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Study on Land Use Change of Tsingtao City Based on Remote Sensing

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Abstract: As an important economic center along the eastern coast of China, Tsingtao, in recent years, rapid urban construction and economic development undoubtedly have had a certain impact on the status of land use changes. This study takes Tsingtao as the research area, and uses the remote sensing image data of Landsat-7 ETM SLC-on in 2001 and Landsat-8 OLI_TIRS in 2014 and 2020 as the data source. First, use ENVI 5.3 software to analyze the remote sensing images of these three periods. Perform image preprocessing and supervision and classification respectively, and obtain relevant data on land use changes in Tsingtao during the study period, and then use ArcMap10.5 software to perform a series of processing such as mapping and drawing, and finally obtain the data to 2001, 2014 and 2020. Classification map of land use in Tsingtao in 2015. It can intuitively reflect the status of land use changes in Tsingtao in recent years through graphs, and at the same time further conduct a comprehensive comparison and analysis of the changes and reasons. The results show that from 2001 to 2020, the change trend of land use in the study area is relatively large. Among them, the proportion of woodland and construction land area continued to increase, increasing by 22.24% and 11.17% respectively; the proportion of cultivated land and grassland area showed a downward trend, while the area of water area was relatively small and did not change much.

Keywords: Remote sensing, Image process, Land use change, Tsingtao city.

1. Introduction

Land resource is one of the most important resources for economic development and human life. With the rapid development of China in the past 40 years, the supply of land resources in big cities has become increasingly tense. Land has become the core factor restricting the development of China's big cities. More efficient use of land is the main means to alleviate this problem. In order to achieve effective use of land, it is necessary to master the situation of land use change[1]. This study uses remote sensing as a technical means, remote sensing images as basic data, and uses supervised classification methods to extract land use information from remote sensing images, so as to master the change of land use in Qingdao, It provides quantitative reference for further efficient use and protection of land resources.

2. Situation of Study Area

Fig.1: Map of Tsingtao City

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Tsingtao is a coastal city in eastern China. It is located at the southern end of Shandong Peninsula. It is also the capital of Shandong Province. Tsingtao is an important industrial, commercial, trade and tourism city in China. With an area of 11293 square kilometers and a total population of 9 million, Tsingtao is familiar to the world with its beautiful coastal customs and famous Tsingtao beer. The administrative division of Tsingtao is shown in Fig. 1.

3. Data and Research Method

3.1. Data resources

The data used in this study is downloaded from the geospatial data cloud（ http://www.gscloud.cn ）. Based on the consideration of multiple factors such as data quality, cloud cover, satellite status and seasonal time, Landsat-7 ETM SLC-on in 2001, Landsat-8 OLI in 2014 and 2020 are finally selected as the data resources[2], detailed description of data resources was expressed by Tabel 1.

Table 1: Detailed description of data

Date	Data Type	Row/Column	Cloud Cover(%)
2001.4.12	Landsat 7 ETM SLC-on	120/34、120/35	0.01/0.01
2014.4.24	Landsat 8 OLI_TIRS	120/34、120/35	0.32/0.49
2020.4.24	Landsat 8 OLI_TIRS	120/34、120/35	0.22/0.28

3.2. Data Pre-Process

Data pre-process is one of the most basic and important step in this paper. It processes the original data into a state that meets the research requirements through a series of preprocessing operations. These operations mainly include the following:

Radiometric calibration. It refers to converting the recorded original DN value into the reflectivity of the outer atmospheric surface in order to eliminate the error of the sensor itself and determine the accurate radiation value.[3]

Atmospheric correction. It refers to the conversion of radiant brightness or surface reflectivity to actual surface reflectivity in order to eliminate errors caused by atmospheric scattering, reflection, absorption, etc. In this study, FLAASH module is selected for atmospheric correction.

Mosaicking. The object of Mosaicking is multiple remote sensing images with overlapping parts. Its purpose is to generate a new remote sensing image without overlapping through a series of processing operations. In this study, we choose to use seamless splicing method, because it can control the image mosaic process more finely through uniform color, generation of edge lines and other methods, and can also preview the mosaic results.

Image cropping. Which aims to remove the areas beyond the study area and only retain the image data of the study area. As the research area is Qingdao, the mosaic image should be cut to retain the image of Qingdao[4]. The use of vector data in the irregular framing clipping method is selected here, so the vector map of the study area needs to be drawn first, and then the image is clipped using the clipping tool.

After the above pre-process operations, the data for the next analysis were obtained, as shown in Fig. 2.

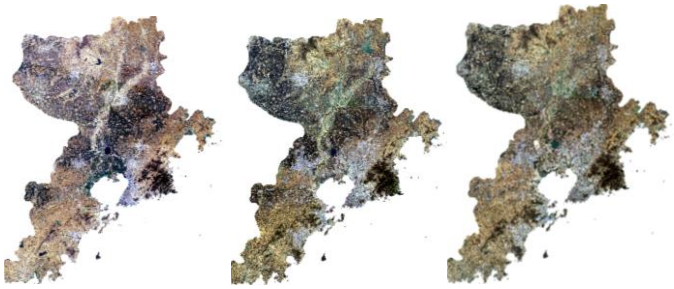

Fig. 2: Image cropping results in 2001, 2014 and 2020(from left to right)

3.3. Study on land use change

After we obtained the appropriate data by pre-processing, land use change situation of Tsingtao city can be studied. This work was completed by the following steps:

Selection and evaluation of training samples

Because supervised classification method was used to distinguish various land use types from remote sensing images in this paper, it needs to establish training samples to complete the supervised classification. Five types of samples were selected, namely, construction land, water area, forest land, farmland and grassland. The establishment of each type of sample was conducted by manual visual interpretation, and 30-50 samples were selected for each type of land use.

After the establishment of the sample, the quality of the sample needs to be evaluated, and the separation degree is mainly selected for this work. The separation degree is an indicator to evaluate the degree of difference between each type of sample. After calculation, the separation degree of the training samples in this study is between 1.8 and 2.0, with high precision, which belongs to qualified samples and can be used to perform supervision classification.

Supervised classification

After the establishment of training samples, it is possible to use training samples to extract the range of various land use types from remote sensing data[5]. In this process, we use ENVI software to automatically carry out the classification, in which the maximum likelihood method was used. The classification results of three times are shown in Fig. 3.

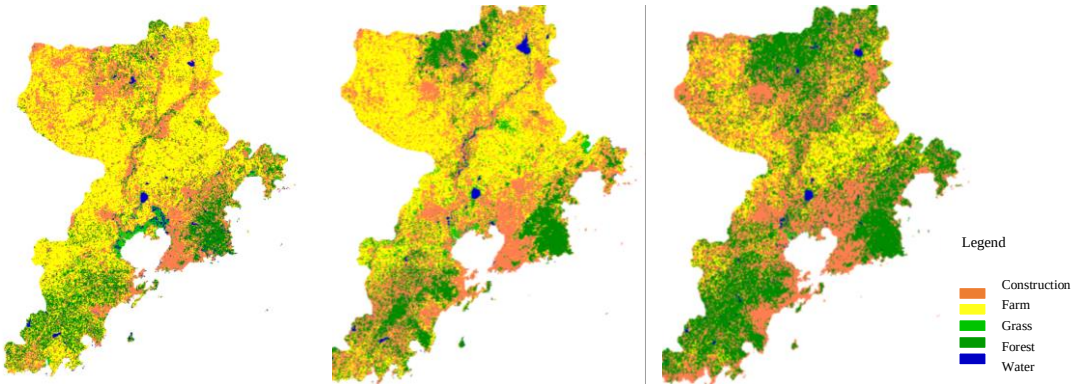

Fig. 3: Supervised classification results in 2001, 2014 and 2020（from left to right）

Classification accuracy evaluation

The evaluation of classification results is a way to judge whether the classification results are true or not. The most commonly used evaluation method is the confusion matrix, whose main indicators include the overall classification accuracy and Kappa coefficient. In ENVI software, the evaluation index values of this study are shown in Table 2. From the table, we can see that the overall classification accuracy and Kappa coefficient are at a very high level, which meets the needs of research work and proves that the classification results obtained are reliable.

Table 2: Overall classification accuracy and Kappa coefficient

Time	Overall classification accuracy （%）	Kappa	Whether met standard
2001	99.8210	0.9810	Yes
2014	99.4442	0.9859	Yes
2020	99.8138	0.9926	Yes

Transfer matrix

The transfer matrix is based on the comparison of the image differences between the two times, showing the mutual conversion of different types of land in the form of a matrix. It can directly display the land use

change. Using ENVI software as a tool[6], this study obtained the land use change of Qingdao from 2001 to 2014 and from 2014 to 2020. The results are shown in Table 3 and Table 4.

Table 3: Land use area transfer matrix from 2001 to 2014 (km²)

Land type	Construction	Water	Forest	Farm	Grass	2014
Construction	1987651	51641	625914	1617136	137570	4419912
Water	18882	55326	8356	23429	17158	123151
Forest	443977	21178	873841	542402	20441	1901839
Farm	1003187	7902	296620	3900606	19332	5227647
Grass	113736	21603	64055	227323	70821	497538
2001	3567433	157650	1868786	6310896	265322	12170087

Table 4: Land use area transfer matrix from 2014 to 2020 (km²)

Land type	Water	Construction	Forest	Grass	Farm	2020
Water	47551	12007	3433	13349	7559	83899
Construction	61460	2142444	408531	164883	2203364	4980682
Forest	38655	1167910	1378214	47166	2033030	4664975
Grass	7804	37637	8052	37189	37455	128137
Farm	2180	207435	70556	2735	2029488	2312394
2014	157650	3567433	1868786	265322	6310896	12170087

4. Results and Discussions

According to the data in Table 3 and Table 4, forest land and construction land are the main land use types in the study area. From 2001 to 2014, the farm land, construction land and grassland in the study area changed greatly. Among them, the area of farm land transferred out is 2410290km², It is much larger than the transferred in area of 1327041km², Mainly transferred to construction land and forest land, increasing 1617136km² respectively and 542402hm². The transferred areas of construction land and grassland are 2432261km²respectively and 426717km², however, the change of water area and forest land is small[7], and the area occupied by them also shows a downward trend.

During 2014-2020, the area of forest land, farm land and construction land in the study area changed greatly. The transferred area of forest land is 3286761km², 490572km larger than its transferred out area². Farm land transferred out 4281408km². It is mainly transferred out to construction land 2203364hm², Construction land transferred to 2838238km², Since 2001, the trend of growth has continued. The change of water area and grassland area is small, and the area occupied by them shows a downward trend.

5. Conclusions

In this paper, land use change of Tsingtao city was discussed. Landsat remote sensing image were used as the basic data resources, the ground features information were extracted from images by supervised classification, so that, the land use type situation of study area was obtained, and then, by comparing the land use types in different years, we can get the change of land use in Tsingtao city.

Through the work of this paper, the following conclusions are drawn:

Landsat images contain data on a global scale, so it is feasible for both global and urban scale surface monitoring.

When extracting land use type information from Landsat images, if the supervised classification method is used, the selection of samples has a direct and significant impact on the classification results.

Through the research of this paper, in the past 20 years, the land use change in Tsingtao city is relatively obvious, and its main trend is to convert cultivated land into construction land. This will pose new challenges to the development and ecological balance of the whole city.

In further studies, there are two points to improve the research results. On the one hand, the types of classify sample can be further increased, so that the types of land use can be distinguished in more detail. At the same time, more advanced classification methods can be used in the supervised classification, which can further improve the classification accuracy. The work in the two aspects will improve the final results.

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