

P1–3PR

Vulnerability and Resilience of Social-Ecological Systems

Project Leader : Chieko UMETSU

Short name : Resilience Project

Keywords : resilience, poverty, social-ecological system, resource management, environmental variability, vulnerability, human security, semi-arid tropics

1. Purpose of Research

1.1 Research Objectives

A. Background and objective

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 a majority of the poor concentrates, poverty and environmental degradation widely prevails. People in this area largely depend on rainfed agricultural production systems and their livelihoods are vulnerable against environmental variability. Environmental resources such as vegetation and soil are also vulnerable against human activities. In order to solve this “global environmental issues”, a key is a quick recovery or a resilience of human society and ecosystems from impacts of environmental variability. Thus in this project we consider society and ecology as one social-ecological system and try to perform empirical analysis for its resilience in semi-arid tropics.

B. Objectives of Research

The objective of the research is 1) to consider impacts of environmental variability through vulnerability and resilience of human activities in semi-arid tropics; 2) to study factors affecting social-ecological systems and the recovery from impacts and shocks; 3) to analyze factors that form the ability of household and community to recover and the role of institution for resilience; and 4) to identify the factors affecting resilience of social-ecological systems and the ways to enhance resilience of rural people in semi-arid tropics against environmental variability.

1.2 Research Organization, Contents and Methodologies

A. Research organization

In order to achieve our objectives, we focus on four themes. Each four themes interlink each other and thus provide comprehensive assessment of resilience of social-ecological systems. Under the supervision of theme leader, respective researchers will participate in sub-programs. Not as ordinary discipline based research groups, we organized theme based research organization. Most researchers involve more than one sub-program, thus making it possible to realize flexible research organization.

Theme I: Ecological resilience and human activities under variable environment

Theme II: Household and community responses to variable environment

Theme III: Political-ecology of vulnerability and resilience: historical and institutional perspective

Theme IV: Integrated analysis of social-ecological systems.

First two themes consider site specific or village level analysis and those studies are extended to temporal as well as spatial analysis in the third and fourth themes for larger scales. We invited appropriate experts in the respective fields such as agronomy and soil science, agricultural and development economics, anthropology, geography, climatology, and remote sensing. The time scale of the analysis is from 1960s to the present when the changes in social and natural environment have been

accelerated.

B. Research areas

The study areas of the project are the countries in semi-arid tropics (SAT) (Figure 2). The large population in SAT live in rainfed agricultural areas and their marginal livelihood is critically depends on fragile and poorly endowed natural resources. The main research area is Zambia in Southern Africa, in addition to Burkina Faso in West Africa, and India in South Asia. In Zambia, drought prone Eastern and Central Provinces are our target research areas.

C. Research contents and methodologies

Theme I: Ecological Resilience and Human Activities under Variable Environment (Theme Leader: Hitoshi SHINJO)

This theme tries to capture the interaction between ecological resilience and human activities under fluctuating environment. In theme I-1, to evaluate the components, capacity and succession of ecological resilience, we will monitor spatial and temporal changes of soil conditions, e.g. organic materials and fertility related properties, succession of grass/shrub/tree communities, micro-climatic condition in above-ground and soil, and degradation of land that are expected to happen during the process of conversion from stable fallow woodland to agricultural land. In theme I-2, the influence of ecological resilience on human activities are revealed by comparison of some soil properties, which is related to ecological resilience, under different landscape, e.g. valley, slope and plane land, the types and histories of land use, and succession stages of agro-ecology.

Theme II: Household and Community Responses to Variable Environment (Theme Leader: Takeshi SAKURAI)

Rural households in the semi-arid tropics have developed various kinds of risk-management and risk coping mechanisms to respond unpredictable rainfall. In order to serve for the integrated analysis of socio-ecological systems, the theme II investigates rural households' strategies against the erratic rainfall in four interrelated sub-themes. Theme II-1 is to measure the risky event objectively, that is, rainfall. Theme II-2 concerns with the endowments of resources available to households including physical, natural, human, financial, and social capitals. Theme II-3 is devoted to the analyses of households' behaviors: risk-management before the rain, adjustment during the rainy season, and risk-coping after harvest. And finally in theme II-4, households' resilience in risky environment is evaluated in terms of income-smoothing, consumption-smoothing, and nutritious status.

Theme III: Political-Ecology of Vulnerability and Resilience: Historical and Institutional Perspective (Theme Leader: Shuhei SHIMADA)

This theme tries to focus on the institutional aspects of social resilience in the area of semi-arid tropics. Social resilience undergoes change along with social, political and economic change and also with ecological change. It is important to understand both in the context of local history and physical settings. Theme III-1 tries to consider the change of economic policy and its impact on agricultural production and land use. Theme III-2 analyzes changes in socio-political and their impacts on land use. Theme III-3 investigates historical changes of drought responses and crop failures and the role of social institution to mitigate such situations.

Theme IV: Integrated Analysis of Social-Ecological Systems (Theme Leader: Mitsunori YOSHIMURA)

The primary goal of this theme is to clarify the relationship between ecological vulnerability, resilience and human activities through investigations of changes in land use and multi-level social/ ecological systems. Theme IV-1 analyzes continent scale climate monitoring to understand the mechanism of the formation of drought. Theme IV-2 investigates land use change and its impact on ecological system such as forest degradation and vegetation change using multi-temporal aerial photographs and satellite imageries. Theme IV-3 considers the role of actors of early warning systems and its effects on food security. Finally in theme IV-4 we analyze and evaluate regional resilience with district level data.

2. Common Issues and Discussions

2.1 Objectives of RIHN Project

A. Why do you conduct proposed research as a RIHN project?

As a RIHN project, it is possible to challenge research agenda that has never been accomplished in any other research funds. For our resilience project, those research agenda includes an experiment of forest-clearing, collection of soil quality and rainfall data at the large number of farm households. Since a research of resilience for social-ecological systems requires researchers from many disciplines, it is a great opportunity to conduct interdisciplinary project as a RIHN project.

B. Relations to “global environmental issues” and proposed research

People who rely their production on environmental resources have vulnerable livelihood against environmental variability. In those areas, deforestation, desertification, and soil degradation caused by a vicious cycle of poverty and environment degradation is a critical issue and it is recognized as one of the “global environmental issues.” The recent Environment Ministerial Summit (G-8) held in March 2005 called especially upon the need of research on impacts of climate change particularly in sub-Saharan regions. The proposed research aims at considering the impacts of environmental variability and increasing resilience of people in semi-arid tropics, which is the pressing global environmental issues for international community.

C. Research area and the relations to “global environmental issues”

The proposed research covers areas including Southern Africa region (Zambia), West Africa region (Burkina Faso), and South Asia (India). Those areas are a part of semi-arid tropics (SAT). In the semi-arid tropics (SAT) regions, the livelihood of the people is considered one of the most vulnerable against climate change. People in this area largely depend on vulnerable rainfed agricultural production systems and increasing food security, resilience of livelihood and reducing poverty are an acute issue in this area.

D. How do you utilize the results of the project to help solving “global environmental issues”?

We consider environmental degradation caused by the “vulnerability” of social-ecological systems as “global environmental issues” and the ways to enhance “resilience” of social-ecological systems as a primary goal of solving “global environmental issues”. During the research project, data collection, observation and analysis will be conducted to find out some key indicators to resilience. By using those

indices, our goal is to provide some options of the ecosystems and resources management at the end of the project.

2.2 Methods to realize “integrated” and “interdisciplinary” project

A. Characteristics and problems of methods and organization

We plan to set four themes that interlink each other in various dimensions from household and community level analysis to temporal and spatial level of analysis. Particularly we invite social scientists who are able to work with natural scientists to make use of scientific information and data for social science research agenda. Research group expected to join the project are anthropometrics expert, cultural anthropologist, early warning specialist, public health expert, forest ecologist, and macro economist. We plan to organize workshops in collaboration with other RIHN projects that share common interests and common research areas with us. Joint publication is also another option for collaboration.

2.3 Towards dissemination of the research outcomes

We plan to publish the research results as books and in academic journals and to disseminate the research results not only at the domestic meetings but also at the international research community such as IHDP. We utilize homepage for making research results available to public.

3. Outcome up to now

3.1 Research Activities during the Pre-Research

A. *Research organization*

- We discussed about the MOU with Zambia Agricultural Research Institute (ZARI) and reached an agreement. The MOU will be signed within FY2006.
- We discussed with researchers and staff members of collaborating institutions: Central Statistical Office, Ministry of Finance and National Planning; Food Security Research Project in Zambia (USAID/MSU); Institute of Economic and Social Research, University of Zambia (INESOR/UNZA); Meteorology Department, Ministry of Communication and Transport; Survey Department, Ministry of Land; Zambia Vulnerability Assessment Committee (ZVAC).

B. *Methodologies*

During the FY2006, we conducted literature review, field observation and preliminary interview for farmers and identified some research targets that should be included in our resilience study.

C. *Results of preliminary field research*

- During the field trip to Zambia in June-July 2006, we identified the field experiment site for Theme I near Petauke in Eastern Province. We obtained permission for the use of fallow land from the district administrator as well as villagers. Also a preliminary soil analysis is underway in order to clarify spatial distribution of soil characteristics. Theme I supports Theme II for soil analysis.
- From August 2006, two graduate students are residing in a village in Southern Province for their interview survey on labor migration, drought response and others. They continue to stay in the respective village until the end of cropping season in June 2007. (Theme III)
- In order to know typical land use change patterns in past years, we analyzed multi-temporal satellite imageries as our preliminary analysis. Using NDVI (Normalized Difference Vegetation Index) which introduced by the visible and near infrared bands combination, we extracted typical land cover change

areas. During the field trip to Zambia in August-September 2006 (Theme IV), we conducted ground truth survey to compare the results of preliminary analysis and actual ground conditions. In this year ground truth, we visited some of typical local villages and interviewed farmers where the land use change in the past is quite rapid. Also, we examined the impact of drought from vegetation change at the national level using mid-level resolution multi-temporal satellite imageries. Furthermore, using rainfall data from national meteorological station in Zambia to show the specific rainfall patterns during drought

- During the field trip to Zambia in November-December 2006, we visited a local hospital, health center and obtained information that during the drought the rate of infant birth weight below 2.5kg increase significantly. Also we obtained information of HIV/AIDS prevalence in rural Zambia.
- For human dimensions and human security, we surveyed global food security issues as well as institutions for food aid and early warning systems developed in Ethiopia for comparison.
- We organized a Resilience Seminar “Developing Methods for Institutional Analysis: Institutional Diversity in Resource Management) by Prof. Elinor Ostrom in July 2nd at RIHN and discussed about the institutions of resource management with many researchers who attended the seminar.
- We organized five Resilience Seminars in FY2007 (2 July, 25 July, 2 October, 9 November, February)

3.2 Changes made from the initial plan

- The effects of drought on humans appear especially in infant health status. The information related to their weight, height, and arm circumference is very important.

3.3 Response to comments by Evaluation Committee in March 2006.

- One committee member had a concern about the scale of analysis. However, the main scale of analysis is village/regional level. Only when it is necessary for larger level of analysis, such as climate, we go beyond national level for analysis.
- Also one committee member mentioned about why we have three research fields. By including India and Burkina Faso, we can consider the different formation of resilience depending on population and land endowment in those regions.
- One committee member suggested literature review. We are planning to incorporate review in PR report.

4. Forthcoming activities

A. Goal for Pre-Research

- We are trying to identify further the priorities of research items and make detailed research plan for the FY2007.

B. Activities in FY2006

- Additional survey for Post-Harvest Survey households in Eastern and Southern provinces are under planning. We plan to identify sample villages in Petauke in Eastern Province, and Sinazongwe in Southern Province for intensive household survey by March 2007.
- We produce PR report by March 2007.

C. Problems and Solutions for Research

- We are expecting to find experts of emergency food and rural energy in Japan or in Zambia.
- We plan to consider opening a field station in Zambia for field observation and monitoring.

5. Research Activities from FY2006 to FY2011

5.1 Time Schedule

	2005 FS	2006 PR	2007 FR1	2008 FR2	2009 FR3	2010 FR4	2011 FR5
Research Methodology	xxx	xx	xx	x			
Zambia							
I. Ecological Resilience	x	xx	xxx	xxx	xxx	xx	x
II. Household/Community	x	xxx	xxx	xxx	xxx	xx	x
III. History/Institution	xx	xx	xxx	xxx	xxx	xxx	x
IV. Integrated Analysis	x	xx	xxx	xxx	xxx	xxx	xxx
India		x	x	x	x	x	x
Burkinafaso			x	x	x	x	
International Workshop			x	x			x
Project Report	FS Report	PR Report	Annual Report	Interim Report	Annual Report	Annual Report	Final Report

Figure 1. Resilience of Social-Ecological System and Four Themes

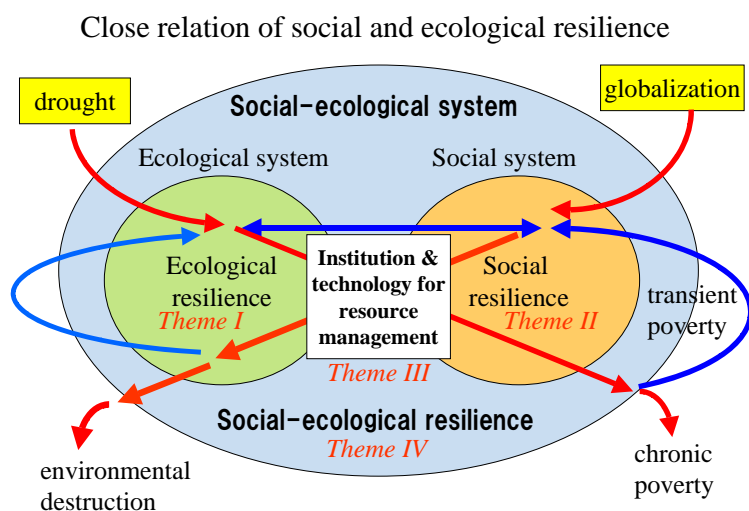
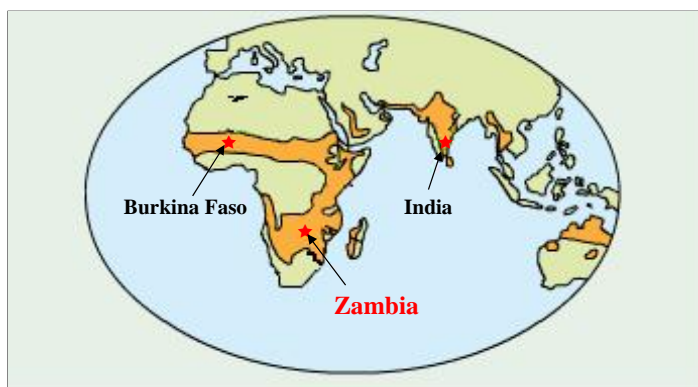


Figure 2. Regions of Semi-Arid Tropics and Study Areas



1-3PR Project Member List (FY2007)

	Name	Affiliation	Department	Title	Field	Role
Leader	Chieko UMETSU	RIHN	Research Department	Associate Professor	resource & environmental economics	Regional analysis, farm survey
A	Shigeo YACHI	RIHN	Research Department	Associate Professor	mathematical ecology	Advisor
	<i>Theme I</i>					
○	Hitoshi SHINJO	Graduate School of Agriculture, Kyoto Univ.	Division of Environmental Science and Technology	Assistant Professor	soil science	organic materials and soil fertility
○	Ueru TANAKA	Graduate School of Global Environmental Studies, Kyoto Univ.	Terrestrial Ecosystems Management	Associate Professor	agronomy	soil degradation and erosion
	Shozo SHIBATA	Graduate School of Global Environmental Studies, Kyoto Univ.	Landscape Ecology and Planning	Associate Professor	forest ecology	tree/shrub components and its succession
	Reiichi MIURA	Graduate School of Agriculture, Kyoto Univ.	Division of Agronomy and Horticulture Science	Lecturer	botany	grass/herb components and its succession
	Hidetoshi MIYAZAKI	Graduate School of Agriculture, Kyoto Univ.	Division of Environmental Science and Technology	Ph.D. Candidate	soil science	measurement of land plot, crop components
	Moses MWALE	Mt. Makulu Central Research Station	Ministry of Agriculture and Cooperatives	Vice Director	soil science	soil analysis
	Yoko NORO	Graduate School of Agriculture, Kyoto Univ.	Division of Environmental Science and Technology	MS. Candidate	soil science	organic materials and soil fertility
	<i>Theme II</i>					
○	Takeshi SAKURAI	Policy Research Institute, MAFF		Senior Economist	development economics	household survey and analysis
	Hiroimitsu KANNO	National Agricultural Research Center for Tohoku Region	Laboratory of Agricultural Meteorology	Team Leader	agricultural meteorology	measurement of rainfall data
	Taro YAMAUCHI	Graduate School of Medicine, The University of Tokyo	Department of Human Ecology	Assistant Professor	human ecology	Assessment of health and nutrition status at individual-, household- and population-level
	<i>Theme III</i>					
○	Shuhei SHIMADA	Graduate School of Asian and African Area Studies, Kyoto University	Division of African Area Studies	Professor	environmental geography	village society and institution
	Minako ARAKI	Faculty of Letters and Education, Ochanomizu University	Geography	Associate Professor	development study	village society and institution
	Kazuo HANZAWA	College of Bioresource Sciences, Nihon University	Department of International Development Studies	Professor	agricultural economics	farm household survey
	Chihiro ITO	Graduate School of Asian and African Area Studies, Kyoto University	Division of African Area Studies	graduate student (MA)	human geography	labor migration in rural area
	Shiro KODAMAYA	Graduate School of Social Sciences, Hitotsubashi University	Division of African Area Studies	Professor	African sociology	agricultural development and social change
	Chileshe MULENGA	University of Zambia	Institute of Economic and Social Research	Senior Lecturer	economic geography	analysis of social behaviors
	Tetsuya NAKAMURA	Graduate School of Asian and African Area Studies, Kyoto University	Division of African Area Studies	graduate student (MA)	agricultural economics	socio-economic responses to environmental change
	<i>Theme IV</i>					
○	Mitsunori YOSHIMURA	RIHN	Research Promotion Center	Associate Professor	remote sensing	ecological change monitoring
	Yukiko IITSUKA	The International Peace Cooperation Headquarters, Cabinet Office	Secretariat	Programme Advisor	development studies	early warning system
	Thamana LEKPRICHAKUL	RIHN	Research Department	Senior Project Researcher	environmental & health economics	household survey and analysis
	Keiichiro MATSUMURA	Graduate School of Human and Environmental Studies, Kyoto University	Cultural, Regional and Historic Studies on Environment	Assistant Professor	cultural anthropology	land tenure system and rural livelihood
	Tazu SAEKI	RIHN	Research Department	Assistant Professor	atmosphere physics	climate monitoring
	Chieko UMETSU	RIHN	Research Department	Associate Professor	resource & environmental economics	regional analysis
	Megumi YAMASHITA	Survey College of Kinki		Lecturer	geographic information	vegetation monitoring
	<i>India</i>					
○	K. Palanisami	Tamilnadu Agricultural University	Water Technology Centre	Director	agricultural economics	household survey and analysis
	Akiyo YATAGAI	RIHN	Research Department	Assistant Professor	climatology	monsoon rainfall analysis
	C.R. Ranganathan	Tamilnadu Agricultural University	Department of Mathematics	Professor	mathematics	economic modelling
	B. Chandrasekaran	Tamilnadu Agricultural University	Tamil Nadu Rice Research Institute	Director	agronomy	rice production analysis
	V. Geethalakshmi	Tamilnadu Agricultural University	Department of Agricultural Meteorology	Professor	agricultural meteorology	monsoon rainfall analysis
	<i>Burkina Faso</i>					
	Kimseyinga Savadogo	University of Ouagadougou	Department of Economics	Professor	economics	household data analysis

○=Core Member; A = Advisor; MAFF=Ministry of Agriculture, Forestry and Fisheries