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Research Article

GIS-Based Urban Agglomeration Landscape Dynamic Observation and Simulation Prediction Algorithm

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In order to improve the intelligence level of urban agglomeration landscape, this paper conducts dynamic observation and simulation prediction of urban agglomeration landscape based on geographic information system. There are many characteristics of GIS technology itself that can be well matched with urban landscape research, so in the process of actually studying the green space landscape pattern, GIS technology has a very large space to play. The first is to use GIS technology to collect basic data of different types of scenic spots. Raster data and vector data are two important data in GIS technology. Among them, vector data with point, line, and surface morphology can relatively express the landscape ecology. Raster data is to determine the specific position of each pixel through the vertical and horizontal row and column relationship of the pixel, which is relatively simple in structure and easy to topology. According to the characteristics of the urban agglomeration landscape, the urban agglomeration landscape is reconstructed on the virtual simulation platform using GIS technology. It can meet the long-term sustainable development of the ecological environment of the scenic area. The research of this paper mainly belongs to the scope of practical research. Taking the existing research results as the first point of experimental research, combined with the relevant research results of design, the dynamic observation and simulation prediction algorithm of urban agglomeration landscape are constructed.

1. Introduction

In the process of urban environment planning in the past, it was often based on paper maps combined with corresponding historical data and information to integrate all the data through manual on-site surveys, so as to realize the planning of the urban environment. In this way, it not only consumes a lot of manpower, material resources, and financial resources but also because of the large amount of content designed in urban environmental planning; the workload is large, the process of manual data collection is slow, and there is a certain information gap, which leads to information collection [1]. Inaccurate and untimely phenomena occur. GIS technology, geographic information system, and RS technology, remote sensing technology, combined with advanced computer technology, can efficiently collect and store urban environmental spatial information and output the collected information in the form of data, with extremely high information collection and transmission capabilities, so it also has higher application value. In urban environmental planning, RS and GIS technologies can efficiently collect urban population information, building structure, urban greening distribution, and other information and form a complete urban environmental information database, which is processed by advanced computer technology such as layer overlay and makes GIS used as a database in urban environmental planning [2–4].

With the continuous development of science and technology, in the process of urban environmental planning, the application of GIS technology has become more and more obvious, which can greatly improve the efficiency of urban environmental planning, increase the efficiency of staff, and thus promote urban development. However, in the actual application process, some cities still have certain problems in the application of GIS technology in urban environmental planning, and the application level is low, which restricts the pace of urban environmental planning. The timely and accurate urban environmental information obtained by using GIS technology can greatly reduce the burden of manual surveys, thereby completing more planning tasks within a certain period of time [5–9]. However, in the actual application process, GIS technology is only used as information query, and simple icon drawing tools did not apply GIS technology in depth, which not only affected the urban environmental planning process but also caused a serious waste of available resources[10-11].

The geographic information system integrates relatively complete spatial information and geographic distribution data. GIS uses computer hardware and software as the technical carrier to realize the functions of geographic distribution data collection, storage, calculation, analysis, and display [12]. The application of GIS technology in landscape planning and analysis of landscape development trends is more common in foreign countries. With technical exchanges and cooperation, the frequency of using GIS in landscape planning in China has gradually increased. With the acceleration of the information age, the state has increased its efforts to build smart scenic areas, and the planning of vegetation landscape patterns has become an important part of smart scenic areas. In this study, GIS is used as a technology to support the dynamic observation and simulation prediction algorithm of the simulated urban agglomeration landscape. The specific realization ideas are as follows: ① using GIS technology to obtain basic data of the research area, including topographic point cloud data, surface orthophotos, vegetation distribution maps, and other information, and calculate and analyze the vegetation landscape pattern index of the area and analyze the vegetation distribution; ② plan the vegetation pattern of the scenic spot according to the advantages and disadvantages of vegetation distribution, and use basic data to build terrain, trees, and grassland models in the computer to present a virtual vegetation pattern simulation [13, 14]. As a result of planning, the use of simulation for vegetation planning in smart scenic areas is conducive to changing the landscape pattern index in real time, revising the vegetation layout, predicting the planning efficiency and scientificity of vegetation in scenic areas, and providing decision support for smart city cluster landscape planning and design.

2. GIS Technology-Based Urban Agglomeration Landscape Dynamic Observation and Simulation Prediction Algorithm

2.1. Color Description of Urban Agglomeration Landscape Pictures Based on GIS Technology. RGB color balance is a very typical color description method. The light matching to be measured satisfies Glassman's law. The specific R, G, and B tristimulus values are shown in the following formula:

$$C[C] = R[R] + G[G] + B[B]. \tag{1}$$

In

$$\begin{cases} R = \int_\lambda k\varphi(\lambda)\bar{r}(\lambda)d\lambda, \\ G = \int_\lambda k\varphi(\lambda)\bar{g}(\lambda)d\lambda, \\ B = \int_\lambda k\varphi(\lambda)\bar{b}(\lambda)d\lambda, \end{cases} \tag{2}$$

where C represents the color to be measured, $[M]$ represents three stimulus value units, λ represents the wavelength of the light to be measured, k represents the spectral distribution coefficient, $\varphi(\lambda)$ represents the spectral distribution function, and $\bar{r}$, $\bar{g}$, and $\bar{b}$ represent the three stimulus values of the spectrum. The modeling process through the image map is shown in Figure 1.

2.2. Urban Height Form. The research on the height of the city should establish dimensions from the perspectives of managers and experiencers. From the perspective of city managers, continue the landscape pattern, shape the characteristic city image, and establish the city's morphological order from the overall level; from the perspective of city experiencers, outline a beautiful city outline at the human scale and experience the city space [15, 16]. Based on this goal, a three-dimensional interactive model is used as a tool to guide the shaping of the height of the city. Multifactor evaluation is to extract the important evaluation factors that are highly controlled by the city, assign weight values, and establish evaluation standards and systems to obtain a highly partitioned extended model. Using GIS as the platform, through the determination of the guidance range and systematic calculation, a three-dimensional guidance model is initially established. Based on the guiding objectives, two levels of "functionality + environmental," three types of elements, and six specific land use factors are selected for comprehensive evaluation. Functional factors mainly consider factors related to the potential of land use, including two types of factors, land value and land accessibility, and specifically cover four types of specific land use factors, planning location, benchmark land price, urban roads, and urban hub stations; environmental factors mainly from the perspective of human settlements, based on landscape elements, two types of specific land use factors in mountainous areas and waterfront areas are evaluated. (1) For land benchmark land price and location value, the land benchmark land price reflects the current value of the land parcel and reflects the overall level and changing trend of land prices in the land market. The value of land parcels sensitively reflects various land use conditions such as location, urban facilities, and environmental factors. These conditions spontaneously dominate the reasonable construction height of land use and potentially reflect the differences in land economic conditions and intensive use value. The planned location reflects the future value of the plot. The central area of the city plays a positive role in economic development and has comparative advantages over other areas [17]. For value assignment

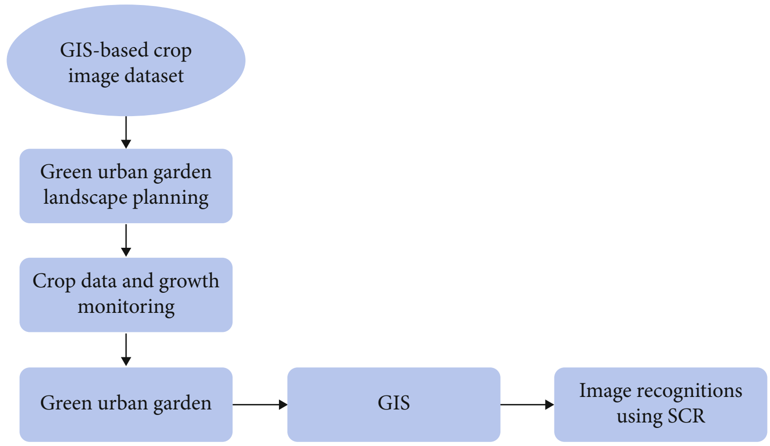

Figure 1: GIS city data processing.

method, judge the value of the plot based on the weight of the planned area. The higher the weight of the plot, the higher the value of the land. In the core area of the city, the weight of land parcels is the highest, followed by the weight of the city subcenter and core land parcels, and the weight of other parcels in the periphery is the lowest. Docking functional units with high-level partitions and establish a partitioned and hierarchical overall height control system. Delimit high priority development areas, high general development areas, and highly strictly controlled areas. High priority development areas are mainly landmark skyscrapers and super high-rise buildings to fully demonstrate the image of the city; high general development areas are mainly small high-rise and high-rise buildings to create a rich city skyline; highly strictly controlled areas are multistorey and low-rise buildings; the construction is mainly based on strict control of construction in accordance with rigid requirements, viewing corridors, wind corridors, landscape relations, and airports. At the same time, the corresponding partitions of the building height are divided into nine levels, which more clearly expresses the control of the base building height of the plot [18].

2.3. Ecological Landscape Indicators. Through the analysis method of landscape index and space, the relationship between topography and landscape structure characteristics can be quantitatively obtained, and the condition of landscape structure can be accurately evaluated, so as to better explain the relationship between landscape structure and function and finally adjust protection based on this ecological environment and economic structure. The ecological landscape pattern reflects the gathering and dispersion of landscape elements in the space. The elements are the location, size, type, direction, shape, and direction of the space. Quantitative analysis of landscape pattern is to construct the connection of landscape structure, phenomenon, and process, which can better explain and understand the function of landscape [19]. Landscape ecologists have proposed a variety of evaluation indicators for the spatial pattern of the landscape; various indicators rely on information as shown in Figure 2.

Calculates the mean of the vegetation landscape type dimension.The dimension value reflects the shape characteristics of the vegetation landscape and is an important indicator of the complexity of the shape of the landscape patch. The analysis of the spatial landscape pattern can be realized through the quantification of the dimensions [20]. The calculation method of the average value of the subdimensions of the landscape type is

$$Z = \frac{\sum_{j=1}^{m} \sum_{i=1}^{n} \left[2\text{In}\left(0.25 Q_{i,j}\right) / \text{In}\left(\lambda_{ij}\right) \right]}{H}, \tag{3}$$

where the patch area, number, and patch perimeter of the vegetation landscape are represented by λ_{ij}, H, and Q, respectively; the proportion of vegetation patch i in the total vegetation is Q_i; and m and n represent the total number of vegetation patch types and the number of patches covered by different types of vegetation patches.

(1) *Diversity Index*. Set the number of a certain type of block type i as m and the area as a_{ij}; then, the area formula of this type of block is [21]

$$A_i = \sum_{i,j=1}^{m} a_{ij}. \tag{4}$$

On this basis, use the spatial analysis of GIS to obtain the landscape element transfer matrix. The Shannon diversity index of the landscape is used to reflect the number of landscape elements and the changes in the proportions of all landscape elements. When the prime area of all landscapes is equal, the diversity of the landscape is the highest, which is expressed by $H_{\max}$.

$$H = -\sum_{i=1}^{n} p_i \log 2^{p i}, \tag{5}$$

where *pi* represents the ratio of the total area occupied by landscape type i and n represents the total number of types.

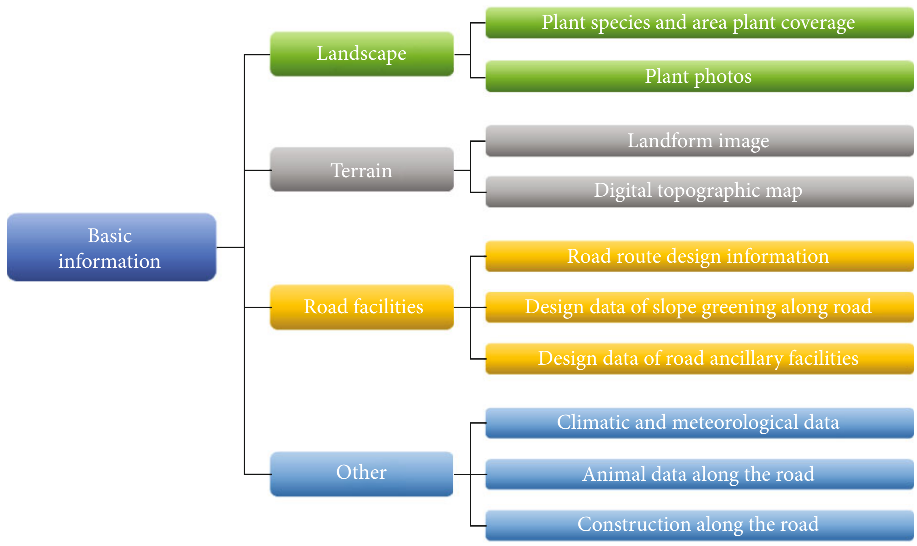

Figure 2: Basic information structure diagram.

The Shannon evenness index E of the landscape is used to describe the uniformity of the distribution of different landscape elements, and the formula is as follows:

$$E = \frac{H}{H_{\max}} * 100\%. \tag{6}$$

(2) For the calculation of species diversity index, there are many calculation methods for diversity index. This study adopts Shannon diversity index [22]. The calculation of this index involves evenness index and species richness index. The calculation formula is

$$D = -\sum_{i=1}^{F} B_i \mathrm{In} B_i, \tag{7}$$

where Bi represents the proportion of the important value of the ith species, F is the species richness index, D is the Shannon diversity index, and V is the Pielou evenness index. The upper limit of the species diversity index and the actual surveyed species diversity index are represented by $D_{\max}$ and D, respectively, and the Pielou uniformity index is the ratio of D to $D_{\max}$.

(3) *Dominance Degree*. The dominance degree is used to measure the degree of dominance of one or more landscape types within the structure of the landscape [23]. The specific calculation formula is

$$D = \log 2^{n} + \sum_{i=1}^{m} (p_i) \bullet \log 2^{p_i}. \tag{8}$$

In the formula, D represents the degree of dominance, and the meaning between pi and m is the same as the above formula. The smaller the value of D, the closer the proportions of landscape types are; the larger the value of D, it means that the landscape is controlled by only one or a few types. However, it needs to be pointed out that when $D = 0$; this type of index has no effect in a completely homogeneous landscape.

(4) *Fragmentation Degree*. It reflects the degree of fragmentation of landscape patches by measuring the number of plates per unit area [24]. The specific calculation formula is

$$F = \frac{\sum_{i=1}^{m} n_i}{A}, \tag{9}$$

where F represents the fragmentation degree of the landscape, n_i represents the number of patches of the ith landscape type, and A represents the total area of the landscape. The larger the F, the more fragmented the patches of the landscape.

(5) *Subdimension*. Previous studies have proved that, compared to the shape and structure of all other landscape types, mosaics in the landscape are the most typical fractal geometry. Fractal theory can be used to study quantification and then be measured by the shape of perimeter. The fractal dimension describes the characteristic parameters of the geometric shape. Because the shape of other graphs reflected as a function of perimeter changes with perimeter changes, it can also quantitatively test the fractal structure of landscape mosaics [25]. The formula of the fractal dimension value model of the landscape type is as follows:

$$\ln [A(r)] = \frac{2}{D_i} \ln [P(r)] + C, \quad (10)$$

where $A(r)$ represents the area, $P(r)$ represents the perimeter, r represents the measurement scale, D_i represents the fractal dimension in the two-dimensional Euclidean space, and C represents the constant. According to the perimeter and area data of all patches, by constructing a regression model with the shape of the above formula, the fractal dimension D_i of this landscape type can be obtained. The size of D_i represents the stability and complexity of the landscape type. The specific numerical theoretical range is between 1 and 2. The larger the value, the more complex the shape of the landscape; $D_i = 1$ represents the shape of the landscape patch. It is a square; $D_i = 2$ means that the shape of the landscape patch is the most complicated. In addition, the fractal dimension D_i can be used to compare the pattern characteristics of landscape elements to determine the impact of different ecological factors on the landscape pattern. If two landscape pattern elements have the same fractal dimension, it means that there is a certain pattern difference between the two.

(6) *Optimal Planning of Urban Ecological Landscape*. The urban ecological landscape image texture is analyzed by analyzing the contrast, information entropy, correlation coefficient, and angular second-order four texture features, and the maximum likelihood method is used to classify its ecological landscape data to realize the optimal layout of the layout [26]. If n'' represents the pixel value, $p(i'', j'')$ represents the element in the i'' row and j'' column in the landscape image cooccurrence matrix; (i'', j'') represents the gray value of the cooccurrence matrix of the ecological image, using the above method to describe the vector of texture features that are widely used in practical applications and analyze the texture of the urban ecological landscape image, and the selected vectors of texture features are information entropy (ENT), angular second moment (ASM), contrast (CON), and correlation function (COR). The specific calculation formula is as follows:

$$\mathrm{ENT} = \sum_{i''=1}^{n''} \sum_{j''=1}^{n''} p\left(i'', j''\right) \times \ln p\left(i'', j''\right), \quad (11)$$

$$\mathrm{ASM} = \sum_{i''=1}^{n''} \sum_{j''=1}^{n''} p\left(i'', j''\right)^2, \quad (12)$$

$$\mathrm{CON} = \sum_{i''=1}^{n''} \sum_{j''=1}^{n''} p\left(i'', j''\right) \times \left(i'' - j''\right)^2, \quad (13)$$

$$\mathrm{COR} = \frac{\left[\sum_{i''=1}^{n''} \sum_{j''=1}^{n''} i'' * j'' p\left(i'', j''\right) - \mu_x \mu_y\right]}{\left(\sigma_x \sigma_y\right)}. \quad (14)$$

3. Result Analysis

Human modern life and urban construction continue to erode and invade urban green space, severely breaking the ecological stability and ecological functionality of the original landscape pattern and also destroying the biodiversity of the original habitat [27, 28]. The pace of urban green space construction cannot keep up with the wanton and disorderly urban expansion process, which has broken the green space matrix pattern in the natural state, causing it to be fragmented into a large number of highly fragmented patches of different sizes. The ecological function and ecology of the green space landscape benefits are greatly reduced. The construction of a reasonable ecological network can alleviate and suppress the high fragmentation of urban green landscapes and can effectively enhance the continuity of urban green landscapes [29]. Therefore, urban ecological corridors should be constructed rationally and used as links to connect discrete patches to form a scientific and rational ecological network and urban green space system. Through the three-dimensional analysis and research of the virtual urban landscape, planning managers can analyze and evaluate the color design, layout, spatial volume relationship, and the relationship between the building and the environment of the planning technical solutions of important areas in the city according to requirements, so as to develop and construct in the city. Pursue a corresponding balance in economic, social, and environmental benefits. At the same time, planning managers can also use the simulated three-dimensional landscape to track the construction and development of urban morphology, and according to the requirements of different stages of urban construction and development, timely adjust the corresponding regulatory detailed planning and urban design plan to better guide the urban landscape construction.

In order to verify the overall effectiveness of the method for optimizing garden landscape spatial pattern gradient under big data analysis, it is necessary to test the method of optimizing garden landscape spatial pattern gradient under big data analysis. In this test, plant diversity is important for evaluating garden landscape spatial pattern gradient [30]. Indicators, using the gradient optimization method of garden landscape spatial pattern under big data analysis (Method 1), the gradient optimization method of spatial landscape at all levels under the background of rapid urbanization (Method 2) and the gradient optimization method of landscape pattern based on land use (Method 3) perform tests to establish the spatial coordinate system of the garden landscape spatial gradient pattern and compare the plant species in the garden landscape spatial pattern gradient optimized by three different methods. The test results are shown in Figure 3. The different shapes in the figure represent different plant species. According to the test results of the gradient optimization method of garden landscape spatial pattern under big data analysis, it can be seen from the

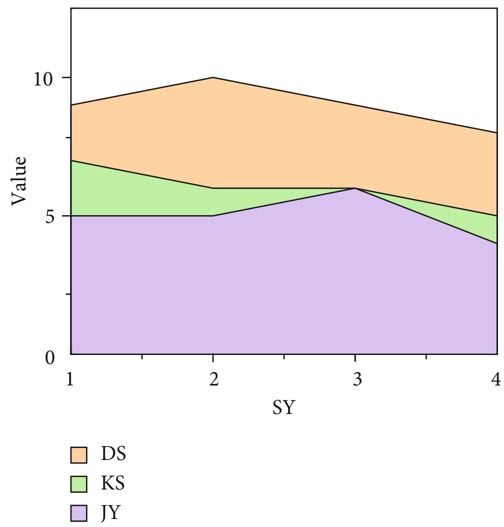

Figure 3: Comprehensive force measurement of three different methods.

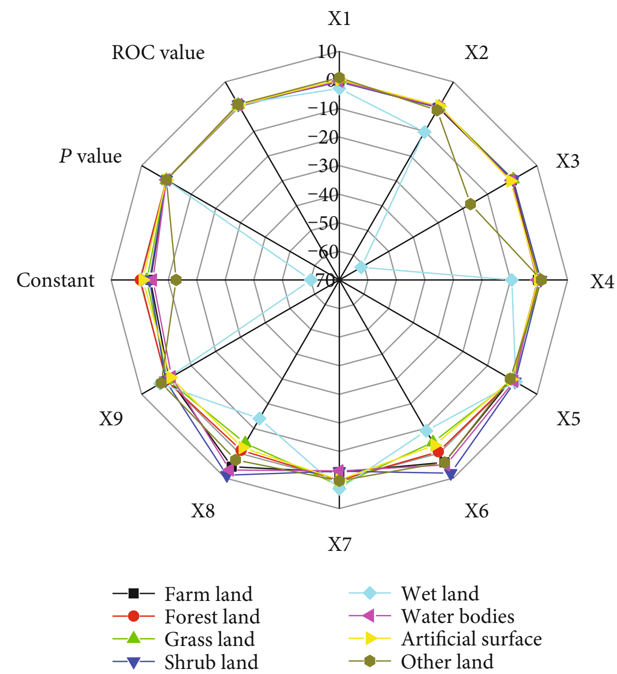

Figure 4: Driving forces of evolution of main landscape types.

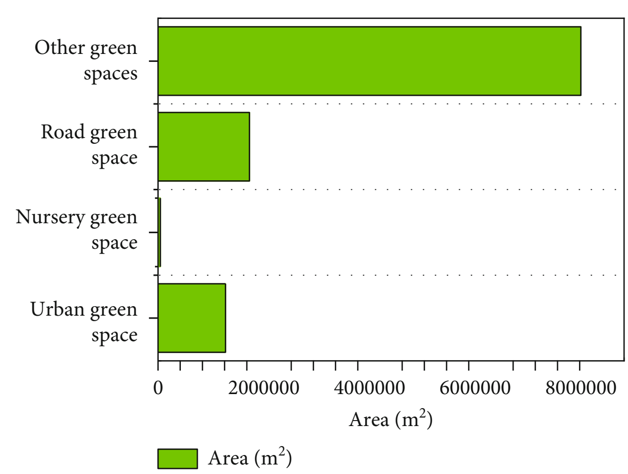

Figure 5: Green space occupancy ratio.

analysis of Figure 3 that using the method of gradient optimization of garden landscape spatial pattern under big data analysis, there are many kinds of plants in the gradient pattern, and the distribution is even. The test results of the gradient optimization method of the spatial landscape at all levels under the background of rapid urbanization, the analysis shows that the gradient pattern obtained by the gradient optimization method of the spatial landscape at all levels under the background of rapid urbanization has fewer plant species and the gradient optimization method of the landscape pattern based on land use, like Figure 4. According to the analysis of the test results, the plant species in the gradient pattern obtained by using the land-use-based landscape pattern gradient optimization method are relatively single. Comparing the optimization results of the three different methods and Figure 5, it can be seen that there are more plant species in the gradient pattern optimized by the gradient optimization method of the garden landscape spatial pattern under the big data analysis.

4. Effect Evaluation

Figure 6 shows the test results of the gradient optimization method of garden landscape spatial pattern under big data analysis. The gradient pattern optimized by the method of garden landscape spatial pattern gradient optimization under big data analysis has more plant species. Figure 6 represents the comprehensive measurement of the gradient of the garden landscape spatial pattern. The value is taken in the interval [-2, 2]. The closer the value of Q is to 0, the better the obtained optimization result of the spatial pattern gradient of the garden landscape. The gradient optimization method of garden landscape spatial pattern under big data analysis, the gradient optimization method of spatial landscape at all levels under the background of rapid urbanization, and the gradient optimization method of landscape pattern based on land use were tested [31].

The degree of fragmentation of the landscape in the study area has been kept in a relatively high state as a whole, which is related to the fact that the terrain of the area is more mountainous and hillier. The degree of landscape fragmentation first increased due to the rise of scattered urban buildings and the impact of human deforestation and land reclamation activities, and then, the degree of fragmentation began to decline due to the closure of reclaimed areas and scattered buildings [32]. It reflects the characteristics of landscape ecology in the process of urban development. Socio-economic and policy planning factors play an important role in the change of urban landscape pattern, and good management and planning intervention have a positive impact on urban ecological construction, like Figure 7.

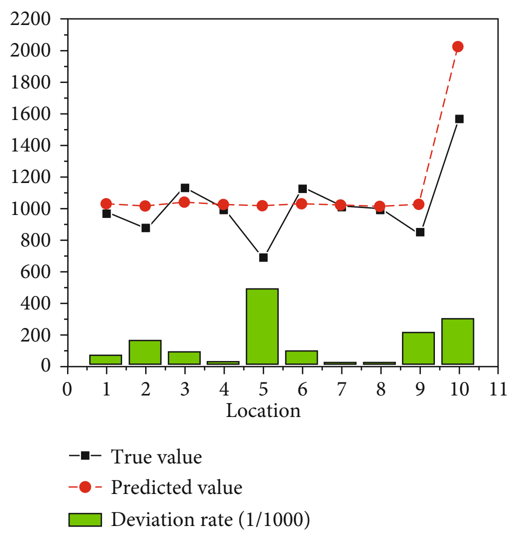

Figure 6: Experimental data monitoring bit rate comparison results.

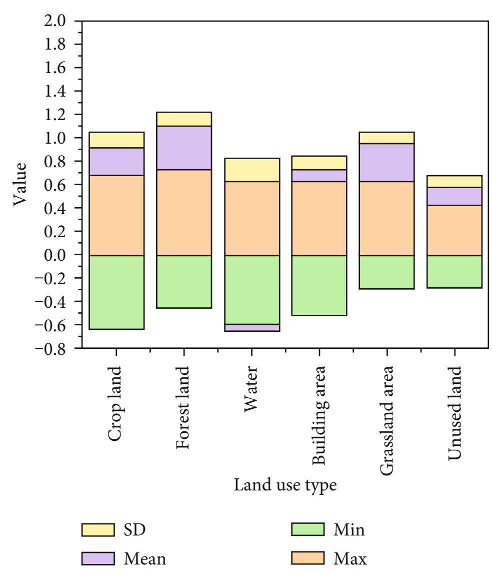

Figure 7: The relation NDVI based on different land use type.

After the method is applied, it has effectively improved the actual environmental problems of the city. Compared with the data from 2012 to 2018, the research method has significantly reduced the sulfur dioxide and smoke and dust content of the city, and the rainfall and green areas have increased. The research method fully takes into account the area and area and proportion of its ecological landscape, and the diversity of the planned ecological landscape allows the city's environmental problems to be effectively controlled during the test period. In order to further verify the effectiveness of the research method through simulation, on the basis of the above experiments, experiments are carried out on the accuracy of the optimal planning of the urban ecological landscape color balance layout with different methods. The higher the accuracy, the higher the precision of the method application process planning. If the accuracy of the method is low, it will directly lead to a rough problem of the landscape planning effect, which cannot meet the current basic requirements in this field.

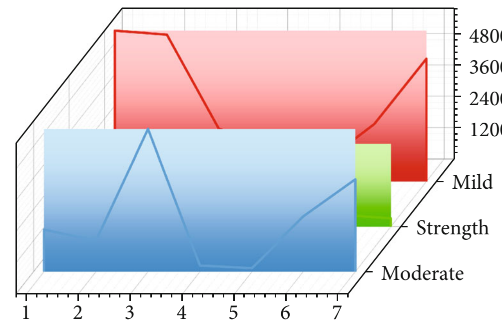

Figure 8: Area composition of soil erosion intensity in different types of areas.

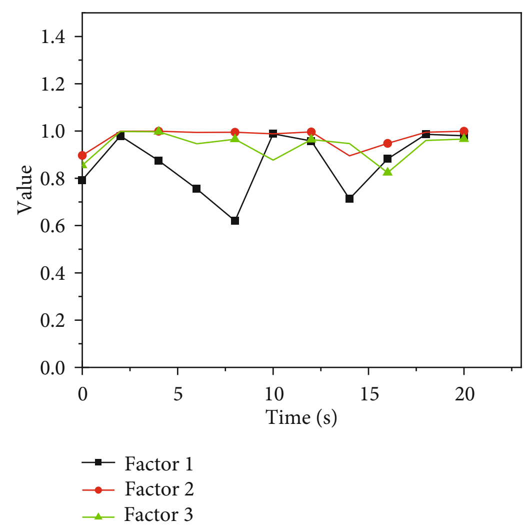

Figure 9: The R2 of each factor varies over time.

It can be seen from the experimental results in Figure 8 that the accuracy and adaptability of the two methods fluctuate during the landscape planning process, but the accuracy of the research method fluctuates less and has better adaptability. Within a reasonable length of landscape planning, the research method has a higher precision of landscape planning, indicating that the method proposed by the research is more precise in application. The above experiments prove that the research method has a good effect on the color balance planning of urban ecological landscape, like Figures 8 and 9.

5. Conclusions

Vegetation planning virtual simulation technology to study vegetation is the main coverage part of the smart scenic area. This article uses GIS technology to obtain the problems in the vegetation pattern of the scenic area and rationally plans the vegetation of the smart scenic area in the virtual simulation platform, which is the long-term sustainability of the smart scenic area. Development provides a scientific reference basis to improve the intelligent level of vegetation planning in scenic spots.

In order to keep up with the process of urbanization, the gradient pattern of the garden landscape space needs to be optimized. When the current gradient optimization method is used to optimize the garden landscape spatial pattern gradient, the optimized gradient pattern has few plant species and uneven distribution, which cannot effectively optimize the garden landscape spatial pattern gradient. A big data analysis of the garden landscape is proposed. The spatial pattern gradient optimization method solves the shortcomings of the current method and optimizes and improves it, laying the foundation for the development of garden landscape. Provide technical support for ecological environment management and protection. However, limited by the depth and breadth of the research, this design did not accumulate data on the rich animal and plant resources of the wetland. This point will be the focus of the next stage of research, and special research work will be carried out. On the other hand, in-depth research on the optimal design of countermeasures for the dynamic evolution of wetland landscapes provides suggestions for improving the ecological restoration rate of wetland landscapes.

Secondly, the vegetation landscape planning method uses GIS technology as an auxiliary guidance technology, which is a quantitative reference tool for rational planning of vegetation patterns. In future research, the role of GIS in spatial pattern planning and design will be further exerted, and a complete spatial pattern planning system will be constructed by combining GIS technology and modern technical means, starting from digital image processing and imagery. Information feature extraction, digital technology to obtain multi-level ground data, in-depth exploration of the temporal and spatial variation factors and influencing mechanisms of vegetation coverage by means of a combination of maps and numbers, provide a scientific basis for in-depth optimization of vegetation coverage. ecosystem.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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