Urban Green Space Planning and Design for Sponge City

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Received 31 May 2022; Revised 17 June 2022; Accepted 20 June 2022; Published 30 July 2022

Academic Editor: Lianhui Li

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Urban green space designed based on the concept of sponge city is an important sponge carrier. Guided by the theory of landscape ecology, this article introduces the artificial neural network (ANN) model and uses the research method of landscape pattern index to establish a model for the proportion of urban green space types and the characteristics and dynamic changes of landscape spatial pattern. Based on the optimal landscape pattern index, the theoretical value of the optimal proportion of ecological green space, community park, comprehensive park, roadside green space, protective green space, and strip green space is obtained through the model. Based on this proportion value, combined with the ANN model, the reasonable evaluation results of patch density and average perimeter area ratio, spread degree, and diversity index of planned green space are obtained. Then, according to the influence of various green spaces on each landscape index, the development trend of urban green space construction in the future is predicted.

1. Introduction

Due to global warming and the acceleration of urbanization, coupled with the increasingly prominent problem of natural resources, the environmental quality of urban development is also increasingly worrying. After meeting the needs of material and cultural life, modern people begin to put forward higher requirements for the living environment. People’s longing for a better life includes people’s hope to see blue sky, green grassland, and breathe fresh air. Therefore, it has become an urgent hope for modern people to change the current situation of the city and build a new ecological city more suitable for people’s living. In this context, the concept of “building a sponge city with natural accumulation, natural infiltration, and natural purification” came into being [1–5].

The essence of sponge city is to establish an ecosystem in the city; use the power of nature for drainage; build a sponge city, make the rainwater of the city reach the natural accumulation, natural infiltration, and natural purification; make the city closer to nature; plan all kinds of resources as a whole; reduce the damage of development and construction to the original ecosystem; and realize the harmonious coexistence between mankind and nature.

As a recreational place for residents, urban green space has important value in the fields of ecological environment, society, and culture. In the construction of sponge city, urban green space, as an important carrier, can effectively play the “sponge” role of “infiltration, stagnation, storage, purification, utilization, and drainage” through the application of low-impact development engineering technology in the construction process [6–9]. However, the green space designed based on the concept of sponge city not only bears the inherent role of recreation, greening, and beautifying the environment, but also should play the role of sponge carrier in the face of water environment problems. If we can form an effective feedback mechanism for such green space from the perspective of users, it will promote the improvement of such sponge facilities and the effective play of sponge function.

From the perspective of land planning, environment, and ecology, urban green space refers to urban nonconstruction land dominated by natural and artificial vegetation. The main contents include two levels: one is the land used for greening within the scope of urban construction land, and the other is the area outside the scope of urban construction land, which plays a role in urban ecology, landscape, and
residents’ leisure life and has a good greening environment. From the perspective of architecture, urban planning, and landscape architecture, urban green space refers to the area where green plants are planted within the scope of urban planning land, which can improve and maintain the ecological environment; beautify the city appearance; provide leisure and recreation sites; or have the functions of sanitation, safety, and protection. According to this definition, the production land of agriculture, forestry, and animal husbandry outside the urban regional planning and nature reserves do not belong to the category of green space. The definitions of urban green space obtained from different angles are different. Generally speaking, urban green space can be divided into broad and narrow concepts. In the narrow sense, it refers to the green land within the scope of urban land construction. In the broad sense, it generally refers to all areas covered by green plants. At present, the urban green space system we plan should be the combination of broad and narrow green space, so as to make a more reasonable analysis and discussion.

Urban environmental problems have always been a major problem restricting human survival and development [10–12]. In order to achieve sustainable development, we must act in accordance with the laws of nature. The proposal of the concept of sponge city is not only the process of constructing the rainwater system of urban low-impact development, but also the process of solving urban problems according to the laws of nature. As an important carrier of sponge city construction, park green space is expected to achieve the goal of “natural accumulation, natural infiltration, and natural purification” of sponge city while realizing the original function of urban park. In fact, after the completion of the sponge park green space, what is the realization of its sponge function? What is the feedback from park users? At present, there is still a lack of theoretical research in this field. Based on this, the purpose of this study is as follows:

(1) We need to comprehensively explore the relevant theories of green space planning and design based on the concept design of sponge city and the theory of post-use evaluation and seek a feasible method for post-use evaluation of the sponge park green space. (2) We hope to establish a feasible post-use evaluation system of the sponge park green space so that it can guide the post-use evaluation of the built sponge park green space. (3) After obtaining the results of post-use evaluation of practical cases, through the analysis of the results, we hope to promote the development and optimization of case green space and provide a reference for the construction and management of similar sponge green space in the future.

2. Overall Research Framework

Recently, the urban green space system planning in various parts of China has different methods, diverse technologies, and different quantitative indicators, so the planning has its own characteristics and has its rationality. However, how to evaluate its rationality, whether there are some deficiencies, and places that can be improved are the main starting point of this article. If problems are found in advance, it is not necessary to adjust the planning, but if we can be aware of the existing problems and consider them in the next round of planning, it will certainly help to promote the green space system planning in a more scientific and practical direction. For urban management departments, after the rapid development of urban construction, all localities will inevitably face the planning of new and old cities.

How to make the new town not completely “start a new stove” but reflect the urban characteristics; continue the green space layout, historical context, and other traditions of the old city; and whether the existing green space system planning is still applicable in the construction of new towns with policy tendencies are the breakthrough points of introducing artificial neural network (ANN) [13–16] to evaluate the existing green space system planning in this article.

ANN is an engineering system that simulates its structure and intelligent behavior based on the understanding of the organizational structure and operation mechanism of the human brain from the perspective of microstructure and function. It is a highly nonlinear processing system formed by the extensive interconnection of a large number of processing units (neurons), which is suitable for simulating complex systems. Human brain activity is a highly nonlinear dynamic system. Although the structure and function of several neurons are very simple, the behavior of the neural network composed of a large number of neurons is colorful and extremely complex. The nature of the overall activity is not equal to the simple addition of the activities of unit neurons.

The main contents of this study include: through the detailed study of the ANN principle, taking the method of landscape ecology as the intermediary, we interpret the feasibility of using the method to evaluate the urban green space system planning and construct the green space system planning evaluation system. According to the process of urban development, we thoroughly analyze the characteristics of the green space system in the urban green space system planning. On this basis, we divide three types of green space representing the “past, present, and future” of the study area and take the “present” green space as a sample to evaluate the rationality of “future” green space planning by establishing a simulation model. ANN is used to establish the relationship model between the proportion of green space types and landscape pattern index, predict the pattern changes of planned urban green space, and provide a reference basis for the overall evaluation of the existing urban green space system planning.

By compiling the network program, we use the artificial neural network model to model the green space data and landscape pattern index, simulate the internal relationship between various green space areas and landscape pattern index based on the existing data, predict the planning development trend, and optimize the green space system planning for sponge city. The technical route of this study is shown in Figure 1.
3. Methods

3.1. Evaluation System of the Green Space System Planning. Landscape ecological planning needs to select the influencing factors and calculate the weight of each factor to superimpose its effect. Similarly, the artificial neural network also needs to preselect the number of factors, that is the number of neurons in the hidden layer. The difference is that its factor characteristics are uncertain, which can only be identified within the network and cannot be truly expressed in language.

The most famous supervised algorithm is the error back propagation (BP) algorithm of a multilayer feedforward artificial neural network [17–20]. Structurally speaking, the network is composed of layers or layers above, that is the input layer, the hidden layer, and the output layer. Neurons in each layer form a full connection, while neurons in the same layer have no connection [21–25]. In the same network, there can be more than two hidden layers, as shown in Figure 2. The network with only one hidden layer is a basic network model.

For the BP network, there is a very important theorem, that is any continuous function in a closed interval can be approximated by a single hidden layer network, so a three-layer network can complete any dimension to dimension mapping. The selection of the number of neurons in the hidden layer is more complex. At present, it is mainly determined according to the previous experience and many experiments. So far, there is no ideal analytical formula to calculate. The number of hidden layers is not the more the better. It is directly related to the requirements of the problem and the number of input and output units. Too much number will lead to too long learning time, not necessarily the best error, poor tolerance, and unable to identify samples that have not been seen before. Therefore, there must be an optimal number of hidden units. The empirical formula can be used as a reference formula for selecting the best number of hidden layer neurons, or the number of hidden layer neurons can be determined by experimental method without formula calculation. The process of this method is: initially put enough neurons and eliminate those that do not work through learning until they cannot contract; or start to put in fewer neurons. After learning a certain number of times, if it is unsuccessful, increase the number until it reaches a more reasonable number.

In the process of landscape ecological planning, between the current situation and planning, many factors need to participate in the planning process. Each factor has a corresponding weight proportion when it plays its role. The determination process of this weight is equivalent to the calculation process of the function, which is completed through the incentive function or transfer function. The relationship between the input layer and the output layer of the network is represented by a function as the carrier, which is the excitation function. The excitation function is an important weaving part of the network. It must be continuously differentiable so that it can be calculated by a gradient method.

3.2. Construction of Network

3.2.1. Input Layer. The selection principle of the input layer is to intuitively express the variables of research events. These variables should be measurable (e.g., distance and
length), searchable (e.g., quantity), or statistical. In relevant studies, elevation, slope, geomorphic zoning, population density, distance from the core landscape, and other indicators are mostly used as the input layer. Most of these indicators are objective or natural factors, which can reflect the impact of natural driving forces and human interference on the landscape to some extent and can better explain the significance of the network. In fact, in urban planning or green landscape planning, in addition to the basic ecological factors that need to be considered in urban construction, in more cases, the factors with practical guiding significance established based on these factors, or “secondary factors,” such as land use punishment, population distribution, etc., or these basic “ecological sensitive factors” are often only used for reference without actual expression status.

In view of the above reasons, in the landscape ecological network of this article, the percentage of the area of various types of landscape is considered to be selected as the input variable, and multiple input variables composed of each sample together constitute the input layer matrix [21]. It is one of the basis to help us determine the dominant landscape elements in the landscape, and it is also an important factor to determine the ecosystem indicators such as biodiversity, dominant population, and quantity in the landscape. In fact, the process of forming the area percentage of various types of landscape in the city has integrated the repeated influence of all ecological, social, land use, and other factors. It can be said to be the “semi-finished product” of green space pattern. Researching on this basis may produce some errors, but this choice can directly adopt the existing achievements and strengthen the application and promotion ability of research, which has certain application value.

3.2.2. Output Layer. The data of the output layer are generally indicators that can reflect the essence or deep meaning of the event. These indicators have a logical connection with the data of the input layer that are not obvious but has a high internal correlation. At present, there are many kinds of landscape pattern indexes, and new indexes have been put forward by scholars. However, these indexes have a great correlation in essence, and the indexes do not meet the requirements of mutual independence [23, 24]. Therefore, using multiple indexes at the same time often cannot add “new” information. Naturally, using these indexes with great correlation to describe landscape pattern is not convincing enough. Theoretically, there must be an index system of landscape pattern, which is enough to describe the landscape pattern, but not redundant.

Therefore, the analysis of the mutual independence of landscape index has become an important research topic. Combined with the actual situation of this study, four landscape pattern indexes of patch density, Shannon diversity index, average perimeter area ratio, and spread degree are selected as the output layer of the network, as shown in Table 1. Based on the principle of landscape pattern index representing green space change and spatial allocation, it is expected to study the relevant characteristic process and change development trend of green space through these four indexes.

1. Patch density, which is the number of patches per unit area, reflects the overall degree of patch differentiation or fragmentation of the landscape. The change of its value can reflect the intensity and direction of human interference. The high patch density indicates that there are many heterogeneous landscape elements in a certain area, with small patch size and high degree of fragmentation. For urban green space landscape, the degree of landscape fragmentation indicates the contribution and ability of urban green space landscape to biodiversity maintenance. Generally, under the condition of equal area, the higher the degree of fragmentation, the smaller the urban green space landscape patch unit, the simpler the function of the landscape unit, and the more unfavorable to biodiversity protection.

2. Shannon diversity index indicates that the whole landscape is composed of only one patch. The increase of this index indicates that the patch types increase or the patch types are distributed in a balanced trend in the landscape. This index can reflect the landscape heterogeneity, especially sensitive to the unbalanced distribution of patch types in the landscape, that is it emphasizes the contribution of rare patch types.

3. The average perimeter area ratio is one of the important indicators of the complexity of landscape spatial pattern. It represents the complexity of irregular objects and is used to measure the complexity of shapes. The lower the value is, the simpler the patch boundary is, and the less conducive to the maintenance of biodiversity.

4. The spread degree, with a value of 0–1, is one of the most important indexes to describe the landscape pattern. This index describes the degree of agglomeration or extension trend of different patches in the landscape. Theoretically, a small value indicates that there are many small patches in the landscape. The landscape is a dense pattern with many elements. When the degree of fragmentation of the landscape is high, it indicates that some dominant patches in the landscape have formed good connectivity.

3.2.3. Network Training. “Network training” integrates two inseparable processes of learning and training. In principle, it is a process of looking for a set of useful weights and thresholds. The popular explanation is a process of learning and integrating the network into the network’s own knowledge and experience through the existing data [21–25]. The connection weight is the knowledge reserve required by the neural network to solve practical problems. The training process of the network can be described as forward propagation of working signal and back propagation of error signal. First, training is to provide a training set, which is
composed of several groups of input samples and the corresponding expected output. At the beginning of network construction, the ownership value and training value contained in the middle of the problem to be solved are unknown. Generally, the initial value of the network is randomly generated. Until the useful weight is found, the artificial neural network cannot represent this problem.

**Step 1.** The system randomly selects a learning sample; calculates the input of each neuron in the hidden layer with the input sample, initial weight, and threshold; and then calculates the output of each neuron in the hidden layer through the excitation function.

**Step 2.** The output of each neuron in the output layer is calculated by using the output matrix, initial weight, and boudoir value of the hidden layer, and then the response of each neuron in the output layer is calculated by the excitation function, that is the actual output of the sample.

**Step 3.** The generalization error of each neuron in the output layer is calculated by using the expected output of the sample and the actual output of the network. The generalization error of each unit in the hidden layer is calculated by using the initial weight of the hidden layer, the generalization error of the output layer, and the output of each neuron in the hidden layer.

**Step 4.** The generalized error is propagated back to the input layer, and the weights and thresholds of the input layer and the hidden layer are gradually corrected.

**Step 5.** The next learning sample is randomly selected and returned to the first step until all learning samples are trained.

**Step 6.** A group of input and output matrices is randomly selected from the learning samples again and returned to the first step until the global error of the network is less than a preset minimum, that is the process of network learning convergence.

**4. Application of Urban Green Space Planning and Design Network**

The trained network should also carry out a performance test. The test method is to select the test sample data and provide it to the network to test the correctness of the network’s output. The test sample data should have a pattern similar to the learning data. These samples can be obtained by direct measurement or simulation. When the sample data are small or difficult to obtain, they can also be obtained by adding appropriate noise to the learning samples or interpolating according to certain rules. In order to better verify the generalization ability of the network, a good test sample set should not contain the same pattern as the learning sample.

When using ANN to simulate the existing urban green space system planning [26, 27], the omnidirectional expression of the landscape index should be considered on the whole green space landscape as far as possible and the index change should be evaluated after the construction of the network from the following aspects:

1. **Evaluate whether the type and proportion of planned green space are reasonable**
   The amount of green space reflects the level of urban green space, and the type proportion of green space can reflect the integrity and spatial structure of urban green space and will indirectly affect the function of green space.

2. **Evaluate whether the landscape fragmentation of the planned green space is reasonable**
   The size of patch density will directly reflect the degree of landscape fragmentation. The greater the patch density, the higher the degree of fragmentation. At the same time, it further reflects the living standard of urban residents, the quality of living environment, and the ecological level of the city.

3. **Evaluate whether the landscape diversity of planned green space is reasonable**
   The level of landscape diversity mainly depends on the number of landscape components and the
proportion of each landscape component. In the landscape system, the more the landscape components and the higher the degree of fragmentation, the greater the information content and uncertainty, the higher the landscape diversity index, and the higher the landscape heterogeneity.

(4) Evaluate whether the landscape fractal dimension of planned green space is reasonable

Landscape fractal dimension mainly measures the complexity of green space shape. The index selected in this study is the average perimeter area ratio. If the urban green space is greatly disturbed by human beings, the patch shape is regular and simple, and the landscape fractal dimension is low, which is unfavorable to the maintenance and construction of biodiversity. By evaluating the rationality of landscape fractal dimension, we can detect whether we pay too much attention to regular design and whether there are too heavy artificial carving traces in the process of green space design, so as to strengthen the attention to the naturalization, ecology, and diversification of green space.

To sum up, the type proportion of green space is related to the fragmentation and diversity of landscape, and there is a certain contradiction between fragmentation and diversity. In the process of evaluation and analysis, we must pay attention to this contradiction and comprehensively weigh and consider the value of landscape index.

5. Case Study

Based on the landscape ecological network, the network is constructed through the network command Newff built in MATLAB, and the hyperbolic tangent sigmoid (Tan-SIGMOD) function and linear function are selected as the excitation functions of the hidden layer and the output layer, respectively. In terms of performance setting, the maximum number of training is 6000, the learning rate is 0.01, and the preset expected error is 0.0001. The preset expectation error is too large and has no popularization value. The preset expected error cannot be set too small, because the number of samples is limited and the error setting is small, which will affect the generalization ability of the network, and there may be large errors in application.

According to the empirical formula of hidden layer design and the actual situation of this case, the number of hidden layer neurons in the network to solve this problem should be between 5 and 15. Therefore, it is necessary to design a network with a variable number of hidden layer neurons for debugging in advance and determine the optimal number of neurons through error comparison and trade-off consideration. In order to improve the training speed, set each index to a higher value during debugging, such as learning rate 0.05 and preset expected error 0.005, and the training error results are shown in Table 2.

It can be seen from Table 2 that in the error test with 5–15 as the number of hidden layer neurons, when the number of hidden layer neurons is less than 7, the network error is greater than 0.005, the preset target error value cannot be reached, and the network cannot converge. In the 6th experiment, when the number of hidden layers reaches 10, the error reaches a lower value, and the error fluctuates with the increase of the number of neurons. In the 10th training, that is when the number of hidden layers reaches 12, the error tends to a stable decline state, the training time is significantly shorter, and the training times are reduced. After less than 20 training, the error can reach the preset expected value. The network can converge without enough training, and the error is very small. Such a network can achieve high accuracy after training. However, when it comes to testing, it is likely to cause great errors, so its generalization ability is very poor and does not have generalization. To sum up, although the minimum error occurs in the network with 13 neurons in the hidden layer, its training time and times are too low and less than the number of samples. Therefore, it is more appropriate to select 10, which can not only ensure the training accuracy, but also improve the generalization ability of the network.

After the network is created, it cannot be directly put into use. It can only be used as an urban green space model after training to meet the requirements. In neural network analysis, the sample data are generally divided into three parts: one part is used for network training, the other part is used as confirmation samples, and the other part is used as test samples. When using, the samples must be classified. According to their role in network analysis, they are divided into training samples (18 randomly selected), test samples (4), and simulation samples. In the selected samples, the protective green space and strip green space are evenly distributed, the roadside green space and community park are concentrated and scattered, and the ecological green space and comprehensive park are more concentrated in some samples. Training sample output layer data are shown in Table 3.

As can be seen from Table 3, the error of the network decreases sharply in the first 20 times of learning, and then gradually tends to be stable. After 135 times of learning, the network converges to reach the preset expected error value. There are two obvious fluctuation periods in the training process. The first occurs when the number of training times is times. At this time, all samples have just participated in a
network training, and the substantial error adjustment is over. The second time occurs when the number of training times reaches 80, that is each sample has participated in the network correction for an average of 4 times. The network has adapted to the information contained in all samples. At this time, the network error no longer fluctuates, but decreases steadily until it reaches the set expected value.

After the network training, it must be tested to confirm its stability and popularization ability before it can be put into use. Its purpose is to determine whether the network meets the requirements of practical application. Test sample input layer data are shown in Table 4, and test sample output layer data are shown in Table 5.

We input the above data into the trained network, and the error is shown in Table 6.

As can be seen from Table 6, except that the diversity index error of samples 2 and 11 is large, the others maintain a high degree of coincidence, that is the network can better simulate the relationship between green space types and landscape pattern and has good popularization ability. The large error in the edge area of network data reflects the disadvantage of insufficient network samples. With the continuous increase of the number of samples, this error is bound to decrease gradually.

6. Conclusions

At present, the impact of green space on urban residents’ life and urban environmental quality, urban characteristics, and historical and cultural preservation is becoming greater and greater. Urban green space has become a comprehensive function of urban residents’ rest place, urban environmental maintenance, urban morphological structure guidance and control, and urban ecological security. The urban green space system planning, as a special planning of urban planning, has always been in a subordinate position of urban planning. In terms of preparation procedures, it is required

**Table 3: Training sample output layer data.**

<table>
<thead>
<tr>
<th>Sample number</th>
<th>Patch density</th>
<th>Shannon diversity index</th>
<th>Average perimeter area ratio</th>
<th>Spread degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>389.2528</td>
<td>1.0789</td>
<td>1105.3014</td>
<td>48.6681</td>
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<td>16</td>
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<td>3</td>
<td>289.0374</td>
<td>1.1400</td>
<td>1043.5673</td>
<td>56.2471</td>
</tr>
<tr>
<td>22</td>
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<td>0.7293</td>
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<tr>
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<td>1.2787</td>
<td>1121.1882</td>
<td>54.5327</td>
</tr>
<tr>
<td>12</td>
<td>153.1831</td>
<td>0.8915</td>
<td>1428.9572</td>
<td>60.9006</td>
</tr>
<tr>
<td>13</td>
<td>153.5420</td>
<td>1.0693</td>
<td>1086.6008</td>
<td>62.4801</td>
</tr>
<tr>
<td>2</td>
<td>184.4429</td>
<td>0.7671</td>
<td>1058.6464</td>
<td>63.1536</td>
</tr>
<tr>
<td>11</td>
<td>113.2049</td>
<td>0.6590</td>
<td>985.4602</td>
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<tr>
<td>26</td>
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<td>0.6319</td>
<td>848.7701</td>
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</tr>
<tr>
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<td>127.8780</td>
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<td>691.9037</td>
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<tr>
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<td>53.8462</td>
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<td>181.5919</td>
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<td>896.5168</td>
<td>49.0279</td>
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</table>

**Table 4: Test sample input layer data.**

<table>
<thead>
<tr>
<th>Sample number</th>
<th>2</th>
<th>11</th>
<th>17</th>
<th>23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protective green space</td>
<td>0.1024</td>
<td>0.0787</td>
<td>0.7189</td>
<td>0.3528</td>
</tr>
<tr>
<td>Roadside green space</td>
<td>0</td>
<td>0.3054</td>
<td>0.1126</td>
<td>0.0909</td>
</tr>
<tr>
<td>Ecological green space</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Comprehensive park</td>
<td>0.7145</td>
<td>0</td>
<td>0</td>
<td>0.2822</td>
</tr>
<tr>
<td>Community park</td>
<td>0</td>
<td>0</td>
<td>0.1236</td>
<td>0.1531</td>
</tr>
<tr>
<td>Banded green space</td>
<td>0.1756</td>
<td>0.6312</td>
<td>0.0656</td>
<td>0.1378</td>
</tr>
</tbody>
</table>

**Table 5: Test sample output layer data.**

<table>
<thead>
<tr>
<th>Sample number</th>
<th>2</th>
<th>11</th>
<th>17</th>
<th>23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patch density</td>
<td>185.0742</td>
<td>153.0066</td>
<td>128.0687</td>
<td>135.0031</td>
</tr>
<tr>
<td>Shannon diversity index</td>
<td>0.8248</td>
<td>0.9235</td>
<td>0.9224</td>
<td>1.5398</td>
</tr>
<tr>
<td>Average perimeter area ratio</td>
<td>1059.0111</td>
<td>1428.0783</td>
<td>693.0627</td>
<td>691.0971</td>
</tr>
<tr>
<td>Spread degree</td>
<td>64.0777</td>
<td>61.0885</td>
<td>67.0027</td>
<td>53.0964</td>
</tr>
</tbody>
</table>

**Table 6: Test sample error.**

<table>
<thead>
<tr>
<th>Sample number</th>
<th>2</th>
<th>11</th>
<th>17</th>
<th>23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patch density</td>
<td>18.9952</td>
<td>-1.2040</td>
<td>-0.9760</td>
<td>0.0170</td>
</tr>
<tr>
<td>Shannon diversity index</td>
<td>-729.0094</td>
<td>307.9940</td>
<td>-0.1029</td>
<td>-0.5096</td>
</tr>
<tr>
<td>Average perimeter area ratio</td>
<td>-0.8021</td>
<td>0.0965</td>
<td>0.2189</td>
<td>-0.0088</td>
</tr>
<tr>
<td>Spread degree</td>
<td>-17.0065</td>
<td>3.9957</td>
<td>-0.2045</td>
<td>-0.0127</td>
</tr>
</tbody>
</table>
to further deepen the content of urban planning green space and put forward systematic and controlling planning points for urban green space construction, which is difficult to avoid the lag of planning.

The theories and methods of landscape ecology provide a theoretical basis for the study of urban green space spatial pattern. The application of GIS and artificial neural network in the analysis of landscape ecological pattern provides technical support for the study of urban green space layout. Through its learning ability, the artificial neural network can well simulate the relationship between urban green space composition and green space landscape pattern. After repeated training and testing of the network, a green space network with strong generalization and promotion ability can be obtained. On this basis, it can predict the quadrats of various green space proportions to judge whether it is in line with the actual situation of green space development in the study area.

Data Availability

The dataset can be obtained from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References


