IV-2: Land Use Change and its Impact on Ecological System

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1. Purpose

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. Human influences of environmental change will be considered and compared with its results and historical and social background.

The first subject of this theme is to understand the situation of land cover and use change caused by drought disaster and human activities after the independence.

2. Outline

For the achievement of above purpose, vegetation and land use/cover monitoring by multi-scale and multi-temporal approaches is the basic analysis. As for the multi-scale and multi-temporal spatial data infrastructure, remote sensing satellite imageries (Continental ~ Country ~ Regional ~ Provincial levels), the aerial photographs (local and plot levels), the various kinds of existing maps (Topography, Climate, Vegetation type, Soil etc.) and GIS data (Statistics, Elevation, Provincial boundaries etc.) will be obtained as required. The method of monitoring vegetation and land use / cover will be established to understand the typical seasonal change of vegetation distribution in country level and to identify the drastically changed area of land use / cover in regional and provincial levels. After identifying the specific area, the local level approaches will be started by using aerial photographs and the gathered field information such as human activities and historical and social background.

3. Preliminary analyses for Vegetation / Land use and cover monitoring in Multi-scale

Vegetation and land cover/use monitoring in continental, country and regional levels were carried out as preliminary analyses in order to confirm the possibility of the use of the existing satellite imageries. For this examination, Terra and Aqua/MODIS (Moderate Resolution Imaging Spectroradiometer) and Landsat/TM (Thematic Mapper) /ETM+ (Enhanced Thematic Mapper Plus) satellite imageries were used.

Terra and Aqua/MODIS have been observed the earth surface once or twice per day. As one of the products of MODIS imageries, there is 500m 32-day Composites which are generated to reduce the cloud areas with 500m grand resolution, so that these imageries are fit to use the multi-temporal vegetation monitoring. Landsat/TM and ETM+ imageries around Zambia are available in 3 or 4 times of 1970s, 1980s, 1990s and 2000s from the holdings of Earth Science Data Interface (ESDI). Therefore, it might be able to understand the land use

and cover change over the period of 30years. Furthermore, the province/district boundaries and 90m DEM (Digital Elevation Model) data are available as the geographical information. All of the imageries and data can be downloaded through internet as free.

The following describes the contents of preliminary analyses.

1) Seasonal change pattern of vegetation coverage in whole Africa continent

Used data were the browse images of MODIS 500m 32days composites observed from 2001 to 2005. The animation for one year (the start and end months are set as Sep.14-Oct.15 and Aug.13-Sep.13 of next year) was generated for 4 years of 2001Sep.-2002Aug., 2002Sep.-2003Aug., 2003Sep.-2004Aug., and 2004Sep.-2005Aug respectively. The greenness areas compared with four animations was moving from the central area to the southern area until Feb.-Mar., and back to the central in May.-Jun. and then moving to the northern area until Aug.-Sep. There is the time lag with about one or two months between Solar Calendar and vegetation growth. The seasonal change pattern of vegetation coverage can be visually understood in the continental level. Fig.1 shows the 2 times of MODIS images observed in 2003/Apr.7-May.8 (left) and 2003/Aug.13-Sep.13 (right) as examples. The greenness area extends over the central Africa on both images. The left image observed during the end of rainy season in Zambia shows much greenness in South hemisphere area compared with the right image observed during the middle of dry season in Zambia.

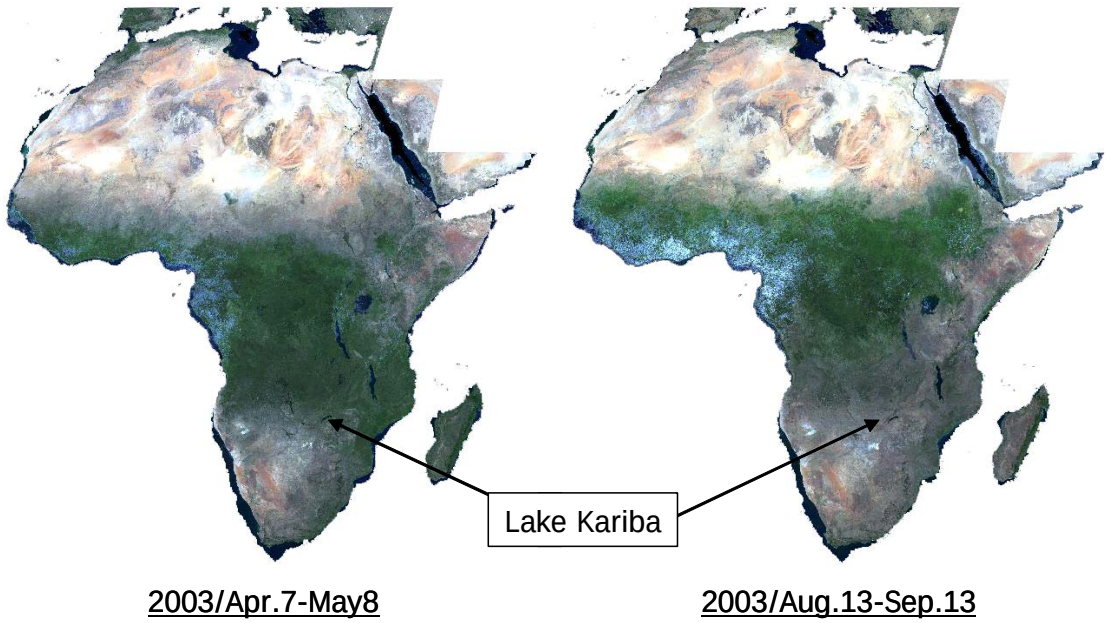

Fig.1 Terra/MODIS images

2) Influence on vegetation coverage caused by drought disaster in whole Zambia

The drought occurred during the rainy season in 2004/2005, and the harvest was decreased. Here, 3times MODIS imageries observed during the end of rainy season

(Apr.7-may8) in 2003, 2004 before drought and 2005 after drought disaster were used. Normalized Difference Vegetation Index (NDVI) was calculated to understand the vegetation coverage distribution. Generally, the higher value of NDVI shows the area covered with higher density of vegetation. NDVI distribution was compared to among the 3 times. Both NDVIs before drought in 2003 and 2004 were almost no changed. Fig.2 shows NDVI distributions in the end of rainy seasons of 2004 and 2005. Vegetation area which has higher values of NDVI extends through the almost whole Zambia before drought in 2004. On the other hand, lower values of NDVI shown by the warm colors are widely shown in Southern and Eastern Provinces after drought in 2005. MODIS 32days composites are very effective multi-temporal imageries in order to know the influence on vegetation coverage caused by drought disaster.

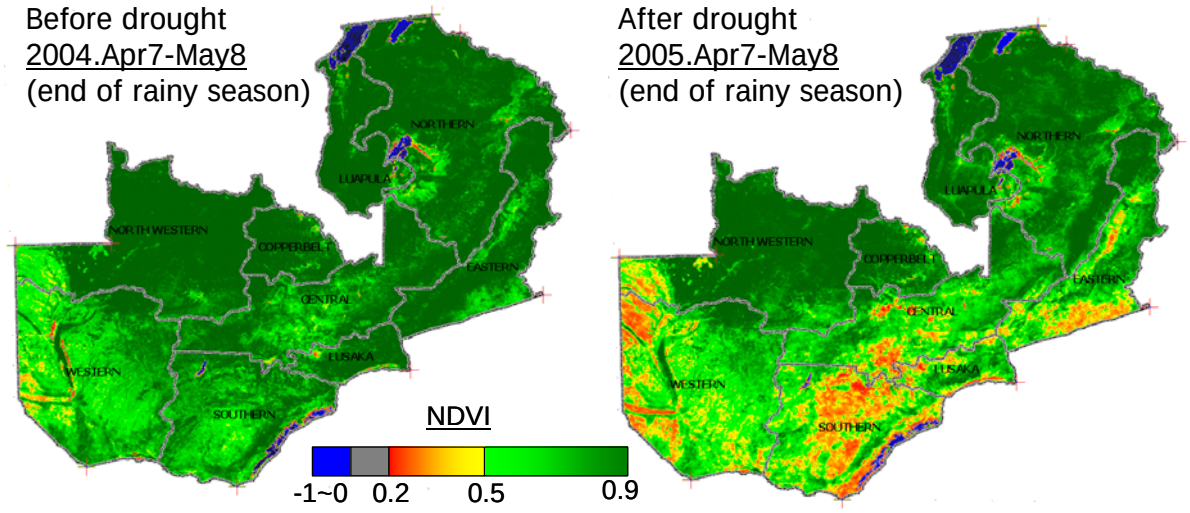

Fig.2 Comparison of NDVI distribution before and after drought

3) Data preparation for land use and cover change analysis in provincial and district levels

Landsat /MSS/TM/ETM+ series are one of the most popular satellite imageries for regional scale analysis and available through the internet recently. In this year, four scenes which cover around Southern province were obtained in 1970s, 1990s and 2000s respectively. Therefore, it might be able to grasp the situations of land use and cover by tracing back until 1970s by using these imageries. The geometric corrections are already done with the map projection of UTM (Universal Transverse Mercator) zone35 for all the downloaded imageries around Southern province. And also, the geometric location accuracy is very high, so that it is able to overlay with the other satellite imageries and GIS data easily.

Fig.3 shows Landsat/ETM+ four scenes observed in 2000s and overlaid with GPS tracks and interested points which were collected at field investigation. By using these Landsat imageries and portable GPS, it is useful to understand the location and gather the field information such as the types of land use/ cover, hearing investigation and photos etc.

Fig.4 shows the NDVI distribution calculated from Lnadsat/TM observed on

1990/3/1 of the rainy season and Landsat/ETM on 2001/12/20 of the beginning of rainy season in whole Sinazongwe district. The left image taken on 1990/3/1 extends the higher NDVI value area widely, on the other hand, the lower NDVI value areas are shown around the lake Kariba and the lowland area on the right image taken on 2001/12/20. It is difficult to compare both NDVI images directly because of the different season, however, possible to understand the situation of land use and cover at each season.

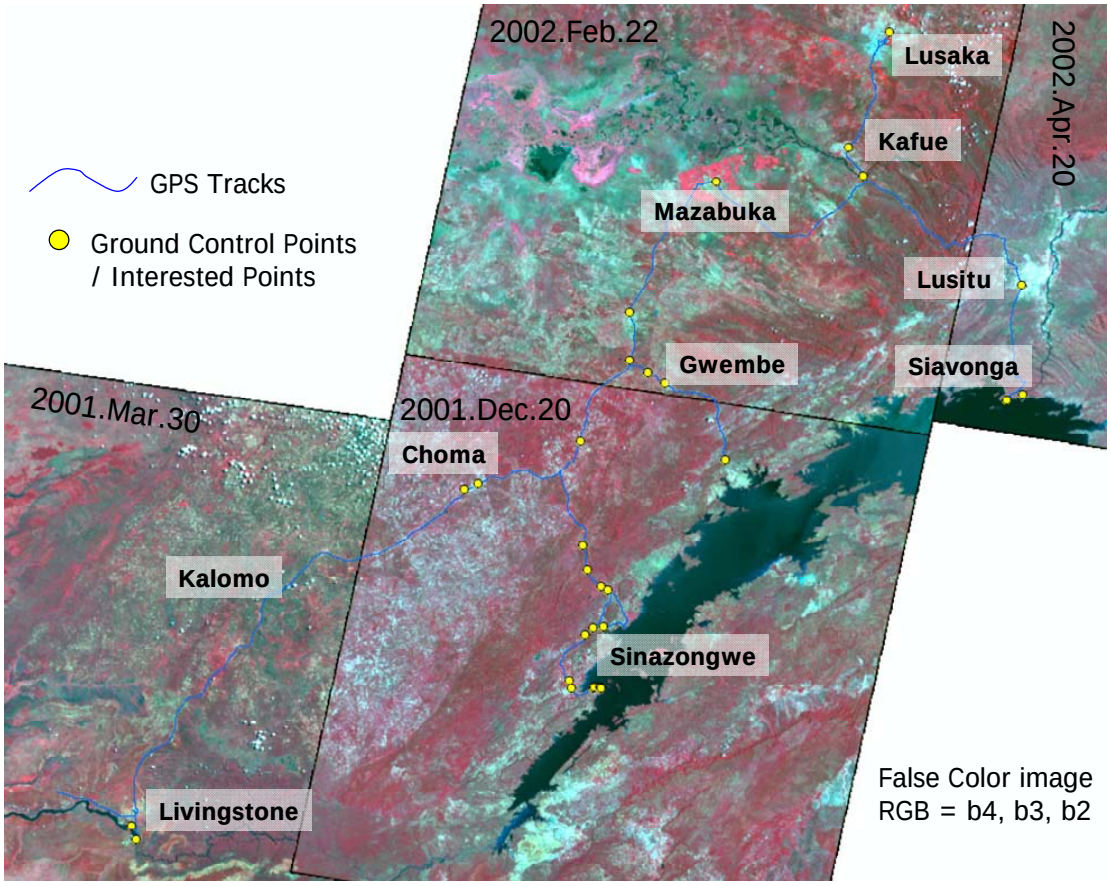

Fig.3 Landsat/ETM+ four scenes with GPS tracks around Lusaka and Southern province

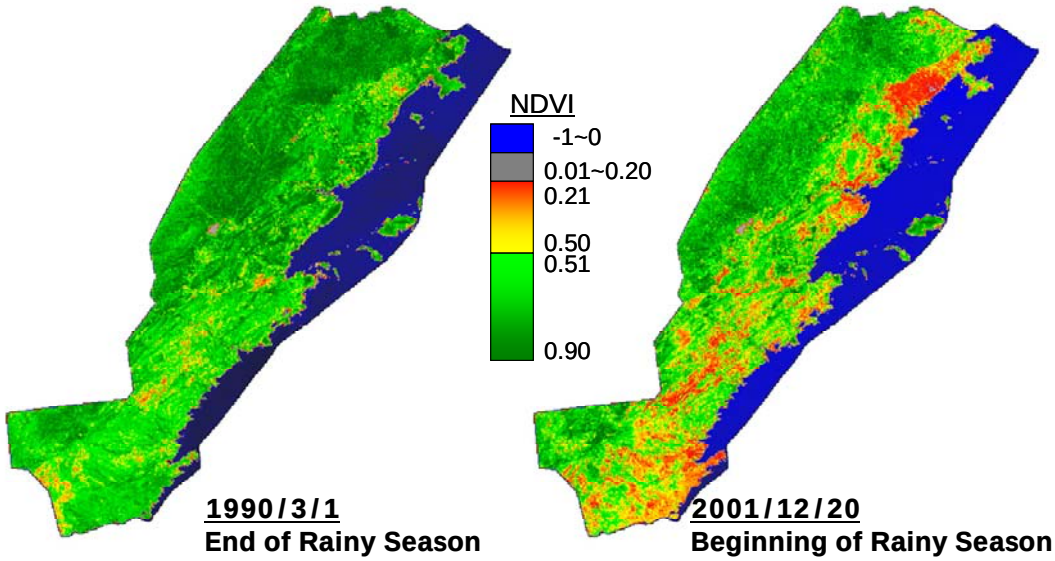

Fig.4 NDVI distributions in Sinazongwe district on 1990/3/1 and 2001/12/20

The existing maps are important information in order to understand the topographical and geographical background. The topographical map with 1:50,000 scale and regional map with 1:250,000 published by survey department are available in whole Zambia. And also there are various thematic maps of Zambia. The following shows the list of obtained maps (Feb. 2007 present). These maps have been scanned and added the map projection coordinate, will be provided with Geo Tiff format.

<< List of Regional, Topographic and the others Maps >>

Regional Map 1:250,000

1) ZS.31.Edition2 SE-35-4 KARIBA
2) ZS.31.Edition2 SE-35-6 LIVINGSTONE
3) ZS.31.Edition2 SE-35-7 SINAZONGWE
4) ZS.31.Edition1 SD-36-10 KATETE
5) ZS.31.Edition1 SD-36-6 CHIPATA
6) ZS.31.Edition1 SD-36-9 PETAUKE
7) ZS.31.Edition2 SD-35-15 LUSAKA (photocopy only, no scanning)
8) ZS.31.Edition1 SD-35-16 RUFUNSA (photocopy only, no scanning)
9) ZS.31.Edition1 SD-35-3 MONZE (photocopy only, no scanning)
10) ZS.31.Edition1 SD-35-2 CHOMA (photocopy only, no scanning)

Topographic Map 1:50,000

1) Series ZS.51, Sheet 1727A2, Edition 2-ZS 1994(Gwembe)
2) Series ZS.51, Sheet 1727A3, Edition 2-ZS 1994(Choma/Gwembe)
3) Series ZS.51, Sheet 1727B1, Edition 2-ZS 1996(Sinazongwe)
4) Series ZS.51, Sheet 1727B3, Edition 1-ZS 1993(Gwembe/Choma/Zimbabwe)

5) Series ZS.51, Sheet 1627C3, Edition 1-ZS 1973(Choma)
6) Series ZS.51, Sheet 1627C4, Edition 1-ZS 1984(Choma)
7) Series ZS.51, Sheet 1627D3, Edition 1-ZS 1985(Gwembe)

The others thematic map (1:500,000 to 1:3,000,000)

1) Vegetation Climate Map
2) Altitude 500,000 Map
3) Mtwara Development Corridor Map
4) Vegetation Soil Wegi District Map
5) Net Migration
6) Relief Drainage
7) Soil
8) Pre-Colonial Kingdom and Migration

4. Summery in FY2006

As the preliminary analysis for vegetation and land use/ cover change monitoring by multi-scale and multi-temporal approaches, the followings were confirmed;

1) It was possible to know the seasonal change of vegetation coverage pattern by MODIS 32days composites imageries in continental and country levels.
2) The influence on vegetation coverage caused by drought could be understood by NDVI distribution from MODIS data.
3) Landsat imageries downloaded from internet had the high location accuracy, so that it is useful for gathering the field information by using portable GPS.
4) It is necessary to obtain Landsat imageries observed during both seasons of dry and rainy seasons in the same year.

5. Plan in FY2007

Sub-theme II is planning about the followings for the next steps.

Continental and County Levels;

- Generation of NDVI data set by all MODIS 32days composites imageries in whole Africa in order to specify the seasonal changing pattern of vegetation coverage
- NDVI profiling around meteorological stations in Zambia and comparison with monthly precipitation data
- To obtain NOAA/AVHRR NDVI Monthly composites before 2000 in order to understand the influence on vegetation coverage by drought disaster in 1990's

Provincial and district levels;

- To obtain Landsat /TM and ETM+ images observed in Dry season of 1990 and Rainy season of 2002
- Searching the images observed in 1991/1992 and 1994/1995 when the precipitation

was decreased

- To identify the area drastically changed Land use and cover in Sinazongwe district

References

Satellite Imageries and GIS data download Web site

Global Land Cover Facility, Earth Science Data Interface (ESDI);
http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp

Southern Africa Humanitarian & Disaster;
http://www.sahims.net/gis/Gis%20Input/zambia_gis.asp