Study on the Spatial and Temporal Changes of Ecological Land in Lanzhou New District

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Abstract. Based on the land use vector data interpreted by remote sensing and using mathematical statistics, we analyzed the quantity and spatial change characteristics of ecological land in Lanzhou New District from 2013 to 2018. We found that in the five years of rapid urbanization in Lanzhou New District, arable land and grassland have been decreasing, and the area of woodland, garden and waters has increased. The total area of ecological land has continued to decline. From 2013 to 2018, the absolute value of a single land use dynamic degree is garden > waters > woodland > arable land > grassland. The temporal and spatial changes of ecological land in Lanzhou New District are affected by many factors such as natural and social factors. Due to its special strategic positioning in China, we believe that policy factors among social factors have become the main driving force for its development and changes.

1. Introduction
Ecological land has ecological functions such as water conservation, wind prevention and sand fixation, climate regulation, soil protection, air purification, and biodiversity protection, which can reflect the quality of a region's ecological environment. Many scholars have conducted a lot of research on ecological land from different angles. Johan Colding has studied how to allocate ecological land resources in the city to maximize the protection of the urban ecosystem. At the same time, he analyzed how to allocate ecological land in the city to make it play an "emergency" function, providing valuable guidance and reference for urban planning and construction[1]. Pierre Grondin et al. used the "Ecological Land Classification of Uniform Vegetation Landscape" method to enhance the traditional ecological land classification method [2]. Naser Ahmadi Sani et al. used GIS, remote sensing and multi-criteria decision analysis to evaluate the suitability of ecological land in multi-functional forestry [3]. Yf H et al. used transformation matrix, landscape index and center of gravity migration methods to explore the temporal and spatial changes of urban ecological land in Zhuhai [4]. JP et al. probed the changes and driving forces of urban ecological land, and provided a scientific basis for optimizing the urban landscape pattern [5].

We takes small-scale areas as the research object, based on GIS technology and mathematical statistics, analyzed the changes in the amount, structure and space of ecological land in Lanzhou New District from 2013 to 2018, and analyzed its influencing factors.
2. Methodology

2.1. Study area and data
On August 12, 2012, the Chinese government issued an announcement formally agreeing to establish Lanzhou New District. Lanzhou New District is located in the Qinwangchuan Basin in the northern part of Lanzhou City, Gansu Province in western China, between 103°26′20″-103°58′18″ east longitude and 36°12′30″-36°52′27″ north latitude. The new district now has six townships under its jurisdiction, namely Zhongchuan Town, Qinchuan Town, Shangchuan Town, Shuping Town, Xicha Town and Shuifu Town. Lanzhou New District is located in the middle of the symbiosis belt of the three capital cities of Lanzhou, Xining and Yinchuan. It is a comprehensive transportation hub planned and constructed in China, and an important window and gateway for Gansu's domestic and international exchanges. It is about 75 kilometers long from north to south and 47 kilometers wide from east to west. In this study, three Landsat TM and ETM + images of 2013, 2016 and 2018 were acquired through the geospatial data cloud (http://www.gscloud.cn/) as the data source, and the data was radiated and geometrically corrected. Demographic and economic data come from 《Gansu Statistical Yearbook》. In this study, arable land, garden land, woodland, grassland and waters with ecosystem service functions are classified as ecological land, and the rest are non-ecological land.

2.2. Single land use dynamic degree
The Single land use dynamic degree can reflect the changes in the number of various land use types in the study area during a certain period of time, analyze the regional differences of land use changes and predict future trends. The formula is as follows:

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

(1)

K represents the single degree of land use dynamics, Ub and Ua represent the area of a certain land use type at the end and initial stage of the study period, and T represents the time interval.

2.3. Qualitative analysis
Qualitative analysis is to use textual language for related description. It is a method to analyze the nature, characteristics, development and change laws of the analysis object mainly based on the analyst's intuition, experience, and subjective judgments.

Based on existing studies, it can be seen that changes in ecological land use are mainly caused by the combined effects of natural and social economic factors. Based on the existing research, combined with the actual situation of the study area, this paper selects the driving factors related to the change of ecological land, including factors such as population, economy and policy, and analyzes them one by one.

3. Results and Discussion

3.1. Changes in the quantity and structure of ecological land
It can be seen from the table 1 that the number of ecological land in Lanzhou New District showed a decreasing trend from 2013 to 2018, from 1,630.31km² in 2013 to 1,464.44km² in 2018. Among them, the area of arable land and grassland showed a decreasing trend, from 328.38km², 1231.97km² to 248.32km², 1101.10km², and the proportion of ecological land area was reduced from 20.14% and 75.57% to 15.81% and 75.19%; garden, woodland, waters is increasing, from 29.91km², 35.75km², and 4.30km² to 58.71km², 49.37km², and 6.94km², respectively. The proportion of ecological land area increased from 1.83%, 2.19% and 0.26% to 3.37%, 2.80% and 0.47%.
Table 1. Changes and percentages of ecological land area in Lanzhou New District 2013-2018

| Land name  | 2013  | 2016  | 2018  |
|------------|-------|-------|-------|
|            | Area (km²) | Percentage (%) | Area (km²) | Percentage (%) | Area (km²) | Percentage (%) |
| Arable land | 328.38 | 20.14 | 224.53 | 15.02 | 248.32 | 16.96 |
| Garden      | 29.91  | 1.83  | 70.42  | 4.71  | 58.71  | 4.01  |
| Woodland    | 35.75  | 2.19  | 41.35  | 2.77  | 49.37  | 3.37  |
| Grassland   | 1231.97 | 75.57 | 1152.55 | 77.11 | 1101.10 | 75.19 |
| Waters      | 4.3    | 0.26  | 5.74   | 0.38  | 6.94   | 0.47  |

3.2. Ecological land change rate
Analyzing the single land use dynamics of ecological land in the same research stage, it can be seen from the table 2 that from 2013 to 2016, the area of arable land and grassland has decreased, and the area of garden, woodland and waters has increased. The absolute value of single land use dynamics is ranked as Garden> Waters> Arable land> Woodland> Grassland. From 2016 to 2018, the area of garden and grassland has decreased, and the area of arable land, woodland and waters has increased. The absolute value of single land use dynamics is in the order of Waters> Woodland> Garden> Arable land> Grassland. From 2013 to 2018, the change rate of garden land was the largest, with a single land use dynamic degree of 0.193, and the grassland change rate was the smallest, with a single land use dynamic degree of -0.021.2013-2018 Lanzhou New District ecological land area change and dynamic degree (%)

Table 2. 2013—2018 Lanzhou New District ecological land and Dynamic degree (%)

| Land use type | 2013—2016 | 2016—2018 | 2013—2018 |
|---------------|------------|------------|------------|
|               | Change area (Km²) | Dynamic (%) | Change area (Km²) | Dynamic (%) | Change area (Km²) | Dynamic (%) |
| Arable land   | -103.85    | -0.105     | 23.79       | 0.053       | -80.06       | -0.049 |
| Garden        | 40.51      | 0.451      | -11.71      | -0.083      | 28.80        | 0.193 |
| Woodland      | 5.60       | 0.052      | 8.02        | 0.097       | 13.62        | 0.073 |
| Grassland     | -79.42     | -0.021     | -51.45      | -0.022      | -130.87      | -0.021 |
| Waters        | 1.44       | 0.112      | 1.20        | 0.105       | 2.64         | 0.123 |

3.3. Analysis on the spatial difference of ecological land
It can be seen from Figure 1 that arable land and garden are mainly distributed in the central and northern parts of the study area, and woodland is mainly distributed in the central and southern parts and along the main canal. The waters are mainly scattered in the middle. The grassland area is the largest and is distributed along the boundary of the study area. From the perspective of changes in spatial patterns,
grassland, arable land and garden in the central, southeastern and northeastern regions have gradually transformed into non-ecological land in the past five years. Part of the arable land and grassland in the northern region was converted into garden, which increased the area of the garden, while a small part of the grassland in the northeastern region was converted into water.

![Figure 1.](image)

**Figure 1.** (a)Distribution map of ecological land in 2013 (b) Distribution map of ecological land in 2016(c)Distribution map of ecological land in 2018

3.4. **Analysis of Influencing Factors of Ecological Land Use Change**

The factors that affect the change of ecological land use types can be divided into two aspects: natural factors and social factors. The influence process of natural factors is an indirect, long-term and spontaneous succession process, and its influence is not significant for a short-term research scale, so we only analyze social factors in this research.

Policy factors are the strongest among social factors. In the initial stage of the establishment and construction of the Lanzhou New District, land use types gradually began to change from arable land and grassland to non-ecological land such as urban construction land. From 2013 to 2016, under the guidance of various plans, the Lanzhou New District developed rapidly. The urban framework has been basically formed, various infrastructures have been basically completed, and the industrial system has been initially formed. A large amount of arable land, grassland and woodland are transformed into other non-ecological land related to human activities. After 2016, this change continues. In the long run, a substantial reduction in the area of ecological land such as arable land and grassland will have a certain impact on the ecological environment of the Lanzhou New District, which may restrict the development of the Lanzhou New District.

The changes in the industrial structure of Lanzhou New District will have a certain impact on the temporal and spatial distribution of ecological land. Overall, the proportion of the primary industry and the secondary industry is declining. The tertiary industry is increasing. In 2013, the total production value of Lanzhou New District reached 29.126 billion yuan. In 2018, the total output value of Lanzhou New District increased by 88.763 billion yuan compared with 2013, reaching 117.888 billion yuan. The government has adopted various preferential policies to attract a large number of enterprises in the Lanzhou New District, which has effectively promoted the development of the secondary and tertiary industries. At the same time, the rapid development of the secondary and tertiary industries has a greater impact on the temporal and spatial changes of ecological land. The growth of the secondary industry and the tertiary industry will inevitably lead to population growth, urban construction expansion and a
large amount of non-ecological land increase, which will lead to the reduction of ecological land such as arable land, grassland and part of other ecological land.

Population is an important factor that affects land use changes, so it is also an important factor that affects the temporal and spatial changes of ecological land. From the perspective of the relationship between man and land, man is the participant and organizer of land use change and an important driving force for land use change. The increase in population directly affects the area of arable land and grassland. With the increase of permanent population, it will inevitably lead to the increase of a series of buildings related to human life, resulting in a large amount of cultivated land, grassland and forest land and other ecological areas decreased.

4. Conclusion
In short, we explored the spatial and temporal changes and influencing factors of the ecological land in Lanzhou New District, a newly emerging national-level new district in western China during the five years from 2013 to 2018. During the study period, the area of non-ecological land such as arable land, woodland, grassland and so on in the Lanzhou New District was greatly reduced. The main reason for this change was policy factors. With the strong support of the Chinese government's policies, the population and economy of Lanzhou New District have developed rapidly, but with it a series of problems such as fragile ecological environment. Therefore, it is urgently needed to conduct in-depth research and continuous attention to make it sustainable. Government departments should still take the construction of ecological civilization as the guide, formulate corresponding policies and systems, control the impact and occupation of ecological land such as non-ecological land, explore new environmental governance measures, and scientifically plan the construction of the Lanzhou New District.

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References
[1] Johan Colding. ‘Ecological land-use complementation’ for building resilience in urban ecosystems. 2006, 81(1):46-55.
[2] Pierre Grondin, Sylvie Gauthier, Daniel Borcard, et al. A new approach to ecological land classification for the Canadian boreal forest that integrates disturbances. 2014, 29(1):1-16.
[3] Naser Ahmadi Sani, Sasan Babaie Kafaky, Timo Pukkala, et al. Integrated use of GIS, remote sensing and multi-criteria decision analysis to assess ecological land suitability in multifunctional forestry. 2016, 27(5):1127-1135.
[4] Yunfeng Hu, Yunzhi Zhang. Spatial–temporal dynamics and driving factor analysis of urban ecological land in Zhuhai city, China. 2020, 10(1):5761-5768.
[5] Jian Peng, Mingyue Zhao, Xiaonan Guo, et al. Spatial-temporal dynamics and associated driving forces of urban ecological land: A case study in Shenzhen City, China. 2017, 60:81-90.