

P1—3FS

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.

In the past, no serious attention has been paid to the vulnerability and resilience of people whose livelihoods and production systems heavily depend on environmental resources. Especially for farmers and nomads in developing countries who rely on environmental resources, a loss of resilience of social-ecological systems, due to an increase in population and the collapse of rural communities, is of critical importance. The aim of this project is to consider human activity within the context of environmental change in view of social-ecological resilience. Thus, to clarify the effects of local environmental change on social-ecological systems as well as the mechanism through which they recover from shock. Also from various case studies, we will try to identify household and community factors that determine the capacity for resilience, and the role of institutions on resilience. By analyzing factors influencing social-ecological resilience, it is possible to introduce policy interventions for enhancing human security in developing countries. (Figure 1)

The concept of resilience has long been discussed among ecologists after the seminal paper “Resilience and Stability of Ecological Systems” by C. S. Holling (1973). The engineering resilience was defined as recovery time to return to the initial equilibrium before disturbance. This unique equilibrium concept was soon expanded to the concept of ecological resilience that emphasizes capacity to endure disturbance incorporating non-linearity, multiple equilibria and regime shift. Recently, some researchers tried to apply those resilience concepts to complex social-ecological systems (Levin et al. (1998); Levin (1999); Berkes, Fikret & Folke eds. (1998); Berkes, Colding & Folke eds. (2003)).

The above development went in tandem with the emergence of ecological economics that was established during the late 1980s. The important agenda was to link socio-economic research with

ecological research. Ecological economics developed mainly in developed countries has less focus on critical development issues such as poverty and environmental degradation. Also conventional development economics ignored ecological issues that are a base for human economic activities. Thus, there is a need to apply the resilience concept of social-ecological systems in order to solve pressing development issues such as resource degradation and to enhance human security.

In the semi-arid tropics (SAT), the livelihood of the people is vulnerable against environmental variability. The SAT (Figure 2) includes regions such as Sub-Saharan Africa and South Asia where the number as well as the share of the people who live in absolute poverty will remain large for some time to come. People in this area largely depend on vulnerable rainfed agricultural production systems. Thus increasing food security, resilience of livelihood and reducing poverty are acute issues in this area. The G-8 Environment and Development Ministers Meeting held in March 2005 called especially upon the need of research for impacts of climate change on vulnerable livelihoods particularly in sub-Saharan Africa regions. The proposed research aims at considering impacts of environmental variability and increasing resilience of people, which is the pressing global environmental issues for international community.

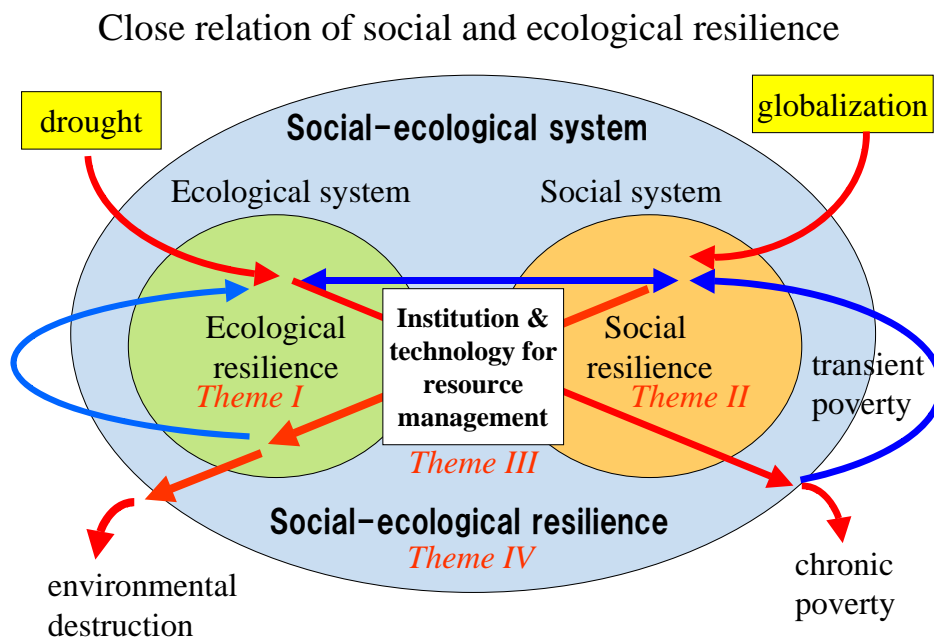


Figure 1. Resilience of Social-Ecological System and Four Themes

B. Objectives of Research

The objective of the research is as follows:

1. We consider impacts of environmental variability through vulnerability and resilience of human activities in semi-arid tropics.
2. We study factors affecting social-ecological systems and the recovery from impacts and shocks.
3. We analyze factors that form the ability of household and community to recover and the role of institution for resilience.
4. Thus we 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.

C. Goal of the Project

We consider environmental degradation caused by “vulnerability” of social-ecological systems as “global environmental issues” and the ways to enhance “resilience” 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.

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. (Figure 4)

Collaborating institutions are as follows:

Zambia

Institute of Economic and Social Research, University of Zambia

Central Statistical Office, Government of Zambia

Mt. Makulu Central Research Station, Ministry of Agriculture and Cooperatives

Meteorological Department, Ministry of Transport and Telecommunications

Survey Department, Ministry of Land Resources

Food Security Research Project, MSU/USAID

India

Water Technology Centre, Tamilnadu Agricultural University, Coimbatore, India

Burkina Faso

University of Ouagadougou, Burkina Faso

B. Research areas

The study areas of the project are the countries in semi-arid tropics (SAT). SAT is characterized by

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

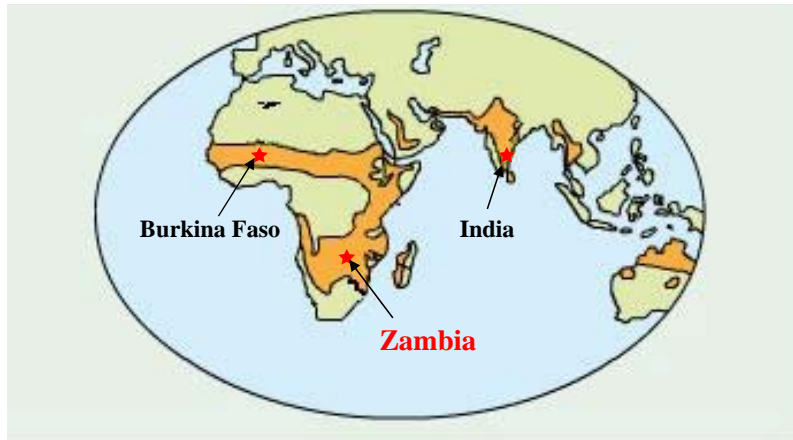
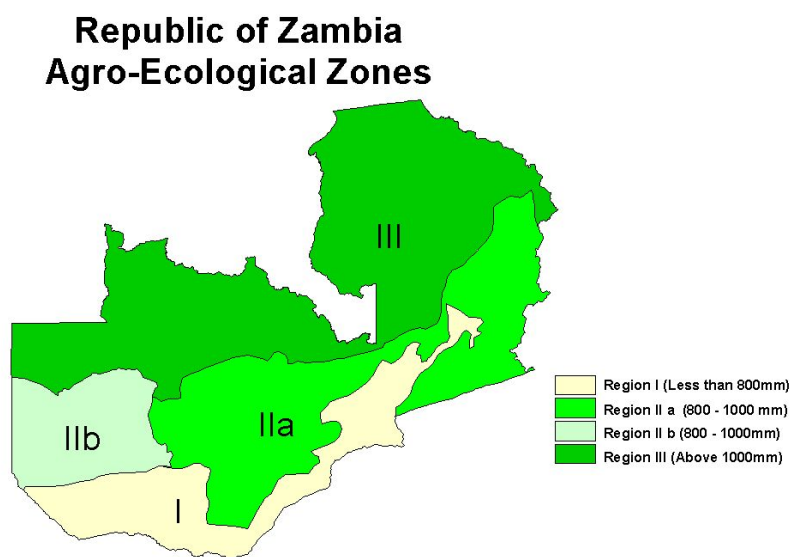


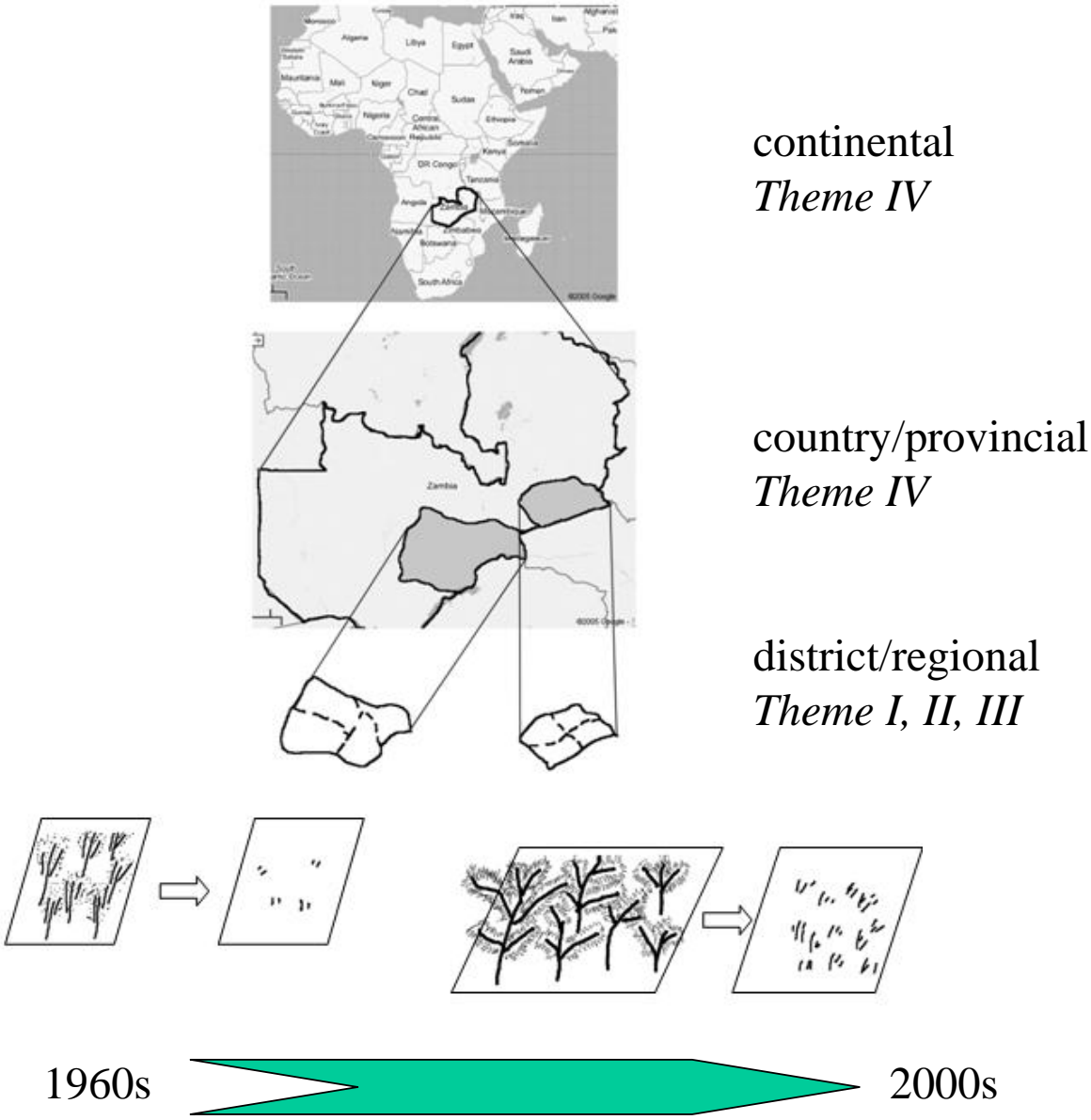
Figure 3. Agro-Ecological Zones in Zambia



The map is based on 30 year period 1961 to 1990

Produced by the Zambia Meteorological Department 2004

Figure 4. Scale of Analysis



unpredictable weather, long dry seasons, inconsistent rainfall and soils with poor nutrients (Barghouti, 1999). This area is a home of one-sixth of the world's population, a half of them live in absolute poverty with less than one US dollar a day. 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 target research areas in SAT are Southern Africa region (Zambia, Zimbabwe), West Africa region (Burkina Faso, Niger), and South Asia (India). Particular emphasis will be placed on the rural agricultural areas in Zambia where intensive field survey will be conducted. In Zambia, drought prone Eastern and Central Provinces are our target research areas. Those areas are in agroecological zone of I and IIa where annual rainfall is less than 800 mm and between 800 mm and 1,000 mm respectively. (Figure 2; Figure 3)

C. Research contents and methodologies

This project tries to provide quantitative and qualitative assessment of resilience of social-ecological systems. Resilience of social-ecological systems largely consists of i) the capacity of natural and social systems to absorb shocks as well as ii) the coping mechanisms when the shock occurs. Those capacity and coping mechanisms may be affected by external socio-economic environment such as institutional changes. We set four themes as follows: The theme first tries to consider ecological resilience through human activities. The second theme analyzes resilience of household and community through ecological conditions. The third theme considers resilience through historical and institutional perspectives. The fourth theme tries to integrate previous three themes for the evaluation of social-ecological resilience in larger scale.

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

Ecological resilience can be defined as the potential of ecosystems to provide people with services in a sustainable manner. In this sense, it is commonly believed that human activities, such as cropping, grazing and tree cutting for fuel, may adversely affect ecological resilience, leading to land degradation. Nevertheless, the non-linearity and variability in the relationship between the human activities and the ecosystems often makes it difficult to find the clear evidence of the cause-effect relationship. In the semi-arid tropics (SAT), particularly, the inter-annual fluctuation of rainfall sometimes mask the change of ecological resilience caused by the human activities. The sub-theme I-1 will deal with the impact of human activities on the ecological resilience with the intensive field experiment, where the spatial and temporal variability of the possible indicators of ecological resilience will be measured. Besides the impact of human activities, we also clarify the interrelations between the ecological resilience and the human activities in the sub-theme I-2, since people in SAT depending heavily upon the ecological resources seem to recognize and cope with the variability of the ecological resilience for stabilizing their livelihood.

By compiling the sub-themes I-1 and I-2, we identify the status of the ecological resilience in the lands of the study areas, how people's welfare depends on the ecological resources and how the ecological resilience changes under the impact of human activities, to develop some sound options of the ecosystems and resources management in SAT.

I-1 Components, capacity and succession of ecological resilience under different human intervention and variable environment (Shinjo, Tanaka, Miura, Shibata, and Saeki)

Although we can define the ecological resilience as above, we have not yet understood how we can parameterize the ecological resilience. Since the past ecological studies strongly suggest the importance of variability and redundancy of ecosystems for their resilience, we will monitor spatial and temporal variability of land characteristics, and try to evaluate the components, capacity and succession of ecological resilience during the process of conversion from stable fallow woodland to agricultural land in Petauke, Eastern Province of Zambia. For this purpose, we will open a parcel of relatively stable Miombo woodland for cropping every year or, in some parcels, returning to fallow during 5 years, to prepare the lands under different levels of human intervention. With the experimental design, the effects of fluctuating climatic factors and the impacts of human activities can be detected independently, unlike the past studies on slash-and-burn farming that have attributed all the temporal changes to human activities. In this field experiment, spatial and temporal variability of the soil properties, the nutrient cycling, the components of plant communities and the micro-climatic variables are determined. Among the variables, we try to identify quantitative indicators that explain the ecological resilience of the study site. In the later period, land capability with different degrees of human intervention and land use history under the same climatic condition of the particular year can be compared in order to evaluate the decrease or regime-shift of ecological resilience of the study site.

I-2 Interrelations between ecological resilience and human activities and its succession under different agro-ecosystems (Tanaka, Shinjo, Miura, Shibata, Miyazaki and Saeki)

It is commonly observed in SAT that one household cultivates the several parcels of the land different from each other in terms of ecological resilience. This way of land management is thought to be “risk management” which helps people cope with the environmental variability. In this sub-theme, how people cope with the variable ecological resilience is revealed by monitoring and comparison of some land characteristics, which are 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. For the detailed study, we identify the conditions and properties of every cultivated and fallow plots of each household, e.g. the areas and boundaries by GPS apparatus, some selected soil properties such as organic matter content and effective soil depth, and the composition of grass and shrub species. In collaboration with the Themes II and III, these results comprehensively explain and define the integrated concept of socio-ecological resilience. Target areas are cultivated and fallow lands of the sample households in Petauke, Eastern Province, and Sinazongwe, Southern Province of Zambia.

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, particularly in sub-Saharan Africa where credit and insurance markets are generally imperfect. Some of the mechanisms such as borrowing and gift-receiving depend on relatives and friends in the same or neighboring villages, and hence in the case of severe drought they will not work well because most of the farmers are simultaneously affected. On the other hand, there are other kind mechanisms that rely on natural resources for

example food gathering in the bush and utilization of wet valley bottoms. As such, which mechanisms a household utilizes and how much extent the mechanisms are effective will be determined by the assets that the household has, natural resources that are available for the household, the severity of the drought, the community characteristics, and so on. At the same time, the natural resource endowments should be affected by rural households' behaviors against droughts. For example, if many households rush for wild foods in the bush, the resources will be exhausted and will not serve as a safety net in the next drought. In other words, the resilience of households and that of ecosystem are dynamically inter-reliant. And because of this inter-reliance, households in the semi-arid tropics are often trapped in the vicious cycle of poverty and environment degradation. This is the fundamental issue that this research project addresses, and we, the project members, consider that the analysis of socio-ecological resilience will show us the way-out from the trap.

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. The details of each sub-theme are as follows.

II-1 Measurement of spatial and temporal distribution of plot-level rainfalls (Saeki, Kanno)

It is well known that in the semi-arid tropics rainfall variability is very large even within a village. Moreover, crops are severely affected if there is no rain in the critical stage even annual rainfall level is high enough. That is, temporal distribution of rainfall also does matter. Nevertheless, most drought studies use annual rainfall observed at regional weather station, simply because spatial and temporal rainfall distribution at plot-level cannot be observed. This is the most significant weakness of existing drought studies. Hence, in this sub-theme, daily rainfall on every sample household's plot will be recorded by utilizing small rain gauges, and the characteristics of spatial and temporal rainfall distribution within a small area will be analyzed. For rural households, rainfall is the most precious natural resource for their subsistence, but the resource availability is not predictable unlike other natural resources such as soil and vegetation. In other words, rainfall is considered to be a risky asset.

II-2 Investigation of households' capital endowments (Sakurai, Shinjo, vegetation specialist)

How a household manages drought risk and copes with drought is a function of not only the magnitude of drought shock but also the resources available to the household. Therefore, in theme II-2, households' capital endowments other than rainfall will be investigated. They include natural capital (agricultural land, fallow land, forest land, livestock, and so on), physical capital (agricultural equipments, houses, and so on), human capital (composition of household members, their education level, their skills, their health status, and so on), financial capital (potential money-lenders, potential gift-givers, saving, and so on), and social capital (membership, network, trust, and so on). Note that some of them are risky asset: for example, livestock holdings and human capital are subject to diseases and death. How risky they are is an empirical question to be answered in this research project like

rainfall variability. On the other hand, some assets such as soil and vegetation will not change a lot during the short research period although we consider that their depletion is a serious problem in the semi-arid tropics. Data will be collected by physical measurement or interview. The advantage of multidisciplinary approach of this research project is the involvement of natural scientists in the physical measurement such as soil and vegetation condition of agricultural land, and health status of household members.

II-3 Analyses of households' behavior against rainfall variability (Sakurai and agronomist)

Given the various kinds of capital endowments measured in sub-themes 1 and 2, the question is how households in the semi-arid tropics behave under the risky environment. Household behavior can be classified into three categories: risk management before the rain, adjustment during the rain season, and risk coping after the harvest. In sub-theme II-3, household behaviors will be recorded by weekly interview, which will enable us to investigate the effect of rainfall and capital endowments on how households' decisions about agricultural input, off-farm labor supply, livestock and other asset transaction, borrowing/lending, gift-giving/receiving, expenditure, consumption, and so on. Since daily rainfall is recorded in sub-theme 1, sub-theme 3 will reveal how households adjust their subsistence strategies during the rain season, which has been rarely studied due to data limitation. As for the risk management before the rain, crop and plot diversification is one of the important strategies to mitigate rainfall risk. With this regard, crop choice (e.g., drought-tolerant crops or drought-susceptible crops), varietal choice (e.g., early maturing or late maturing), and technology choice (e.g., with tillage or without tillage) will be analyzed from the agronomic view point.

II-4 Evaluation of households' resilience (Sakurai and anthropometrics expert)

Finally, in sub-theme II-4 the performance of households' risk management and coping behaviors will be evaluated from the viewpoint of resilience. Ignoring ecological aspect for a moment, in this sub-theme income smoothing and consumption smoothing will be used as criteria of households' resilience. They will be evaluated not only within a year (i.e. seasonal variation) but also over years (i.e. yearly variation due to the rainfall) using the data collected by the weekly household interview over years during the project period. However, a criticism about this method is that household income and consumption (or expenditure plus self-consumption) cannot be physically measured even in weekly interviews. Hence, in order to have an objective indicator, we will conduct anthropometrics: namely the measurement of body weight and height. They will be used as a criterion of households' resilience.

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.

Social resilience has close relation to social vulnerability. They are the both sides of a coin. As the study of social vulnerability has far developed than that of resilience, it is helpful to take

advantage of the results of the vulnerability study. It is said that there are two sides of vulnerability; external side and internal side. The former has relation to risks, shocks and stresses that are caused by uncertain rainfall, price fluctuations, political instability, and other changes in access to markets. The latter has relation to defenselessness of society such as a lack of social security system. And the social resilience has to do with something socially embedded systems and functions that mitigate or alleviate the increased vulnerability.

The semi-arid tropics (SAT) is an area where the external side of risk is high and people's vulnerability is also high. People in the SAT, however, are not despair of their ecological environment. They endeavor to reduce risk, increase adaptability, and seek a degree of autonomy, by several ways. Lots of means are taken to avoid or mitigate the external risks and shocks, and also there are many strategies both deliberate and automatic to get rid of the hardship. Social institutions play an indispensable role to support these endeavor.

Theme III tries to make clear: i) why society at SAT is prone to increase vulnerability?; ii) what is the process of increasing social vulnerability?; iii) what kind of strategies are taken and what sort of social devices including institution are functioning to alleviate the vulnerability?

Each society has different historical background and location. We will pay much attention to the regional specificity not so as to identify the variety of society but to clarify and extract the general factors. We hope that we can find out the portfolios that worked for social resilience to avoid risks and to cope with difficulties. Components of theme III are as follows. The above mentioned focus points will be studied in the course of pursuing these sub-themes.

III-1 Change of economic policy and its impact on agricultural production and land use (Kodamaya, Hanzawa, Shimada, Umetsu)

Impacts of economic change on cultivation system, land tenure, food marketing and consumption will be studied. This is to understand the economic background of change in land use in the study area. The Governmental reports, both national and local level and other publications on agricultural development program will be collected and analyzed in this sub-theme. The increase of cassava production and cash crops, such as cotton and sun flower, and decrease of sorghum and millet production will be studied along with the influence of agricultural policies.

III-2 Socio-political change and its relationship to the change of land use (Shimada, Araki, Kajoba)

Change in customs and social institutions that have relation to agricultural production will be studied in this sub-theme. Traditional land tenure system, mutual help system both intra- and inter-kin groups, community-based resource management, and self-help institutions will be studied. Institutions are viewed here as dynamic terms and as the products of social and political practices. The change of institution inevitably cause change in the position of stake holders, which then have repercussion to the former again. This is why long-term field study based on participatory observation will be important for this study.

III-3 Vulnerability and social resilience of household and community (Shimada, Umetsu, Araki)

Historical narrative on drought, heavy rain, poor harvest, marketing failure of products will be

collected. And discourses about the reasons of poor harvest and failure in marketing will be analyzed in the context of socio-economic change. The experience of reduced consumption, off-farm works, asset disposal, exploit of community help, gleaning, collection of fuel, gathering wild foods among others will be interviewed in different types of household such as cattle rich household or women headed household. For the collection of data, we will conduct intensive household level interview in some of study areas. The functions of social institutions and cultural background will also be studied that have played an important role for the mitigation or even eradication of vulnerability. In this sub-theme, some of non-agricultural factors, such as the impact of HIV/AIDS, migration, and activities of NGO's will also be studied.

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

The primary goal of this research theme is to clarify the relationship between ecological vulnerability, resilience and human activities through investigations of changes in ecological system and multi-level social system. For this purpose, we select drought disaster and early warning system for food security as a case study. The drought is known as one of the serious natural disaster for local people. Also the drought causes lack of food and it is the word that expresses poverty of African countries typically. Therefore early warning system (EWS) for food security has been discussed from the 1980's when severe famines hit the continent. Here we try to clarify the mechanism of drought occurrence and do its disaster monitoring with three different spatial scales such as global/continental, country and district level. Furthermore the vulnerability and resilience of the ecological system will be summarized by integrating the results of this analysis with historical, socio-economic background in order to understand the impacts on rural communities by country level actions of early warning system for drought disaster.

IV-1 Global monitoring on environmental change (Saeki, Yoshimura)

In order to know the characteristics of African semi-arid tropics (SAT) region, its climate and geopolitical conditions will be clarified. Through the climate research, the occurrence mechanism of natural disaster such as drought will be clarified by the climate change monitoring with global/continental level. Through the geopolitical research, human impacts of natural disaster will be investigated and its rural communities influence will be clarified by vital statistics with country scale.

IV-2 Land use change and its impact on ecological system (Yoshimura, Yamashita, Cultural Anthropologist)

In order to know ecological system influences by environmental change (drought disaster), forest degradation and vegetation change will be investigated. For these investigations, land cover and use change analysis will be conducted using multi-temporal aerial photographs and satellite imageries. Through these analyses, human influences of environmental change will be considered and compared its results and historical and social background.

IV-3 The early warning systems and food security (Umetsu, Yoshimura, Cultural Anthropologist)

In order to understand Food security as an emergent issue for Sub-Saharan Africa, The role of the

United Nations (UN), World Food Programme (WFP) for the constructing the early warning system (EWS) will be investigated. The practical problems and what kinds of EWS functions are useful for rural community will be discussed through field level investigations and what kinds of influence on the resilience of rural communities will be clarified by the actions of EWS.

IV-4 District level analysis of drought responses and resilience index (Umetsu, Saeki, Sakurai, Shimada, Shinjo, Tanaka, Yoshimura)

1) District level statistical data on socio-economic indicators, agricultural production and grain prices are collected from the Central Statistical Office and the Department of Agriculture; 2) Crop Forecast Survey and Post Harvest Survey of Central Statistical Office (CSO) are combined with our own reanalysis planned in year 2006; 3) District level data will be analyzed with socio-economic and institutional factors as well as agro-ecological factors to provide mapping of resilience index; 4) The statistical information would be supplemented by the field interview survey of farm households. Socio-economics indicators are overlaid with agro-ecological information such as rainfall and soil conditions.

2. Outcome up to now

2.1 Research Activities during the Feasibility Study

A. Research organization

- We set four themes as mentioned before and invited appropriate researchers to participate in the project. Their fields include agronomy and soil science, development economics, resource economics, anthropology, environmental geography, climatology, remote-sensing specialist.
- We identified potential collaborating institutions and researchers in Zambia, India and Burkina Faso.
- To prepare for the field research in Zambia, research permits of core members during 2006-2011 have been approved in December 2005 by the Government of Zambia through the assistance of the Institute of Economic and Social Research, University of Zambia. The affiliation procedure of core project members with ISER/UNZA has been completed.

B. Methodologies

During the FY2005, we conducted literature review, field observation and preliminary interview for farmers, we identified some research targets that should be included in our resilience study. Details are mentioned in the previous section.

C. Results of preliminary field research

- The 2004/5 cropping season in Zambia was hit by severe drought since 1991/2 cropping season. Especially in Eastern and Southern Provinces, crop failure of maize ranged between 85-90 percent.
- Recently, drought resistant cotton production is increasing in Eastern and Southern Provinces. The increasing cotton production needs to be examined carefully in the context of food security.
- During the field trip to Zambia in August 2005, we conducted a field observation for the potential field sites in Eastern and Southern Provinces of Zambia. We obtained a partial weather data from the Meteorological Department, Ministry of Communications and Transport. Also we obtained information on geographical data from the Department of Survey, Ministry of Land Resources.

- During the field trip to Zambia in November 2005, we obtained the data set of Crop Forecast Survey for 8000 farm households in the 2004/5-drought year from the Central Statistical Office. We plan to obtain additional data sets for Post Harvest Survey in 2004 and 2005.

- We had a discussion on project collaboration with researchers and the staff of the following institutions.

The Institute of Economic and Social Research, University of Zambia (UNZA); Faculty of Agriculture, UNZA; Mt. Makulu Central Research Station, Ministry of Agriculture and Cooperatives; Central Statistical Office; Survey Department, Ministry of Land Resources; Meteorological Department, Ministry of Transport and Telecommunications; Food Security Research Project, Michigan State University and USAID.

D. The 6th Open Meeting of IHDP at Bonn

- We organized a session (Adaptive Management and Resilience: Local Responses to Environmental Stress and Risks) at the 6th Open Meeting of the Human Dimensions of Global Environmental Change Research Community, 9-13 October 2005 held at the University of Bonn.

E. Meetings held during FS in FY2005

- April 28: 7th Resilience seminar

Title: Rural development scheme that aims at coexistence of economic activity and environmental conservation: The case of Tanzania; Speaker: Ueru Tanaka, Graduate School of Global Environmental Studies, Kyoto University

- June 10: 8th Resilience seminar

Title: The introduction of recent studies on resilience of lake ecosystems; Speaker: Shigeo Yachi, RIHN

- July 21: 9th Resilience seminar

Title: Social transformation and change in land use in East Zambia: the case of new farmland opening by Chewa farmers; Speaker: Ryuta Yoshikawa, Graduate School of Asian and African Area Studies, Kyoto University

Title: Response of agricultural society to variation of international coffee price: economic liberalization in 1990s and the “coffee crisis” in Ethiopia; Speaker: Keiichiro Matsumura, Graduate School of Human and Environmental Studies, Kyoto University

- October 21: 10th Resilience seminar

Title: Reconstructing the concept of “sustainable development” with focus on ecological resilience

Speaker: Satoshi Kojima, Institute for Global Environmental Strategies

- November 25: 11th Resilience seminar

Title: Meteorological data measurement in Mali, West Africa: 2001-1004; Speaker: Hiromitsu Kanno, National Agricultural Research Center for Tohoku Region

Title: How do farmers cope with plot-specific rainfall variability? : The empirical study in Mali, West Africa; Speaker: Takeshi Sakurai, Policy Research Institute, Ministry of Agriculture, Forestry and Fisheries

- December 9: FS member meeting

2.2 Problems and Solutions for Research

A. Problem and solutions during IS/FS study

Although theoretical study is ahead of empirical study in resilience research, few empirical researches have been done that applies resilience to practical development issues. Therefore, it is required to apply this concept to regional problems. We set themes I, II, III that study closely with local communities and then extend further to theme IV with wider geographical scope.

B. Changes made from the initial plan

During the incubation and feasibility study, we initially considered only Zambia and South India. However, in PR we will expand the research area to semi-arid tropics (SAT). Thus it may be possible to have comparative analysis of resilience based on differences of population pressure and land endowment.

3. Research Activities from FY2006 to FY2011

3.1 Time Schedule

	H17 FS	H18 PR	H19 FR1	H20 FR2	H21 FR3	H22 FR4	H23 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	xx	xx	xx	xx	x
Burkina Faso			x	xx	xx	xx	x
International Workshop		x		x			x
Project Report	FS Report	PR Report	Annual Report	Interium Report	Annual Report	Annual Report	Final Report

PR (FY2006)

I: Preparation of the monitoring plots in the Miombo fallow woodland in Petauke site; Pre-treatment for clearing the Miombo fallow woodland (e.g. bark peeling); Preliminary survey on soil, topography and vegetation in Petauke, Eastern Province, and Sinazongwe, Southern Province of Zambia; Selection of the sample households in Petauke and Sinazongwe.

II: Study site will be determined (four villages from Petauke district, Eastern province and another four villages from Sinazongwe district, Southern province in Zambia). They will be selected considering representativeness of each district, variation among them in terms of distance from the district capital as well as rainfall level. Then, census will be conducted in each village, based on which village household will be stratified and sample household will be drawn from each strata.

III: Collect necessary publications and statistical data available to serve for the study III-1. Select three villages or more from the Central, Southern, and Eastern Provinces of Zambia for the study of III-2 and III-3.

IV: Data source retrieval and data collection and data base construction; drought and its related information gathering at international organizations; design of metrological stations

FR1 (FY2007)

I: Setting of weather and soil monitoring apparatus in the Petauke site; Opening of the Miombo fallow woodland (Y1 plot) for cultivation and recording of the entire processes; Field survey and sampling of soil and vegetation in the Petauke plots and laboratory analyses; GPS survey of the plot boundaries of the sample households, hearing and observation of land use at each plot in Petauke and Sinazongwe; Hearing and observation of conventional farming systems and land use types.

II: Rainfall gauges will be installed before rain starts in October. Weekly household interview will also start before the rain. Soil sampling and vegetation study will be conducted during the rain season. Anthropometrics will be carried out at least twice in a year: during the rain season and after the harvest. The data will be shared among sub-themes II-1, 2, 3, and 4.

III: Intensive field study by participatory method will be started to collect household level information about family structure and agricultural production system. This is the base-line study for the sub-theme of III-2 and III-3.

IV: Data analysis for constructed data base in PR: 1) Drought period and area identification using metrological data; 2) Drought disaster monitoring using satellite data; 3) Comparison of district level population data; Set up metrological stations in the fields; Analysis that relates drought and Population statistics; selection of comparative country and regions for Zambia.

FR2 (FY2008)

I: Continuation of the weather and soil monitoring in the Patauke site; Opening of the Miombo fallow woodland (Y2 plot) for cultivation, cultivation in Y1 and Y2 plots, survey of soil and vegetation, measurement of crop yield, sampling and laboratory analyses; Completion of GPS survey, additional GPS survey for newly converted plots, continuation of land use monitoring in Petauke and Sinazongwe; Hearing and observation of minor husbandries (e.g. seasonal labor migration, livestock keeping, gathering and fishing); Preparation and commencement of the comparative field research in Semi-arid India)

II: The same as FR1.

III: Intensive study for III-2 and III-3 will be continued. Records and narratives about misery and difficulties that caused social vulnerability will be collected.

IV: Drought disaster monitoring at Petauke and Shinazongwe area; Investigation of EWS and case study for '90 drought disaster.

FR3 (FY2009)

I: Continuation of the weather and soil monitoring in the Patauke site; Opening of the Miombo fallow woodland (Y3 plot) for cultivation, cultivation in Y1, Y2 and Y3 plots, survey of soil and vegetation, measurement of crop yield, sampling and laboratory analyses; Additional GPS survey for newly converted plots, continuation of land use monitoring, survey of soil and vegetation, measurement of crop yield in Petauke and Sinazongwe; Preparation and commencement of the comparative field research in Semi-arid West Africa)

II: The same as FR1.

III: Intensive study will be continued. The focus of interview will be concentrated on the process of increase of social vulnerability and the processes of alleviation of it.

IV: Seasonal and dairy change analysis of observed metrological Ddta; Agricultural land use and settlement change analysis by aerial photographs; Interviews at villages in Petauke and Shiazoungue; Interviews at villages of PR2 case study area.

FR4 (FY2010)

I: Continuation of the weather and soil monitoring in the Patauke site; Opening of the Miombo fallow woodland (Y4 plot) for cultivation, cultivation in Y1, Y2 Y3 and Y4 plots, survey of soil and vegetation, measurement of crop yield, sampling and laboratory analyses; Additional GPS survey for newly converted plots, continuation of land use monitoring, survey of vegetation, measurement of crop yield in Petauke and Sinazongwe.

II: The same as FR1.

III: Intensive study will be continued. The study of III-3 will be started to analyze the functions of social institution that has played for the vulnerability and resilience of society.

IV: Model development that relates drought disaster and statistics of population based on Zambia research results; Validation of Zambia model at case study area.

FR5 (FY2011)

I: Continuation of the weather and soil monitoring in the Patauke site; Opening of the Miombo fallow woodland (Y5 plot) for cultivation, cultivation in Y1, Y2 Y3, Y4 and Y5 plots, survey of soil and vegetation, measurement of crop yield, sampling and laboratory analyses; Geo-statistical analyses on spatial and temporal variation of soil and vegetation; Additional GPS survey for newly converted plots, continuation of land use monitoring, survey of vegetation, measurement of crop yield in Petauke and Sinazongwe; Analyses on the components and indicators of ecological resilience, inter-relations between ecological resilience and the impact of human activities; Comparative analysis of the ecological resilience in SAT (Southern Africa, West Africa and India) to seek some sound options of the ecosystems and resources management systems.

II: Analyses of the four-year data collected from FR1 to FR4.

III: It is aimed to find out the portfolios that worked for social resilience to avoid risks, to cope with difficulties, and recover from the misery.

IV: Integrated analysis of ecological system and social system

3.2 Outcome Expected until Evaluation Committee Meeting

A. Until FY2005 Evaluation Committee Meeting

- FS project report is under preparation.
- We are trying to contact Central Statistical Office to arrange the supplementary household survey for the same sample households interviewed for Post Harvest Survey in the Eastern and Southern Provinces during the summer of 2006.
- We continue searching researchers to strengthen our project team.

C. Until FY2007 Evaluation Committee Meeting

I-1. Components and some indicators of ecological resilience are revealed

II-1. Quantitative measurement of spatial and temporal distribution of rainfall and its impact on

household behaviors.

III-1. Complex processes of increasing and mitigating vulnerability will be analyzed in connection with local specificity.

IV-1. The occurrence mechanism of natural disaster, human impacts of natural disaster and its rural communities influence will be clarified

Until the FY2011 Evaluation Committee

I-1. Components and some indicators of ecological resilience are revealed

I-2. Inter-relations between ecological resilience and the impact of human activities are revealed

I-3. Some sound options of the ecosystems and resources management are proposed

II-1. Quantitative measurement of spatial and temporal distribution of rainfall and its impact on household behaviors.

II-2. Quantitative assessment of households' dependence on various kinds of resources to mitigate rainfall risk and to cope with drought shock.

II-3. Quantitative evaluation of households' income as well as consumption smoothing as indices of households' resilience.

III-1. Complex processes of increasing and mitigating vulnerability will be analyzed in connection with local specificity.

III-2. The factors or combination of factors that work for mitigation of vulnerability will be disclosed.

III-3. The assumption that environmental degradation reflects a growing lack of synchrony between the society and its natural environment will be tested from the social resilience point of view.

III-4. It is hoped that we can suggest possible solutions to restore harmony to environment-society relations by strengthen community-based natural resource management institutions.

IV-1. The occurrence mechanism of natural disaster, human impacts of natural disaster and its rural communities influence will be clarified.

IV-2. The ecological system influences by environmental change, human influences of environmental change and historical and social background will be clarified.

IV-3. Functions of early warning system, their usefulness and practical problems for rural community will be clarified.

IV-4. The resilience index and mapping will provide the useful information for increasing resilience of rural communities in drought prone areas.

4. Common Issues and Discussions

4.1 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. Relatively long term (6 years) with relatively large funds for one project makes it possible to realize such research. 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, a support from RIHN to conduct interdisciplinary project is a large asset to initiate such a 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, Zimbabwe), West Africa region (Burkina Faso, Niger), 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.

4.2 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.

C. Research group expected to join the project

- Anthropometrics expert, macro economist, cultural anthropologist,
- India: water management and human security in Tamilnadu (Umetsu, Palanisami, Yatagai, Geethalakshmi, Sakurai and others from FY2006)

-The state of Tamilnadu is endowed with 5% of total land and a home of 7% of total population in India. About 60% of labor force in Tamilnadu engage in agriculture. Recently over exploitation of groundwater and water scarcity in tank irrigated area is becoming a major problem for the sustainability of agricultural regions. This research component aims at 1) analyzing the rainfall patterns in the state by accumulating the weather data of monsoon rain; 2) analyzing the flow of rainfall into the watershed by hydrological tool; 3) analyzing responses of farmers and communities for water scarcity; thus 4) consider measures to enhance resilience and sustainability of rural areas.

- Burkina Faso: soil resource management and human security (Tanaka, Sakurai and others from FY 2007)

-Soil resources in agricultural areas in Burkina Faso are under the threat of degradation because of various factors such as population pressure, intensified agriculture, and migration. We try to analyze various social and physical factors that are affecting soil degradation in resource poor rural areas of Burkina Faso.

C. Collaboration with other RIHN project

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.

4.3 Towards dissemination of the research outcomes

We want to disseminate the research results not only at the domestic meetings but also at the international research community. Therefore, possible strategies are as follows:

Publication

1. Publication of workshop report (annual)
2. Book publication out of international workshop (Japan, Zambia, and others)
3. Publication in the academic journals

Presentation

1. Presentation at the domestic and international workshop
2. Presentation and session organization at the international research community such as IHDP
3. Presentation and session organization at the academic conference

Dissemination

1. Make research results available at project homepage.
2. Make research results available at the open forum for public.

5. Reference List

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5.2 Publication of members

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1-3PR Project Member List (FY2006)

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	Reiichi MIURA	Graduate School of Agriculture, Kyoto Univ.	Division of Agronomy and Horticulture Science	Lecturer	botany	grass/herb components and its succession
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	Moses Mwale	Mt.Makulu Central Research Station	Ministry of Agriculture and Cooperatives	Chief Agricultural Research Officer	soil science	soil analysis
	<i>Theme II</i>					
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	<i>Theme III</i>					
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	<i>Theme IV</i>					
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