Analysis of Land Use Dynamics and Driving Forces in Xilin Gol League, Inner Mongolia

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Abstract

Based on the remote sensing data of Xilin Gol League in 1995, 2005, 2015 and 2020, with the support of ENVI5.3 and ArcGis10.6, this paper analyzes the dynamic evolution law of land use in Xilin Gol League by using land use transfer, land use dynamic attitude and driving force, and provides reference for land management and ecological protection in Xilin Gol League. The results showed that: (1) From 1995 to 2020, the area of Cropland, forest land, industrial and mining and water area all showed an increasing trend, while the area of grassland and unused land showed a decreasing trend (2) From 1995 to 2020, the dynamic attitude of single land use of Cropland, forest land, water area, industrial and mining in-creased, while grassland and unused land decreased. The dynamic attitude of comprehensive land use showed an overall downward trend. (3) The dynamic change of land use in Xilin Gol League from 1995 to 2020 is mainly due to the influence of population increase, rapid eco-nomic development and natural environment factors.

Keywords

Transfer Matrix; Land Use; Driving Force; Xilingol League.

1. Introduction

Land use refers to the use status of land or the social and economic attributes of land [1], including the use mode of land biophysical characteristics and also the intention hidden under thecontrol of land biophysical characteristics. Land use change can reflect the complex relationshipbetween human beings and the environment [2], and is one of the core fields of current globalenvironmental change research [3,4]. By analyzing the dynamic changes of different land uses in time and space, the impacts of human activities on ecology, resources and environment can be directlyor indirectly reflected [5]. In the research onland use, the traditional artificial fieldinvestigation method time-consuming to low efficiency, difficult to meet the needs of social development, remote sensing technology because of its wide observation, collecting large amount of information and observation time is short, are widely used in the land use data collection, such as ji-yuan liu [6] people through remote sensing information technology, The evolution process of land use in the 20thcentury is analyzed. Wang Liangjian et al. [7] used aerial remote sensing combined with GIS technology to quantitatively analyze the dynamic change process ofland use in the region and the mutual transformation of various land use types.

Based on the previous work, this paper takes Xilin Gol League as the research area, uses the land use change data of 1995, 2005, 2015 and 2020, and uses ArcGIS10.6 and Envi5.3 to calculate the land use transfer matrix and land use dynamic attitude, and analyzes the driving force of land use change. Based on the land use pattern and economic development needs of thestudy area, the paper provides guidance for the formulation of overall land use planning, land management and ecological protection

2. StudyArea and Data Source

2.1 Overview of the Study Area

Xilingol League is located in the central partof Inner Mongolia Autonomous Region, between 115°13 '~ 117°06' E and 43°02 '~ 44°52' N, covering a total area of about 203,000 km^2. In 2020, the GDP of

Xilin Gol League reached 83.984 billion yuan, with a permanent population of 1.1071 million, among which 817,900 were urban residents, accounting for 73.88%. The rural population is 289,200, accounting for 26.12%. Compared with the sixth national population census in 2010, the permanent resident population increased by 79,053 people, of which the urban population increased by 189,439 people and the rural population decreased by110,386 people, with the urban population proportion rising by 12.75 percentage points. Xilingol league area is a high level was themain body, with a variety of landscape areas,the terrain meteorological low north, east, south how low mountain hills, basin, strewn at random, meanwhile, for the greater hinggan mountains to the west and the yinshan mountains eastward flows, flat terrain west and north, scattered with some low hills and lava plateau, plateau meadows. Altitudes between 800~1800 meters, the northern temperate continental climate, the climate is characterized by strong wind, drought, cold, 20 major rivers, 1363 large and small lakes.

2.2 The data source

Two Landsat-5 TM images in 1995 and 2005 and two Landsat-8 OLI remote sensingimages in 2015 and 2020 were selected as the basic data. The images were acquired during the vegetation growing season (June to August) of Xilin Gol League, which was convenient for visual interpretation.Firstly, geometric correction, radiometric calibration and Flaash atmospheric correction were performed on the basic image. Secondly, through visual interpretation combined with the high-resolution data view provided by Google Earth, interpretation marks were established to supervise and classify the landuse in the study area. The classification accuracy was all greater than 80%, meeting the classification requirements.

Statistical Yearbook of Xilin Gol League; Communique of the 7th National Population Census of Xilin Gol League.

3. The Research Methods

3.1 Land use Transfer Matrix

The land use transfer matrix can be used to reflect the area change of land use type conversion in the study area during the study period. The calculation formula[8] is as follows.

$$S_{ij} = \begin{bmatrix} S_{11} & S_{12} & S_{1j} & S_{1n} \\ S_{21} & S_{22} & S_{2j} & S_{2n} \\ S_{i1} & S_{i2} & S_{ij} & S_{in} \\ S_{n1} & S_{n2} & S_{nj} & S_{nn} \end{bmatrix}$$

S is land use area, S_{ij} is the area of type i land use type when t_1 is converted to type j land use type when t_2, and n is the number of land use types.

3.2 Land use Dynamic Attitude

3.2.1 Single Land use Dynamic Attitude

It is used to quantitatively describe the rate of quantity change of certain land use types in a certain period of time. The calculation formula[9] is as follows.

$$K = \frac{U_b - U_a}{U_a} \times \frac{1}{T} \times 100\%$$

K is the dynamic attitude of a single land use, U_a and U_b are the number of a certainland use type at the beginning and end of the study, respectively, and T is the length of the study period.

3.2.2 Comprehensive Land use Dynamic Attitude

It reflects the overall change of land use types in the study area during the study period, and the calculation formula[10] is as follows.

$$L_c = \frac{\sum_{i=1}^{n} \Delta L_{ui-j}}{2\sum_{i=1}^{n} L_{ui}} \times \frac{1}{T} \times 100\%$$

L_c is the dynamic attitude of comprehensive land use , L_{ui} is the land area of site i at the beginning of the study period , L_{ui-j} is the area of land class i changing into land class j during the study period , n is the total number of different land classes in the study area , and T is the year between the study period.

4. Results and Analysis

4.1 The Basic Characteristics of Land use Change

The land use types in Xilingol League have changed greatly in recent 25 years (Figure 1, Table 1), which is mainly manifested as the increase of cultivated land area by 409km^2, or 0.2%; The forest area increased by 228km^2, or 0.11%; The water area increased by 259km^2, with an increase of 0.13%; The urban and rural industrial, mining and residential land increased by 705km^2, an increase of 0.35%; The grassland area decreased by 1154km^2, with a decrease of 0.76%. The unused land decreased by 4km^2, or 0.02%.

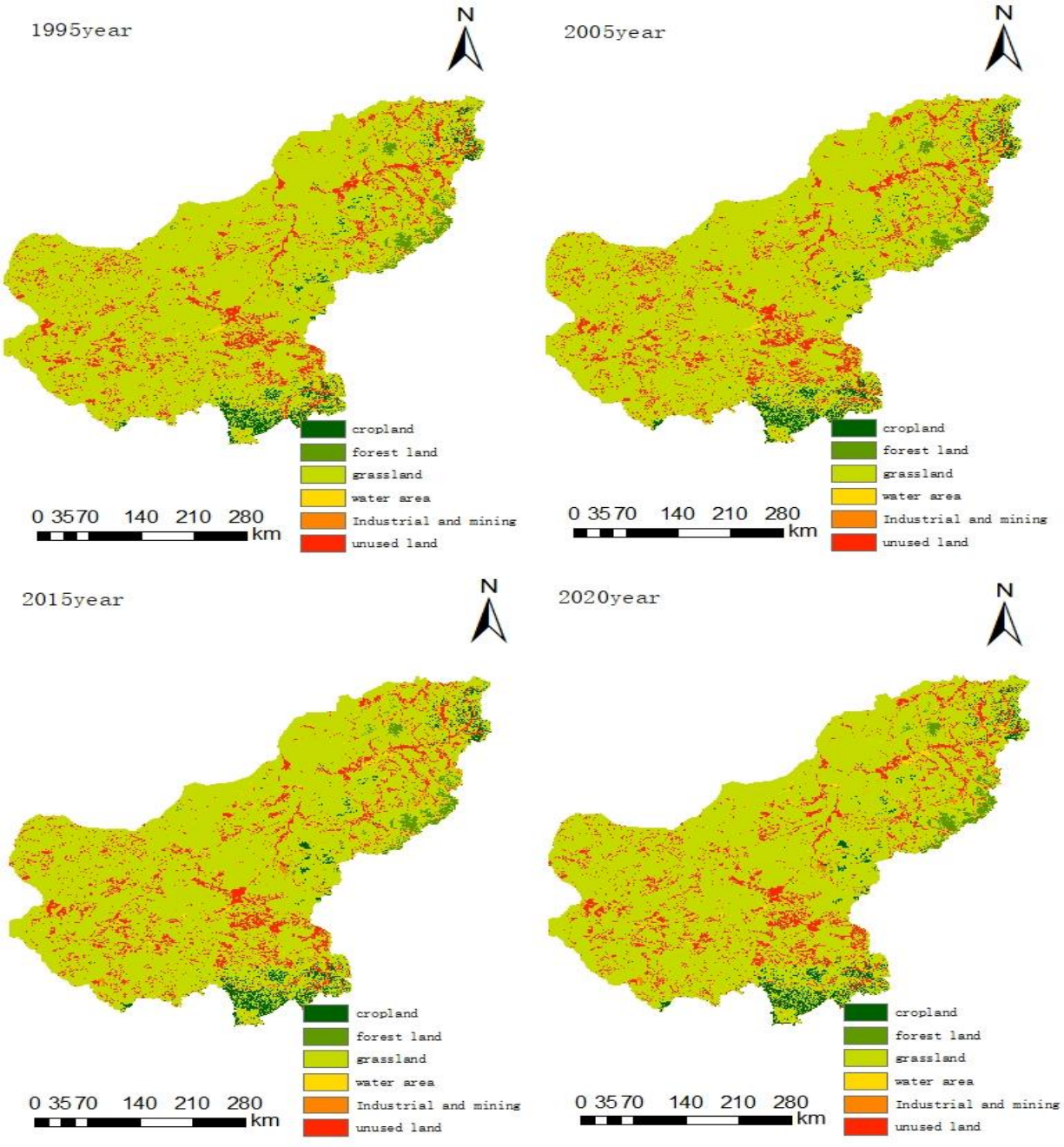

Fig. 1 Distribution of land use types in Xilin Gol League from 1995 to 2020

Tab. 1 Changes of various types of land use areas in Xilin Gol League

Land use type	1995year		2005year		2015year		2020year	
	area /km^2	proportion /%	area /km^2	proportion /%	area /km^2	proportion /%	area /km^2	proportion /%
cropland	5419	2.70	5809	2.89	5790	2.88	5828	2.90
forest land	2849	1.42	2916	1.45	2910	1.45	3077	1.53
grassland	169047	84.23	167308	83.36	167757	83.59	167893	83.47
water area	1324	0.66	1402	0.70	1581	0.79	1583	0.79
industrial and mining	466	0.23	533	0.27	1058	0.53	1171	0.58
unused land	21600	10.76	22734	11.33	21606	10.77	21596	10.74

4.2 Land useTransfer Matrix Analysis

The area transfer matrix of land use types inthree periods was obtained by dynamic monitoring of four images of Xilin Gol League in the last 25 years (Tables 2~ 4). On the whole, the area of cultivated land, woodland, water area and urban and rural industrial and mining settlements increased from 1995 to 2020. The area of grassland and unused land will be reduced.

From 1995 to 2005, the area of cultivated land increased, which was mainly transferred from grassland (541km^2) and unused land (38km^2). The area of woodland increased, mainly from grassland (90km^2) to grassland. The area of grassland decreased, which was mainly transferred to unused land (2525km^2)and cultivated land (541km^2). The water areaincreased, mainly from unused land (220km^2)and grassland (65km^2); The increase of industrial and mining residential land was mainly transferred from grassland (62km^2) and unused land (14km^2). The area of unused land increased, mainly from grassland(2,525 km^2) and water (178km^2).

From 2005 to 2015, the area of cultivated land decreased, which was mainly transferredto grassland (116km^2) and urban and rural industrial and mining residential land (15km^2). The decrease of woodland area was small.The area of grassland increased, mainly fromunused land (981km^2) and cultivated land (116km^2). The water area increased, mainly from unused land (191km^2) and grassland (71km^2). The area of urban and rural industrial and mining settlements increased, mainly from grassland (463km^2) and unused land (42km^2). The area of unused land decreased and was mainly transferred to grassland (981km^2) and water (191km^2).

From 2015 to 2020, the area of cultivated land increased, mainly from grassland (2,576km^2) and unused land (218km^2). The area offorest land increased, mainly from grassland (1075km^2) and unused land (71km^2). The area of grassland increased, mainly from unused land (9593km^2) and cultivated land (2553km^2). The water area increased, mainlyfrom grassland (643km^2) and unused land (321km^2). The area of urban and rural industrial and mining settlements increased, mainly from grassland (594km^2) and arable land (129km^2). The area of unused land decreased and was mainly transferred to grassland (9893km^2) and water (321km^2).

Tab. 2 Area transfer matrix of land use types in Xilin Gol League from 1995 to 2005 km^2

Land use type		2005year						
		Cropland	Forest land	grassland	water area	industrial and mining	Unused reduce land	
1995 year	Cropland	5228	1	182	1	0	7	191
	Forest land	0	2817	30	0	0	2	32
	grassland	541	90	165761	65	62	2525	3283
	water area	0	0	30	1116	0	178	208
	Industrial and mining	2	1	4	0	457	2	9
	Unused land	38	7	1301	220	14	20020	1580
	newly increased	581	99	1547	286	76	2714	—

Tab. 3 Area transfer matrix of land use types in Xilin Gol League from 2005 to 2015 km^2

Land use type		2015year						
		Cropland	Forest land	grassland	water area	industrial and mining	Unused reduce land	
2005 year	Cropland	5672	3	116	1	15	2	137
	Forest land	3	2895	12	0	6	0	21
	grassland	115	12	166639	71	463	8	669
	water area	0	0	6	1318	2	76	84
	Industrial and mining	0	0	3	0	530	0	3
	Unused land	0	0	981	191	42	21520	1214
	newly increased	118	15	1118	263	528	86	—

Tab. 4 Area transfer matrix of land use types in Xilin Gol League from 2015 to 2020 km^2

Land use type		2020year						
		Cropland	Forest land	grassland	water area	industrial and mining	Unused reduce land	
2015 year	Cropland	2794	66	2553	7	129	223	2978
	Forest land	63	1846	917	7	18	52	1057
	grassland	2576	1075	153027	643	594	9798	14686
	water area	14	3	557	599	5	402	981
	Industrial and mining	122	13	499	6	349	69	709
	Unused land	218	71	9893	321	75	11024	10578
	newly increased	2993	1228	14419	984	821	10544	—

4.3 Dynamic Change of Land use

4.3.1 Single land use dynamic change

From 1995 to 2005, the dynamic attitude of cultivated land, woodland, water area, urban and rural industrial and mining settlements, and unused land increased, while the dynamic attitude of grassland decreased. From 2005 to 2015, the dynamic attitude of grassland, water area, urban and rural industrial and mining residents increased, while the dynamic attitude of cultivated land, woodland and unused land decreased. From 2015 to 2020, the dynamic attitude of cultivated land, woodland, grassland, water area and urban and rural industrial and mining residents will increase, while the dynamic attitude of unused land will decrease.

From 1995 to 2020, the dynamic attitude of cultivated land, woodland, water area, urban and rural industrial and mining residents increased, while the dynamic attitude of grassland and unused land decreased.

Tab. 5 Dynamic attitude of land use in Xilin Gol League

Land use type	1995-2005year		2005-2015year		2015-2020year		1995-2020year	
	area	k/%	area	k/%	area	k/%	area	k/%
Cropland	390	0.72	-19	-0.03	38	0.13	409	0.3
Forest land	67	0.24	-6	-0.02	167	1.15	228	0.32
grassland	-1739	-0.10	449	0.03	136	0.02	-1154	-0.03
water area	78	0.59	179	1.28	2	0.03	259	0.78
Industrial and mining	67	1.44	525	9.85	113	2.14	705	6.05
Unused land	1134	0.53	-1128	-0.5	-10	-0.01	-4	-0.001

4.3.2 Dynamic Change of Integrated Land use

From 1995 to 2020, the dynamic attitude of comprehensive land use in Xilin Gol League is 0.03%. The dynamic attitude of comprehensive land use from 1995 to 2005 was 0.09%. From 2005 to 2015, the dynamic attitude of comprehensive land use was 0.06%. The dynamic attitude of comprehensive land use in 2015-2020 is 0.02%. On the whole, the dynamic attitude of comprehensive land use showed a downward trend.

Tab. 6 Dynamic attitude of comprehensive land use in Xilin Gol League

Year	Dynamic Change of Integrated Land use(%)
1995-2005year	0.09
2005-2015year	0.06
2015-2020year	0.02
1995-2020year	0.03

4.4 Analysis of Driving Forces of Land use Change

4.4.1 Natural Factors

The landform has a great relationship with the dynamic change of land use. The cultivated land and the urban and rural industrial and mining settlements are mainly distributed in the low-lying areas and the areas with more frequent human activities. The climatic characteristics of strong wind and drought resulted in a small reduction of grassland area.

4.4.2 Human Factors

Besides the natural factors, the most important factors are human factors, and the land use structure and dynamic change are mainly restricted by population and economy.

The population of Xilin Gol League has increased from 906,000 in 1995 to 1,107,100, among which the urban population is larger than the rural population. First of all, the ever-increasing population demands ever-increasing natural resources, which is one of the main reasons for the increase of arable land area and urban and rural industrial and mining residential area. Secondly, with the promotion of the new urbanization strategy, the area of urban and rural industrial and mining residents will also increase. Finally, when the local government develops the economy, the land use structure will also change greatly.

5. Conclusion and Discussion

(1) From 1995 to 2020, the area of Cropland, forest land, industrial and mining and water area all showed an increasing trend, while the area of grassland and unused land showed a decreasing trend in Xilin Gol League.

(2) From 1995 to 2020, the dynamic attitude of single land use of Cropland, forest land , water area, industrial and mining increased, while grassland and unused land decreased. The dynamic attitude of comprehensive land use showed an overall downward trend.

(3) The dynamic change of land use in Xilin Gol League from 1995 to 2020 is mainly due to the influence of population increase, rapid economic development and natural environment factors.

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