Analysis and Research on the Change of Landscape Ecological Pattern in the Surrounding Area of Guishan in Yuyao City

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Abstract. In this study, the area around Guishan in Yuyao is taken as the research object, and data processing and analysis are carried out by using Fragstats 4.2 and other software. The changes of the land use landscape pattern in the area in 2012 and 2019 are analyzed to provide basic research for the future ecological sustainable planning and development of the area. The results show that the degree of landscape heterogeneity of the overall landscape pattern in the study area is gradually increasing, and land use is developing toward diversification and homogenization. This is because in the process of urbanization, the landscape ecological pattern in the study area will inevitably be affected by many factors and changed. Therefore, through quantitative analysis of the landscape ecological pattern change process in the study area, it can reflect more scientifically changing process, which is conducive to scientific and reasonable planning for the next step, and thus better maintain the balance of natural ecology. Through quantitative analysis of the landscape ecological pattern change process in the study area, it can reflect its change process more scientifically, which is conducive to the next step to provide a basis for scientific and rational planning and better maintain the balance of natural ecology.

1. Introduction

With the rapid development of cities and towns in China and the rapid increase in population, the natural ecological environment around the central urban area has been destroyed due to frequent disturbances of human activities, which is not conducive to the sustainable development of cities. Landscape pattern refers to the spatial arrangement of landscape patches of different shapes, sizes, and numbers, reflecting the effects of various ecological processes on different scales. Different landscape pattern indexes are usually used to describe landscape patterns at corresponding scales. By comparing the same landscape pattern at different periods, it can reveal the characteristics and ecological changes of the landscape pattern in the studied area, so as to clarify the impact of human activities on the regional ecological environment, and discover the inherent laws of landscape pattern evolution. This study takes the surrounding area of Guishan Mountain on the southeast side of Yuyao downtown as a research object, and quantitatively analyzes the changes in the land use landscape pattern of the district in 2012 and 2019, providing a basis for the future ecological sustainable planning and development of the area.
2. Study area overview

Yuyao City is located in the middle of the Ningshao Plain in eastern Zhejiang, and is located in the southern wing of the Yangtze River Delta. Its terrain is generally high in the south and low in the north, with a slight depression in the middle. Guishan and the surrounding area are located in the southeast of Yuyao City. The research area ranges from Xiaoyong Railway and Yangming East Road in the north, Tanjialing Road in the south, G228 Line in the east, and Zhongsan Road in the west. The total area is about 16.1 square kilometers and it is divided into the green ecological core in the southeast area of the city in the upper planning, which is composed of mountain parks such as Guishan, Snake Mountain and Fengshan. The terrain in the area is dominated by plains, surrounded by water systems, rivers in vertical. The study area has horizontal directions, open sight and major rivers such as Yaojiang, Houqingjiang, and Zhiliangjiang.

2.1 Data selection and processing

The main data is the shp. format data of the land use status in the surrounding areas of Guishan in Yuyao City in 2012 and 2019. The data source is accurate and can meet the needs of this study. Combined with the relevant analysis and research [6-8] and the summary analysis of the current land use characteristics of the study area, the landscape type of the study area can divide into 9 categories, namely Cultivated Land, Other Agricultural Land, Garden Land, Forest Land, Water Body, Rural Construction Land, Regional Transportation Facilities Land, Industry Land and Other Town Construction Land.

Table 1. Landscape pattern index and significance

| Index  | Index name                | Ecological significance                                                                 |
|--------|---------------------------|----------------------------------------------------------------------------------------|
| PD     | Patch Density             | Reflects the number of patches per unit area, and to some extent reflects the fragmentation of the overall landscape. |
| LPI    | Largest Patch Index       | Describe the complexity of patch shapes in different landscape types.                   |
| LSI    | Landscape Shape index     | Describe the complexity or regularity of the shape of the landscape patch type, used to measure the complexity of the landscape spatial pattern |
| PAFRAC | The Perimeter Area Fractal Dimension | It reflects the complexity of landscape patch shape and the degree of influence by human activities, and its small value indicates that the patch shape is simple and regular, and the degree of human disturbance is large. |
| AI     | Aggregation Index         | Reflects the degree of aggregation of different patch types in the landscape, the larger the value, the more concentrated the patches |
| SHDI   | Shannon’s Diversity Index | This indicator can reflect landscape heterogeneity, and is particularly sensitive to the uneven distribution of various patch types in the landscape. |
| SHEI   | Shannon’s Evenness Index  | Represents the unevenness of the area distribution of different patch types in the landscape. |
| CONTAG | Contagion Index           | Describe the degree of reunion or extension of different patch types in the landscape. A small value indicates a high degree of landscape fragmentation. |
| IJI    | Interspersion and Juxtaposition Index | An important indicator describing the landscape spatial pattern. A large value indicates that each patch type is close to each other and has a high degree of dispersion. |
2.2 Selection and calculation result of landscape index
The landscape index can concentrate the landscape pattern information at a high concentration and clearly and quantitatively reflect the characteristics of landscape structural composition and some aspects of spatial configuration[9-10]. In this study, some types of landscape pattern indexes (as shown in Table 1) were selected to analyze the changes in the landscape ecological pattern in the study area. The data processing software used in the study is mainly ArcGIS10.5, Fragstats4.2, AutoCAD2014 and Excel2007. Using ArcGIS10.5 to convert the land use data information in 2012 and 2019 into a grid format (Geotiffs.) to make a landscape pattern map (Figure 1 and Figure 2). Then import the raster file into Fragstats4.2 landscape index calculation software, set the relevant parameters, and select the relevant landscape pattern index to calculate the landscape pattern index data in the study area in 2012 and 2019 (as shown in Table 2).

### Table 2. Changes of landscape pattern index table

| Landscape type               | Year | CA  | PLAND | NP  | PD   | LPI  | AREA_MN | LSI  | PAFRAC | AI  |
|-----------------------------|------|-----|-------|-----|------|------|---------|------|--------|-----|
| Cultivated Land             | 2012 | 583.37 | 36.26 | 127 | 7.8943 | 3.8214 | 4.5935 | 22.2927 | 1.3984 | 95.5790 |
|                            | 2019 | 424.10 | 26.36 | 281 | 17.4664 | 3.2631 | 1.5093 | 28.8180 | 1.3003 | 93.2275 |
| Other Agricultural Land     | 2012 | 41.91  | 2.60  | 100 | 6.2159 | 1.5566 | 0.4190 | 17.3900 | 1.6078 | 87.2373 |
|                            | 2019 | 59.30  | 13.61 | 219 | 90.0667 | 1.5847 | 0.0409 | 37.7476 | 1.5309 | 75.9066 |
| Garden Land                 | 2012 | 23.78  | 1.48  | 73  | 6.2159 | 0.0923 | 0.2377 | 13.4949 | 1.3018 | 86.9886 |
|                            | 2019 | 20.07  | 1.25  | 52  | 3.2322 | 0.2677 | 0.3859 | 9.7000  | 1.3783 | 90.1348 |
| Forest Land                 | 2012 | 16.47  | 1.02  | 38  | 2.3621 | 0.0923 | 0.2377 | 13.4949 | 1.3061 | 72.6240 |
|                            | 2019 | 9.40   | 0.58  | 247 | 15.5350 | 0.0931 | 0.0381 | 17.4634 | 1.3383 | 72.6240 |
| Water Body                  | 2012 | 252.36 | 15.69 | 294 | 18.2749 | 12.0412 | 14.102 | 27.3852 | 1.4610 | 91.8218 |
|                            | 2019 | 227.95 | 14.17 | 245 | 15.2287 | 8.7291  | 1.9304 | 21.9818 | 1.3061 | 95.0275 |
| Rural Construction Land     | 2012 | 342.81 | 21.31 | 134 | 8.3294 | 1.8144 | 2.5582 | 18.4642 | 1.3453 | 95.2684 |
|                            | 2019 | 354.39 | 22.03 | 200 | 12.4316 | 2.6650  | 1.7720 | 24.9297 | 1.3872 | 93.6189 |
| Regional Transportation Facilities Land | 2012 | 83.69  | 5.20  | 27  | 1.6783 | 4.3471 | 3.0996 | 39.6284 | 1.6958 | 78.7673 |
|                            | 2019 | 107.53 | 6.68  | 87  | 53.2693 | 5.1616 | 0.1255 | 48.9205 | 1.6847 | 76.7700 |
| Industry Land               | 2012 | 129.28 | 8.04  | 69  | 4.2890 | 1.1142 | 1.8736 | 10.6440 | 1.2397 | 95.7384 |
|                            | 2019 | 131.07 | 8.15  | 113 | 8.8886 | 0.9369 | 0.9166 | 14.1769 | 1.2097 | 94.2193 |
| Other Town Construction Land| 2012 | 135.14 | 8.40  | 47  | 2.9215 | 1.4354 | 2.8752 | 14.6323 | 1.8587 | 94.1111 |
|                            | 2019 | 275.00 | 17.09 | 183 | 11.3749 | 2.2211 | 1.5027 | 21.6958 | 1.2925 | 93.7346 |

3. Discussion and analysis
As shown in Table 2, there are some changes in the landscape pattern index in the study area in 2012 and 2019, which are specifically reflected in the Construction Land (including Regional Transportation Facilities Land, Industry Land and Other Town Construction Land), Cultivated Land, Forest Land, Garden Land, Other Agricultural Land, Garden Land and Water Body Land.

3.1 Variation of the horizontal spatial pattern of patch types

3.1.1 Changes in the landscape pattern of the urban construction land. With the acceleration of the urbanization development process, urban construction land in Yuyao City continues to expand and spread around the central urban area. Within the study area, construction land is divided into Regional Transportation Facilities Land, Industry Land and Other Town Construction Land. The Percent of landscape(PLAND) of the three types of land all showed an upward trend, and the Mean patch area(AREA_MN) and Aggregation index(AI) of the landscape both declined, while the perimeter area fractal dimension(PAFRAC) of landscape also decreased, which indicates the degree of landscape fragmentation of construction land is enhanced, and the shape of patch of construction land is simpler. The above data changes indicate that in 2012-2019, the research area is greatly affected by human activities, the shape of the construction land landscape tends to be simple and regular. At the same
time, the construction land has a disorderly occupation of the original natural ecological landscape, which leads to the fragmentation of the landscape environment and has a certain impact on the regional ecological landscape.

![Figure 1. Landscape ecological pattern of the study area in 2012](image1)
![Figure 2. Landscape ecological pattern of the study area in 2019](image2)

3.1.2 Changes in landscape pattern of Cultivated land and Rural construction land. Cultivated land and Rural construction land are the two main types of landscape within the study area. The Largest patch index (LPI) and Percent of landscape (PLAND) of cultivated land are both showing a downward trend. The two indexes showed an upward trend, indicating that with the development of urbanization, cultivated land patches have been invaded and the village scale has expanded. The Number of patches (NP) and Patch density (PD) of cultivated land and rural construction land landscapes increased, and the Mean patch area (AREA_MN) decreased, reflecting the increased fragmentation of the two landscapes. Among them, the Landscape Shape index (LSI) of cultivated land landscape increased from 22.2927 to 28.8180, the Aggregation index (AI) decreased by 2.35, each patch tended to be scattered, and the degree of concentration decreased. The Landscape Shape index (LSI) of the forest landscape increased by 6.4655; the Aggregation index (AI) decreased by 1.6495. From the comparison of the landscape pattern maps in 2012 and 2019, it can be concluded that the construction of the land for rural construction and the land for regional transportation facilities has divided the cultivated land landscape and the shape of the patch due to complex irregularities.

3.1.3 Changes in landscape patterns of other landscape types. The proportion of forest land, garden land and other agricultural land landscapes in the study area is relatively small. From 2012 to 2019, the Percent of landscape (PLAND) of the other Agricultural Land has increased, but the proportion of forest land and garden land has declined. Among them, the overall change trend of garden landscape is relatively small. Under the strong disturbance of human activities, the Percent of landscape (PLAND), number of patches (NP), patch density (PD), Landscape Shape index (LSI), and perimeter-area fractal dimension (PAFRAC) are all decreasing trends, which reflecting the weakening of the water landscape and the simpler shape regularization; the Aggregation index (AI) has increased, increasing by 3.2057, indicating that the water patches are becoming more and more concentrated.

| Year | LSI   | PAFRAC | CONTAG | IJI   | SHDI  | SHEI  |
|------|-------|--------|--------|-------|-------|-------|
| 2012 | 25.9212 | 1.3028 | 52.804 | 73.836 | 1.7565 | 0.7994 |
| 2019 | 30.7801 | 1.3575 | 48.3219 | 80.284 | 1.8551 | 0.8443 |
3.2 Changes in landscape pattern horizontal spatial pattern

Based on the landscape level, the changes in the landscape index in the study area in 2012 and 2019 are shown in Table 3. The overall number of patches (NP) and patch density (PD) in the landscape both showed an increasing trend. Among them, the number of patches (NP) increased by 718 and the patch density (PD) increased by 44.63, indicating that the degree of landscape heterogeneity and fragmentation in the study area increased during 2012-2019. The Contagion index (CONTAG) in the landscape pattern in the study area decreased from 52.804 to 48.322, and the Interspersion and Juxtaposition index (IJI) increased by 6.448. This change in the landscape pattern reflects the increased proximity between patch types and the increased fragmentation and dispersion of the landscape.

The Shannon’s diversity index (SHDI) in the landscape index can reflect the heterogeneity of the landscape, reflecting the abundance and complexity of the landscape type, and the Shannon’s evenness index (SHEI) reflects the uniformity of the distribution of the landscape type. From the change of the two indexes, the diversity index increased 5.61, the Shannon’s evenness index (SHEI) increased from 0.7994 to 0.8443, indicating that the land use in the study area has become richer, the complexity has become larger, and the degree of fragmentation has increased. At the same time, the landscape dominance has decreased, the diversity has increased and the distribution is more even.

4. Conclusions

Through research, it was found that during 2012-2019, the urban construction land in the landscape pattern around Guishan in Yuyao City increased significantly, the landscape shape tended to be simple and regular, and the construction land in villages also showed an increasing trend, but the cultivated land, forest land and water landscape were degraded. In general, the degree of landscape heterogeneity of the overall landscape pattern in the study area is gradually increasing, and land use is developing toward diversification and homogenization. According to the relevant construction materials in the study area and the comparison of the landscape pattern maps of the study area in 2012 and 2019, It can be seen that the reason for the scattered, complex, irregular and diversified landscape in the study area is the acceleration of urbanization, the construction of transportation facilities, the human intervention of water system, the development and expansion of villages, etc.

This study shows that in the process of urbanization, the landscape ecological pattern in the study area will inevitably be affected by many factors and change. Therefore, through quantitative analysis of the landscape ecological pattern change process in the study area, it can reflect more scientifically changing process, which is conducive to scientific and reasonable planning for the next step, and thus better maintain the balance of natural ecology. Through quantitative analysis of the landscape ecological pattern change process in the study area, it can reflect its change process more scientifically, which is conducive to the next step to provide a basis for scientific and rational planning and better maintain the balance of natural ecology.

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