Accumulating Multi-spatial and Temporal Data to Understand People's Livelihoods at the Village Level

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Abstract

We aim to use a multi-spatial and temporal approach to trace people's livelihoods from a village to a regional level. For this, we accumulated various spatial data and considered the seasonal and inter-annual changes. The principal data was from satellite images, aerial photographs and a crop allocation map determined by field investigation. Our concept of a multi-spatial and temporal approach was used to integrate the various kinds of data.

1. Introduction

Land surface conditions such as vegetation cover and land-use/cover are reflections of the natural environment and of human society. Thus monitoring land surface changes is crucial for understanding the vulnerability and resilience of social-ecological systems. Spatial and temporal scales are important factors for monitoring land surface conditions. For example, changes of vegetation cover on a country scale generally depend on differences in the seasonal climate pattern. Changes of vegetation and land cover on a regional scale are caused by the consequences of environmental variability and human activities under the conditions of the climate local and the relevant agricultural system. For this, remotely sensed satellite images and aerial photographs are powerful tools to monitor the land surface conditions across a wide area. However, to understand the phenomenon shown on such momentary images, field investigations and a consideration of temporal events are indispensable.

This report describes the practicability of integrating multi-spatial and temporal data of satellite images, aerial photographs and the results of field investigation to understand people's livelihood at a village level.

2. Multi-Spatial Scales for Understanding Livelihood

Figure 1 shows our concept of multi-spatial scales to understand people's livelihood, with a specially focus on farming, at the village level. The crop field distribution from household activities illustrates the village; this can be seen at the largest spatial scale of a few kilometers square. This scale equates to the field investigations of each household's activity. The gathering together of villages forms a community, which has a larger area. This scale of a 5-10 kilometers square is almost the same as aerial photographs or magnified satellite images that have a 15-30m pixel size. Furthermore, the gathering together of communities then demonstrates the region. Land surface conditions at a regional scale can be shown in the satellite images such as those in the

Landsat series.

Here, we regard the middle scale in figure 1 as the common one for the integration of various kinds of data. The crop field distributions generated by the field investigations are scaled up to the common scale, and, as much as possible, the land surface conditions shown in the satellite imageries are scaled down to the common scale. In this way, the satellite imageries can be linked to the results of the field investigation.

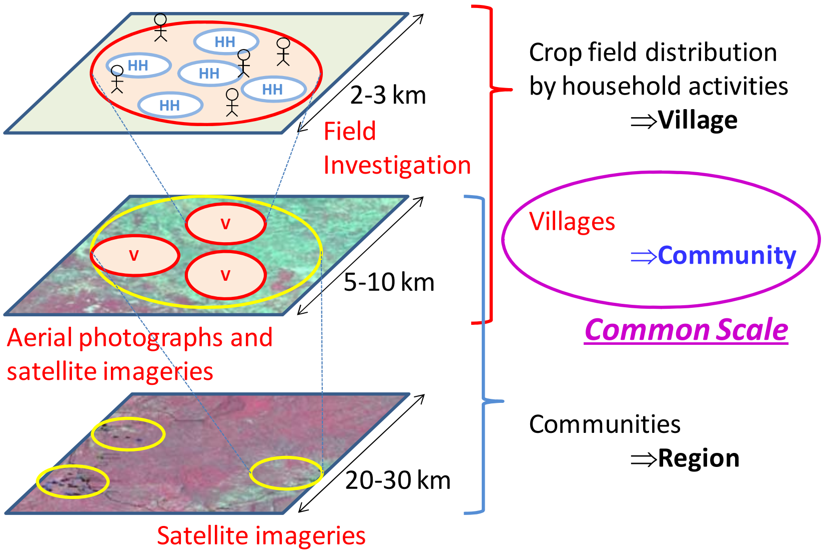

Figure 1. Concept of multi-spatial scales for understanding village livelihoods

3. Multi-temporal Understanding of the Land-use Strategy

The land surface shows various conditions that accord with seasonal and inter-annual changes. Figure 2 shows the concept of the multi-temporal understanding of a land-use strategy at the village level.

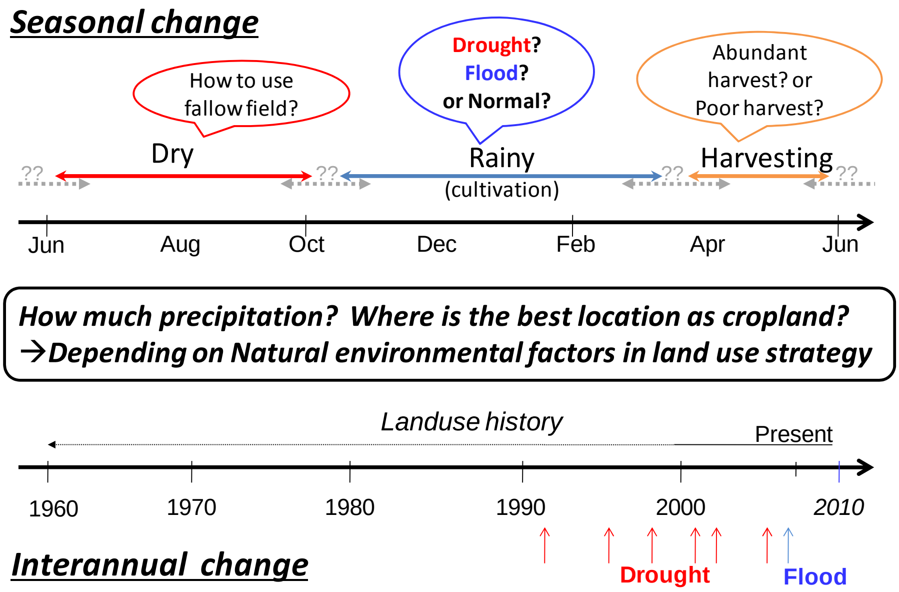

Figure 2. Concept of a multi-temporal understanding of land-use strategies at the village level

Seasonal changes are essentially caused by the climate. In this study area, a year can generally be divided into dry, rainy and harvesting seasons from the point of view of the crop calendar. However, the change point between seasons is unclear by year. Precipitation is an important factor when deciding the annual crop plan. Therefore, when farmers choose the best location for a particular crop field they consider features of the terrain such as in a valley or on a ridge. The land-use strategy of each household is influenced by natural environmental factors.

Inter-annual changes depend on the land-use history that can corresponded to various events such as the construction of the Kariba dam, migration, population increases, and the annual land-use strategy that accords with climate variations.

As for seasonal data, since 2007 we have carried out field investigations, and we obtained Landsat/ETM and Terra/ASTER satellite images from after 2001. The inter-annual data consists of aerial photographs and satellite images inform the 1970s, 80s, 90s, and 2000s.

4. Field Investigations for Crop Allocation Mapping

The crop field distribution at the village level for one year shows household's activities related to people's livelihoods. In this study, the crop allocation map was generated to understand people's livelihoods from year to year. The study area for the crop allocation mapping is shown in figure 3. Sites A, B and C are located in the lower terrace, middle escarpment and upper terrace, respectively, in the Sinazongwe district, Southern province. This is the common study area for this research project; thus many rain-gauges were installed at Sites A, B and C by the Theme-II group.

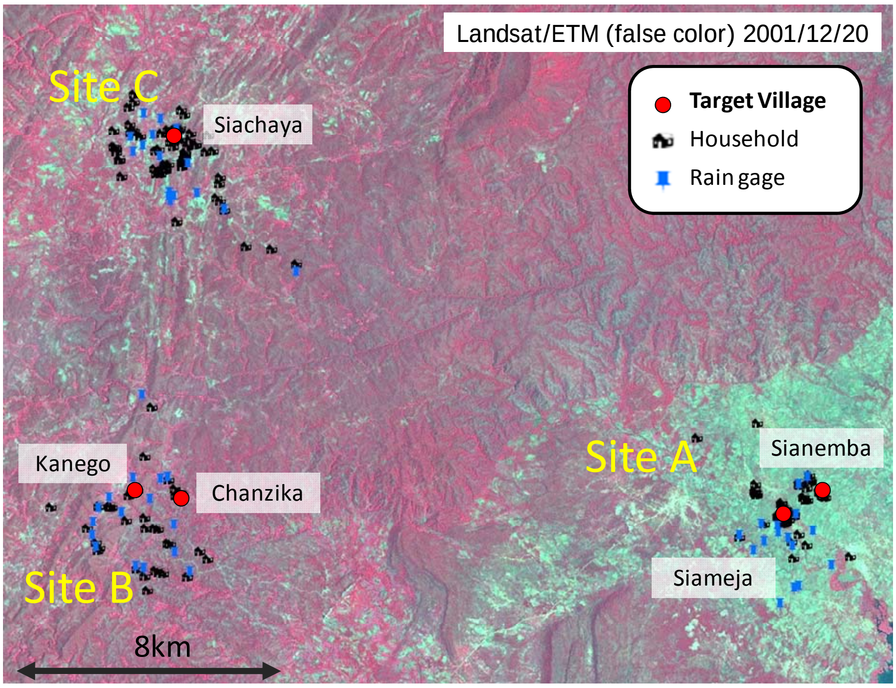

Figure 3. The study area for the field investigation

Field investigations for crop allocation mapping were carried out for 221 households in the Sianemba, Sianemeja (Site A), Kanego, Chanzika (Site B) and Siachaya (Site C) villages during the rainy season of 2007/2008 and the dry season of 2008.

To build up the crop allocation map, we used a portable GPS to measure boundaries at a sub-field level that recognized different crops at Sites A, B and C. We also carried out interviews about field names, topography, soil name, crops, cultivated varieties and kinds of fertilizer with all households to understand their coping strategies related to climate variations. Table 1 sets out the classification code and its description as attribute information to the crop allocation map, which shows the crop field boundaries and the attribute information in the GIS data format.

Table 1. The classification code and its description about crop field

Code	Discription about crop field
RCo	Rainy season /Cowpea
RC	Rainy season /Cotton
RFm	Rainy season/ Finger Millet
RGn	Rainy season/ Groundnut
RG	Rainy season/ Garden
RM	Rainy season/ Maize
RO	Rainy season/ Other
RP	Rainy season/ Pearl millet
RSf	Rainy season/ Sunflower
RSo	Rainy season/ Sorghum
RS	Rainy season/ Sweet Potato
D	Damaged fields by water
DB	Dry season/ Banana
DC	Dry season/ Cotton
DG	Dry season/ Garden
DM	Dry season/ Maize
DO	Dry season/ Other
DSu	Dry season/ suger cane
DS	Dry season/ Sweet Potato
RFa	Fallow
RF	Rental Field

The crop field distribution at Site B (Middle escarpment) as a sample of the field investigations is shown in figure 4 with an overlay of the Landsat/ETM (Pansharpened false image) observed on 20 December 2001. The boundaries of the crop fields during the rainy season in 2007/2008 and the dry season in 2008 are shown in blue and yellow lines, respectively. The red lines show fields damaged by water from a flood in December 2007. The purple lines show fallow fields and a rental field from another village. From looking at the crop allocation map overlain to Landsat/ETM, the accuracy of the positioning of each crop field location can be seen as adequate.

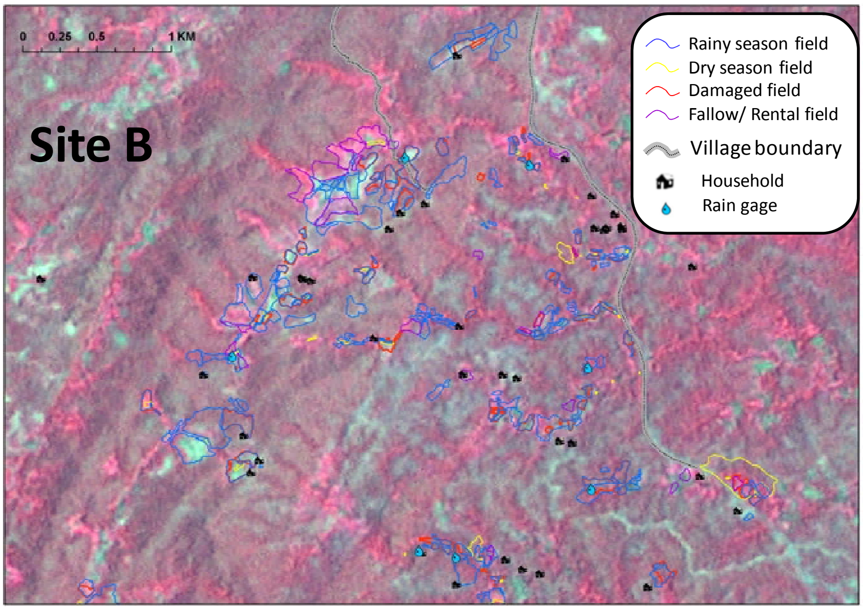

Figure 4. Crop field distribution at Site B during rainy and dry seasons

Figure 5 shows the crop allocation map for Site A. The code in the map legend corresponds to that of table 1. It can be seen that maize and cotton fields dominate.

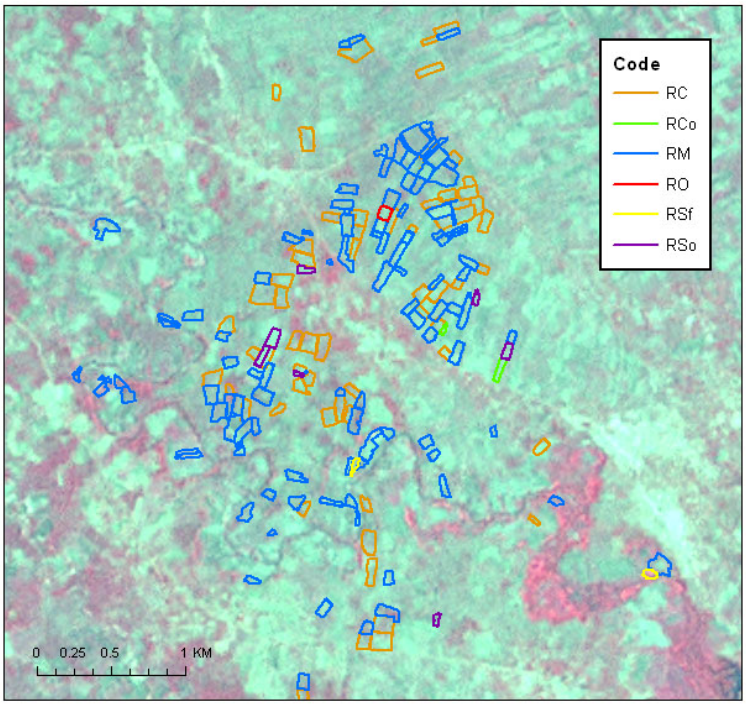

Figure 5. Crop allocation map at Site A during the rainy season

5. Satellite Images

We obtained satellite images taken with an optical sensor at middle-high resolution to identify crop field distributions and land surface conditions reflecting seasonal and inter-annual changes. These images cover almost the entire Sinazongwe district in the Southern province. Table 2 lists the satellite images we obtained from the 1970s to 2000s to identify crop field distribution and land surface conditions according to seasonal and inter-annual changes. The spatial resolutions of Landsat/MSS, TM, ETM and Terra/ASTER are about 80m, 30m, 30m and 15m, respectively. Landsat/ETM has multi-spectral and panchromatic images; the resolution of the panchromatic image is 15m.

Table 2. Satellite images obtained for the study

Satellite/Sensor	period	yyyy/mm/dd					
Landsat/MSS	1970s	1972/11/23	1973/3/11				
Landsat/TM	1980s	1986/11/17	1987/2/21				
Landsat/TM	1990s	1990/3/1					
Landsat/TM		1995/1/26					
Landsat/ETM	2000s	2001/8/30	2001/10/1	2001/12/20	2002/2/6	2002/2/22	2002/5/13
Landsat/ETM		2002/8/17	2002/10/20	2002/11/21	2003/4/30	2003/6/1	
Terra/ASTER		2003/7/3	2003/11/24	2004/1/11	2004/6/3		
Terra/ASTER		2004/7/21	2004/8/22	2005/3/9	2005/6/13		

In FY2008, radiometric and geometric corrections were done for all satellite images to compare them and to overlay the GIS data collected in the field investigations that used GPS, such as in figures 4 and 5.

6. Aerial Photographs

To generate the Digital Elevation Model (DEM) and the large scale topographical map of our study area, Sites A, B and C, we obtained aerial photographs archived by the Survey Department of Zambia. Aerial photos had been taken after the independence at a scale of about 1: 30,000 in 1965, 1970, 1980 and 1991. However, the 1965 photos did not include our study area. Thus we were able to use aerial photographs taken in 1970 (90sheets), 1980 (67sheets) and 1991 (72sheets). Figure 6 shows a sample DEM and an Ortho aerial photo around the middle of Sites B and C.

From the aerial photographs, we can detail and analyze the terrain features by DEM and so generate detailed topographical maps at a scale of about 1:10,000 for 1970, 1980 and 1991.

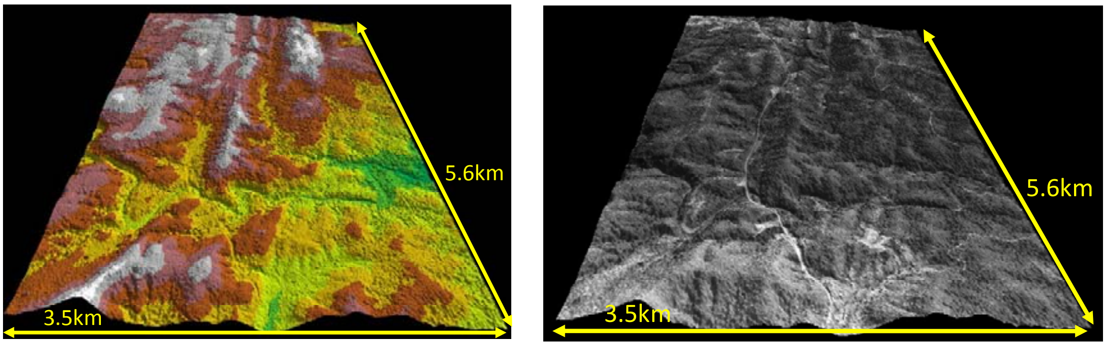

Figure 6. Top views of the Digital Elevation Model (left) and Ortho photo (right)

7. Plans and Expected Results in FY2009

We plan to analyze inter-annual changes in crop field distribution from aerial photos and the satellite images inform the 1970s, 1980s, 1990s and 2000s to understand the land use history related to people's livelihoods. Seasonal changes in crop field distribution will be detected from the satellite images taken in the 2000s based on the crop allocation map of 2007/8 to understand coping strategies related to climate variations the effect on livelihoods. We will then examine the relationship between crop field distribution and terrain features in drought, flood and normal years.

We are also planning to integrate data related to the household census and livestock farming into the data of crop fields.