The Spatial-temporal Changes of the Land use/cover in the middle Yangtze Plain

Li Rendong[a,b] Liu Jiyuan[a] Zhuang Dafang[a]

[a] Institute of Geographic Sciences and Natural Resources Research, CAS, Beijing, China 100101

[b] Institute of Geodesy and Geophysics, CAS, Wuhan, China 430077

Abstract- The middle Yangtze plain, located on the central of China, is well-known to the world as one of the regions mostly suffering from flooding disaster in China in recently. The increasing flooding is not only the results of the nature process, but also the results of the land use/cover change. The research on the land use/cover change is very helpful to trace the flooding damage. In this paper, a series of land use/cover coverage were first generated through visually interpreting LandsatTM and ETM image data of 1990, 1995 and 2000 with MGE and ARC/INFO software. Then, based on the net-change analysis, conversion matrix and dynamic degree model, the characteristics of spatial-temporal change and the transfer of land use/cover were analyzed in this area. The results showed that the areas of farmland and woodland decreased, while that of built-up area, water area, grassland and non-used land increased during the past 10 years, and there was a significant shifting from farmland to water body or built-up area. From 1990 to 2000, the cultivated land decreased by 78600 hm2, of which 55% was changed to water area, especially most to fishpond, and 33.41% to the built-up land. For the same 5-year interval, the pace of land-use change in 1990-1995 was much faster than in 1995-2000. By using the dynamic degree model, it was found that the greatest changes of land use/cover occurred in big city, i.e., Wuhan City，Nanchang City, and the slowest change mainly in the counties near the Dongting Lake and the Poyang Lake. Because the large-scale land reclamation from lake ever in history has been curbed effectively in this flooding plain since 1990, the authors deduced that the worsened flooding risk in this area should be attributed to the over-reclamation before 1990. Since 1990, although there has been the return of the cultivated land to lake, it has not sufficiently alleviated the flooding disaster duo to a limited restore of water body.

Ⅰ. INTRODUCTION

Changes of land use and land cover (LUCC) are of the most importance among human alteration of the Earth's land surface [1]. The research on the changes is not only one of core projection in the Global change study, but also one of the hot spots in the resources management and environmental sciences.

The middle Yangtze plain of central China is one of important bases for grain product as well as one of the well-known regions seriously suffering from flooding disaster in the whole country [2]. Because land use/cover change is one of key factors resulting in the increasingly flooding disaster in the low-lying flooding plain, it is important to identify the dynamic process of the change.

For a long time, the change of land use/cover in the area is seldom explored systematically due to the lack of adequate and acute serial data on land use. So, this study is aimed at presenting the spatial-temporal patterns of the change via two phases: (1) Generating a series of land-use coverage were gotten firstly through visually interpreting Landsat TM and ETM image data; and (2) Analyzing the spatial-temporal characteristics of land use/cover changes at different period during the last decade.

Ⅱ. STUDY AREA

The middle Yangtze River plain of central China covers an area of 138345km^2, of which 30234km^2 in Hunan province, 70490km^2 in Hubei province and 37620 km^2 in Jiangxi province (Fig.1). In this area, there are top-ranking fresh lakes in China, including Poyang Lake which is the largest lake, Dongting Lake which is the next, and the well-known Jianghan Lakes.

The area has a subtropical monsoon climate, with an average annual rainfall range of 1000–1600 mm, and annual mean temperature of approximately15-17℃. Because of the long-term silt deposition and over-done reclamation, the Dongting Lake shrank rapidly from 4350 km^2 in the 1940s to

less than 2691 km2 in 1979, and the Poyang Lake from 5200 km2 to 3800 km2, and the Jianghan Lakes from 8330 km2 to 2370 km2. Accompanying with the sharp shrinkage of these lakes, the flooding and waterlogging is becoming more and more serious. For instance, the economic loss caused by the disasters in the Dongting Lake area remarkably increased from 16 billion yuans in 1950-1959 to 109 billion yuans in 1990-1998. Obviously, the land use was one of the key factors that have resulted in the increasing flooding damages. How about the recent change of land use/cover in this area recently? This is the project need to study further.

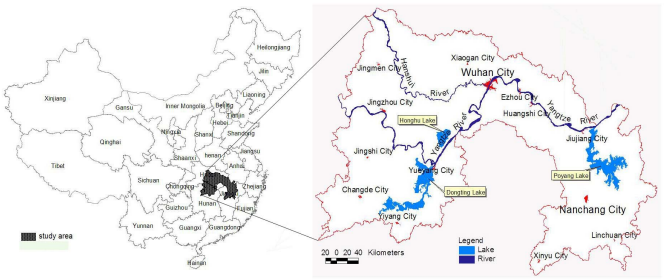

Fig.1 Distribution map of the middle Yangtze Plain

III. Data and methods

A. Data Sources

The basic spatial data of land use/cover of 2000 in this paper came from the national resource and environment database, and moreover, the Landsat TM and ETM data, which were captured in 1990,1995 and 2000 respectively, were used for extracting the information of the land use change while topographic map, regional thematic research data and maps were consulted Besides, statistic data on social and economics used in this paper were gathered from statistic yearbook, and household survey.

B. Methods

The information of land use/cover change can be extracted from satellite data by means of image-to-image comparison, image-to-map comparison and map-to-map comparison. In this process, the automated image classifier generally work well in spectrally homogeneous areas, but not in highly heterogeneous regions even though many techniques have been developed for improving automated classification [3]. The remote sensing characteristics of different land use/cover types vary according to not only the spectral reflectance but also the shape, size, position, etc., and it is impossible for any particular automated image classifier to be applicable to mapping all of them [4]. In reality, supported by GIS, manual interpretation of satellite image has been applied with satisfactory accuracies to the detection of the spatial-temporal dynamic of land use/cover change processes [5] [6] [7] [4].

In this paper, a method of visually interpreting image on screen, based on the image-to-map comparison, was adopted. The first step was to make the land use map from the Landsat TM/ETM image of 2000[8], and build up the database with the ARC/INFO software. A two-level classification system was applied. There are six catalogs in the first-level, i.e., cultivated land, woodland, grassland, water area, built-up area and non-used land. In the second-level of the classification, there are 19 types. As example, the cultivated land is split into paddy field and dry land. The second is to overlay the land use map of 2000 on the 1990 and 1995 image data respectively, and extract the changing information of the land use/cover after registering the different images geometrically. By means of image-to-map comparison, the changing boundaries of the land use/cover types can be detected.

Ⅳ.RESULTS

A. The temporal Patterns of Land use/cover Changes

The research results indicated that the areas of farmland, woodland and grassland decreased, while of others, water area, grassland, built-up area and unused area, increased from 1990 to 2000.

As shown in table 1, the farmland land decreased by 78580 hm^2 in 1990-2000, taking account for 1.04% of the total cultivated land. For the 5-year interval, a decrease was continuously observed though the pace declined. It reduced by 65426 hm^2 in 1990-1995 while only 13154 hm^2 in 1995-2000, and the percent of farmland area decreased in total area changed from 0.87% to 0.18% correspondingly. A little decrease of 3051 hm^2 and 210 hm^2 were detected for woodland and grassland respectively during the last ten years. Among the land use categories that areas increased, the area of built-up area increased significantly by up to 41382 hm^2, with an expansion rate of 7.28% of the total built-up area during the decade. At the different period, it was found that

the increasing area in the previous 5 years was 28058 hm^2more than that in the late 5 years. Another land-use type whose area increased remarkably was water area, with an increase of 34012 hm^2, about 1.90% of the water body area during the 10 years. An outspread of 39614hm^2 was observed in the first period, and small shrinkage of the water area was detected in the second period in reverse. The grassland area decreased by 1162 hm^2 in the previous 5 years, however, increased by 952 hm^2 in the late 5 years. Unused land, including beaches and swamp, changed greatly due of the seasonally fluctuated of water level. It increased about 1996 hm^2 in 1990-1995, while by 8444 hm^2 in 1995-2000. This can be an implication that the flooding stresses in the district seem to become more serious.

Table 1 The area net changes of the land use/cover in study area (hm^2)

classes	1990-2000	1990-1995	1995-2000
farmland	-78580.33	-65426.51	-13153.82
woodland	-3051.49	912.12	-3963.61
grassland	-210.14	-1161.81	951.67
Water body	34011.65	39613.55	-5601.90
Built-up land	41382.29	28058.31	13323.98
Unused land	6448.02	-1995.66	8443.68

B. The Conversion of Land use/cover Changes

What did the land use and land cover in the study area change from and to during the recent decades? These issues can be addressed by the analysis on the conversion of land use/cover change.

Table 2. Conversion of land use/cover in the study area from 1990 to 2000 (hm^2)

		Farm-land	Wood-land	Grass-land	Water-area	Built-up area	Unused-land
Farm-land	area	--	6288	332	65687	33112	323
	%	--	6.0	0.3	62.1	31.3	0.3
Wood-land	area	4240	--	2090	706	5700	75
	%	33.1	--	16.3	5.5	44.5	0.6
Grass-land	area	409	2707	--	1185	468	9
	%	8.6	56.6	--	24.8	9.8	0.2
Water-area	area	22152	665	2147	--	2082	9942
	%	59. 9	1.8	5.8	--	5.6	26.9
Unused-land	area	360	99	0	3422	20	--
	%	9.2	2.5	0.0	87.7	0.5	--

There is a significant shift from farmland to water body and built-up area. As shown in table 2, about 62%(65687 hm^2) and 31%(33112 hm^2) of the farmland area decreased were changed into water body and built-up area respectively during the period of 1990-2000,and at the same time there were about 22152hm^2 area shifted from water body to cultivated land, and 4240 hm^2 from woodland. Because the farmland area changing to water area was far more than that changing from water area, the large-scale reclamation from lake ever in history has been curbed effectively in the studied area.

The expansion of every kind of built-up land was remarkably at the expense of farmland. 80.01% of the increased area came from cultivated land between 1990 and 2000, and the loss of forest took account for the most of the remains. None of built-up land was observed changing to other land use classes.

The spread of the water area was come mainly from farmland, unused land and grassland, hardly from forest. Most of the woodland area decreased was lost to built-up land, and the unused land area mainly to water area at two periods.

C. The Spatial Differentiation of Land use/cover Changes

In order to reveal the regional differentiation of land use/cover change, the dynamic degree model was used. The model is defined as follows (Liu et al., 2000):

$$s = \{ \sum_{ij}^{n} (\triangle si\text{-}j/si) \} *(1/t)*100\% \qquad (i,j = 1,2,\ldots n)$$

where si is the total area of the land use type 'i' at the beginning of monitoring, △si-j is the overall area of land use type 'i' changed to 'j' type from the begin to the end of the monitoring period, t is the period of the years from beginning to the end of monitoring, and s is the land use change rate among the period 't', which is the land use change dynamic degree.

Taking the administrative unit as basic mapping unit, the degree was calculated and mapped out. Fig.2 revealed that, from 1990 to 2000, the city, such as Wuhan City, Xiantao City, Nanchang City, Ezhou, Huangshi, and Hanchuan, had high dynamic degree of more than 50, suggesting the faster changes of land use/cover in the cities. Counties near to the Poyang Lake and Dongting Lake, had got the lower value of less than 5, and the changing speed was lower in this region.

Ⅴ.CONCLUSION AND DISCUSSION

The increasing flooding in the middle Yangtze plain is not only a natural process, but also the result of inappropriate land

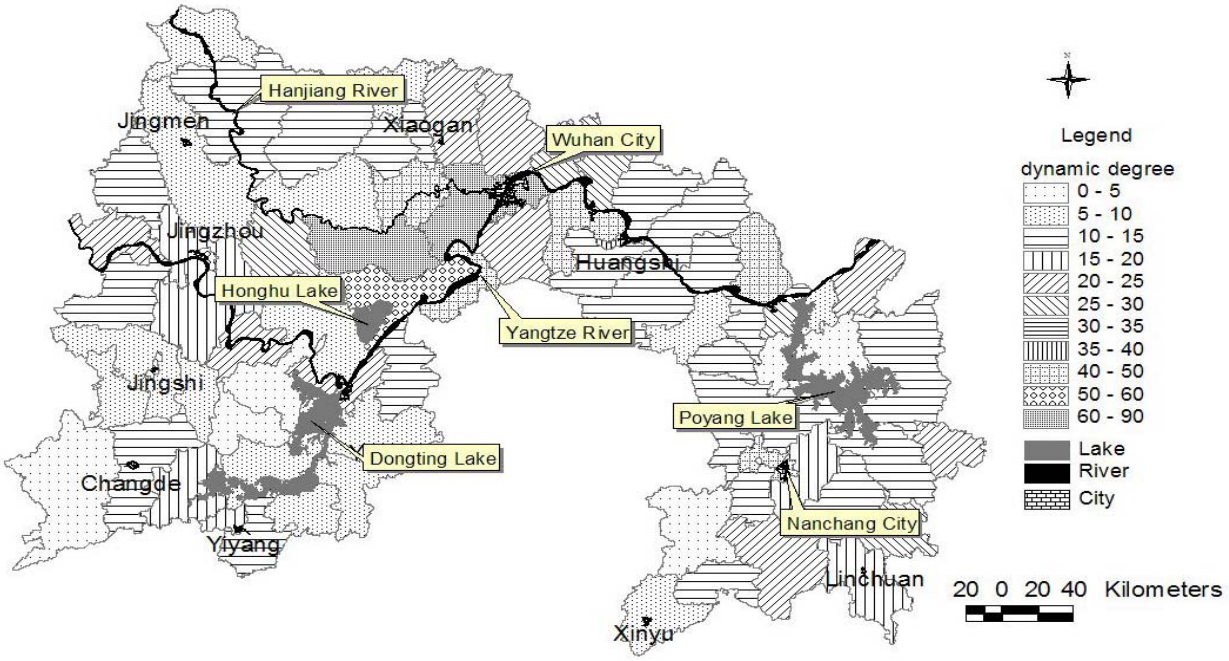

Fig.2 Distribution of the dynamic degree of the land use/cover change in the study area

use, i.e., the large-scale land reclamation from lake in history. Thus, explicitly monitoring the spatial-temporal changes of land use/cover is of most importance to trace the flooding damage.

From 1990 to 2000, the areas of farmland, woodland and grassland decreased, while that of built-up area, water area and non-used land increased, and the changing pace in 1990-1995 was much faster than in 1995-2000. Land use in city-level administrative unit changed rapidly duo to their well economic condition and more population. The slowest changed area existed in the counties near to east and southeast of the lake area. Since 1990, there was a significant shifting from farmland to water body or built-up area. Because large-scale reclamation from lake ever in history has not been observed in the studied area since 1990, it can be concluded that the worsened flooding risk in this area should be attributed to the over-reclamation before 1990.

ACKNOWLEDGEMENT

All the authors are indebted to the projects of knowledge innovation of CAS (project number KZCX2-SW-415) and the Open Research Fund Program of LGISEM (project number 200401) for their financial support to the study.

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