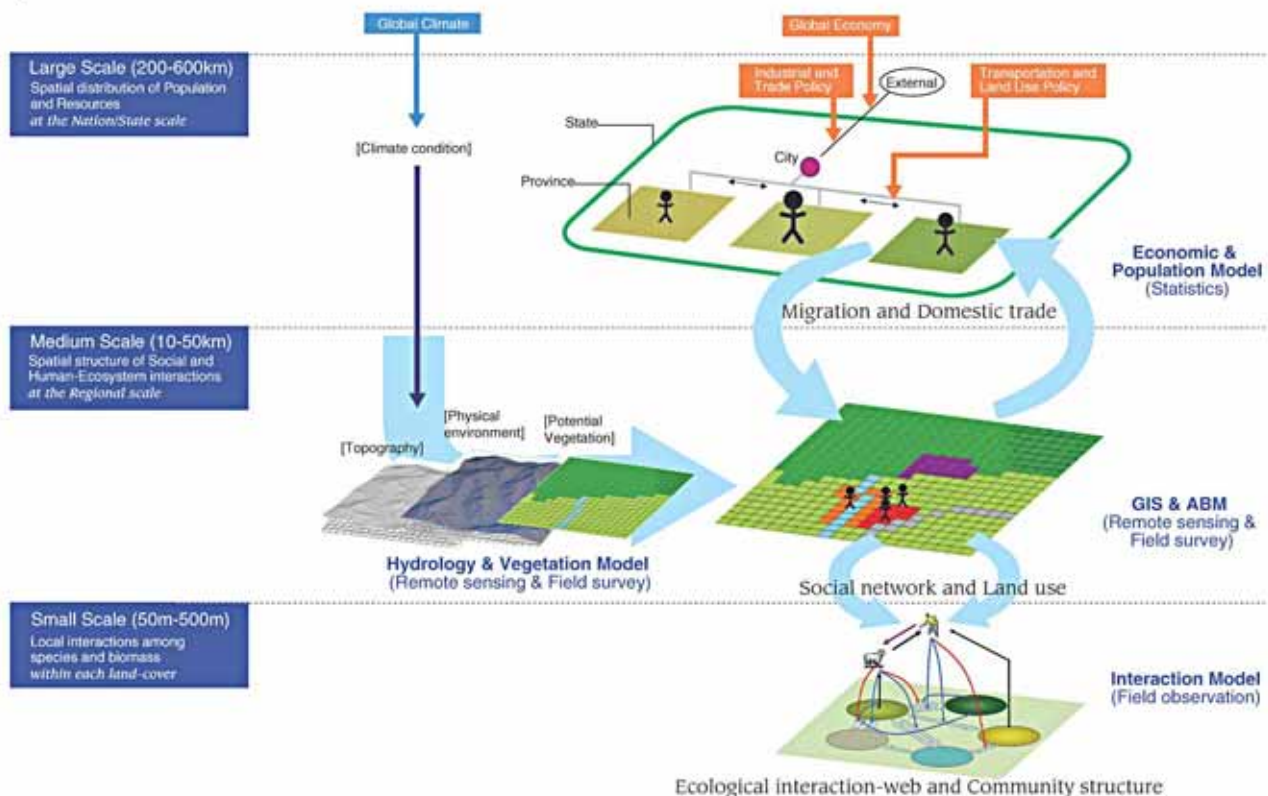
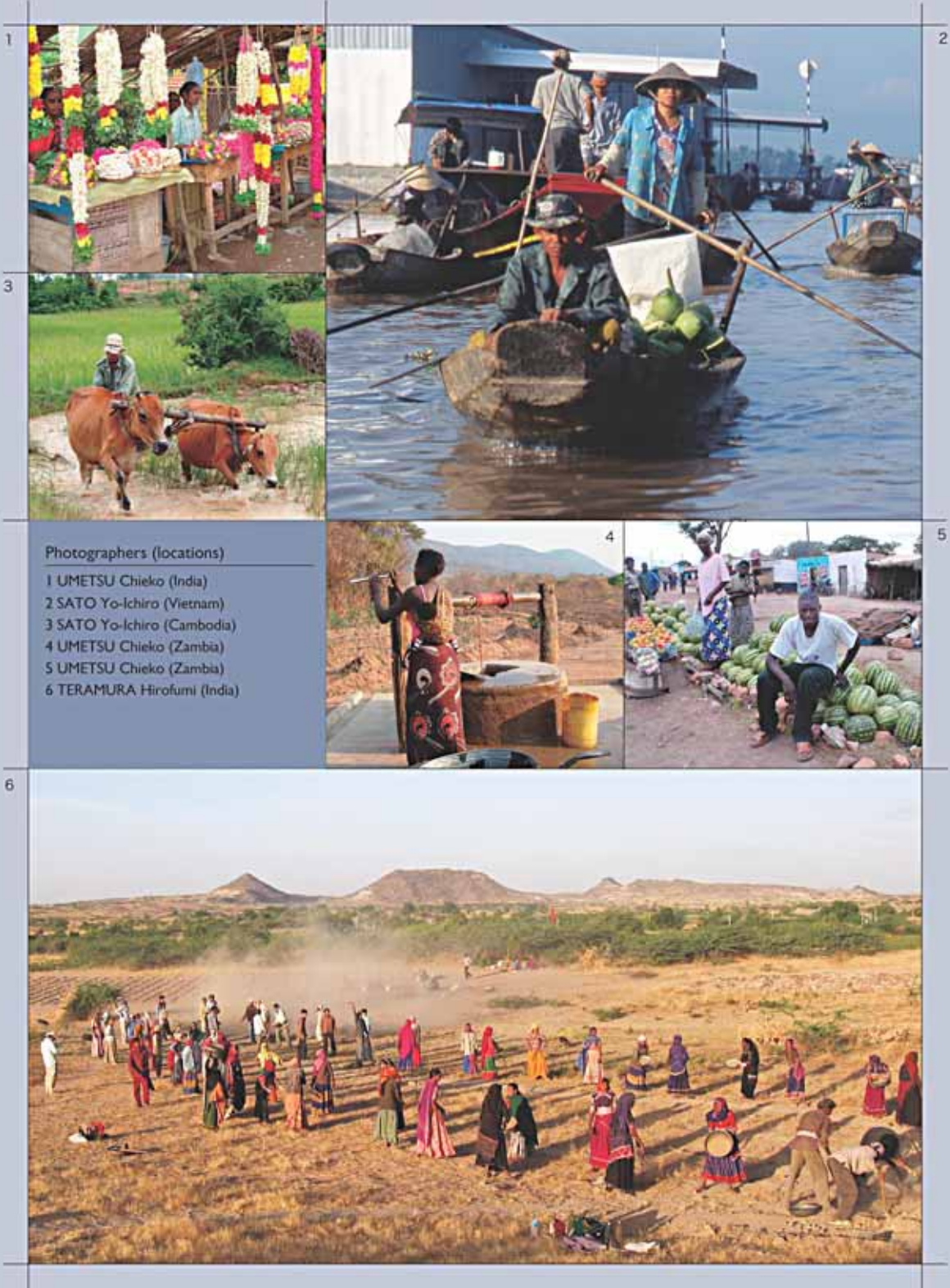


Figure 2 Hierarchical structure of the model





Degradation of the earth's environment is seriously affecting people's lifestyles. But by reconsidering excesses in daily life, it is possible to alleviate the burden on the environment. Research activities at RIHN also look at the lifestyles of people inhabiting areas with different natural features.



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- 6 TERAMURA Hirofumi (India)