

Analysis of Cropland Changes in the Arid Northwest Region of China - A Case Study of Yulin City

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ABSTRACT

Utilizing land use/land cover (LULC) remote sensing monitoring data from China for the 1980s, 2000, and 2018, this study investigated the patterns and driving forces of cropland change in Yulin City through the application of a land use transfer matrix. The results indicated that the cropland area initially increased and then decreased, a trend closely associated with national ecological policies. Cropland changes in Yulin City were influenced by both natural and socio-economic factors, with ecological policies and urbanization development playing dominant roles.

KEYWORDS

Yulin City; Cropland; Driving forces; Transfer matrix

1. INTRODUCTION

Yulin City is located in the northern part of Shaanxi Province, on the western bank of the middle reaches of the Yellow River. Its northern part belongs to the Mu Us Sandy Land, characterized by windy, sandy grasslands, accounting for 42% of the city's area, while its southern part falls within the Loess Hilly and Gully Region, constituting 58% of the total area [1-2]. The terrain is higher in the northwest and lower in the southeast. The climate is characterized by hot, rainy summers and cold, dry winters, with an annual average temperature of 7–13 °C and an average annual precipitation of approximately 400 mm, showing significant seasonal variation [3]. It is one of the regions in China most severely affected by wind erosion, desertification, and soil erosion, exhibiting typical semi-arid climate features of Northwest China. In recent years, alongside national efforts to protect the ecological environment and combat desertification in the Mu Us Sandy Land, Yulin City has implemented ecological projects such as the Grain for Green Program (conversion of cropland to forest and grassland). These initiatives have induced significant changes in the land use/land cover of Yulin City, leading to effective ecological restoration; however, the stability of the ecological environment remains relatively fragile [4-5]. Therefore, this study takes Yulin City as the research area. Based on remote sensing data of land use from the 1980s to 2018, and employing the land use transfer matrix and land cover status index, this research aims to comprehensively understand the spatiotemporal characteristics of cropland change in Yulin City and explore its driving factors. The goal is to provide theoretical support for ecological environmental protection and the sustainable development of the regional eco-economy in the study area.

2. DATA SOURCES AND RESEARCH METHODS

2.1. Data Sources

The data used in this study were obtained from the Chinese Land Use/Land Cover Remote Sensing Monitoring Database provided by the Resource and Environmental Science Data Center of the Chinese Academy of Sciences (<http://www.resdc.cn>). This database includes eight periods of land use remote sensing data: the late 1980s (1980s), mid-1990s (1995/1996), late 1990s (1999/2000), 2005, 2010, 2015, and 2018, with a spatial resolution of 1 km [15]. This study selected data from three periods (the 1980s, 2000, and 2018) to investigate cropland changes. The cropland remote sensing monitoring data were mosaicked and extracted via masking to obtain spatial distribution data of cropland in Yulin City for the 1980s, 2000, and 2018. Projection transformation was performed, unifying the projection to WGS84, with the storage format being TIF.

2.2. Transfer Matrix

Cropland change involves not only increases and decreases in area but also mutual conversions among different land types. Based on the land use/land cover remote sensing monitoring data, this study utilized functions such as density slicing and confusion matrix in ENVI to derive the land use transfer matrix. This approach visually displays the structural characteristics of regional cropland changes and the directions of change among various land use types, enabling a quantitative description of cropland transfer.

3. RESULTS AND ANALYSIS

3.1. General Characteristics of Cropland Change

In 2018, the cropland area in Yulin City was 15,569 km², widely distributed in the eastern and southern parts of the city, forming a mixed landscape of cropland and grassland, accounting for approximately 80.88% of the total area of the region. Between the 1980s and 2000, the spatial pattern of cropland in Yulin City remained relatively stable overall. Significant changes in cropland occurred between 2000 and 2018. Over the 40-year period, the absolute change in cropland area within the study area was 974 km² (Table 1). The cropland area exhibited a pattern of initial increase followed by decrease.

Table 1. Area Statistics of Cropland in Yulin City from the 1980s to 2018

	1980s		2000		2018		1980s~2018 Change /km ²
	Area/km ²	proportion/ %	Area/km ²	proportion/ %	Area/km ²	proportion /%	
Cropland	16 551	38.87	16 632	39.06	15 569	36.56	-974

3.2. Land Use Transfer Matrix

Using cropland data from Yulin City for the 1980s, 2000, and 2018, the land use transfer matrices for Yulin City from the 1980s to 2000 and from 2000 to 2018 were obtained (Table 2). As shown in the table, land use type conversion in Yulin City from the 1980s to 2000 was not pronounced, with a transfer rate of only 4.14%. The land type with the largest transfer area was unused land, of which 1,183 km² was converted to grassland, while 68 km² and 58 km² were converted to cropland and woodland, respectively; other transfer areas were relatively small. Compared with the period 1980s–2000, land use transfer in Yulin City from 2000 to 2018 was significant, with the main transfer directions being mutual conversion between cropland and grassland, and between grassland and

unused land. Cropland changes in Yulin City primarily occurred between 2000 and 2018. The primary destinations for decreased cropland were grassland and construction land.

Table 2. Land Use Transfer Matrix of Yulin City from the 1980s to 2000 (Area: km²)

Transfer Area /km ²	Cropland	Woodland	Grassland	Construction Land	Water	Unused Land	Total
Cropland	16 464	14	30	9	2	32	16 551
Woodland	10	1 814	33	0	0	3	1 860
Grassland	78	109	17 339	5	6	88	17 625
Construction Land	0	0	0	109	0	0	109
Water	12	0	4	0	552	7	573
Unused Land	68	58	1 183	7	1	4 544	5 861
Total	16 632	1 995	18 589	130	561	4 672	42 579

4. DRIVING FORCE ANALYSIS

4.1. Natural Factors

Changes in natural factors inevitably lead to alterations in the cropland pattern of the study area. Temperature and precipitation directly affect vegetation growth and distribution. Against the backdrop of global warming, the annual average temperature in Yulin City gradually increased from the 1980s to 2000, while precipitation slowly decreased. After 2000, the overall intensity of temperature change weakened, and precipitation fluctuated considerably but showed no clear increasing or decreasing trend. The rise in temperature increased evapotranspiration in Yulin City, and with no significant change in precipitation, the area of water bodies in the region continued to decrease.

4.2. Socio-economic Factors

Cropland change results from the combined effects of multiple driving forces. In addition to climatic conditions influencing cropland, human activities and national policies are another driving force behind cropland changes in Yulin City. Since 1998, the implementation of national projects for desertification control, the Grain for Green Program, and cropland protection policies, coupled with the response of the Yulin municipal government, accelerated cropland changes. In Yulin City during 2000–2018, cropland area decreased, while grassland and woodland areas increased significantly, correlating with the Grain for Green Program.

5. CONCLUSION

The cropland area in Yulin City decreased by 974 km². Land use type transfer in Yulin City was significant from 2000 to 2018, with the main directions being mutual conversion between cropland and grassland, and between grassland and unused land. Cropland changes in Yulin City were influenced by a combination of natural and socio-economic factors. The cropland area exhibited a pattern of initial increase followed by decrease, a trend closely associated with national ecological policies.

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