E-04 (FR3) Vulnerability and Resilience of Social-Ecological Systems

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SUMMARY OF RESEARCH OBJECTIVES AND CONTENTS

1. Research Objectives

The objective of this research is 1) to consider impacts of environmental variability on vulnerability and resilience of human activities in the semi-arid tropics; 2) to study factors affecting social-ecological systems and their recovery from shocks; 3) to analyze factors determining ability of households and communities to recover from environmental shocks and the roles of institutions in improving household resilience; and 4) to identify the factors affecting resilience of social-ecological systems and ways in which the resilience of subsistence farmers in the semi-arid tropics to environmental variability can be strengthened.

2. Background

A vicious cycle of poverty and environmental degradation, such as forest degradation and desertification, is a major cause of global environmental problems. This is especially the case in the semi-arid tropics (SAT) including Sub-Saharan Africa and South Asia, where a majority of the world's poor are concentrated. Within the SAT, communities' livelihoods depend critically on fragile and poorly endowed natural resources, and poverty and environmental degradation are widespread. People in these regions depend largely on rain-fed agriculture, and their livelihoods are vulnerable to environmental variability. Environmental resources such as vegetation and soil are also vulnerable to human activities. To surmount these environmental challenges, human society and ecosystems must be resilient to (recover quickly from) environmental shocks. Thus in this project we consider society and ecology as one social-ecological system and empirically analyze its resilience.

3. Research Methods

a. Research Contents and Methodology

The research is organized into four themes focusing on different dimensions of resilience. Theme I investigates the influences of ecological resilience on human activities by comparing soil properties in different landscapes (e.g. valleys, hill slopes and plains), the types and histories of land use, and agro-ecological succession. Theme II evaluates household resilience in risky environments in terms of income-smoothing, consumption-smoothing, and nutrition status. Theme III focuses on the institutional aspects of social resilience in the SAT. It examines how social, political, economic and ecological changes shape social resilience. Theme IV clarifies the relationship between ecological vulnerability, resilience and human activities, through investigations of historical and spatial changes in land use and multi-level social-ecological systems.

b. Research Areas

The primary study sites are in the drought-prone Eastern and Southern provinces of Zambia, Southern Africa (Figure 1). Minor study areas are located in Burkina Faso, West Africa, and India, South Asia.

4. Project Organization

Research Organization

The four themes interlink and thus provide a comprehensive assessment of resilience of social-ecological systems

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

5. Research goals in FY2009

- Clarification of the factors controlling maize yield in the field experiments in Eastern and Southern Province, Zambia
- While continuing the household survey, anthropometric measurements, and rainfall recording that were initiated in November 2007 (the onset of the rainy season of 2007/08), we will start analyzing the impact of the variability of rainfall on household consumption and nutritious condition. In addition, we will conduct an agronomic study in order to determine the relationship between rainfall variability and maize yield at the farmers' field level.
- Continuation of field research on livelihood in intra-village activities (agriculture, forestry, animal husbandry) with respect to increasing vulnerability of rural areas and village-urban economic activities (labor migration, networking). Furthermore, we conduct research on land tenure systems which is the foundation for rural resource use.
- Multi-temporal and spatial change analysis caused by environmental change in 2008-09 and its effects for household's livelihood and food aid activities by the Zambian Government and NGO in Sinazongwe intensive research sites.

6. Progress up to Now

During the FY2006 (PR) we focussed on establishing research collaborations with various institutions in Zambia. During the FY2007 (FR1) we prepared experimental field sites and installed monitoring equipment such as weather stations, on-farm rain gauges and soil moisture measurement devices. Comprehensive household surveys and monitoring of rainfall and crop growth commenced in November 2007. During of the FY2008 (FR2) the first cropping season of 2007/2008 was completed. During of the FY2009 (FR3), the second cropping season of 2008/2009 was completed and harvest season of the third cropping season 2009/2010 is expected to start in March/April 2010.

- For an empirical approach to resilience, we focus on the mechanism and the speed of recovery in food consumption and livelihoods of agricultural households after shocks such as drought and

flooding (Figure 2). Theme 1 measures the level of decline of agricultural production through maize yields. Theme 2 observes the speed of recovery in food consumption, body weight and skinfold thickness. Theme 3 considers qualitatively under what conditions livelihoods do or do not decline, how they recover and the differential coping strategies utilized by households. Theme 4 visualizes the spatial pattern of resource use by agricultural households.

- The field experiment in Eastern Province revealed that pattern of soil nutrients release and weed growth differed according to the duration of cultivation, which in turn affected maize yield. Compared to the first year, more nutrient was released at the initial stage of maize growth and weed grew more rigorously in the second year. As a result, maize yield did not differ in both years. Field experiment in Southern Province suggested that annual variation of maize yield was influenced by topographical position of the fields. Field at the top of the slope had the better yield in the year with much rainfall, while that at the bottom of the slope had the reduced yield in the year with much rainfall.
- The 2007/08 rainfall was extraordinarily heavy, but its damage depends on household and the impact of these rainfall events depends on household characteristics based on the information from our local level precipitation data at the field level. Moreover, our household survey found a significant reduction of food consumption among households who suffered heavy rainfall. The anthropometric measurements, on the other hand, confirm a pattern of seasonal change in body weight.
- Field experiments in the Southern Province suggest that annual variation of maize yields were influenced by topographical context of the fields. In upper terrace (Site C), fields at the top of the slope had better yields in high rainfall years, while fields at the bottom of the slope had lower yields in high rainfall years.
- Based on a GIS analysis of damaged fields during the 2007/2008 rainy season, flood damages are concentrated in poorly-drained fields in lower terrace areas (Site A), steep fields in mid-escarpment (Site B), and valley bottom fields in the upper terrace area (Site C). We also measured the area of damaged fields for each household.
- After floods, farmers responded by replanting maize, shifting from maize to potato and beans, getting cash income from livestock sales, engaging in season activities such as fishery and wage labor to offset a shortfall of income, which indicated various coping mechanisms by affected households.
- We organized resilience seminars and workshops. In August, we held the 2nd Lusaka Workshop “Towards Resilience of Rural Households in Drought-prone Areas” and invited participants from Zambia and neighboring countries. In March, we organized Tsunami Workshop in Singapore.
- Project annual reports, working papers and a Japanese translation of a resilience workbook by Resilience Alliance, are all available at the project web site.
  http://www.chikyu.ac.jp/resilience/publication-W_e.html
- At IHDP2009 Open Meeting in Bonn, two sessions were organized by the Resilience Project. Eight project members presented at the meeting. Also three project members became members of IHDP committee and sub-committee of Science Council of Japan.

7. Research Plan until the next PEC Meeting in FY2010

For the next two years of research (FR4, FR5), we plan to conduct the following:

1. While refining the theoretical aspects of resilience, we need to consider the practical applicability of the resilience approach based on the field research.
2. Integration of the research and data should be accelerated for the common goal for analyzing resilience of the farm households qualitatively and quantitatively.
3. For FY2010 and early FY2011 weather monitoring, plot experiments, household surveys, and the accumulation, compilation and analysis of data sets will be continued.
4. The first monitored 2007/2008 cropping season was an abnormal flood year, against which the 2008/2009 cropping season should be compared.
5. Coping strategies of farm households for environmental changes will be analyzed and assessed qualitatively and quantitatively.
6. To provide feedback to the local community we provided rainfall information for the first cropping season 2007/2008 to local farmers. We will continue to do so.
7. We prepare for the RIHN International Symposium and RIHN Forum for FY2011. We also prepare for working workshop for book publication.
8. Collaboration with other international research organizations should be enhanced.
9. The concept of resilience can be applied to other RIHN project as well. We continue promoting inter-project initiatives within RIHN projects and other research groups.

8. Research Activities from FY2006 to FY2011

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		
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. Regions of Semi-Arid Tropics and Study Areas

Figure 2. Approaches to Resilience