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Analysis of Land Use Type Changes in Yulin City in the 21st Century

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Abstract

Using remote sensing monitoring data of land use/land cover in China in 2000 and 2020, this study explores the changes in land use types in Yulin City through the land use transfer matrix. The results indicate that the main types of land use in Yulin City are grassland, cultivated land, and unused land. From 2000 to 2020, the order of absolute changes in the area of land use types in the study area is: unused land>grassland>construction land>cultivated land>forest land>water area, and its changes are closely related to national ecological policies; The area of construction land has significantly increased after 2000, which is consistent with the process of urbanization development; The continuous decrease in water area is mainly influenced by natural factors. The changes in land use types in Yulin City are influenced by both natural and social factors, with ecological policies and urbanization development dominating.

Keywords

Yulin City; Land Use Type; Transition Matrix.

1. Introduction

Land use is the most direct transformation of the Earth's surface by human activities, running through the entire process of human survival and development, and is a product of the joint influence of humans and nature [1]. In recent years, with the development of the economy and changes in human survival methods, there have been significant changes in global land use/land cover, directly affecting global changes in terrestrial ecosystems [2]. Land use/land cover dynamic changes have gradually become a research hotspot for scholars both domestically and internationally, occupying an important position in the field of global sustainable development research [3].

Yulin City is located at the northern end of Shaanxi Province, on the west bank of the middle reaches of the Yellow River. The northern part of Yulin City belongs to the Maowusu sandy land, which accounts for 42% of the total area. The southern part belongs to the loess hilly and gully area, which accounts for 58% of the total area [4,5]. The terrain of this region is high in the northwest and low in the southeast, with a climate characterized by hot and rainy summers and cold and dry winters. The average annual temperature is 7-13 ℃, and the average annual precipitation is about 400 mm, with significant seasonal differences. It is one of the most severe areas of wind erosion, desertification, and soil erosion in China, and has a typical climate characteristic of the northwest semi-arid region. In recent years, with the protection and control of the ecological environment of the Mu Us sandy land in China, Yulin City has implemented ecological projects such as returning farmland to forests and grasslands, which have caused significant changes in land use/land cover in Yulin City and effectively restored the

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ecological environment. However, the stability of the ecological environment is still poor. Therefore, this study takes Yulin City as the research area, based on remote sensing data of land use from 2000 to 2020, and uses land use transfer matrix to grasp the spatiotemporal changes of land use types in Yulin City as a whole, aiming to provide theoretical support for ecological environment protection and sustainable development of regional ecological economy in the research area.

2. Materials and Methods

2.1. Data Source and Preprocessing

The data of this study is from the Resource and Environmental Science Data Center of the Chinese Academy of Sciences (http://www.resdc.cn) The provided China Land Use/Land Cover Remote Sensing Monitoring Database includes nine periods of land use remote sensing data from the late 1980s (1980), mid-1990s (1995/1996), late 1990s (1999/2000), 2005, 2010, 2015, 2018, and 2020, with a spatial resolution of 1 km. The types of land use include 6 primary types of farmlands, forest land, grassland, water area, residential land, and unused land, as well as 25 secondary types. This study selected data from two periods of 2000 and 2020 for the study of land use type changes. Remote sensing monitoring data of land use types were embedded and masked to obtain spatial distribution data of land use types in Yulin City in 2000 and 2020. Projection transformation was completed, and the unified projection was WGS84, with the storage type in TIF format.

2.2. Land Use/Cover Transfer Matrix

The change in land use types is not only an increase or decrease in area, but also a mutual transformation relationship between various types. This study is based on remote sensing monitoring data of land use/land cover, and utilizes functions such as ENVI density segmentation and confusion matrix to obtain a land use transfer matrix. This intuitively displays the structural characteristics of regional land use type changes and the direction of each land use type change, and quantitatively describes the transfer of land use types. The calculation method for the transfer matrix is shown in formula:

$$S_{ij}=\begin{bmatrix} S_{11}S_{12}\cdots S_{1n} \\ S_{21}S_{22}\cdots S_{2n} \\ \vdots \quad \vdots \vdots \quad \vdots \\ S_{n1}S_{n2}\cdots S_{nn} \end{bmatrix}$$

In the formula, Sij represents the area of different land use types. N is the number of land use types, and i and j are the serial numbers of land use types in the early and late stages of the study.

3. Result and Analysis

3.1. Temporal and Spatial Changes in Land Use/Cover

The main types of land use in Yulin City in 2020 were grassland and arable land, with an area of 18.874 km2 and 15.569 km2, respectively (Figure 1 and Table 1). They are widely distributed in the eastern and southern parts of Yulin City, forming a mixed landscape of arable land and grassland, accounting for approximately 80.88% of the total area of the area. Unused land and forest land take second place, with an area of 4125 km2 and 2431 km2, respectively. Most of the unused land is concentrated in the northwest of Yulin City, which is located in the Nanyuanfeng Beach area of Maowusu Sandy Land, accounting for 9.68% of the total area. Forest

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land is distributed in a scattered manner in the study area, with a high degree of fragmentation. The construction land and water area are relatively small and mostly distributed in the central part of the research area, with the construction land distributed in a point shape and the water area distributed in a linear shape.

The absolute changes in the area of land use types within the study area over the past 20 years were as follows: unused land>grassland>construction land>cultivated land>forest land>water body. The areas of grassland, construction land, and forest land increased by 1249 km2, 991 km2, and 571 km2, respectively, while the areas of unused land, cultivated land, and water body decreased by 1736 km2, 974 km2, and 83 km2, respectively. The cultivated land area showed a phenomenon of first increasing and then decreasing, significantly increasing from 2000 to 2020, while other land use types showed a slow change trend. Special attention should be paid to the continuous decrease in the water area of Yulin City, mainly due to global climate drought. Against the backdrop of global warming, the evaporation in the region continues to rise, while there is no significant trend in rainfall [14], resulting in a decrease in water area. For semi-arid areas, water bodies have a very important impact on the improvement of the entire ecosystem service function. Therefore, it is necessary to not only improve the impact of global climate drought on the ecosystem of the study area, but also protect local water resources from pollution and destruction.

Table 1. Area statistics of Land use types in Yulin City from 2000 to 2020

LUCC	2000		2020	
	Area/km²	Proportion /%	Area/km²	Proportion /%
Cultivated land	16 632	39.06	15 569	36.56
Woodland	1 995	4.69	2 431	5.71
Grassland	18 589	43.66	18 874	44.32
Artificial surface	130	0.31	1 100	2.58
Water	561	1.32	490	1.15
Unused land	4 672	10.97	4125	9.68

3.2. Land Use/Cover Transfer Matrix

Table 2. Land use transfer matrix of Yulin City from 2000 to 2020

Transfer area /km2	Cultivated land	Woodland	Grassland	Artificial surfac	Water	Unused land	Total
Cultivated land	8 724	817	6 400	309	124	257	16 631
Woodland	546	804	496	41	10	98	1 995
Grassland	5 690	687	10 686	466	99	955	18 583
Artificial surface	55	3	19	43	8	2	130
Water	130	20	147	26	214	22	559
Unused land	428	99	1 120	214	25	2 785	4 671
Total	15 569	2 431	18 874	1 100	490	4 125	42 579

Obtain the transfer matrix of land use types in Yulin City from 2000 to 2020 based on land use type data from 2000 to 2020 (Table 2). From the table, it can be seen that there was a significant transfer of land use types in Yulin City from 2000 to 2020, with the main transfer direction being the mutual transfer of arable land and grassland, grassland and unused land. The changes in land use types in Yulin City mainly occurred between 2000 and 2020, and the decrease in

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arable land mainly occurred in grasslands and construction land; The increase in forest land and grassland mainly comes from the conversion of unused land, cultivated land, and forest grassland. The rapid increase in construction land in Yulin City from 2000 to 2020, with construction land increasing from 130 km2 to 1100 km2, mainly due to the transfer of arable land, grassland, and unused land. The water area continues to decrease, decreasing from 559 km2 to 490 km2. The main direction of its transfer is grassland and construction land, with a large proportion of water turning to grassland, indicating that the reduction of water area is jointly affected by human activities and natural factors, and natural factors dominate.

4. Summary

(1) The main types of land use in Yulin City are grassland, cultivated land, and unused land. Between 2000 and 2020, the absolute change in the area of land use types in the study area was as follows: unused land>grassland>construction land>cultivated land>forest land>water body. The areas of grassland, construction land, and forest land increased by 1249 km2, 991 km2, and 571 km2, respectively, while the areas of unused land, cultivated land, and water body decreased by 1736 km2, 974 km2, and 83 km2, respectively.

(2) From 2000 to 2020, there was a significant transfer of land use types in Yulin City, with the main transfer direction being the mutual transfer of arable land and grassland, grassland and unused land. The construction land has increased from 130 km2 to 1100 km2, mainly due to the transfer of arable land, grassland, and unused land. The water area continues to decrease, and its main direction of diversion is grassland and construction land.

(3) The changes in land use types in Yulin City are influenced by a combination of natural and social factors, and are closely related to national ecological policies; The area of construction land has significantly increased after 2000, which is consistent with the process of urbanization development; The continuous decrease in water area is mainly influenced by natural factors.

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