

E

Ecosophy

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Global warming is a “global” environmental problem that affects almost all systems of the world, as most people can easily recognize, including climate, sea-level, hydrological regimes, vegetation, agricultural production, marine resources, and so on. On the other hand, some environmental problems that might normally be recognized as “local” environmental problems, like desertification, deforestation, and loss of biodiversity, must be defined as “global” environmental problems. For example, in arid regions, water resources development and management by construction of large reservoirs and irrigation systems has been “successfully” implemented for enhancement of agricultural productivity with more stable water supply. As the result, however, issues have arisen concerning the distribution of developed water resources. In addition, changes in agricultural production systems due to globalization of economies and market bring much more serious water shortages. World food trade implies that water shortage in a food production area leads directly to food shortage in a food importing area. Therefore, the desertification that might be observed as a local issue should be identified as a global environmental problem.

Dust, pollutant particles and greenhouse gases in the atmosphere travel physically across regions of the earth; and trade activities are certainly typical of the artificial transfer of the materials across the boundaries of the world. As well as these trans-boundary movements of materials, the relationship between human activities and natural systems can cross boundaries with the evolving global information network. Consequently, we are losing the diversity of individual regions.

Internationalization of human lifestyles means loss of cultural diversity. Facing these global and local environmental problems, we must find accord between two different perceptions: “one globe” and “local value.”

Completed Research	Leader	Theme
E-01 (CR2)	YACHI Shigeo	Multi-Disciplinary Research for Understanding Interactions between Humans and Nature in the Lake Biwa-Yodo River Watershed
Full Research	Leader	Theme
E-02 (FR5)	SEKINO Tatsuki	Interaction between Environmental Quality of the Watershed and Environmental Consciousness: With Reference to Environmental Changes Caused by the Use of Land and Water Resource
E-03 (FR5)	TAKASO Tokushiro	Interactions between Natural Environment and Human Social Systems in Subtropical Islands
E-04 (FR2)	UMETSU Chieko	Vulnerability and Resilience of Social-Ecological Systems

Multi-Disciplinary Research for Understanding Interactions between Humans and Nature in the Lake Biwa-Yodo River Watershed

The differences in problem consciousness among various stakeholders occurring from "hierarchy" of a watershed could be a major hindrance to governance, leading to conflicts between top-down and bottom-up Management. We proposed a system of "hierarchical watershed management" to overcome the restrictions derived from these hierarchical characteristics (Figure). Based on this idea, we conducted research on the agricultural turbidity problem in the Lake Biwa watershed to develop a methodology for environmental diagnosis and consensus building with an emphasis on communication. Our project is unique in 1) developing a new methodology to promote governance and participation of residents by 2) our transdisciplinary approach to natural science and social science 3) practiced in three scales in the Lake Biwa watershed (Shiga prefecture as macroscale, Inae district as mesoscale, local communities in Inae district as microscale, 4) moving towards practical watershed and global environmental studies.

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Specific Research Findings

(1) A new watershed diagnosis method revealing the relationship between Lake Biwa and its rivers

The results of newly developed watershed diagnosis methods including stable isotope ratios and rare elements indicate that agricultural activities related to smaller rivers flowing into the eastern part of the lake have a large potential impact on the water quality and eutrophication of Lake Biwa, and that fine-tuned water management and water channel cleaning by local residents through a bottom-up approach is both effective and necessary for the environmental preservation of Lake Biwa.

(2) Clarification of an integrated picture of the agricultural turbid water problem and establishment of a communication methodology to support local residents' voluntary environmental preservation activities

In the background of the agricultural drainage issue, lies a drastic change of Japan's agricultural policy and agricultural community structure, which caused an increase in part-time farmers and decrease in young farmers. A workshop method was developed to support residents themselves

discussing the local water environment and its future prospects using maps. Practical workshops were held to confirm how the provision of information related to the current status of the water environment or measures for water environmental preservation would affect the farmers' awareness of environmental considerations or their actions. These results indicate the need to develop a communication method based on the assumption of the individuality of the community and the importance of conditions such as social capital that allow such a method to work effectively.

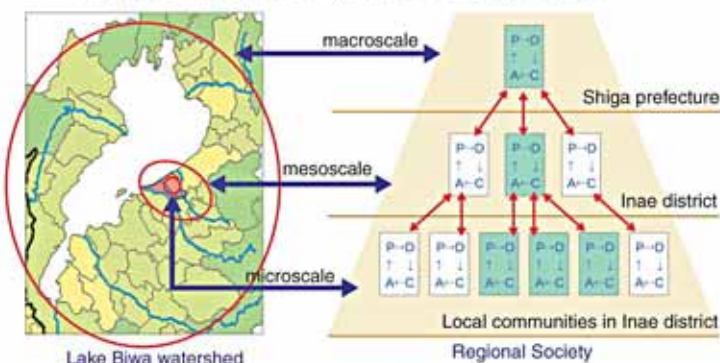
Contributions to Global Environmental Studies

There are two important issues that must be dealt with if we are to solve global environmental problems: (1) a watershed area is important in terms of scale. Dealing with it not only solves regional environmental problems but also constitutes a test bed for specific solutions to global environmental problems; and (2) It is essential to appropriately coordinate various stakeholders with various patterns of involvement in the environment that are deeply rooted in the area. Although this project has the methodology for watershed management as its main theme, we believe the project provided a prototype methodology which can contribute to the way we consider and solve global environmental problems.

Communication of Research Findings

The project final report (in Japanese, ISBN 978-4-902325-11-9) is now available at University libraries in Japan and at the libraries of cities and towns in the Shiga prefecture. In it, 5-year transdisciplinary research on watershed management is compiled as a first step to "watershed environmental studies" with close connection to global environmental problems. Readers will find not only the new research findings but also the message and dynamism of the project emphasizing the importance of practice in regional societies, the social meaning of transdisciplinary collaboration, and academic and social issues to be challenged.

Figure Hierarchical Watershed Management System Applied to Lake Biwa Watershed in the Case of Agricultural Turbidity Problem



Shiga prefecture, Inae district (region colored ■) and local communities in Inae district indicated by red circles (left) and green boxes (right) are regional stakeholders concerning the agricultural turbid water problem, however, their consciousness of the problem is not the same. The hierarchical watershed management system is a mechanism to promote watershed management by governance of the various stakeholders in the region by building 1) feedback mechanism (PDCA cycle) consisting of monitoring with diagnosis indicators at each scale, and 2) mechanisms to promote communication between hierarchies (indicated by red arrows).

Interaction between Environmental Quality of the Watershed and Environmental Consciousness: With Reference to Environmental Changes Caused by the Use of Land and Water Resource

People's value judgment system on the environment, or the environmental consciousness, is explored through theoretical analyses and empirical surveys in order to identify the environmental elements and the human-sociological factors that are affecting the formation of this consciousness. Environmental changes caused by a virtual impact to a watershed environment are predicted and proposed to people. People's judgments on such environmental changes are analyzed to elucidate the relationship between people's environmental consciousness and the environmental quality. We will develop response-prediction models for a watershed environment and a methodology to clarify the changes in the people's value judgment on the environment.

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Purpose of the project

How do we perceive the environment? People's attitudes toward the environment are based on their various value judgments on it. We define this value judgment system as "environmental consciousness." What kinds of changes in the environmental qualities affect the formation of the people's environmental consciousness? We need quantitative evaluation of the changes in the environment to understand its present status and to predict its future. On the other hand, clarifying the relationships between the environmental quality and the environmental consciousness is important for wiser uses and conservation of the natural environment. In this project, we will develop a set of response-prediction models to simulate environmental changes as well as a methodology to analyze the people's value judgments when they are presented with the predicted environmental changes. Although the project is conducted mainly in the Lake Shumarinai watershed, Hokkaido, Japan, the method will be developed to be applicable to other environments.

Methods and research area

In this project, several virtual scenarios of environmental changes are assumed. People's value judgments on those changes will be elucidated. The method developed in this project requires three functions: (1) quantitative prediction of changes in environmental elements caused by virtual environmental modifications, such as logging and dairy farming, (2) comprehensively informing the environmental changes to people and (3) analysis of the relationship between changes in the people's value judgments and those in the environmental elements. The method is composed of the response-prediction model for the environment and the tools to develop and analyze the attitude surveys. The main research area is the Lake Shumarinai watershed in northern Hokkaido, Japan. However, we are developing the method to be applicable not only to this particular watershed environment, but also to other environments. Attitude surveys are conducted through interest questionnaires and scenario questionnaires. From scenario questionnaire, the people's valuation to the environmental changes caused by human impacts can be estimated. Such people's environmental valuation would be a key factor for the Public Involvement in the strategic environmental assessment process.

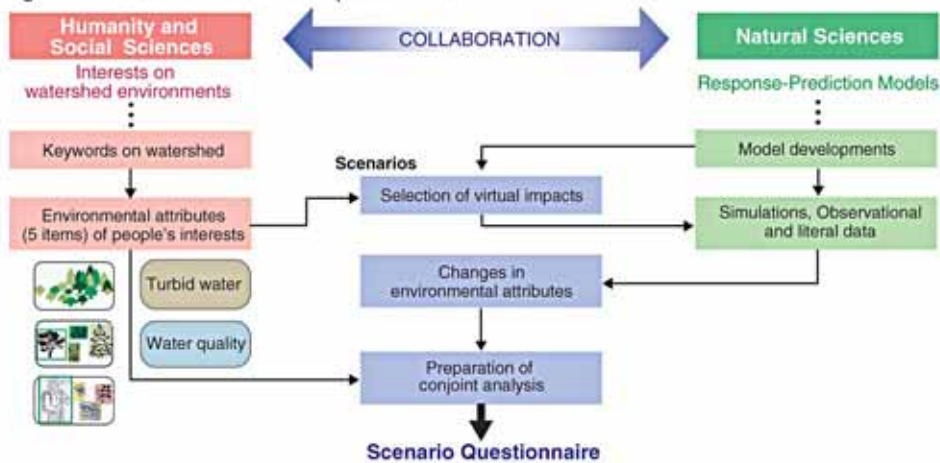
Progress to date

Planning the Scenario questionnaire

Scenario questionnaire, which is the most important survey in the project, has been con-

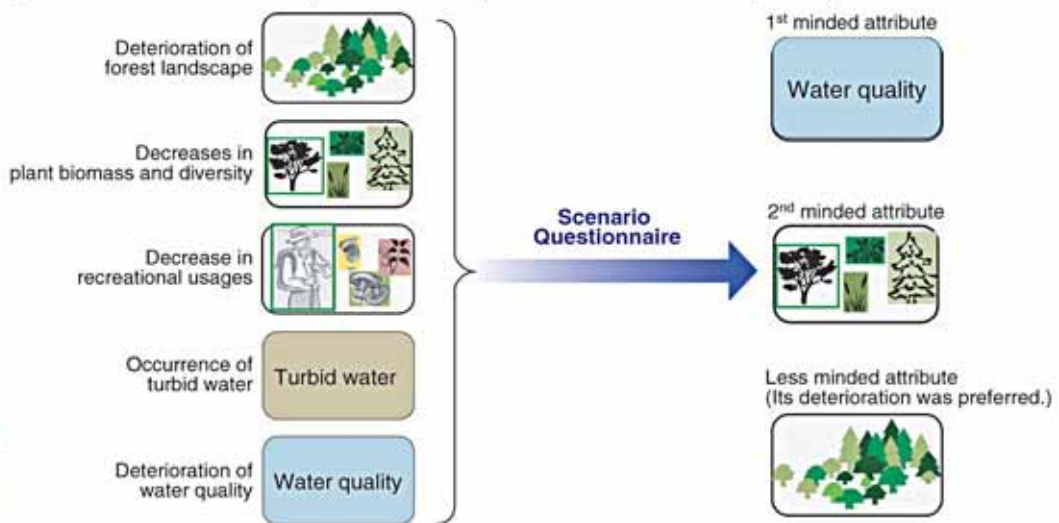


Figure 1 Procedure for a scenario questionnaire



In order to implement a scenario questionnaire, intensive collaboration between human and social sciences (left-hand part of the figure) and natural sciences (right-hand part) must be needed.

Figure 2 Results of the scenario questionnaire using realistic scenarios in the conjoint analysis.



Partial utility value estimated by the conjoint analysis of the scenario questionnaire was the largest for the water quality, while that for the forest landscape showed the opposite sign compared with other attributes.

ducted in the fiscal year 2007. People's preference on plans was surveyed for residents in 8 river drainage systems in Japan and in the Horokanai town, where the Lake Shumarinai is located. Five environmental attributes were selected, with respect to people's interests in watershed environments elucidated from keywords collected in the interest survey (the left-hand part of Figure 1). Several virtual plans including forest logging in the Lake Shumarinai watershed were selected. Environmental changes were estimated using the response-prediction model, field observations and literal information (the right-hand part of Figure 1). The people's preference on the plan-selection has been estimated using the conjoint analysis (the middle part of Figure 1). The conjoint analysis can elucidate attributes that are respected by residents. As shown in Figure 1, it is essential for implementing the scenario questionnaire to collaborate between the natural sciences, which predict environmental changes caused by the impact, and the humane-social sciences, which investigate people's preferences on the watershed environment.

People's valuations to environmental changes

Conjoint analysis suggested that people would firstly appreciate the plan in which the water quality was preserved (Figure 2). Secondary minded attribute was "Decreases in plant biomass and

diversity." Interestingly, the deterioration of the forest landscape (the decrease in forest area) showed the opposite sign of the partial utility value. It suggested that the deterioration of the landscape was less minded, or rather preferred by the people. In the case of the scenario questionnaire including unrealistic environmental changes, which were not based on the simulation results using the response-prediction model, the deterioration of the forest landscape was not preferred as in cases of other four attributes. Further analyses are needed to clarify the variations in the people's valuation to environmental changes.

Plan hereafter

In the last year (2008) of the project, an experiment to plan the environmental program will be conducted in Horokanai Town. Stakeholders (residents, local government, farmer's and fishermen's cooperatives and so on) will join the scenario workshop to make future visions of the town. In the workshop, results of the project will be assessed their effectiveness for making the public involvement substantial. Although the scenario questionnaire may be a complicated and laborious method, people's preference on environmental changes should be considered when we make a decision on measures for natural environments.

Interactions between Natural Environment and Human Social Systems in Subtropical Islands

A variety of environmental problems have arisen on islands around the world, leading to the deterioration of precious natural environment and the disappearance of local cultures. In order to resolve environmental issues on islands, it is necessary to thoroughly understand the interaction between natural environment unique to islands and the human social systems that are found on islands. Using Iriomote Island in Okinawa Prefecture as a model, we hope to find information that will help resolve these issues. We aim to provide guidelines for building island human social systems that are sustainable in the future.

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The Purpose of the Project

Islands throughout the world are faced with ongoing deterioration of their precious natural environment due to water shortages, industrial development and other factors. Along with this, local cultures are at risk of disappearing. To solve these problems, it is important to fully understand interaction between natural environment and human social systems on islands. As islands are geographically limited areas, their natural environment and human social systems tend to be different from others, as well as vulnerable. The main subjects of this project are environmental issues related to the unique features of islands. Iriomote Island, a typical subtropical island located in Okinawa Prefecture, is an ideal model for studying island environment, as it is rich in natural resources such as water and virgin forests, as well as traditional art and culture.

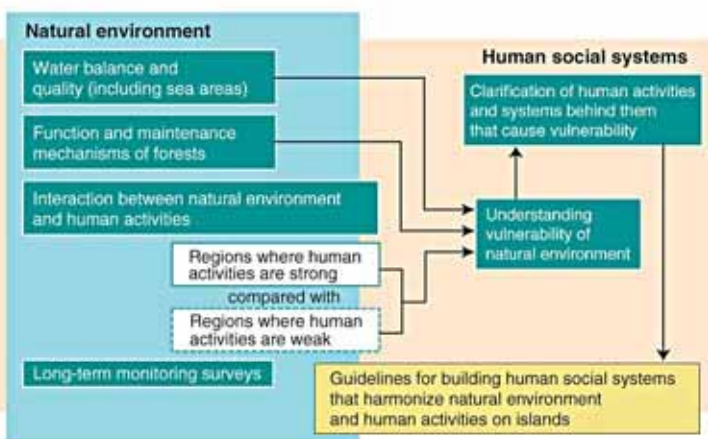
Research Methods

1) We will build a water balance model of Iriomote

Island based on the estimated amount of precipitation, river flow, and evapotranspiration. The model will be used as a standard for future water usage. We also assess the human impact on rivers.

- 2) We clarify functions and maintenance mechanisms of broadleaved evergreen and mangrove forests, while studying biodiversity and interaction among organisms. We take a closer look at the dynamism of forests and assess the human impact on forests. As for the gathered research materials, we will use them as references for global warming issues.
- 3) We look into the background of human activities causing deterioration of natural environment, from the perspectives of industrial development, demographic structure and government policies. In particular, we explore how the main industry of the island has changed from traditional agriculture to tourism and how the social system has changed during the transfer period.
- 4) Regarding the decision-making process in communities, we study how local people should understand the impact of human activities on the natural environment and how local common rules should be modified according to changes in the use of natural resources.

Figure 1 Overview of the Project



Progress Status, Achievements, and Future Challenges

1) To clarify the water balance on Iriomote Island, we have installed a monitoring device on the island. The database is being built up to help us make more accurate predictions about the quantity and quality of water that will be available in the future. Our observations have indicated that rain on the island is acidic throughout the year. We will identify the origins of the substances that cause the acid rain, estimate the total amount of such substances falling on the island, and monitor the impact. We will also

Photo 1 Seagod Festival (Shirahama Area)



Photo: Fumio Sakuma, Nature Image Inc.

Photo 2 Water Balance on Iriomote Island



Photo: Watanabe Suimon Kikaku

Photo 3 Industries as Bases of Life for the Islanders



Photo: Fumio Sakuma, Nature Image Inc.

identify substances that are carried down a river into the sea, especially to coral reef areas along coasts, and assess the impact.

- 2) Our studies have shown that typhoons affect turnover in broadleaved evergreen forests. In forests including those of mangroves, we have been keeping track of production/circulation of substances, while monitoring the impact of human activities. We will provide information on effective maintenance and management of forests in the future.

- 3) We have gathered a variety of reference materials including demographic statistics, administration policies and information on local industries, and categorized them for further analysis. We use these materials to develop measures to promote networking of small-scale industries from the viewpoint of island economics. In this process, we focus on tourism, agriculture, health and education.

- 4) We have been in close contact with the islanders by participating in various local events and educational programs designed for schools and communities. As a result, we learned that community centers on the island play a large role in the communities' decision-making processes.

To solve environmental problems on Iriomote Island, local people need a solid economic infrastructure to build self-esteem and become independent. To achieve this, it is important to share useful information with the islanders. We will proceed with this project so that the findings can contribute to promoting local industries and growing new ones. We take part in education at schools and in communities from the planning stage, and would like to help locals promote the island's traditional culture and smooth handover of its performing arts to younger generations.

※ <http://www1.gifu-u.ac.jp/~kawakubo/iriomote/index01.html>

Photo 4 Function and Maintenance Mechanism of Forests



Photo: Fumio Sakuma, Nature Image Inc.

Photo 1-4: Iriomote Island, located in the southwest of the Ryukyu Islands, is a perfect place to study natural environment. It is typical of subtropical islands that have precious natural environment. The islanders have developed an original lifestyle, even though the island itself has been under the influence of neighboring districts.

Vulnerability and Resilience of Social-Ecological Systems

A vicious cycle of poverty and environmental degradation such as forest degradation and desertification is a major cause of global environmental problems. Especially in semi-arid tropics (SAT) including Sub-Saharan Africa and South Asia where the majority of the poor is concentrated, poverty and environmental degradation is widely prevalent. People in this area largely depend on rain-fed agricultural production systems and their livelihoods are vulnerable to environmental variability. Environmental resources such as vegetation and soil are also vulnerable to human activities. In order to solve these "global environmental issues", a key factor is a quick recovery from, or a resilience of human society and ecosystems to, the impacts of environmental variability. This project aims at identifying the factors affecting resilience and the ways to enhance the resilience of rural people in developing countries to environmental variability.

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Purpose of the Research Project

In developing countries, loss of resilience of social-ecological systems (Figure 1) due to an increase of population and the collapse of rural communities is of critical importance especially for farmers and nomads whose livelihoods rely heavily on environmental resources. This project tries to consider human activity against environmental change in view of social-ecological resilience and thus to clarify the effects of local environmental change on social-ecological systems as well as the mechanism through which the systems recover from such shocks. Also, from various case studies, our research tries to identify factors that determine the adaptive capacity of households and communities to environmental shocks, and the role of institutions on strengthening social-ecological resilience. By analyzing the factors influencing social-ecological resilience, it is possible to

introduce policy interventions for enhancing human security in developing countries.

Research Methods and Target Areas

The method for comprehensive assessment of resilience is organized in four research themes as highlighted below in Figure 1.

- Theme I: We focus on soil and forest resources for analyzing ecological resilience.
- Theme II: We conduct intensive interviews of farm households/communities and identify the factors affecting social resilience.
- Theme III: We consider historical changes in land tenure systems made by government policies and their effects on natural environment as well as social-political factors of increasing vulnerability and the process of collapse and recovery of resilience in different communities.
- Theme IV: We cover larger areas utilizing statistical analysis, remote sensing data and aerial photographs to help trace long-term changes in land cover in addition to analysis of data on rainfall and temperature. By utilizing the information provided by themes I, II and III, we will develop comprehensive and integrative methods for assessing social-ecological resilience.

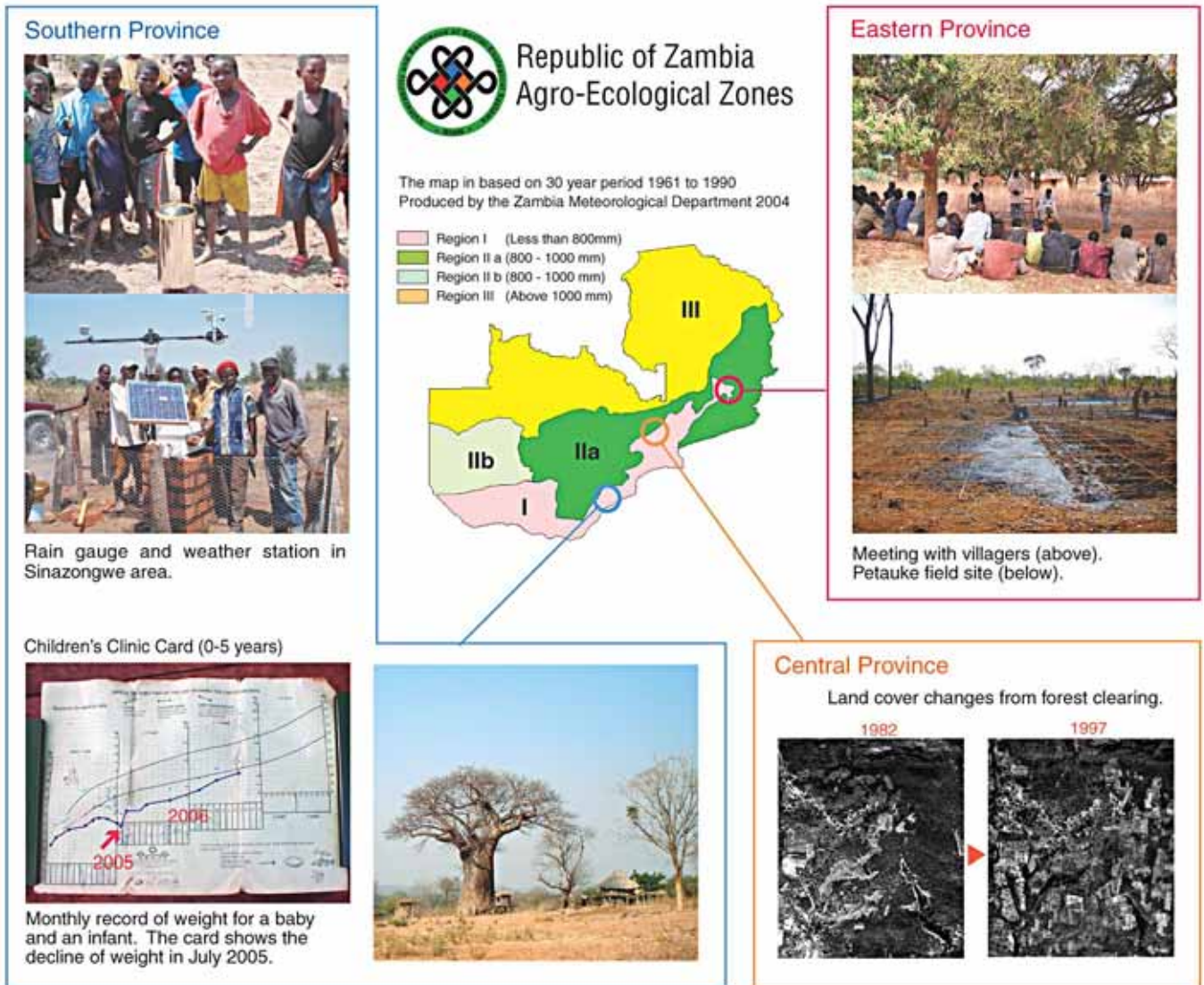
The main field sites are located in the semi-arid tropics (SAT) including Western Africa, Southern Africa and South Asia (India). Our main field site

When the ecological system receives a disturbance/shock from climate variability such as rainfall, the disturbance affects social resilience through agricultural production in agricultural society. If social resilience is low, a household or a community may fall into chronic poverty. If social resilience is high, a household or a community goes through transient poverty and recover to the original state. Institution, culture and technology for resource management link a bridge between ecological and social resilience and have an important role for building social-ecological resilience.

Figure 1 Close Relationship of Social and Ecological Resilience



Figure 2 Major Field Sites and Agro-Ecological Zones of Zambia (Classified by Precipitation)



is Zambia (Figure 2). The field sites were selected on the basis of agro-ecological zones and a history of recurrent extreme weather conditions, especially droughts.

Research Outcomes to Date and Expected Results

During the FY2007 (FR1), we set up weather stations, rain gauges, prepared experimental fields, and conducted extensive household survey. After the start of the rainy season in November, we started field surveys and monitoring.

- At the experimental site in a village in Eastern Province, a survey of vegetation and topography was conducted. After land clearing, maize cultivation was commenced with the monitoring of meteorological and soil conditions.
- Based on the census survey, we identified three zones based on agro-ecological characteristics and selected study sites (total 48 households in 5 villages) in the Sinazongwe area, Southern Province. In November, weekly household survey, plot level rainfall measurement was launched. At the same time, weather stations were installed in two sites and started monitor-

ing. In the same villages, field trials were commenced to identify soil fertility parameters. Household surveys in villages revealed the farmers' strategy of diversification for production activities to mitigate crop failure and the role of migrant labor for their livelihood.

- In order to study country level environmental and social changes, we started analyzing meteorological data, satellite images, and an extensive household survey conducted in early 2007. We have collected documents about food security policies of Zambian government and donors, and conducted research about the food relief program in Southern Province.

The above study covers a wide range of fields such as agronomy, climatology, geography, social-economics, nutrition and health and we are expecting to obtain valuable information and data sets for considering resilience.

As we did in the last fiscal year 2007, we continue to organize workshops and seminars in and outside of Japan and make research results available to the public by uploading working papers and reports at our project website.