Remote Sensing-Based Spatiotemporal Analysis of Land Use Changes in Shanghai

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Keywords: Shanghai, Remote Sensing, Land Use Type, Urban Expansion.

Abstract: It is very important for urban planning and construction to monitor the change of urban land area in real time and investigate and analyze it. As the largest city in China and one of the major financial centers, Shanghai's land area changes are extremely obvious, especially located in a special position at the mouth of the Yangtze River, at the end of the plain of the middle and lower reaches of the Yangtze River. 3,000 years ago, a large amount of sediment brought by the upper reaches formed a broad coastal plain here. This phenomenon is still continuing now. The land area of Shanghai is about 5,800 square kilometers, while the current area of Shanghai is nearly 7,000 square kilometers, and the area has changed greatly, which has a great impact on the administration and urban planning of Shanghai. This paper will use arcgis to make maps of Shanghai from 1980 to 2010 and draw corresponding coastlines to analyze the change of Shanghai's land area. The comprehensive influence of land reclamation and sediment deposition on Shanghai in recent years is reflected by exploring the change of its land structure.

1 INTRODUCTION

In recent years, with the continuous development of remote sensing technology, we have learned a lot of information through satellite data, which is of great help for us to analyze the change of urban land area in time and space (Du Peijun, Liu Sicong, & Tan Kun, 2012). Remote sensing monitoring of urban land use change is of great significance for accurately grasping the characteristics of urban expansion, optimizing the pattern of urban land use, and promoting coordinated regional development (Li Xiaoyong & Kuang Wenhui, 2019). On the whole, the land use in Chinese cities is changing from low to high level (Liu Jiyuan & Buheaosier,2000). Through satellite data from different regions and time, we will focus on the economic center of Shanghai to explore the reasons and impacts of such a huge change in land area since the 1990s. Rational urban expansion and land use are of great significance(Wu Dewen, Mao Hanying, Zhang Xiaolei, & Huang Jinchuan, 2011).Although with the development of human society, urban construction and land use are constantly promoted, we still encounter problems of one kind or another in the face of natural factors (Xiang Chunling, 2014). Shanghai is located in the alluvial plain of the middle and lower reaches of the Yangtze River. The terrain of the middle and lower reaches of the Yangtze River is flat, and the sediment is mainly sedimentation (Zhao Qingying, Yang Shilun Liu Shouqi,2002). Every year, the huge amount of sediment carried by the rolling water of the upper reaches of the Yangtze River is deposited in the lower reaches. As a result, the land area of Shanghai along the river and along the coast is increasing day by day (Xiaodong Zhang, Rui Xie, Daiyu Fan, Zuosheng Yang, Hongmin Wang, Chuang Wu, & Yuhan Yao, 2004). At the same time, due to the continuous development of the city and the continuous increase of land use, Shanghai's land reclamation is also the reason for the change of its land area and the constant change of land feature structure. The harmonious coexistence between man and nature has always been a key issue discussed by the times (Zhou Hongchun & Dai Tiejun, 2023). As a space for human survival, it is very important for cities to rationally plan and coordinate the surrounding environment, especially for cities like Shanghai, which are deeply influenced by both the natural environment and human society.

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Fang, Z.
Remote Sensing-Based Spatiotemporal Analysis of Land Use Changes in Shanghai.
DOI: 10.5220/0013043000004601

In *Proceedings of the 1st International Conference on Innovations in Applied Mathematics, Physics and Astronomy (IAMPA 2024)*, pages 241-246
ISBN: 978-989-758-722-1

It is very important for eco-city construction to reasonably balance the relationship between the ever-increasing land area and urban construction (Huang Guangyu & Chen Yong, 1997). At the same time, while natural sediment deposition, Shanghai's reclamation has a great impact on its land area change. The area of its own wetland is also being encroached upon (Yi A L & Wang J, 2021). Nevertheless, the practice of Shanghai itself is of great value for discussion and worth learning from, especially under the complex urban conditions of multiple nature reserves in Shanghai at the same time. The complex reasons behind it and the real land area changes are of great interest to us.

2 MATERIALS AND METHODS

2.1 Study Area

Shanghai is located in the east of China, on the west coast of the Pacific Ocean, where the Yangtze River and Qiantang River flow into the sea. It is part of the alluvial plain of the Yangtze River Delta. It lies between 120° 52 '-122 ° 12' east longitude and 30° 40 '-31 ° 53' north latitude. The land area is 6,340.5 square kilometers. On average, the land area along the river and coastal areas will increase by nearly 10 square kilometers every year. As of December 31, 2009, the city's cultivated land 1897.59 square kilometers; 179.89 square kilometers; 506.05 square kilometers of forest land; 16.41 square kilometers of grassland; 2557.94 square kilometers of land for towns, villages and industrial and mining areas; 402.17 square kilometers of transportation land; 2,749.17 square kilometers of water area and water conservancy facilities; Other land 49.90 square kilometers.

2.2 Data Acquisition and Methodology

Data source is mainly from the United States Geological Survey (usgs) landset5 remote sensing digital image, resolution of 30 × 30 meters. Moreover, through screening, our research period was from 1984 to 2010. Since the research area was in the south, the cloud cover of these remote sensing satellite data was selected as small as possible, and the images with little noise interference were selected as far as possible. Meanwhile, the ground control point (GCP) and digital elevation model (DEM) were corrected and processed on landset satellite data. Data preprocessing and radiation calibration, atmospheric correction and splicing cropping of the original satellite data to obtain the initial image, these steps not only help to eliminate the noise and bias in the image, but also improve the reliability of subsequent analysis. In addition, EDRAS IMAGINE version 9.2 is used to classify the land into urban land, rural construction land, agricultural land, sediment deposition, industrial land, industrial land, and water body. The planning is classified one by one, and different land elements are accurately extracted. Then, the classified images are used to set the legend scale and warp and latitude network through Arcmap, and different land use types are marked with different colors on the legend to make different land use more clearly displayed in the image. In this way, the land classification map of Shanghai in different years is formed. These processes and methods enable us to have a clear and obvious understanding and feeling of the urban change and development and land planning of Shanghai in different years, as well as the influence of natural sediment deposition on Shanghai.

2.3 Urban Expansion Change Detection

Due to a large amount of land reclamation and a large amount of sediment deposition in the upper reaches of the Yangtze River, the land area along the coastal areas of Shanghai is increasing day by day, which also has an impact on the original land structure of Shanghai. Therefore, we need to intuitively feel the changes of the land area of Shanghai by comparing the land structure of Shanghai in different years with the changes of the coastline of Shanghai in the past 20 years. Firstly, the data of Shanghai satellite in recent 20 years are extracted, and the remote sensing images are binarized by edras, and the sea water and land are separated and classified. The binary image is used to enhance the edge of the classified image. The edge enhancement function in ERDAS IMAGINE is adopted and 3×3 transformation kernel is selected to complete the process. Thus complete the coastline extraction. In addition, using the classification method again, the land structure of Shanghai is divided into vegetation, nature reserves, buildings, wastelands, and coastal shoals. Each element is accurately extracted, classified and mapped. Then, the classified land image of Shanghai is extracted into arcmap. By adding legend and scale and adjusting the image size, the land cover structure map of Shanghai in a certain year in the past 20 years is drawn, and the land classification map is made year by year, and finally compared.

3 RESULTS

Shanghai's urban expansion and full development of land resources from 1984 to 2010 is a typical example of today's mega-economic cities.

(1) The expansion mode and rapid development performance of Shanghai. For Shanghai, which has been one of the economic centers in the 20th century, the main reasons for its urban expansion are the development through reform and opening up, the advantages of geographical location for transportation, and the suitable climate located in the subtropical zone. After research, its development mode is reflected in the late 1980s with the People's Square as the center, radiating the surrounding area, to the geographical location, using its gentle terrain to vigorously develop industry, but also using its advantage of the sea to carry out industrial construction. More and more agricultural construction areas become cities, and the proportion of urban land is increasing.

(2) The adjustment and change of the proportion of land use types in Shanghai. In the early 1980s, the land use of Shanghai was less than that of today. Urban land was concentrated but accounted for a small proportion, rural construction land was large and extensive, industrial areas were not concentrated enough, and undeveloped land area was large. By 2010, the gap between the proportion of agricultural land and urban land in Shanghai has been decreasing, and the high-density urban area of Shanghai has increased to 2,117.51 square kilometers in 2010. At the same time, urban land increased, industrial land began to concentrate on a large scale, there were industrial land and dredged fisheries resources area, land types were rich, and urban expansion land resources development increased.

In the process of 1984-2010, the urban expansion of Shanghai was remarkable. In the 2010 urban classification map, it can be clearly seen that the urban land of Shanghai was transformed from the original People's Square as the center to the construction area of near and far suburbs into industrial land and urban land. The original sediment deposit area of Jiangxin Island was hollowed out and turned into a fishery resource area. As can be seen from the figure, in fact, the gap between the proportion of agricultural construction land and the

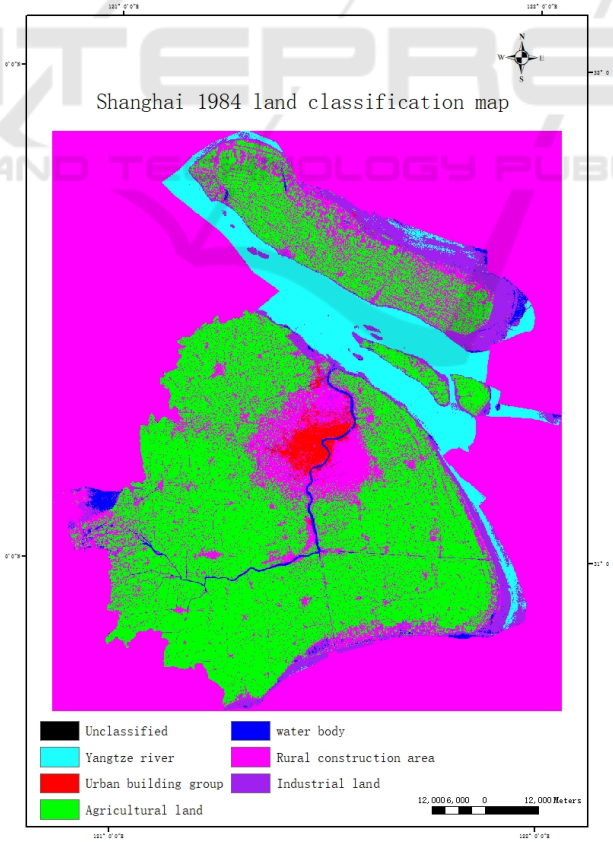

Figure 1: Shanghai 1984 land classification map (Picture credit: Original).

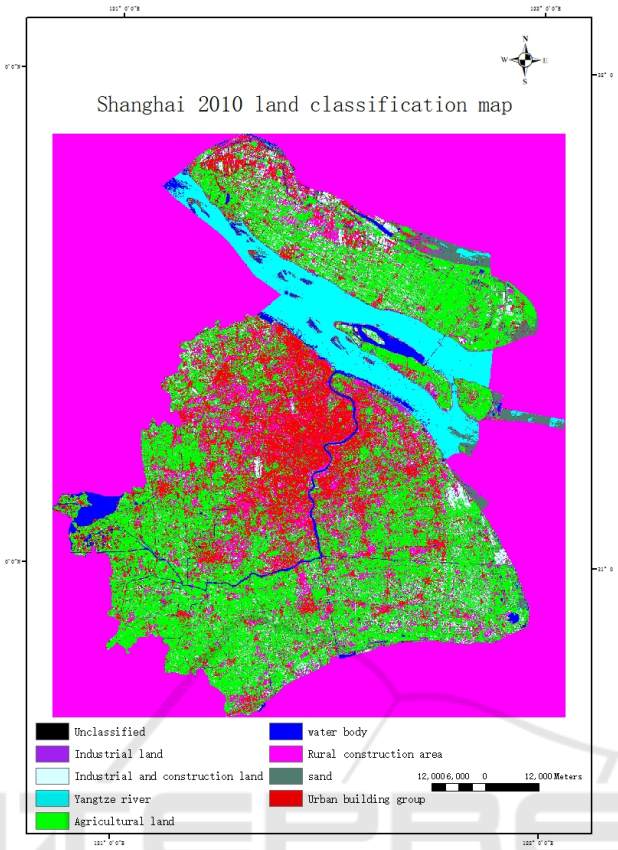

Figure 2: Shanghai 2010 land classification map (Picture credit: Original).

total land area of Shanghai and the proportion of urban construction land in 2010 is getting smaller, and the industrial zone is getting larger. Meanwhile, due to the development of transportation and economy, the industrial and transportation land in Shanghai is developing rapidly. The high-density urban area of Shanghai has increased to 2,117.51 square kilometers, which is several times that of the same kind of land in Shanghai in 1984. Meanwhile, due to population expansion and population inflow, Shanghai began to develop cities in the outer suburbs in order to alleviate the population pressure in the central urban area, and implemented the policy of "one city, nine towns". This has also promoted Shanghai's urban expansion and the development and utilization of suburbs in another dimension. It can be inferred that in 2010, Shanghai's outer suburbs will be the main industrial land growth, increasing to 471.30 square kilometers. The development of the central city is saturated, and the construction of the outer suburbs is growing, and the industrial land is more regionally concentrated.

4 CONCLUSION

Land use change is an important manifestation of the coordination between human activities and natural environment, and the study of satellite remote sensing data in its spatio-temporal dimension can better demonstrate the process of urban spatio-temporal expansion.

Under the influence of reform and opening up, and driven by the market economy, Shanghai's land development and utilization has changed by a big ten, from the central group of People's Square to the radiation development centered on the central city. This is also closely related to the geographical location and policies of Shanghai. Due to its proximity to the sea, the continuous growth of industrial land in Shanghai during this period directly promoted the increase in the area of industrial land in Shanghai and drove the surrounding economy. Moreover, fishing and agriculture in Jiangxin Island and other places also developed, and fishing areas were built by dredging. In 2001, with the

implementation of the strategy of "One city and nine towns" in Shanghai, the urbanization area of Shanghai has expanded by leaps and bounds to the outer suburbs. The development of the whole city has also changed from the original single-center structure centered on the People's Square to the open multi-center group structure, and Xujiahui is becoming the new center of their respective regions.

In terms of time and space, it can be seen from the classification map that the spatial change of land development and utilization in Shanghai in different periods is uneven, and the pattern is generally more in the east and less in the west. With the passage of time, the trend of suburbanization of land development and utilization is obvious. In the early 1980s, the land development and utilization change in Shanghai was mainly concentrated in the central city, and by 2010, the land development and utilization change had shifted to the outer suburbs, and even crossed the near suburbs rapidly in the middle period.

In terms of land development and utilization types, the overall trend of land development and utilization change in Shanghai is that high-density urban areas increase the most area, and transportation develops significantly during this period. The emergence and concentration of industrial and transportation areas reflect the huge growth of industrial land in Shanghai and the great role of transportation in the development of Shanghai.

The change of rural construction land is to continue to expand outward, but with the development of central cities, the growth rate of rural construction will slow down to a certain extent, and rural land may be replaced by high-density buildings in the future.

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