Landscape Patterns of Wetland Parks in Suzhou based on ArcGIS and Fragstats: a Case Study of Huqiu Wetland Park and Taihu Hubin National Wetland Park

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Abstract. Taking Huqiu Wetland Park and Taihu Hubin National Wetland Park as the study objects, ArcGIS and Fragstats techniques were used to analyze the landscape pattern characteristics of the two parks in terms of patch type and landscape level. The results showed that the landscape types of both Huqiu Wetland Park and Taihu Hubin National Wetland Park were dominated by wetlands, accounting 37.7% and 82.24% of the total park area of the parks respectively. The aggregation index were 99.72 and 99.96 respectively, and the aggregation of wetland patches in Taihu Hubin National Wetland Park was higher. The percentages of grassland and built-up area were higher in Huqiu Wetland Park than in Taihu Hubin National Wetland Park, but plaque agglomeration was lower than that in Taihu Hubin National Wetland Park. In terms of landscape diversity, Huqiu Wetland Park's Shannon Diversity Index of 1.33 and Shannon Uniformity Index of 0.83 were both higher than Taihu Hubin National Wetland Park's 0.63 and 0.45, indicating that dominant landscape was not sufficiently prominent and that the patch. The differences in landscape patterns between the two wetland parks are related to their planning design, regional location, surrounding environment and human disturbance.

1. Introduction
As one of the three major ecosystems of the Earth, wetlands have unique ecological characteristics of both land and water, and are the most biodiverse ecosystem in nature [1]. It not only provides material resources for human life and survival, but also has the functions of water nourishment, water purification and climate regulation. In recent years, the construction of wetland parks has been carried out in various places in China, and the construction of wetland parks is regarded as an important method of wetland protection. Wetland parks not only provide the city with recreational land, but also purify the city's water and maintain urban ecological security, while their landscape patterns are the result of the interaction of various factors in the long-term development of the city. How to quantitatively analyze the patterns and ecological processes in different scales of landscapes is an important and challenging research topic in landscape ecology, which has important implications for the planning, design and management of urban green space systems and ecological landscapes [2]. The study of wetland landscape patterns also focuses on the large scale of provinces, cities, rivers and lakes, and less on the small scale of urban green spaces [3-6]. By analyzing the landscape pattern of wetland park, the landscape structure and spatial pattern of wetland park can be understood more concretely, which is also the important basis of wetland park renewal planning.
This paper takes two wetland parks in Suzhou as the research object, on the basis of the classification of its landscape elements, based on ArcGIS and Fragstats analysis of the spatial distribution characteristics and differences of the landscape pattern of two wetland parks, in order to provide scientific basis for the planning and construction of Suzhou wetland park and wetland protection.

2. Overview of the Study Area

Suzhou city is located in the south of Jiangsu Province, west of Taihu Lake. Suzhou has a subtropical monsoon climate with abundant heat and rainfall, with an average annual precipitation of 1100 mm and an average annual temperature of 15.7℃. With dense river network and numerous lakes, suzhou has rich wetland resources. According to the "2019 Annual Report of Suzhou Wetland Protection", the wetland area of Suzhou is 339,500 hm$^2$ (paddy field without water), accounting for 40% of suzhou's land area. Among them, the area of natural wetlands is 268,762.41 hm$^2$, accounting for 31.66% of the national land area. In this paper, the Huqiu Wetland Park and Taihu Hubin National Wetland Park in Suzhou was chosen as the object of study, and the basic overviews of the two parks are shown in table 1.

| Wetland Park            | Area    | Major Wetland Types                  |
|-------------------------|---------|--------------------------------------|
| Huqiu Wetland Park      | 1203 hm$^2$ | Permanent rivers, swamps, paddy fields |
| Taihu Hubin National Wetland Park | 630 hm$^2$ | Permanent lakes, swamps |

3. Study Methods and Data

3.1. Sources of Basic Data

The boundaries of Huqiu Wetland Park and Taihu Hubin National Wetland Park is derived from the planning and design plans of the two parks. Guided by China's land use remote sensing monitoring data from the Resource and Environment Science and Data Center of the Chinese Academy of Sciences. Take Google Earth remote sensing map in August 2019 as the base image. With reference to the national wetland classification system, and taking into account the specific conditions of the two parks, the land use types of the two wetland parks were categorized into five types: wetland, woodland, grassland, cropland, and construction land (figure 1). Arcmap10.5 software was used to classify the park patches, and then the land use classification vector map was converted to raster format and imported into Fragstats 4.2 software for analysis, and the data statistics were done on Microsoft Excel software.

Figure 1. Landscape type spatial distribution in the study areas.
3.2. Landscape Pattern Index

The landscape pattern was analyzed from two levels: patch type and landscape level. A total of seven type level indices of landscape area (CA), proportion of landscape area (PLAND), plaque density (PD), maximum plaque index (LPI), mean plaque area (MPS), landscape shape index (LSI), and agglomeration index (AI) were selected in this study at the plaque type level. There are six landscape level indices of patch number (PD), edge density (ED), landscape shape index (LSI), agglomeration index (AI), Shannon diversity index (SHDI), and Shannon evenness index (SHEI) at the landscape level.

4. Results and Analysis

4.1. Analysis of Landscape Pattern on Patch Type Level in Wetland Park

From table 2, it can be seen that the landscape type of Huqiu wetland Park is mainly wetland, the wetland area reaches 453.48 hm$^2$, accounting for 37.70%. It indicates that wetland landscape is the matrix landscape type of the park. This is followed by grasslands and woodlands with 32.15% and 20.7% respectively. The park's wetland landscape had the highest maximum patch index, average patch area and aggregation index at 19.55%, 5.81 hm$^2$ and 99.72, respectively. It shows that the wetland patches in the park are in a large aggregated distribution state. Grasslands had the highest plaque density and landscape shape index at 67/hm$^2$ and 35.99, respectively, respectively, reflecting that grassland patches were scattered and distributed in the wetland park with complex and diverse shapes. The aggregation index of construction land was the lowest at 99.09, and the average patch area of 1.08 was relatively low, indicating that the patches of construction land were small and scattered. A small amount of cultivated land is distributed in the park, and the patch density, maximum patch index and landscape shape index are the smallest, which are 1.75 / hm$^2$, 0.27% and 6.18 respectively, indicating that the cultivated land patch area is small, relatively concentrated and of regular shape.

| Wetland Park          | Class         | CA/hm$^2$ | PLAND/% | PD / hm$^2$ | LPI/%  | MPS / hm$^2$ | LSI   | AI  |
|-----------------------|---------------|-----------|---------|-------------|--------|--------------|-------|-----|
| Huqiu Wetland Park    | Wetland       | 453.48    | 37.70   | 6.48        | 19.55  | 5.81         | 19.25 | 99.72|
|                       | Woodland      | 248.95    | 20.70   | 17.21       | 0.83   | 1.20         | 28.49 | 99.44|
|                       | Grass land    | 386.70    | 32.15   | 67.00       | 6.83   | 0.48         | 35.99 | 99.43|
|                       | Arable land   | 24.25     | 2.02    | 1.75        | 0.27   | 1.15         | 6.18  | 99.66|
|                       | Construction land | 89.54 | 7.44    | 6.90        | 1.90   | 1.08         | 27.69 | 99.09|
| Taihu Hubin National Wetland Park | Wetland | 518.25    | 82.24   | 1.59        | 80.66  | 51.82        | 3.79  | 99.96|
|                       | Woodland      | 11.80     | 1.87    | 4.28        | 0.29   | 0.44         | 9.38  | 99.21|
|                       | Grass land    | 69.47     | 11.02   | 23.96       | 6.06   | 0.46         | 15.08 | 99.46|
|                       | Construction land | 30.63 | 4.86    | 13.81       | 1.30   | 0.35         | 16.50 | 99.10|

Taihu Hubin National Wetland Park landscape type is dominated by wetlands with a wetland area of 518.25 hm$^2$, accounting for 82.24%. Wetland is the dominant landscape type. Grassland occupies the second place, accounting for 11.02%, and other landscape types occupy less than 10% of the area. The maximum patch index, average patch area and aggregation index of wetland in this park are the highest, which are 80.66%, 51.82 hm$^2$ and 99.96 respectively, however, the patch shape index was the lowest, only 3.79, indicating that the wetland landscape is concentrated in a patchy distribution state and the shape is relatively uniform. The proportion of landscaped area for construction is very small, only 4.86%, and the agglomeration index is also the smallest, only 99.1, the patches are scattered and small, this is because the park follows the national wetland park design guidelines, the whole park to protect the natural wetland resources, the construction land planning is less. In addition, the forest land
area in the park is also relatively small, only 1.87%, which is insufficient as an ecological buffer zone between the urban construction area and the lake.

Compared to Huqiu Wetland Park, Taihu Hubin National Wetland Park has a higher percentage of wetland landscape area, average patch area, and aggregation index, indicating that the Taihu Hubin National Wetland Park has an advantageous wetland landscape that is more conducive to the ecological functioning of wetlands and conservation of biodiversity.

4.2. Analysis of Landscape Pattern on Patch Type Level in Wetland Park

The landscape pattern index at the landscape level reflects the landscape character of the entire study area, as shown in table 3. Huqiu Wetland Park has a higher total area, patch density, edge density, and shape index than Taihu Hubin National Wetland Park. In terms of landscape diversity, the Shannon Diversity Index and Uniformity Index at Huqiu Wetland Park are 1.33 and 0.83 respectively, both higher than the 0.63 and 0.45 at Taihu Hubin National Wetland Park, it reflects the homogeneity and fragmentation of landscape patches in Huqiu Wetland Park, with dominant patches being less prominent and a more even distribution of patches of all types within the park. Taihu Hubin National Wetland Park has a more dominant landscape with less human disturbance and a higher agglomeration index reflecting the aggregated distribution of patches.

Table 3. Overall characteristics of wetland park landscape pattern.

| Wetland Park         | TA/hm² | PD/hm² | ED/m² | LSI  | AI   | SHDI | SHEI |
|----------------------|--------|--------|--------|------|------|------|------|
| Huqiu Wetland Park   | 1202.91| 99.34  | 212.61 | 35.19| 99.52| 1.33 | 0.83 |
| Taihu Hubin National | 630.15 | 43.64  | 87.36  | 7.88 | 99.85| 0.63 | 0.45 |
| Wetland Park         |        |        |        |      |      |      |      |

5. Conclusion

Based on GIS interpretation mapping and Fragstats landscape pattern index analysis, the landscape spatial patterns of two wetland parks in Suzhou were quantitatively analyzed and comparatively analyzed, and the following conclusions were drawn:

1. The dominant landscape type in both Huqiu Wetland Park and Taihu Hubin National Wetland Park was wetland, with 37.7% and 82.24% wetland area, respectively, and maximum patch indexes of 19.55 and 80.66, respectively, and Taihu Hubin The wetland landscape was more dominant in Taihu Hubin National Wetland Park; the aggregation indexes were 99.72 and 99.96, respectively, and the wetland patches in Taihu Hubin National Wetland Park were more aggregated.

2. The proportion of grassland area in Taihu Hubin National Wetland Park was lower than in Huqiu Wetland Park, but the aggregation of patches was higher than in Huqiu Wetland Park, indicating a more concentrated distribution of grassland landscapes in Taihu Hubin National Wetland Park. Taihu Hubin National Wetland Park has the lowest percentage of woodland landscape area at only 1.87%. This is much lower than the 20.7% in Huqiu Wetland Park.

3. In terms of landscape diversity, Huqiu Wetland Park has one more land type than Taihu Hubin National Wetland Park, namely cropland. As for The Whole Park, the Shannon diversity index of 1.33 and the Shannon evenness index of 0.83 are both higher than those of 0.63 and 0.45 in Taihu Hubin National Talking Park, which shows that Huqiu Has a relatively small number of advantages and a homogeneous distribution of all the types of patches in the landscape. As for the whole Park, the fragmentation of the patches is relatively serious.
6. Discussion

6.1. Current Features of the Landscape Pattern
Landscape pattern is influenced by physical, social, landscape and environment, reflecting different ecological processes and structural functions [7]. Taihu Hubin National Wetland Park's dominant landscape is more prominent, with 82.24% wetlands and concentrated, patchy patches, and 95.13% natural features (wetlands, woodlands, grasslands), it shows that the landscape structure and ecological quality of this wetland park is superior, with high landscape integrity and continuity, fully reflecting the ecological value of the wetland park. The Huqiu Wetland Park, on the other hand, is located at the border of the city center and is subject to human interference due to its frequent recreational activities and urban construction activities, as well as carrying more park functions such as recreation for city residents. Therefore, the natural landscape in this park is fragmented, resulting in less connected landscape patches. In the future landscape planning and design update, it is necessary to pay attention to the reasonable planning of landscape pattern, strengthen the creation of natural landscape such as forest land, and make use of small natural landscape patches to strengthen the integrity and continuity of natural landscape, so as to play a greater ecological function. The low landscape integrity and continuity of Huqiu Wetland Park may be related to the fact that arable patches are still present in the park, and it is recommended that measures be taken to restore the park to a natural landscape.

In terms of the general characteristics of the landscape pattern, the Shannon Diversity Index and Uniformity Index at Huqiu Wetland Park were 1.33 and 0.83, respectively, and at Taihu Hubin National Wetland Park were 0.63 and 0.45, respectively. The Shannon diversity and uniformity indices of the two parks differed considerably, suggesting some differences in the overall landscape pattern of the two, possibly due to differences in their planning and surroundings, and to some extent affecting the degree of landscape fragmentation in both.

6.2. Conservation and Restoration of Wetland Landscapes
A wetland park is different from an urban park or a nature reserve; it is a specific area where wetland conservation, education, ecotourism and other activities are carried out on the basis of the conservation of wetland ecosystems and the rational use of wetland resources. Its landscape pattern is the product of various human activities and the surrounding environment, and it also affects the distribution of species and ecological processes in the landscape through the size and shape of the patches.

All the wetland parks in Suzhou have rich natural resources, which are important ecological nodes and biological habitats of the whole city, and have important functions of environmental regulation and social service. In the current context of rapid development in Suzhou City, due to frequent urban construction activities, residents have limited knowledge of wetlands, wetland resources and wetland parks are subject to more human interference, more likely to cause wetland park landscape fragmentation. Therefore, in future wetland protection work, attention should be paid to the balanced planning of different landscape types in Suzhou Wetland Park in order to improve the stability of the wetland ecosystem structure and functional diversity, and to maximize the ecological service function of the wetland.

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