LAND USE CHANGES IN THREE GORGES RESERVOIR AREA IN RECENT 30 YEARS

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ABSTRACT:

The eco-environment in Three Gorges Reservoir Area was given a lot of attention due to the construction of the three gorges hydropower station. The land use / cover change (LUCC) is one of the causes of ecological environment changes. In this paper, we monitored the temporal-spatial landscape dynamic change from 1978 to 2005 in the Three Gorges Reservoir Area, based on the multispectral scanner (MSS) and thematic mapper (TM) images of remote sensing of 1978, 1988, 1995, 2000 and 2005. Using the monitoring data, we studied on the changes in several analysis indexes and techniques. The results indicated that: in the recent 30 years, cropland, woodland, grassland reduced continuously, at the same time, water body and built-up areas increased obviously on the dynamic degree 1.918% in 2000-2005 period, and 2.894% in 1995-2000 period respectively; built-up area changed in the most ratio and greatest speed which is at the cost of cropland, woodland, grassland.

1. INTRODUCTION

The construction of three gorges hydropower station in China is a large hydropower project. It will give great benefits to human, such as preventing or controlling flood, generating electricity and shipping, but at the same time, it will bring some effect to the entironment, for example, land use change caused by migration, water pollution and geological disaster brought by rising water line(Q. Wang,2006). A lot of attention was paid to entironment in Three Gorges Reservoir Area. The land use/ cover is an important part of the natural environment. LUCC is one of the focuses in global entironment change research since the new century and one of the important reasons of environment changes(Liu J Y. and Shi P J.,1996; Ding F,2004; Zhao S H ,2003). Here we used remote sensing data gathered between the end of 1970S to 2005, to analysis the magnitude and pattern of land use changes in Three Gorges Reservoir Area, and to reveal the driving forces on the changes, which will be helpful for the land resource protecting, utilizing, and management in Three Gorges Reservoir Area.

Locating at latitude 29°16′N-31°25′N and longitude 106°16′E - 111°28′E, central China, lower section of the upper reaches of the Yangtze River, linking section of central China and southwest China, the Three Gorges Reservoir Area consists of submerged portions and resettlement involved in 23 counties and cities. The total land area with 20 million people is about 58 000 km^2 in the whole reservoir area (Meng J J, 2005). This region has many cross and deep valleys and rich water resources. Most of the countries are poor and low productivity level in the reservoir area (Z. Q. Huang, 2006).

2. DATA SOURCE AND CHANGE DETECTION

With the image data in five special history times for the entire Three Gorges Reservoir Area: MSS for 1977, Landsat-TM for 1988, 1995, 2000, and 2005, we monitored the land use change between each two sequence periods by man-computer interactive interpretation (Fig.1). Based on one time period type map of land use/cover, we obtained the land use/cover type maps of the rest periods by using ARCGIS analysis techniques.

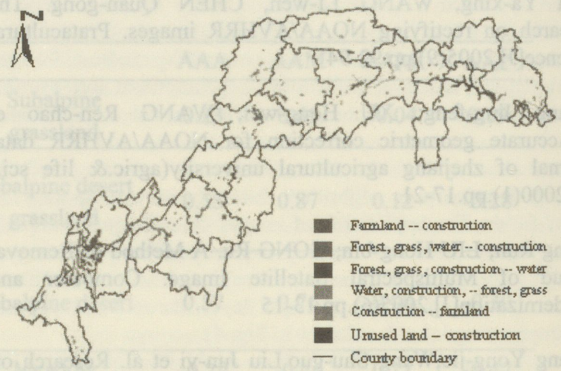

Figure 1. LUCC map in Three Gorges Reservoir Area from 1977 to 2005

We used classification system developed by the Chinese Academy of Sciences, which is a hierarchical classification system of 25 land-cover classes. In order to suit the convenience of the study. The 25 classes of land cover were grouped further into 6 aggregated classes of land cover – croplands, woodlands, grasslands, water bodies, built-up areas and unused land (J. Y. Liu, 2005).

3. CHANGE ANALYSIS

Using the monitoring data we studied on the spatial-temporal changes of land use for 5 different time in Three Gorges Reservoir Area. In order to reveal the change synthetically and accurately, we analysed the land use data in several analysis indexes and techniques, including the area ratio of land use / cover change, the dynamic degree of land type area change, and land transformation matrix.

3.1 the Area Ratio of Land Use / Cover Change

The area ratio of land use / cover change refers to the proportion of the changed area in the total areas. It is a simple and effective way for weighing the relative quantity of area change for a land

use/cover type. We calculated the area change ratio for the main land use type in the five series time periods(Tab.1). It can be seen from Tab.1 that the area of cropland, woodland, and grassland were reducing continuously, whereas the construction land, water, and unused land area were increasing obviously. Change percent of the land for construction was the highest in the four comparison periods, It had been rising since the first studied period(1977-1987) by 7.1%, and arrived at the top of 10.8% in the forth period(2000-2005). The result is caused by growing population and urbanization. The population is dense and quickly increasing in Three Gorges Reservoir Area. It had grown from 14.8 million in 1992 to 20.0 million in 2004 (http: // www.3g.gov.cn). This growth in population and urbanization had increased the demand for food, houses, and factories (Hunter L M, 2004 and Semwal R L, 2005). Furthermore, The Three Gorges Project accelerated the regional economy, leading to the rapid rise in the use of construction land.

Land use type	1977 -1987 (%)	1987 -1995 (%)	1995 -2000 (%)	2000-2005 (%)
Cropland	-0.107	-0.055	-0.059	-0.295
Woodland	-0.022	-0.082	-0.157	-0.250
Grass land	-0.040	-0.030	-0.129	-0.047
Water land	0.389	0.090	-0.551	9.589
Construction land	7.104	8.118	14.471	10.776
Unused land	0	0	1.312	-7.371

Table 1. the area ratio of land use / cover changes in Three Gorges Reservoir Area

3.2 The Dynamic Degree of Land Type Area Change

The dynamic degree of land type area change indicates the speed of annual land use area change, which is an important index to show change. It can describe the speed of LUCC in a certain region quantificationally. The calculation formula is

$$D_c = \frac{A_{t2} - A_{t1}}{A_{t1}} \times \frac{1}{t_2 - t_1} \times 100\%$$

Where A_{t1}= area of a kind of land use type in time t1
A_{t2} = area of a kind of land use type in time t2
The results according to this formula are shown in Tab.2

Land use type	1977 -1987 (%)	1987 -1995 (%)	1995 -2000 (%)	2000-2005 (%)
Cropland	-0.011	-0.008	-0.012	-0.059
Woodland	-0.002	-0.012	-0.031	-0.050
Grass land	-0.004	-0.004	-0.026	-0.009
Water land	0.039	0.013	-0.110	1.918
Construction land	0.710	1.160	2.894	2.155
Unused land	0	0	0.262	-1.474

Talbe 2. Dynamic degree of single land use in Three Gorges Reservoir Area

From Tab.2, we can see in the four periods, cropland, forest, grass all reduced annually in a lower speed, however, the land for construction increased in a higher speed annually, and the change was accelerating continuously in every following period. For each type the most outstanding period is: 2000-2005 for cropland by 0.059, 2000-2005 for forest by 0.05%, 1995-2000 for grass by 0.026%, 2000-2005 for water by 1.918%, 1995-2000 for construction by 2.894%, and 2000-2005 for unused land by 1.474%, which indicates that in third period and forth period (Three Gorges Project construction time) land use converted most rapidly. The main reason is the rising water line of Three Gorges dam.

3.3 land transformation matrix

Land transformation matrix is to show the pattern of changes, namely, from what to what. We made land transformation matrix in every time period to track the change. Limited by paper length , we took an example for 2000-2005 period in which the amount of land use changes was the greatest. The land transformation matrix during 2000-2005 was shown in Tab.3.

From	To Crop	Wood	Grass	Urban	Village	Other built-up	Water	Unused land
Cropland		0	0	59.99	5.25	5.41	0	0
Woodland	0		0	9.68	9.09	4.87	3.77	0
Grassland	0	0		3.46	4.88	5.72	7.30	0
Urban land	0	0	0		0	0	28.07	0
Village land	0	0	0	0		0	0	0
Other built-up	0.22	0	11.77	0	0		0	0
Water body	0	0	1.53	0	0	1.77		0
Unused land	0	0	0	0	0	0	0	

Table 3. Land transformation matrix during 2000-2005

It can be seen from Tab.3 that the conversion process took place mainly between cropland, woodland, grassland and built-up land, water.

Thereinto, the conversion from cropland to urban land is the most dominating. This illustrated that urban expanding took use of a lot of cropland. In addition, some urban land was converted to water area, which was caused by the Three Gorges dam sluicing and nearby town submerged. It is obvious that the increase of construction land and water area is at a cost of the decrease of cropland, woodland, grassland.

4. CONCLUSION AND DISCUSSION

1) All the above analyses have shown that the land use and land cover status in Three Gorges Reservoir Area have changed significantly in the recent 30 years. Cropland, woodland, grassland decreased continuously, at the same time, water body and built-up areas increased obviously.

2) Build-up areas increased continuously, and the increasing speed had being enhanced based on a bigger number, it arrived at the biggest 2.894% in 1995-2000 period, which were at the cost of cropland, woodland, grassland.

3) In 2000-2005 period, water body increased most quickly by 1.918% on the dynamic degree of change at the expense of woodland, grassland and even built-up areas, as a result of three gorges dam built.

4) The research also released that the land use changes in Three Gorges Reservoir Area are drived by two main forces: one is the growing population with the non-agriculture population scale enlarging, another is the constructing Three Gorges Project, which brought migration moving, land submergence, and accelerated the regional economy, leading to the rapid rise in the use of construction land.

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