

P1-3FR

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 theme interlinks with one another and thus provides 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. The four main themes are:

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 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 Southern 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, we will monitor spatial and temporal changes of soil conditions, to evaluate the components, capacity and succession of ecological resilience, 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 is 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 is revealed by a comparison of 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 to 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/Chieko UMETSU)

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 extensive household survey 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 agendas include 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 are critical issues and they are 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 are 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 to climate change. People in this area largely depend on vulnerable rainfed agricultural production systems. Increasing food security, resilience of livelihood and reducing poverty are acute issues 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 policy options to improve the ecosystem and resource 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. Researchers joining the project this fiscal year include anthropometrics expert, cultural anthropologist, early warning system specialist, public health expert, forest ecologist. We plan to organize workshops in collaboration with other RIHN projects that share common themes and common research areas with us. Joint publication is also another option for collaborations.

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 web site for making research results available to public.

3. Outcome up to now

3.1 Research Activities during the First Year of Full-Research (FR1)

A. *Research organization*

- Based on the MOU with Zambia Agricultural Research Institute (ZARI) which was signed in March 2007, we started a collaborative research with ZARI in Eastern and Southern Provinces.
- We organized the first Lusaka Workshop on the 3rd September 2007. Participants included Zambia Agricultural Research Institute (ZARI), our major counterpart, Central Statistical Office (CSO), Food Security Research Project of the Michigan State University (FSRP/MSU), Japan International Cooperation Agency (JICA) Zambia Office, and the University of Zambia (UNZA).

B. *Methodologies*

During the FY2007, we conducted literature review, field observation and interview with farmers and identified some research targets that should be included in our resilience study.

C. *Results of FY2007 field research*

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

I. At the experimental site in a village in Eastern Province, survey on vegetation and topography was conducted. After land clearing, maize cultivation was commenced with the monitoring of meteorological and soil conditions. In the same villages as Theme II in Southern Province, the field trials were commenced to identify the soil fertility parameters.

II. We identified three zones in the Sinazongwe area, Southern Province based on agro-ecology, selected study sites (5 villages) in each zone, and conducted census in July 2007. Then, using the census results, 16 households were drawn as samples in each study site. In September/October, rain gauges

were installed in plots of the sample households and rainfall measurement started. In November, weekly household survey was launched.

III. Shimada participated in a seminar at the Oxford University entitled “Resilience, realities and research in African environment” and collected information on research on resilience and vulnerability and their application to development assistance. Also Nakamura studied strategies for diversifying farm livelihood, and Ito studied the role of migrant labor. Hanzawa and Kodamaya continued research on drought prone C village in the Central Province.

IV. *IV-1* We have installed meteorological observation sensors and rain gauges to monitor atmospheric environment at Southern Province, Zambia in this September. We started analysis of objective analysis data and observational data by Zambia Meteorological Department.

IV-2 The satellite imageries were obtained through the internet during the last FY2006. In this year, we have searched and purchased the useful satellite images which were observed before and after the agricultural and meteorological droughts in order to identify the land use/cover changes caused by serious droughts. Also, we investigated some principal study sites to collaborate with the theme I. Furthermore, we collected some documents and statistical data. *IV-3* We have collected documents about food security policies of Zambian government and donors, and conducted research about the food relief program in Sinazongwe district (Southern Province). *IV-4* During the field survey in September, we visited some of the sampled household for the extensive survey early 2007. Also we reviewed the methods for analyzing socio-economic data with GIS data.

- We organized five Resilience Seminars in FY2007 (23 April; 20 June; 30 July; 22 November 2007; 15 February 2008) and co-organized one RIHN Seminar (23 May 2007). We organized Hamamatsu Workshop (11-12 May), Otaru Workshop (8 March). Project web site is now available for dissemination of information. The web site address is: www.chikyu.ac.jp/resilience/. We started Resilience Working Paper Series and made them available at the project home page.

4. Forthcoming activities

A. Goal for 2nd year of Full-Research (FR2)

- We started the main research activities and trying to identify further the priorities of additional research items and make detailed research plan for the FY2008.

B. Activities in FY2008

- 1) Maize yield in the field trials will be measured and its controlling factors will be identified from measured environmental parameters. Field trials will be continued to evaluate the effects of variation in meteorological conditions on maize yield. 2) Continued monitoring and training enumerators after setting up rain gauges for rainfall data and starting intensive household surveys are necessary. 3) Hanzawa and Shimada will continue field study at C. village at Central Province, and other members will continue their studies at the villages in Southern Province. One new researcher is expected to start long-term field study in a village in Gwembe Tonga area. 4) In addition to the satellite and meteorological data accumulated as basic information, we need further to obtain data sets with different spatial and temporal scales. Also, research topics under collaboration with other themes should be accelerated.
- We will produce FR2 (interim) report by January 2009.

C. Problems and solutions for research

- 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
Burkina Faso			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

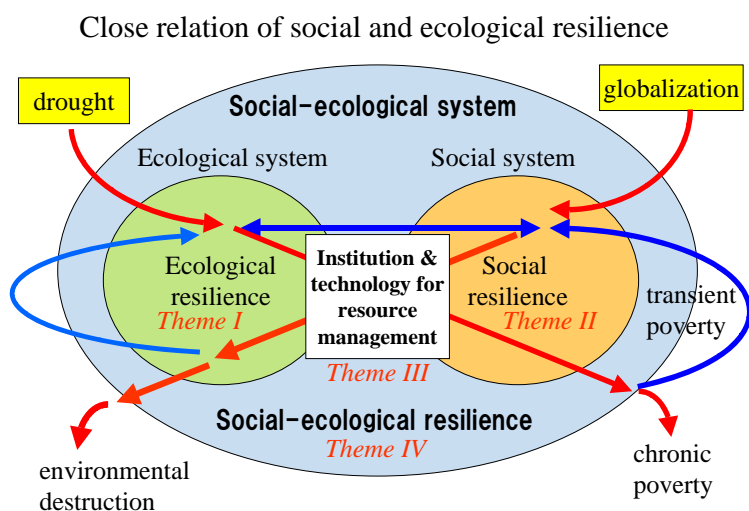
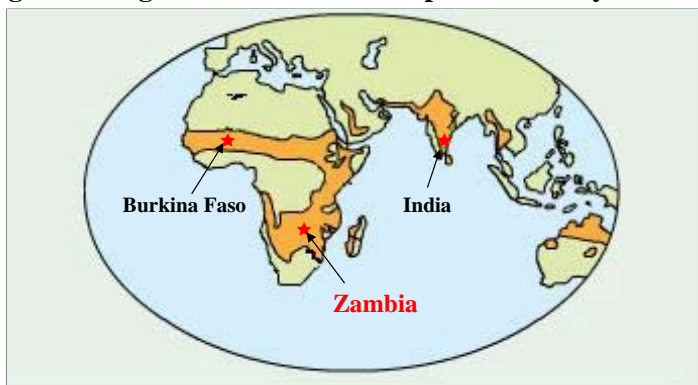


Figure 2: Regions of Semi-Arid Tropics and Study Areas



1-3FR 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>					
O Hitoshi SHINJO	Graduate School of Agriculture, Kyoto Univ.	Division of Environmental Science and Technology	Assistant Professor	soil science	organic materials and soil fertility
O Ueru TANAKA	Graduate School of Global Environmental Studies, Kyoto Univ.	Terrestrial Ecosystems Management	Associate Professor	agronomy	soil degradation and erosion
Shozo SHIBATA	Field Science Education and Research Center, Kyoto Univ.	Kamigamo Experimental Station	Professor	forest ecology	tree/shrub components and its succession
Reichi MIURA	Graduate School of Agriculture, Kyoto Univ.	Division of Agronomy and Horticulture Science	Lecturer	botany	grass/herb components and its succession
O Hidetoshi MIYAZAKI	RIHN	Research Department	Project Researcher	soil science	measurement of land plot, crop components
O Moses MWALE	Mt. Makulu Central Research Station, Zambia Agricultural 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	Graduate Student (MS)	soil science	organic materials and soil fertility
<i>Theme II</i>					
O Takeshi SAKURAI	Policy Research Institute, MAFF	Laboratory of Agricultural Meteorology	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	School of Medicine, Hokkaido University	Department of Health Sciences	Associate Professor	human ecology	community health and nutrition
<i>Theme III</i>					
O 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
Gear M. Kajoba	University of Zambia	Department of Geography	Senior Lecturer	geography	land tenure system and food security
Shiro KODAMAYA	Graduate School of Social Sciences, Hitatsubashi 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	social-economic responses to environmental change
<i>Theme IV</i>					
O Mitsunori YOSHIMURA	Remote Sensing Technology Center of Japan (RESTEC)	Secretariat	Senior Researcher	remote sensing	ecological change monitoring
Yukiho IITSUKA	The International Peace Cooperation Headquarters, Cabinet Office	Research Department	Programme Advisor	development studies	early warning system
O Tamana LEKPRIHAKUL	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	atmospheric 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>					
O K. Palanisami	Tamilnadu Agricultural University	Centre for Agri. & Rural Development Studies	Director	agricultural economics	household survey and analysis
Akiyo YATAGAI	RIHN	Research Department	Assistant Professor	climatology meteorology	monsoon rainfall analysis
C.R. Ranganathan	Tamilnadu Agricultural University	Department of Mathematics	Professor	mathematics	economic modelling
B. Chandrasekaran	Tamilnadu Agricultural University	Directorate of Research	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

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