Analysis of Land Use Dynamic Change in Meilan District of Haikou City Based on Remote Sensing Images

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Abstract

With Landsat TM remote sensing images from Meilan District, Haikou City in 1993 and 2011 as the data source, this paper uses the Maximum likelihood method (MLC), GIS spatial analysis method and digital statistics method with the help of ENVI5.1 and ArcGIS 10.2 software platform, to extract the spatial information of the research area and calculate the dynamic transfer matrix of land use type in Meilan Area. The classification map of land uses remote sensing image in each period of the study area was obtained. Through the analysis of the classification map of remote sensing images, the dynamic change law of land use in Meilan District of Haikou City in the past 14 years are drawn, and the influence factors are analyzed to provide a basis for the intensive utilization of urban land resources. The results of the data are as follows: during the study period, construction land increased by 6836.64 hm2, and other types of land decreased, especially forest land and cultivated land decreased by 6692.23 hm2 and 6112.39 hm2 respectively. The changes in social and economic conditions such as population size, rapid urban development and the pursuit of superior living conditions are the driving factors of land use evolution in the study area.

Keywords

Remote Sensing Images; Land Use; Dynamic Change; Haikou City.

1. Introduction

Land use/land cover change (LUCC) has been an important component of global environmental change and an important cause of global environmental change since the 1990s. It has been paid more and more attention by international organizations and countries all over the world and has become the forefront and hot topic of global change research in the world.

Land-use change reflects the characteristics of land use purpose and uses mode under the influence of drivers. The process of urbanization leads to the decrease of cultivated land, the destruction of vegetation, soil erosion, and so on, which leads to the change of urban land use. Monitoring the dynamic changes of urban land use makes it easy to grasp the change law of urban land use from a macro perspective, which is of some reference significance to the scientific planning of urban space. Taking Meilan District of Haikou City as the research object, this paper analyzes dynamic changes of land use in the last 14 years since 1993 and summarizes the law of change to provide the basis for the intensive utilization of urban land resources, slow down the contradiction of human and land resources, and find the driving factor of the evolution of land use.

2. Overview of the study area

Meilan District is located in the northeast of Haikou City, between latitude 19°57'~20°05' north and longitude 110°10'~110°23' east. It is adjacent to the Nandujiang River in the east, Qiongshan District in the south, Longhua District in the west, and Qiongzhou Strait in the north. It has the geographical advantage of being "close to the river and the sea". The total area of the whole district is 581km^2 and the total population is 655,000. The landforms of the Meilan District is mainly coastal stepped landforms, mainly coastal plains, with low geothermal heat and obvious advantages in location resources. Meilan District is close to the river and the sea, with a coastline of more than 100 kilometers, fertile land and extensive red land. There are Meilan Airport and Dongzhai Port Mangrove National

Nature Reserve in the territory. Nandu River, Meishe River and Haidian River flow through the city and flow into the sea. The Haiwen Expressway and Qiongwen National Road traverse the entire region, which has unique advantages in natural resources.

3. Data sources and research methods

3.1 Data sources

The remote sensing images data selected in this paper are land-based satellite data of the United States, and the two phases of the image are Landsat TM in 1993 and 2011, with a resolution of 30m. Besides, there are administrative maps of the Melan District, 1:5 million topographic maps, land-use status maps, various documents, information and related year statistics.

3.2 Research methods

The technical route of this study is shown in Figure 1: First of all, we use ENVI5.1 remote sensing processing software to pre-process data such as geometric correction and image cutting of remote sensing images in 1993 and 2011. Then we carry out remote sensing images enhancement processing, and finally use the maximum adage method to supervise and classify the images separately, extract the main types of land use, and combine the results of field visits and various statistical data, modify the misconceived areas, and use the classification and comparison method to extract land use change information. With the support of ArcGIS10.2 software, through the spatial overlap analysis of the land-use status map of Meilan District in 1993 and 2011, we can get the spatial overlap matrix table of land-use area transfer between 8a Melan district. We construct regional land use change index models such as land-use change index, land-use change type multi-degree and inordinateness index, quantitatively study the time and space change of land-use in Meilan district, clarify the regional characteristics of land-use change in Meilan district, and provide effective decision support for land sustainable use.

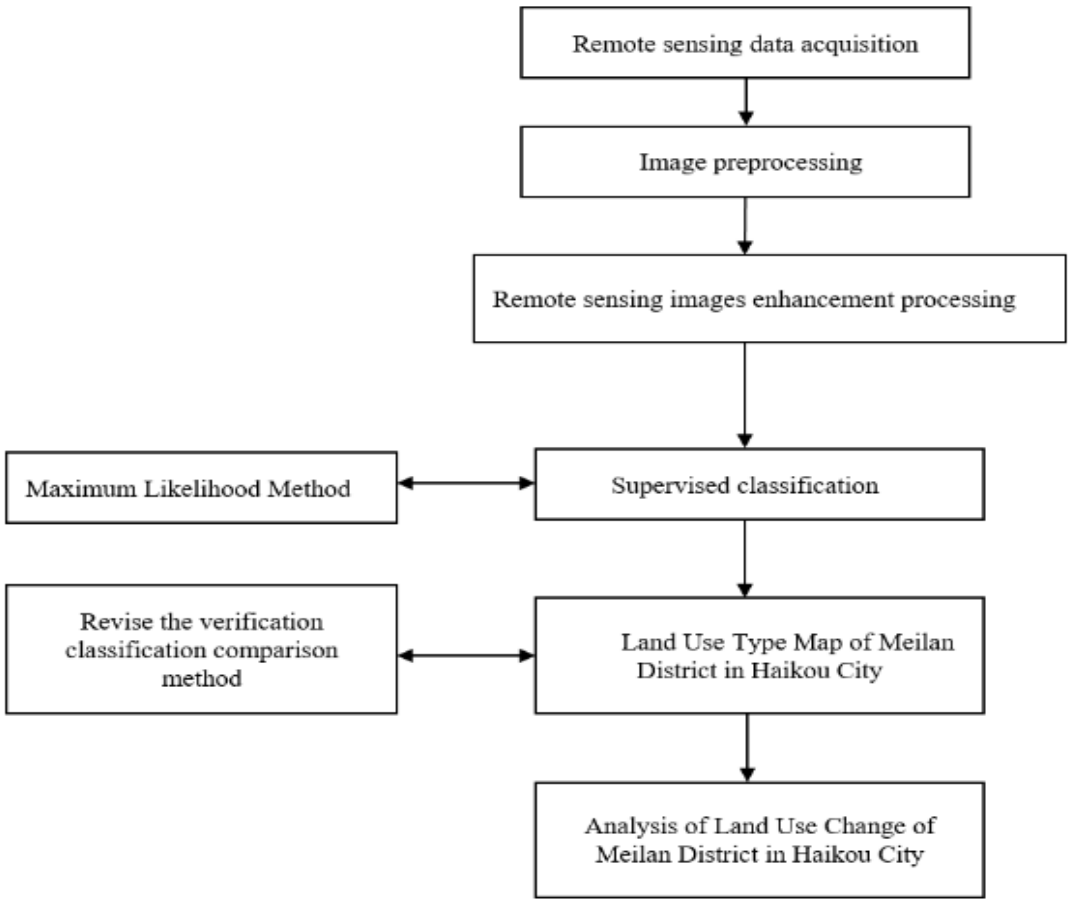

Figure 1 Technology roadmap

4. Extraction of remote sensing images information

4.1 Preprocessing of remote sensing images

In order to eliminate all kinds of geometric distortion of remote sensing images, we need to the geometric correction of two-phase TM images. Using ENVI software, we use three polynomial methods to geometric correction of remote sensing images, and the total residual error is tested to be within 0.5 pixels, which meets the accuracy requirements of geometric correction. In order to unify the interpretation standards and facilitate the analysis of graphics overlays, based on the 2011 image, we register the 1993 TM image and uniformly adopt Transverse Mercator projection.

4.2 Remote sensing images enhancement processing

Since the study area is Meilan District, there is a lot of dust above the city, and the remote sensing images will be a little bit fuzzy. Therefore, to reduce the ambiguity of the TM image, the two phases of remote sensing images have been processed for Haze Reduction. The method is essentially based on the Tasselled Cap transform. First, we perform principal component transformation on the image to find and eliminate the components related to the ambiguity, and then perform the principal component inverse transformation back to the RGB color space to achieve the purpose of removing haze. Remote sensing images after Haze Reduction are clearer, which is convenient for subsequent classification and interpretation.

4.3 Classification and accurate evaluation of remote sensing images

On the image-processed remote sensing images, according to the established image characteristics of the image classification, the classification of remote sensing images in this study is based on the Bayesian Information Criterion (BIC) of the Maximum Likelihood Method of Supervised Classification. Combined with the national land use type standard and the actual situation of land use resources in Meilan District and referring to the land use map of Meilan District, this study divides the land use type into five types of cultivated land, forest land, construction land, waterbody and unused land. Finally, according to the interpretation mark of the image, concerning the relevant thematic map, combined with the results of the actual field investigation, this study tested the accuracy of the classification results, and calculated that the Kappa coefficients of the 1993 and 2011 image classification charts were 0.84 and 0.82 respectively, which met the requirements of the minimum allowable accuracy of 0.7, to meet the accuracy of land use change monitoring.

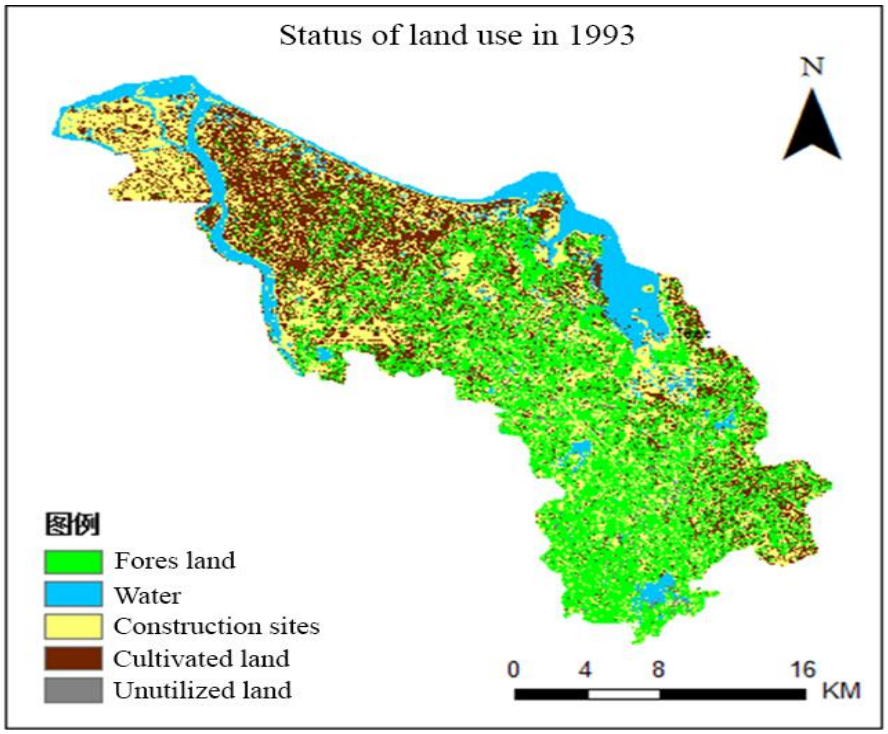

Figure 2 Land use types in 1993

The images after supervised classification will produce some small spots. In this study, the Clump and Eliminate methods in the ENVI module are used to merge the small spots into the adjacent large spots. Finally, the ArcGIS 10.2 software is used to output the result of image interpretation and classification into a map, and the land use type maps in 1993 and 2011 are shown in Figure 2 and Figure 3.

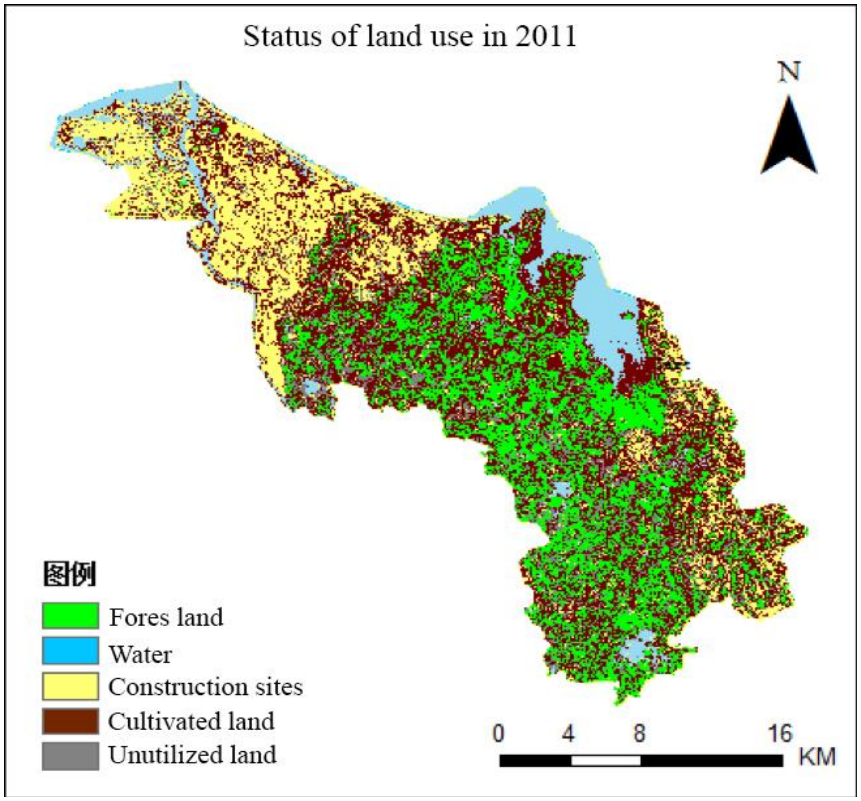

Figure 3 Types of land use in 2011

5. Result analyses

5.1 Analysis of land use dynamic change process in Meilan District

From Figures 2 and 3, it can be seen that the area of construction land in Meilan District, Haikou City has increased greatly, and urban development has expanded to the southeast and northwest on the basis of the old city section of Haifu Road and Binjiang Road Meilan District. First, it expands to the southeast, development density is relatively concentrated. In particular, Haikou Meilan International Airport was officially opened to navigation on May 25, 1999, which accelerated the development of urbanization, resulting in a surge in demand for construction land and a decrease in forest land and waterbody. Second, it expands to the northwest, especially Haidian Island. The island integrates five-star hotels, top resort communities, and university education. The development and construction of residences, roads and shopping malls have led to changes in land use structures such as woodlands and waterbody and an increase in the area of construction land.

On the ArcGIS software platform, the original transfer matrix of land use is calculated by using the method of map algebraic calculation. As can be known from Table 1, the rate of change of various land types between study area 8a and the transfer rate between them is relatively large, and the conversion types are complex and diverse.

The area of construction land in Meilan District of Haikou City increased the most from 1993 to 2011, while the area of cultivated land, forest land and waterbody decreased, which shows from the side that the scale of urban space is expanding, the area of urban construction land is increasing, the demand for land is increasing, resulting in the reduction of cultivated land, forest land and waterbody, and the increase and decrease of construction land and cultivated land, forest land and waterbody. Among them, the area of construction land increased by 6838.64 hm^2, an increase of up to 39.63%,

and other types of land decreased, especially forest land and cultivated land decreased by 6692.23 hm^2 and 6112.39 hm^2 respectively.

Judging from the transfer rate between various land use types, the forest land is mainly converted to construction land, the transfer rate is 17.22 percent, and the second is the transfer to cultivated land. Among the woodlands in 2011, cultivated and unused land contributed the most. Cultivated land is mainly transferred to urban construction land. The transfers rate is as high as 20.93 percent, followed by the transfer to forest land. Unused land and forest land contributed the most to cultivate land in 2011. The construction land is mainly converted into cultivating land. Among the construction sites in 2011, the contribution rate of cultivated land was the highest, at 25.98 percent. Unused land is mainly converted into cultivating and forested land. Woodland contributed the most to unused land in 2011.

Table 1 Land use conversion matrix in Meilan District from 1993 to 2011 (hm 2)

	Woodland	Water	Cultivated land	Unused land	Construction land	Total in 1997
Woodland	7622.88	67.91	7928.52	2421.48	1745.35	19786.17
Water	171.24	4141.22	1156.26	141.69	943.65	6554.09
Construction land	3565.94	548.98	6726.52	2015.19	4401.82	17258.47
Cultivated land	1542.99	323.94	5376.40	1416.54	4895.57	23555.45
Unused land	1890.18	36.29	2542.90	80.78	25.36	5584.53
Total in 2011	13093.94	5121.93	17443.06	6077.39	24097.11	67738.73

5.2 Analysis of the driving forces of dynamic changes in land use

Land use/cover change reflects the relationship between human beings and nature, and the issue of influencing factors and driving mechanisms of change is a key issue in the study of land use/cover change. This paper mainly discusses the impact of land use/cover change on the Meilan District of Haikou City from the following factors.

(1) population factors. Land-use change is the manifestation of human-land interaction and one of the most significant manifestations of human activities on natural resources and the environment. Haikou's population grew rapidly, reaching 1.6044 million by 2011. During this period, the rapidly increasing population will inevitably require a large number of urban construction land, to promote the urban fringe of land such as cultivated land, forest land, etc. into urban construction land. With the increase of population, the social pressure brought about by the tension between people and land is bound to further drive the drastic changes in land use.

People's living need has a special impact on land use/cover. With the development of society, the improvement of people's living standards, people's demands on social convenience are getting higher and higher, such as transportation, convenient transportation between cities and villages is the price of requisitioning forest land and agricultural land, which will also bring about land use/cover changes.

(2) economic factors. Population growth and economic development, domestic and foreign analysis of the driving force of urban expansion shows that population growth and socio-economic development are the main drivers of urban expansion. Since the reform and opening up, the economy has developed rapidly. Industrial structure adjustment, from the first, second to the tertiary industry, the economic output income of urban land is much greater than agricultural land, and agricultural land on the edge of the city has the potential to quickly convert into urban land. These agricultural land were quickly requisitioned as urban land and industrial sites, all kinds of enterprises and institutions in need of land have to the edge of the city to grab land, so the construction land area increased by up to 39.63 percent. From 1993 to 2011, the rapid expansion of cities is closely related to "real estate fever" in the research area. In this process, due to the occupation of land in the completion of construction into production takes a certain amount of time, which led to a part of the land idle out, affecting the efficiency of land use.

At the same time, the adjustment of agricultural structure will make some agricultural land want to change compared to agricultural land with higher economic output. If rice paddies and vegetable fields are converted to cash crop orchards, the area of orchards will increase, and the cultivated land will be reduced, and the reduced cultivated land will need to be compensated from the forest land, which will lead to the reduction of forest land.

(3) social factors. Social factors play an important role in land use/cover change. The influence on land use through policies, laws and other means is enormous, which guides the productive economic activities of the society, and then affects the mode and intensity of land use. The country's "Converting farmland to forest" policy of the 1990s, for example, would have prompted some of the cultivated land to be converted into forest land and no longer opened up for cultivated land. The establishment of the international tourist island in 2008 brought a large number of tourists to Hainan. Meilan District has Haikou Meilan International Airport, a large number of tourists in the area of Haikou, accelerated the construction of infrastructure, resulting in a surge in construction land.

6. Conclusions

From the above analysis, the following conclusions can be drawn:

(1) The changes in land-use in the study area are very complex, and the various types of land-use will be converted from one to the other. From 1993 to 2011, land-use changed dramatically, mainly due to demographic, economic and social policies and other factors.

(2) Between 1993 and 2011, the change in construction land was most pronounced, increasing by 6838.64 hm^2, followed by cultivated land area (forest land decreased by 6692.23 hm2 and cultivated land decreased by 6112.39 hm^2). Most of the expansion of construction land come from forest land and cultivated land.

(3) Land use in Meilan District between 1997 and 2011 showed an increase in the area of settlements and construction land and a decrease in the area of other types of land, which is consistent with the results of many regional studies and reflects the general law of land use changes during the period of population growth and rapid economic development. But this should be paid enough attention to in the Meilan area, which is dominated by agricultural production, and in the urban construction with ecological civilization construction as its core.

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