Conceptual Approach for Data Integration of Social-Ecological Change and Human Activities toward Community Resilience

- from Southern Province Collaborative Research -

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Abstract

The aim of this study is to clarify the relationships between social-ecological vulnerability, resilience and human activities from a multi-disciplinary point of view. Accordingly, this paper describes a conceptual approach to data integration for social-ecological change and human activities toward community resilience using multi-disciplinary data.

1. Introduction

In this study, we attempt to clarify the relationships between social-ecological vulnerability, resilience and human activities from a multi-disciplinary point of view. We adopt the multi-spatial and multi-temporal approaches to achieve this purpose. The multi-spatial approach refers to recognizing phenomena on land surfaces from different spatial scales, while the multi-temporal approach refers to summarizing epoch-making events according to the respective time period. Until last year, we independently gathered multi-temporal and spatial data based on each research team members' interests. In particular, this year we established intensive research sites in the southern province of Zambia, and they are now ready to begin data integration for social-ecological vulnerability and resilience. This paper describes a conceptual approach for such data integration of social-ecological change and human activities toward community resilience.

2. Phenomena and Scaling

Earth surface phenomena begin from one point and enlarge to cover wide areas. The scaling properties of earth surface variables should be known and should guide the analysis of satellite and GIS data. Although the identified scale data of satellite imagery is relatively well-specified compared with other types of geographic data, it may still lack precision because such data depends on a complex generalization process applied by the analyst. When satellite sensors detect phenomena, they should appear homogeneous on the imagery of some spatial scales but heterogeneous on that of different spatial scales. On the other hand, the extrapolation of point phenomena and model estimates to large areas remain a major problem in geographic analysis, and

continued research is needed to identify appropriate sampling and scaling strategies for sparse ground phenomena, especially in the context of regional and global assessments. It seems difficult to introduce the relationships among various times and scale dependent on phenomena, because those relationships change due to both spatial and time scales. Furthermore, it is necessary to integrate variable information from isolated studies as GIS attribute data and also to establish logistic concepts for data integration.

3. Concept of Resilience Based on Social-Ecological Environments and Human Activities

Human activities are affected by both social and ecological environments. Conversely, human activities themselves affect both social and ecological environments. Thus there is a cross-interaction among them. We depict this relationship in Figure 1.

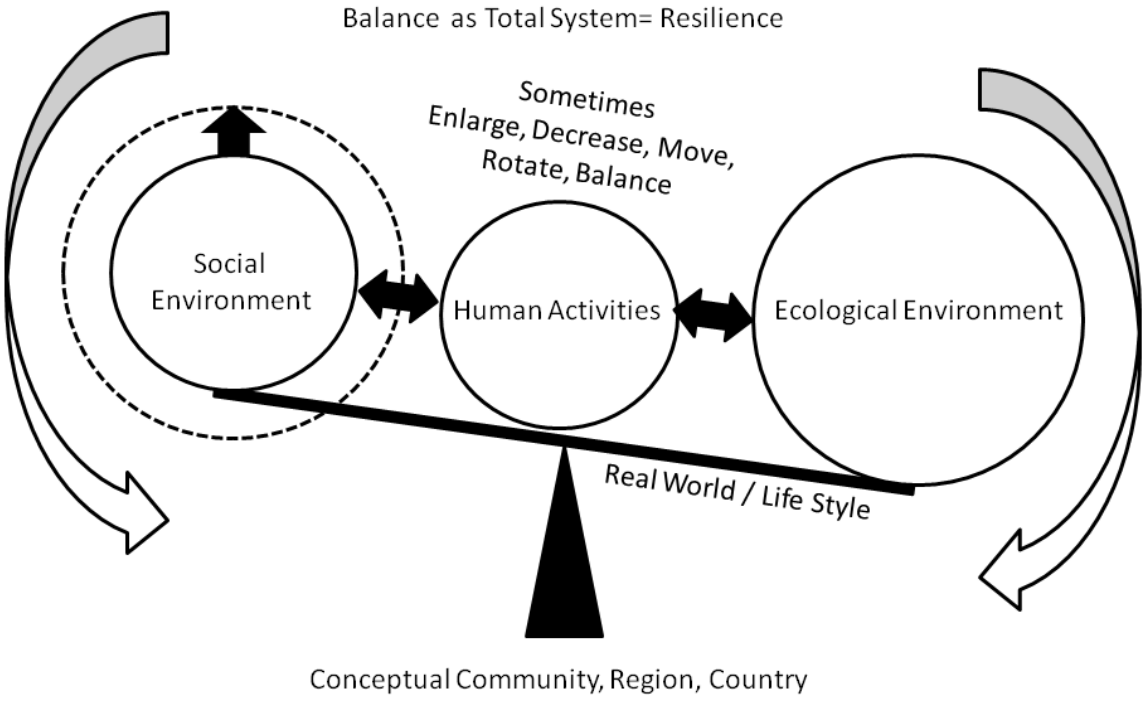

Figure 1 Concept of Resilience Based on the Social Environment, Ecological Environment, Human Activities and Their Surroundings

In Figure 1, the seesaw "bar" expresses the real world, or human lifestyle. The social environment, ecological environment and human activities are the three components of this system. When the system is stable, it is said to be in a resilient condition. Each component will enlarge, decrease, move, and rotate independently in response to shocks or other influences from outside the system, shown by arrows in the figure. Real social and ecological environments exist along the length of the bar, sometimes being stable, while at other times becoming unstable. Unstableness is

caused by unbalances among these three factors along the bar or by forces outside of the system, as shown by the arrows in the figure. In this system, the components interact with each other without overlapping. However, any possible overlapping within this system should be defined. We assume that the minimum unit of this system is the community.

4. Social-Ecological Data Gathering and Their Cross Relationships

The most serious environmental problems in Africa are the pressures of large populations and the aggravation of ecosystems caused by excessive land use. Most of the cultivation crops in semi-arid tropic (SAT) areas already struggle under severe environmental conditions, and therefore many cannot survive when desiccation and high temperatures advance. After the 1960s, drought disasters caused by chronic desiccation occurred in many African countries, causing a large decrease in viable cultivation crops. The prolonged drought caused serious food shortages, starvation and other serious social problems in Africa. These frequent drought disasters after the 1960s occurred at the same time as the first world oil crisis. Together, these two historical events had negative influences on the economies and political environments of African countries. Furthermore, subsequent years have seen annual decreases in total precipitation, with famine becoming a chronic, serious problem in many countries, causing some to become food aid recipients. Furthermore, the protracted famine has fueled social unrest, and some African governments have even been overturned.

To prove the concept of resilience based on social-ecological environments and human activities, multi-disciplinary field data must be gathered and verified. For this purpose we set up three intensive research sites, Site-A, Site-B and Site-C, in the Sinazongwe district of the southern province of Zambia to conduct collaborative research on the resilience level of communities. Figure 2 shows the geographical distribution of the three intensive research sites. Lake Kariba can be seen in the lower right part of the figure. Site-A is located on the lower terrace, Site-B the middle escarpment, and Site-C the upper terrace.

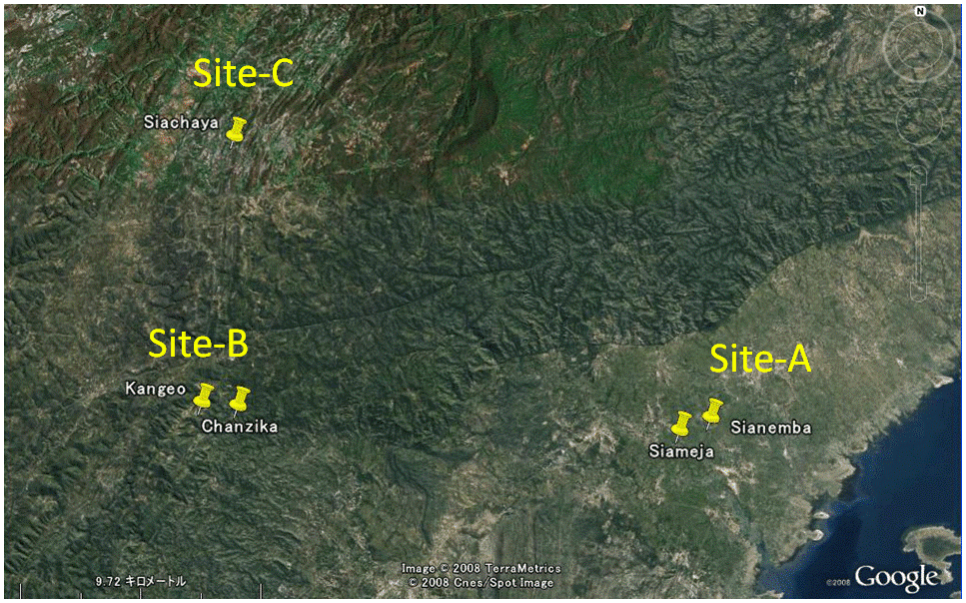

Figure 2 Intensive Research Site Distribution

The three sites were selected based on the terrain, location and level of community diversity. Collaborative field investigations at each of these sites are still being conducted.

Figure 3 illustrates the cross relationships among the various types of gathered social-ecological data. We assume that people are vulnerable against climate change and food security. The blight blue boxes with red letters represent the impact factors on human resilience. The gray boxes with black letters are the products of community activities. The white boxes represent various community events and acts. The arrows illustrate cross-effect streams; for example, climate change in the form of changing amounts of solar radiation can cause increases or decreases in precipitation. Increased precipitation can cause flooding, while decreases can cause drought. The government and international society, on the other hand, are triggers for social changes. Cash, crops and land are the results of human activities for livelihood. As the figure illustrates, in reality all of these factors affect each other either directly or indirectly.

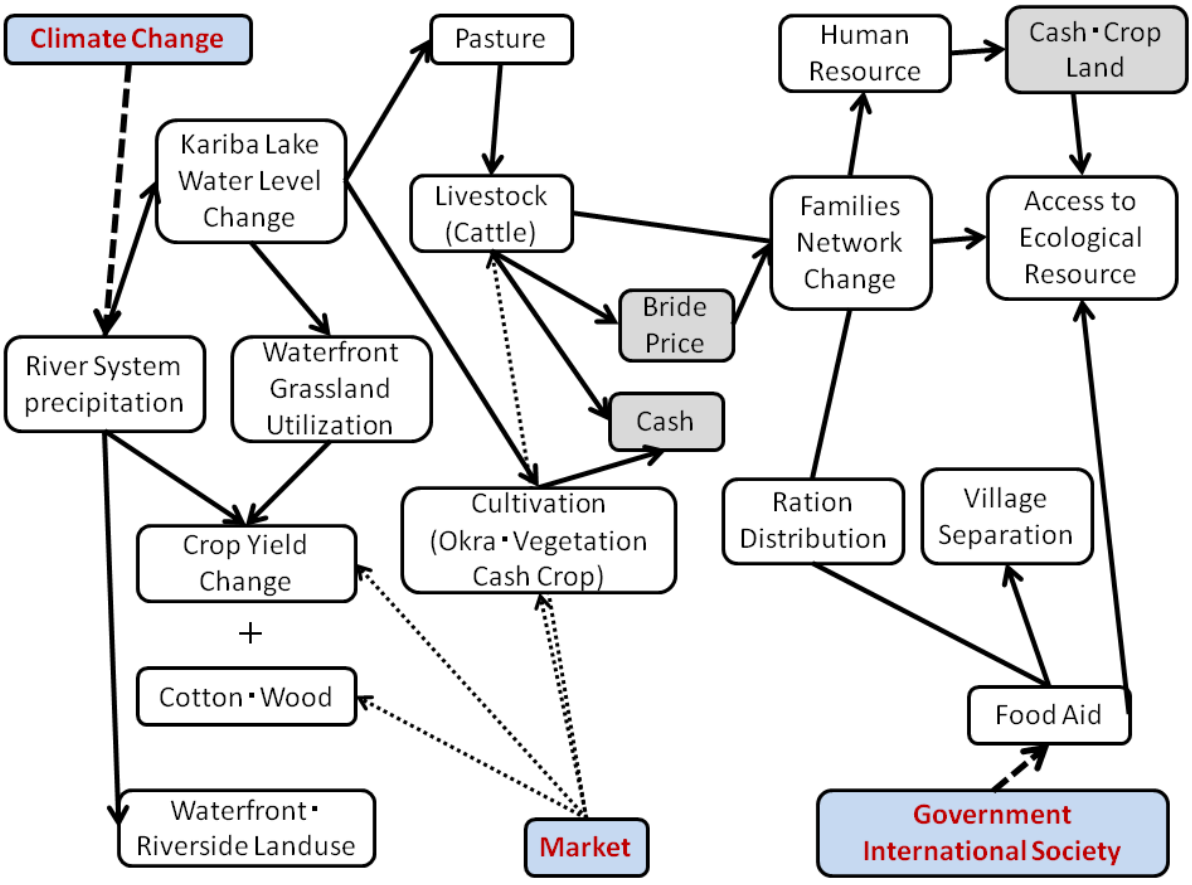

Figure 3 Social-Ecological Data and their Cross Relationships

In Figure 3, ecological environmental change caused by climate change on the left side and social environmental change as the result of the activities of government and international society on the right side are the two main driving forces of this system. The ecological environment is connected to the social environment by cash-product exchange, in which the key issue is the market. Furthermore, local institutions and customs can also be considered in this system, as can

immigration and its related effects. In particular, immigration is an important issue to this region because when the Kariba dam was constructed in the 1950s, the government forced the local native tribes to emigrate from the Zambezi valley to the upper regions.

5. Future Research Directions toward Community Resilience

Resilience based on social and ecological environments and human activities, as illustrated above in Figure 1, is the conceptual framework by which we investigate community resilience. The data gathered heretofore and their cross-relationships (shown in Figure 2) comprise the primary results of our field investigations. However, the interpretation of these primary results is complicated, and thus we must make efforts to further organize this data to gain a better understanding of resilience at the community level. We did, however, gain an increased understanding of coping behavior in response to vulnerability: people develop several networks that act as safety nets to survive against any possible shocks to their environment.

As for future research, we are currently investigating the following research topics in corroboration with other multi-disciplinary research scientists.

1) Land acquisition, inheritance and strategies
2) Agriculture and livelihood activities
3) Immigration, food security and village separation
4) Pastures, livestock and treatment
5) Family networks, marriage and coping behavior in response to social vulnerability
6) Geographic conditions and coping behavior in response to ecological vulnerability
7) Coping behavior related to resilience

We are still in need of collaborators with different professional backgrounds, and it is necessary to discuss community resilience in more detail while also expanding the scope of the research from community level resilience to include both regional and country-level considerations.