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Remote Sensing Monitoring of Land Use Change in Jinan City

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Abstract. Studying land use change is an efficient means to deal with the problem of human and land in today's region. Therefore, this paper takes Jinan as the research area, taking Landsat8 OLI images in 2014, 2018 and 2021 as the data source, and uses ENVI software to preprocess the images (radiation calibration, atmospheric correction, geometric correction, image fusion, splicing and cropping), then uses the maximum likelihood method in supervised classification to study the area and distribution information of land use types in different periods, and finally compares the image classification results in the three periods. The study shows that during these three periods, the area of cultivated land and construction land has been increasing, the area of forest land and water body has decreased first and then increased, while the area of bare land has been decreasing. This result can provide theoretical basis for post-urban planning and sustainable development ecological environment management.

Keywords: land use change, Landsat8 remote sensing image, Maximum likelihood method, dynamic monitoring

1. Introduction

Land use largely reflects the degree of human influence in the land system, and the land system itself is a complex natural and social complex[1-3].In-depth study of land system can effectively optimize the research in various disciplines and technical fields and improve its research efficiency, involving important factors such as ecology, society and economy. Therefore, studying land use change is an efficient means to deal with the problem of human and land in today's region[4-5]. With the continuous development of the city, the limitations of modern land resources are obvious, the available land is decreasing day by day, and the ecological environment has changed dramatically due to the expansion of the city, which has affected the habitat of organisms in the ecosystem[6-8]. However, urban construction is accelerating the upgrading, and building demolition changes frequently, which adds to the workload of land-related work. The fixed position, limited area, different quality and relativity of sustainable use of land determine that land resources cannot be used at will. Nowadays, with the accelerated development of cities, how to solve the increasingly serious land use problem and how to alleviate the increasingly tense contradiction between people and land has become a shackle[9-10]. To solve such problems, it is necessary to monitor and investigate land use. Because the remote sensing earth observation technology has the advantages of wide coverage, strong macroscopic, fast, multi-temporal and rich comprehensive information.By monitoring, analyzing and comparing the changes of land use at different stages in the same area, more accurate data can be obtained while saving manpower and material resources, and the accuracy and efficiency of the results can be improved. With the help of remote sensing technology, this study monitored the land use types of Jinan in 2014, 2018 and 2021, and analyzed the land use situation of Jinan in each period. The conclusion can be used as a theoretical basis for future urban planning and sustainable development of ecological environment management.

2. Research Area and Research Methods

2.1. Study area

Jinan, also known as Quancheng,Shandong Province Administer prefecture-level cities,provincial capital、 sub provincial city、 megalopolis、 Jinan metropolitan area.Core city, confirmed by the State Council.Bohai rim region.The central city in the south wing. The total area is 10244.45 square kilometers.

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By the end of 2022, the permanent population of Jinan was 9.415 million, and the urbanization rate of the permanent population was 74.3%. Jinan is located in China.East China, central and western Shandong,North China Plain.The southeast edge is located between 36 01′-37 32′ north latitude and 116 11′-117 44′ east longitude.

2.2. Research data

Considering the multi-band and multi-resolution characteristics of Landsat8 remote sensing data, this study takes Landsat8 image as the data source. Downloading Landsat8 OLI remote sensing data from geospatial data cloud website requires two Landsat 8oli images with track numbers of 122-34 and 122-35, respectively. The downloaded images are in three periods of 2014, 2018 and 2021, with little cloud cover, no obvious ice and snow coverage, no stripes, good color contrast and good imaging quality. In addition, this study needs the administrative boundary of Jinan City to cut the spliced remote sensing image. The vector file of Jinan City boundary is downloaded from Alibaba Cloud DataV.GeoAtlas geographic gadget, and the data link is converted through MapShaper website, and then the data is processed through ArcGIS to get the vector file of administrative boundary of Jinan City.

2.3. Image data preprocessing

In this paper, the preprocessing of remote sensing image data mainly includes: radiation calibration (eliminating all the errors of radiation-related sensors in the image, using the Radiometric Calibration tool in ENVI), atmospheric correction (eliminating the errors caused by atmospheric scattering, Using FLAASH Atmospheric Correction model in ENVI, geometric correction (eliminating geometric distortion caused by atmospheric transmission, sensor itself, earth curvature and other factors, correcting geometric distortion caused by system and non-system factors, and using Select GCPs:Image to Image in ENVI Classic), image fusion (improving the utilization rate of image information, improving the accuracy and reliability of computer interpretation, and improving the original image)Spatial resolution and Spectral resolution, improve the spatial resolution to 15m, use the Diffuse Pan Sharpening tool in ENVI), image mosaic (get a seamless and full-range image covering Jinan, use Seamless Mosaic tool in ENVI) and image cropping (only keep the remote sensing information of Jinan, use the Subset Data from ROIs tool in ENVI).

2.4. Supervision classification

Supervised Classification is to select the feature parameters with the samples provided by the training area under the condition of prior knowledge (training site), establish a discriminant function, and then substitute the values of pixels of unknown types in the image into the discriminant function, and classify the ground objects to which the samples belong according to the discriminant criterion. Supervised classification can selectively determine the classification category according to the application purpose and regional characteristics, and avoid some unnecessary categories. Before supervised classification, it can be determined whether the training area samples are accurately classified by checking the training area samples, thus avoiding blindness and errors in classification, and avoiding re-classification of spectral clusters in unsupervised classification. There are many supervised classification methods, among which the calculation principles are different, such as characteristic space method, parallelepiped method, minimum distance method, maximum likelihood method and so on. Each method has its own advantages and disadvantages, and can be applied to different cases of classifying source data. In this study, a nonlinear classification method based on Bayesian criterion, namely Maximum Likelihood Classification, is selected. This method is simple and easy to implement, and the classification accuracy is relatively high.

3. Results and Analysis

3.1. Classification results and accuracy evaluation

According to the overall situation of actual land use in Jinan area, select the training sample type suitable for the whole research area. The land use in Jinan can generally be divided into agricultural cultivated land, bare land for development and utilization, developed and constructed area, vegetation forest land and water body, so the following five training samples are selected: cultivated land, vegetation, bare land, construction land and water body. After selecting the training samples, check the sample separation degree for three years,

all of which are above 1.9, and the accuracy is qualified, and classify them. The classification result is shown in Fig. 1.

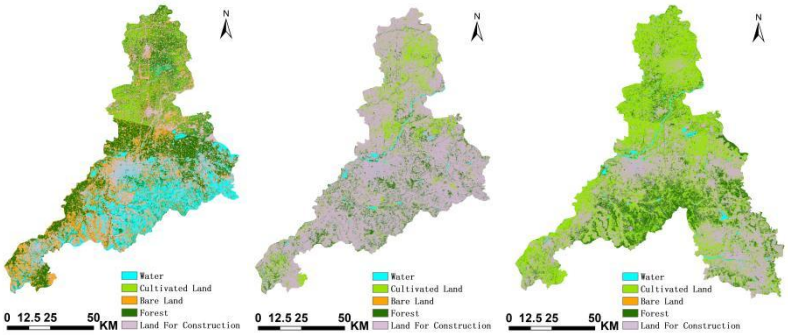

Fig. 1: Land use distribution map of Jinan in 2014, 2018 and 2021

As can be seen from the Fig.1, the scope of the study area has changed in the three periods. Because the administrative planning of Laiwu District and Gangcheng District was incorporated into Jinan City in 2019, the shape of the study area has changed.

After the classification is completed, the accuracy is evaluated, and the confusion matrix is tested by using the confusion matrix using ground truth roi tool in ENVI software, and the confusion matrix accuracy report is obtained (as shown in Table 1). The accuracy is higher than 90%, and the Kappa coefficient is greater than 0.8, which can meet the requirements of this study.

Table 1: Supervised classification accuracy and Kappa coefficient

Year	Classification accuracy	Kappa coefficient
2014	92.9329%	0.9108
2018	99.0798%	0.9845
2021	99.8342%	0.9916

As can be seen from Table 1, the accuracy of image classification in 2014, 2018 and 2021 were 92.9329%, 99.0798% and 99.8342% respectively, and the Kappa coefficients were 0.9108, 0.9845 and 0.9916 respectively. The accuracy is higher than 90% and Kappa coefficient is higher than 0.8, which shows that the classification results are of high accuracy and good classification, and can be used for result analysis.

By further using ENVI software, the proportion of various land use types is counted, and then the occupied area is calculated, and the results shown in Table 2 are obtained by summary.

Table 2:Statistics of maximum likelihood classification results of images in the study area

Land use types	2014		2018		2021	
	area/km^2	ratio/%	area/km^2	ratio/%	area/km^2	ratio/%
bare land	1448.96	18.12	1223.73	15.30	1434.223	14.00
woodland	1784.03	22.31	1287.72	16.10	2467.89	24.09
plough	1539.52	19.25	1742.02	21.78	2303.98	22.49
land for construction	1776.78	22.21	2842.85	35.50	3894.94	38.02
water body	90.56	1.13	90.38	1.13	143.42	1.4

It can be seen that the area of all kinds of ground objects in the three periods of the study has changed obviously. From 2014 to 2018, the construction land has increased significantly, and the area of cultivated land and forest land has decreased significantly. In 2021, with the inclusion of Laiwu area, the proportion of construction land increased again, but the proportion of forest land also increased.

3.2. Three-period image classification results analysis

The final classification result is ideal. We can analyze the image classification in 2014, 2018 and 2021, and compare the three time periods to realize the dynamic monitoring and analysis of land use in Jinan.

Comparing the classification results of the two images with the Change Detection Statistics tool in EVNI software, we can get the change matrices of the ground object categories in the study area from 2014 to 2018 and from 2018 to 2021 respectively, and further analyze the change matrices to get the land use change statistics table, as shown in Table 3.

Table 3:Statistics of land use change in Jinan City in each period

Land use type	2014 to 2018	2018 to 2021
bare land	-99.87%	-93.6%
woodland	-60.48%	44.424%
plough	58.102%	48.018%
land for construction	82.243%	42.896%
water body	-4.308%	46.511%

According to Table 3, from 2014 to 2018, bare land, forest land and water body all decreased, with bare land decreasing by 99.87%, forest land decreased by 60.48% and water body decreased by 4.308%. However, the cultivated land increased by 58.102% and the construction land increased by 82.243%. It can be seen that a large amount of land was developed for production activities from 2014 to 2018. According to the actual situation, Jinan's economy developed rapidly during this period. From 2018 to 2021, bare land decreased significantly, and other utilization types increased, with bare land decreased by 93.6%; Woodland increased by 44.424%, cultivated land increased by 48.018%, construction land increased by 42.896%, and water body increased by 46.511%. In 2019, Laiwu was merged into Jinan, which affected the land use situation in Jinan to some extent. The increase of woodland, cultivated land, construction land and water body came from the merger of Laiwu City to some extent. But at the same time, it can be seen that Jinan has started the policy of protecting and building forest land while developing and building land, and maintaining the ecological environment has become a topic in the new era. Protecting forest land and water bodies that conserve organisms plays a very important role in shaping a better urban living environment and ecosystem.

4. Conclusion

In this study, Jinan city was taken as the research area, and the remote sensing images of Landsat 8 OLI in 2014, 2018 and 2021 were used as the source data. The data were preprocessed and supervised by the maximum likelihood method, and the information of land use classification was obtained. Then, the image classification results of three periods were compared and analyzed, and the dynamic monitoring of land use change was realized. After analysis and research, it was concluded that from 2014 to 2021, cultivated land and construction, It is found that the land use in Jinan city has changed from a land development policy to a policy of taking into account ecological development and economic development. Provide reasonable basis and suggestions for the scientific development of Jinan in the future. With the rapid development of cities, urban ecology and residents' living environment need to be improved along with the improvement of living quality. General Secretary Xi Jinping emphasized in the Report to the 20th CPC National Congress of the Party: "Nature is the basic condition for human survival and development. Respecting nature, conforming to nature and protecting nature are the inherent requirements of building a socialist modern country in an all-round way. We must firmly establish and practice Lucid waters and lush mountains are invaluable assets's philosophy and plan development from the height of harmonious coexistence between man and nature. " Therefore, the development of Jinan has embarked on the road in line with today's trends and goals, and the next step can be to further study the relationship between land use types and ecological environment in Jinan and its impact.

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