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*Research Article*

# Optimization of Suzhou Garden Infrastructure Layout Based on Federal Learning

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Along with the accelerating urbanization process in China, the problem of urban infrastructure layout has become increasingly prominent. The high density of buildings and the extremely unreasonable distribution of infrastructure make the development face great resistance. This paper reveals the problems in the layout of garden infrastructure by studying and analyzing the theoretical foundations of federal learning and distributed learning and provides an in-depth analysis and elaboration of the problem. The paper uses the shape index and landscape index of green infrastructure (green space, arable land, and water bodies), the average width of roads, road network density, and weighted buildings to conduct a comparative study through the differences in ventilation speed and temperature at different layout garden scales. According to the problems existing in the garden layout in the experimental results, corresponding improvement measures are targeted, and the infrastructure layout of the garden is combined with ecology to make the layout within the garden more suitable.

## 1. Introduction

*1.1. The Current State of Green Infrastructure Development.* As urbanisation continues to increase, more people are living in cities, and cities are becoming larger, the original pattern of the countryside and natural areas surrounding dotted cities is gradually shifting in the opposite direction of the map bottom relationship. As urbanization accelerates, the green patches within the city are gradually fragmenting, especially as a large number of residential areas are being built, fragmenting the originally connected green infrastructure in the city. In the context of improving the ecological environment of residential areas, how to create a more comfortable and healthy living environment by optimizing the layout of green areas in residential areas, while ensuring good ventilation and light conditions in residential areas, has become an urgent issue. Current research on the layout of green infrastructure is mainly focused on the urban and regional scales. The article is examined at the community scale, where little attention has been paid to the issue of community scale green infrastructure planning patterns through specific plant configurations and paved surface practices for green infrastructure to cope with surface runoff, thus allowing urban stormwater management issues to be controlled.

The development and proper functioning of gardens cannot be guaranteed without the support of various infrastructures, and the concept of green infrastructure was developed to emphasize the importance of considering green facilities as something similar in nature to roads and utility networks. It is a national natural life support system, a network of natural areas and open spaces with internal connectivity, emphasizing the connectivity of the whole, that is, the interconnectedness of the green network. Spatially, green infrastructure is a system of natural and man-made green space networks consisting of core areas, connecting corridors, and small sites.

Currently, the various areas of green space within the garden are isolated from each other. Isolated patches of green space will limit contact between the organisms within them and other populations, leading to an island effect on the survival and development of organisms within the patch, which will reduce biodiversity in the long term and is therefore detrimental to the ecological development and balance of the environment as a whole. The concept of green infrastructure considers more than just "green" and includes two basic functions: firstly, to serve the rest, health, and aesthetic needs of the public by protecting and connecting dispersed green spaces. The second is to protect and connect natural areas to maintain biodiversity and avoid environmental fragmentation [1]. A scientific and rational green infrastructure planning system should be multiscale; a single-scale green infrastructure planning cannot give full play to the effectiveness of green infrastructure and take targeted measures in the planning process because the planning objectives cannot be clearly defined.

In recent years, Morphological Spatial Pattern Analysis (MSPA) has been introduced into the planning and design of green infrastructure networks to identify centres and connections within the green infrastructure. MSPA is an image processing method that can more accurately discern the type and structure of a landscape [2], and uses a series of image processing rules to identify centres, connections, and other features associated with green infrastructure after reclassifying the raster land cover map into the foreground (green infrastructure elements) and background (nongreen infrastructure elements) [3].

The main factor affecting the connectivity of green infrastructure within gardens is that buildings and plot roads block the connection of green spaces. As the concept of conscious connectivity is lacking in planning and design, there are ways to improve the landscape pattern of green infrastructure within gardens and enhance connectivity. Buildings consume a lot of energy as artificial grey infrastructure providing housing for humans. By installing climbing plants on the walls of buildings, not only can the ecological performance of the buildings themselves be improved, but the blocking effect of the buildings on the green infrastructure can also be reduced.

Optimising the design of hard surface paving such as roads is also essential. Roads are essential as a transport link space within the gardens. Carriageways need to have sufficient load-bearing capacity to meet traffic and firefighting requirements, while pavements on footpaths and squares can be ecologically transformed. More permeable green surfaces should also be installed, not only to reduce surface runoff but also to strengthen the connections between the core areas of green space.

Setting up connecting corridors can effectively increase regional connectivity. The current internal planning and design of gardens are more concerned with the aesthetics of form and the requirements of use and function and less concerned with the ecological role of the landscape. Most of the green areas in the internal planning and design of gardens are small patches of isolated green areas, lacking connecting corridors and with low landscape connectivity. This can be achieved by adding linear green infrastructure elements, such as water systems and green roads, to connect the different core areas and form an interconnected green infrastructure network.

*1.2. Current State of Federal Learning Research.* The optimization produced by the federal learning model for the layout of landscape infrastructure can effectively solve the layout problems that currently exist and make the layout of the infrastructure more rational. With the rapid development of big data, federation learning has received more and more attention and many research works now exist to improve the performance of federation learning from different perspectives. In terms of communication efficiency, McMahan et al. [4] designed an algorithm for deep network federation learning based on iterative model averaging the federation averaging algorithm, which can improve communication efficiency well. Konečný et al. [5] focused on communication efficiency in federation learning systems and proposed two methods (structured update and sketch update) to reduce uplink communication costs. Smith et al. [6] propose a system-aware optimization approach to consider high communication costs, confusion, and fault tolerance in distributed multi-task learning. Lalitha et al. [7] propose a distributed learning algorithm to train machine learning models through a network of users in a fully decentralized framework.

In terms of privacy and security, Bonawitz et al. [8] designed a novel, communication-efficient, fault robust protocol for securely aggregating high dimensional data. Chamikara et al. [9] address the data privacy leakage problem through a distributed perturbation algorithm called DISTPAB, which distributes asymmetries in a distributed environment by exploiting them for privacy preserving tasks, thereby alleviating computational bottlenecks.

In terms of model convergence, Wang et al. [10] analyzed the convergence bound for distributed gradient descent from a theoretical perspective and proposed a control algorithm that trades off between local updates and global parameter aggregation to minimise the loss function for a given resource budget. Sprague et al. [11] proposed a new asynchronous federation learning algorithm and investigated the convergence speed of the algorithm relative to training the same model on a single device training the same model on a single device, and investigated the convergence speed of the algorithm when distributed over multiple edge devices with stable data constraints.

In terms of federation learning applications, Bonawitz et al. [12] built a Tensorflow-based production system for federation learning in the mobile device domain. Leroy et al. [13] proposed a practical approach based on federation learning to solve out-of-domain problems by continuously running embedded speech-based models.

In addition, Kim et al. [14] proposed a blockchain federation learning (BlockFL) architecture in which local learning model updates can be exchanged and verified. Malle et al. [15] proposed an architecture for federated learning based on personalized recommendations from client devices to jointly create and enhance global knowledge graphs. In this network, individual users will train their local recommender engines while a server-based voting mechanism will aggregate the client side models being developed, thus preventing overly subjective overfitting of data that would compromise the global model. By utilizing the consensus mechanism in blockchain [16], allows ondevice machine learning without any centralized training data.

Research on federation learning can be seen to focus on three main areas: (1) reducing the communication overhead during training, (2) improving the security of the training process, and (3) analysis of the convergence of federation learning at a theoretical level. However, the issue of effectively optimizing the layout of the garden infrastructure while protecting data privacy has not been fully investigated. This paper takes a fresh look at the training efficiency, accuracy, and multiple influencing factors of federated learning to effectively improve the performance of federated learning systems.

## 2. Federal Learning Works

Federated learning [17, 18] is an emerging distributed learning technique designed to enable endpoint data and personal data privacy, allowing for efficient machine learning with multiple participants and multiple computing nodes. In terms of the overall framework, the distributed learning system consists of the following modules: a data and model partitioning module, a stand-alone optimization module, a communication module, and a data and model aggregation module. The distributed learning framework is shown in Figure 1.

Although distributed learning [19, 20] has many similarities to federal learning, in distributed learning, the worker nodes have no decision-making power, and everything is controlled by a central node. Each worker node in federated learning has full autonomy over the local data and can autonomously decide when and how to join federated learning for modeling, and federated learning places more emphasis on protecting data privacy.

Federated learning aims to collaboratively train shared models with private data on different edge devices while protecting data privacy. The process of federated learning is illustrated in Figure 2, which gives the details of how it works.

It is important to note that the training completion time is not important for each edge device, as the edge devices can adjust the amount of work they need to do per training. However, if some devices take too long to train during a training round, the rest of the devices that have completed training will have to wait for that device to complete the round, which will cause the whole training process to take more time to converge.

## 3. Design of Methods for Optimizing the Layout of Garden Infrastructure

This paper examines the indicators of green space, cultivated land, water bodies, shape index, landscape index, average road width [21], road network density, and weighted buildings. Due to the dense garden buildings, the roads are mostly hard-surfaced, leading to relatively prominent thermal environment problems, showing a strong heat island effect with multiple high-temperature centres concentrated [22]. Therefore, the garden is selected as the object of study in this paper, and the data on temperature changes within the garden from 1981 to 2020 are given in Table 1.

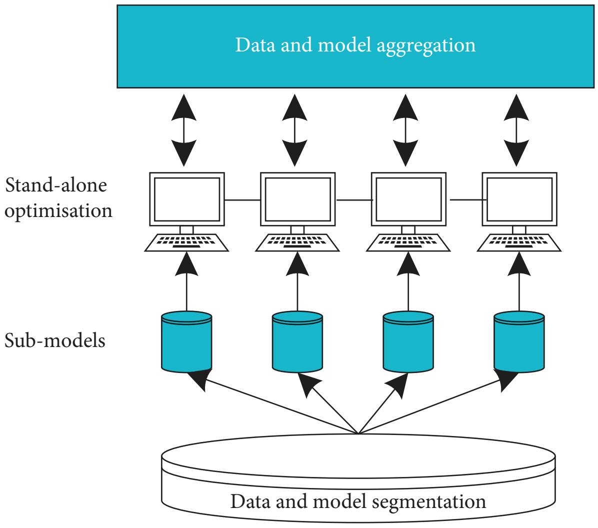


Figure 1: Distributed learning framework.

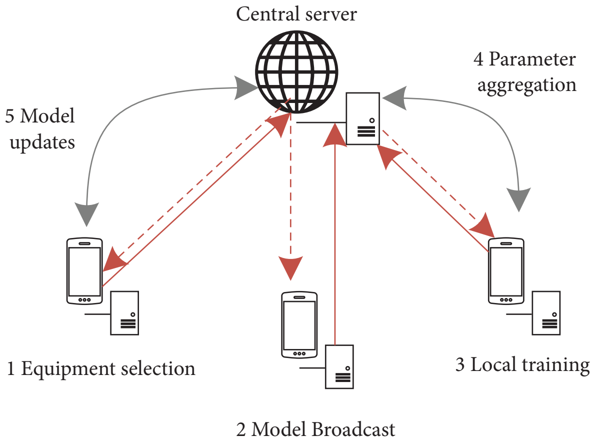


Figure 2: Principle of federal learning.

The curve of the average temperature change in the gardens from 1991 to 2020 is shown in Figure 3. It can be seen that the average temperature within the gardens has increased year on year, leading to an increase in the thermal environment problems within the gardens, probably due to the reduction in ventilation caused by the poor layout of the infrastructure, which has caused the problem of increasing temperatures year on year.

The EU is ambitiously committed to a low-carbon energy and economic transition by 2050. This low-carbon transition implies a sustainable energy development path based on renewable energy sources, which should first address energy poverty, vulnerability, and equity issues and the same development issues for the layout of landscape infrastructure [23].

## 4. Experimental Analysis

*4.1. Factor Selection and Indicator Structure.* The quantification of the ventilation potential or surface roughness of gardens is partly based on the use of CFD simulations and

Table 1: Detailed data on the average temperature of the gardens from 1991 to 2020.

| Year | Temperature (°C) | Year | Temperature (°C) | Year | Temperature (°C) |
|---|---|---|---|---|---|
| 1991 | 16 | 2001 | 16.2 | 2011 | 16.2 |
| 1992 | 15.9 | 2002 | 16.1 | 2012 | 16.8 |
| 1993 | 15.8 | 2003 | 15.7 | 2013 | 16.9 |
| 1994 | 16 | 2004 | 16 | 2014 | 16.8 |
| 1995 | 15.5 | 2005 | 16.3 | 2015 | 16.7 |
| 1996 | 15.6 | 2006 | 16 | 2016 | 16.6 |
| 1997 | 15.6 | 2007 | 15.6 | 2017 | 17.3 |
| 1998 | 16.5 | 2008 | 16.3 | 2018 | 17.2 |
| 1999 | 15.7 | 2009 | 17.2 | 2019 | 16.5 |
| 2000 | 15.5 | 2010 | 16.7 | 2020 | 17.4 |

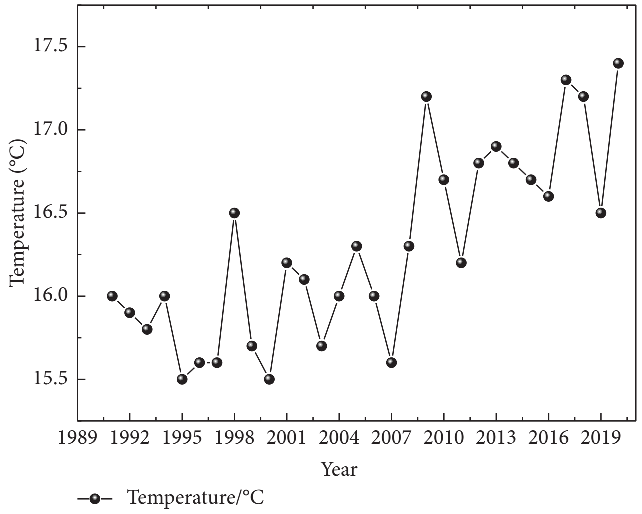


Figure 3: Graph of average temperature change in gardens 1991–2020.

validation measurements to analyse the correlation between factors and ventilation. The other part is based on garden meteorology, combined with relevant indicators from building morphology, landscape ecology, and garden planning, to analyse and measure the characteristics of building assemblage patterns and ecological patches. Either the surface ventilation potential is assessed directly or the optimization of the thermal environment is used to indirectly characterize the ventilation potential of the garden; a typical listing is shown in Table 2.

From a holistic perspective, the factors that influence the potential for surface ventilation include buildings, roads, green spaces, water bodies, and many others. The open spaces such as green spaces and water bodies and the surrounding buildings are in a "bottom of the map" relationship with each other, with close energy flow, and should be considered as a whole. Based on interviews with two associate professors and PhD students in landscape architecture, two in urban and rural planning, and one in meteorology, the "existing GI", "potential GI" and "GI map base space," were selected. "The impact of the infrastructure layout of the internal elements on ventilation was compared from the perspectives of scale and layout, respectively. The evaluation system constructed is shown in Table 3.

*4.1.1. Indicator Meaning.* The established GI evaluation indicators include a landscape index (PLAND) and a shape index (SHAPE) for green spaces, water bodies, and arable land, which describe their scale and layout characteristics, respectively. The landscape index (PLAND) represents the proportion of a certain type of landscape within a certain range in the total and is calculated as:

$$\text{PLAND} = \frac{A_i}{A}, \tag{1}$$

where $A_i$ represents the area of a particular type of landscape within the evaluation unit and $A$ represents the total area of the evaluation unit. The landscape indices of ecological patches such as arable land, water bodies, and green areas have a great positive influence on the landscape environment. With the same landscape index for natural patches, differences in the layout of patches also have an impact on the ventilation potential, and three different layout characteristics are given in Figure 4.

The shape of patches index (SHAPE) was introduced as a supplement to the landscape index and is calculated as

$$\text{SHAPE} = 0.25 \times \frac{P_i}{\sqrt{a_i}}, \tag{2}$$

where $P_i$ represents the length of the boundary of the plaque $i$ within the evaluation unit and $a_i$ represents the area of the plaque. The larger the value, the more complex the shape of the patch and the longer the exchange interface between the patch and the air of the surrounding environment, thus facilitating the convection of cold air in the space and hot air in the surrounding action space, indicating a more rational infrastructure layout of the patch.

The potential GI evaluation index was combined with the perceived ventilation capacity of roads in the established literature and was only calculated for roads above 20 m in this paper. Although the size of the angle between the road alignment and the prevailing wind direction also affected the ventilation potential, the study area had a spiderweb of roads, with significant differences in alignment in all areas except within the first ring road, which was relatively consistent. In this paper, two indicators, such as average road width and road network density, were selected for testing.

The average width of the road is calculated by the formula:

Table 2: Typical research results on urban ventilation potential.

| Interdisciplinary | Key indicators |
|---|---|
| Architectural morphology | Windward area of building |
| Architectural morphology | Sky openness, street height to width ratio |
| Landscape ecology | Landscape index, green space patch aggregation |
| Landscape ecology | Greenfield patch area, greenfield patch shape index |
| Urban planning | Water area, green area, building density |

Table 3: Detailed distribution of evaluation systems.

| Subject of evaluation | Evaluation perspective | Evaluation indicators |
|---|---|---|
| Both G1 | Size | W1 greenspace landscape index |
| | | W2 water body landscape index |
| | | W3 arable landscape index |
| | Layout | W4 green space shape index |
| | | W5 water body shape index |
| | | W6 arable shape index |
| Potential G1 | Size | W7 average road width |
| | Layout | W8 density of road network |
| G1 chart bottom space | Size and layout | W9 weighted building windward area density |

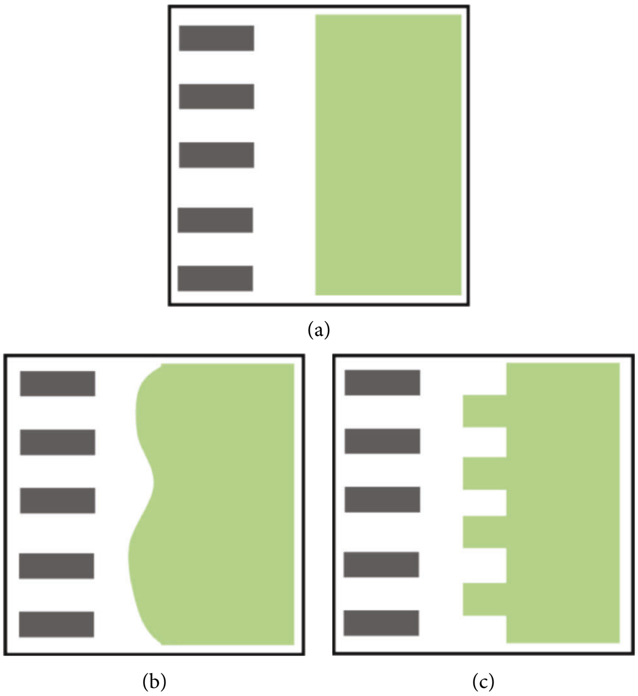


Figure 4: Illustration of different layout features under the same landscape index. (a) Smaller air exchange interface, (b) general air exchange interface, (c) large air exchange interface.

$$ARW = \frac{\sum_n^{i=1} W_i L_i}{\sum_n^{i=1} L_i}, \quad (3)$$

where $W_i$ and $L_i$ represent the red line width and actual length of the $i$ rd road within the evaluation unit. A higher *ARW* value indicates a wider ventilation corridor, a stronger ventilation potential for the corresponding unit, and a more rational road layout.

The density of the road network is calculated by the formula:

$$\text{RND} = \frac{\sum_{i=1}^n L_i}{A}, \quad (4)$$

where $L_i$ represents the actual length of each road within the evaluation unit and $A$ represents the total area of the evaluation unit. The higher the value, the more dense the ventilation corridor is and the greater the ventilation potential of the corresponding unit.

The evaluation indicators for the bottom space of the GI diagram show that the average building height (ABH), building density (BD), building volume ratio (FAR), sky openness (SVF), and building windward area density (FAD) are all influential factors for the landscape. The FAD indicator with weighted wind direction and wind frequency covers the main characteristics of ABH, BD, and FAR and is clearly covariant with SVF, which are important factors in determining whether the infrastructure layout is reasonable.

Considering the covariance of all factors and the simplicity of the system, the weighted windward area density of buildings is selected as the evaluation index, which can reflect the scale and layout characteristics of the building in a balanced manner, and its calculation formula is

$$\begin{aligned} \lambda_{F(\theta,z)} &= \frac{A_{(\theta)\mathrm{proj}(z)}}{AT}, \\ \lambda_{F(z)} &= \sum_{16}^{i=1} \lambda_{F(\theta,z)} P_{(\theta,i)}, \end{aligned} \tag{5}$$

where $A_{(\theta)\mathrm{proj}(z)}$ is the projected area of the windward side of the building for a given wind direction $(\theta)$ and average building height $(z)$, $AT$ is the total area of the evaluation unit, $P_{(\theta,i)}$ represents the wind frequency at the $i$ th wind direction position and $\lambda_{F(z)}$ is the weighted 16 wind direction position FAD value.

*4.1.2. Division of the Evaluation Unit.* In the process of dividing the evaluation units, as spatial carriers within the study garden, the way in which the boundaries are divided and the scale of the units should be fully considered. Both the green infrastructure and the building spaces that intersect with it are important factors that influence the wind environment, and it is necessary to evaluate the objective integrity of these factors. Four methods of dividing evaluation units are given in the paper, as shown in Figure 5. The third method is unable to measure the ventilation potential of the road, and the different sizes and shapes of the evaluation units are not conducive to the identification of potential wind corridors at a later stage, so the fourth method is finally chosen as the division of the evaluation units in this paper.

*4.2. Calculation of Indicator Weights by Hierarchical Analysis.* The hierarchical analysis considers the problem to be decided as a system of multiple influencing factors and extracts the evaluation indicators of the influencing factors at multiple levels in the system. A judgment matrix is constructed between each level so that the optimal solution is derived based on the weights of the evaluation indicators. The hierarchical analysis method is divided into four steps: building a hierarchical model, constructing a judgment matrix, testing the consistency of the hierarchical single ranking, and testing the consistency of the hierarchical total ranking.

The hierarchical analysis method is used to construct a structural model for the evaluation of factor indicators affecting the layout of landscape infrastructure with the aid of Yaahp software. The target layer of the model is the urban ventilation potential. The criterion layer contains the existing GI ventilation potential as well as the potential GI ventilation potential and the GI map-bottom space ventilation potential. The indicator layer contains the green space landscape index, water landscape index, cultivated land landscape index, green space shape index, water shape index, cultivated land shape index, average road width, road network density, and building windward area density, respectively.

In this paper, 2 professors, 3 associate professors, 3 PhDs, and 10 practitioners in the fields of landscape architecture, urban and rural planning, and climatology were invited to assign scales. 16 valid questionnaires were returned, with an effective rate of 87.5%. When comparing two impact factors, a certain scale value is used to indicate the importance of the two indicators, so that subjective judgements can be quantified in numerical terms. For comparing the importance of indicators, a scale of nine numbers from 1 to 9 is usually used. The meaning of these nine numbers is shown in Table 4.

These scales are worth the visual comparison effect shown in Figure 6, from which it can be seen that the importance of the indicator is proportional to the corresponding number, with larger figures indicating a higher importance of the indicator.

Due to the complexity of the factors influencing the layout of the infrastructure in the garden, there is a large difference between the front and back scales when the assessors compare two indicators. The consistency of the judgment matrix is also random, which requires the introduction of an average random consistency index RI value for the judgment matrix and the automatic correction of inconsistent questionnaires using a correction tool.

$$\begin{aligned} CR &= \frac{CI}{RI}, \\ CI &= \frac{\lambda_{\max} - n}{n - 1}, \end{aligned} \tag{6}$$

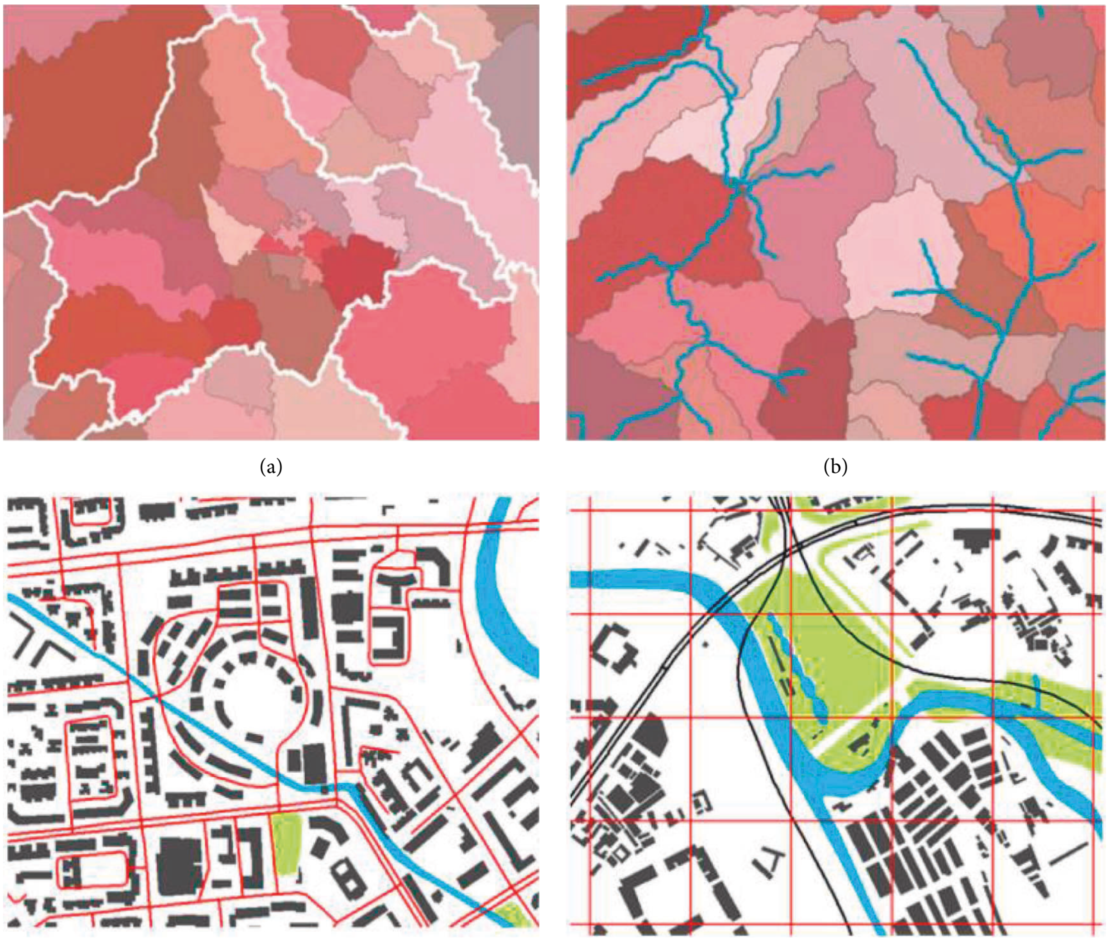
$n$ is the order of the judgment matrix. When $CI$ is larger, the consistency of the judgment matrix is worse, when $CI$ is closer to 0, it means the consistency of the judgment matrix is better, when $CI = 0$, it means the judgment matrix satisfies the consistency completely.

Where $RI$ is a random consistency indicator, which is related to the order of the judgment matrix, the correspondence of which is shown in Table 5.

When $CR < 0.1$, the judgment matrix passes the consistency test, when $CR \geq 0.1$, the judgment matrix does not satisfy the consistency test and needs to be corrected to make $CR < 0.1$.

After averaging the revised values of the 16 valid questionnaires, the weights of each indicator were obtained as shown in Table 6.

*4.3. Entropy Weighting Method.* The entropy weighting method can overcome both the subjectivity of the hierarchical analysis method in determining weights and the repetitiveness of the attributes of multiple indicators and is suitable for the evaluation of objective data and diversified comprehensive indicators. Its principle lies in reflecting the



(a) (b) (c) (d)

Figure 5: Four ways of dividing evaluation units. (a) Illustration of units by administrative boundaries, (b) schematic representation of units by sub-catchment, (c) illustration of the division of units by road boundaries, and (d) illustration of cell division by grid boundaries.

Table 4: Indicator importance scale value.

| Type of indicator | Indicator value |
|---|---|
| Equally important | 1 |
| Slightly important | 3 |
| Significantly important | 5 |
| Strongly important | 7 |
| Extremely important | 9 |
| Between the above | 2, 4, 6, 8 |

amount of information through the degree of disorder of the data. If the entropy value of an evaluation indicator is higher, the greater the uncertainty, the smaller the amount of information it contains, the less important it is in the system, and the smaller the weight it takes up accordingly. The weighting data of the nine indicators calculated by the entropy weighting method are shown in Table 7.

*4.4. Combined Weighting Method.* The integrated weighting method is calculated using the following formula.

$$M_i = \frac{A_i + B_i}{2}, \tag{7}$$

where $M_i$ indicates the final weight for the indicator $i$, $A_i$ indicates the weight of the indicator $i$ obtained by subjective evaluation using the hierarchical analysis method, $B_i$ is the weight of the entropy weight method, and indicates the weight of the indicator $i$ obtained by objective evaluation using the entropy weight method. The comprehensive weights of the indicators are calculated as shown in Table 8.

The results of comparing the combined indicator weights with the weights of the AHP and entropy methods are shown in Figure 7.

*4.5. Discussion.* The deterioration of the ecological environment worldwide since the twentieth century has posed a challenge to the construction of urban spaces. With urbanization, resource and energy consumption have increased, biodiversity levels have declined, environmental pollution is approaching critical levels, and the conflict between human habitat activities and the ecological environment is becoming increasingly prominent. The

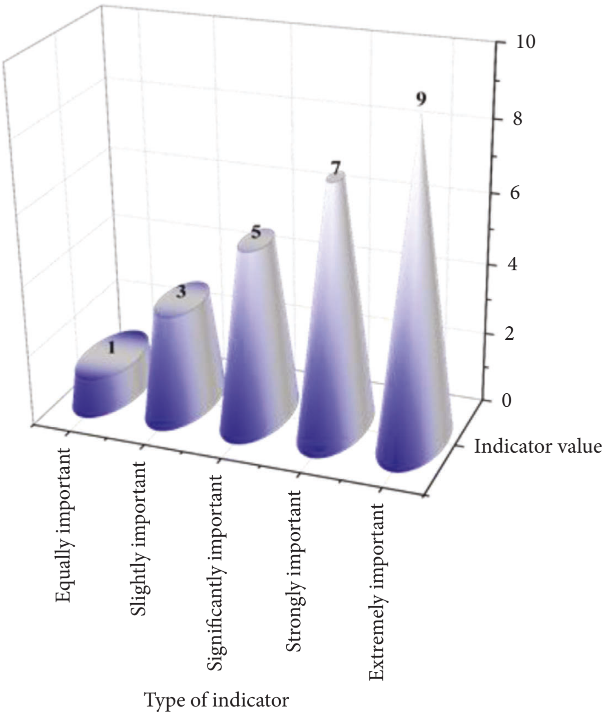


Figure 6: Comparison of the importance of indicator types.

Table 5: Random consistency indicators.

| $n$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| RI | 0.02 | 0.23 | 0.48 | 0.90 | 1.02 | 1.28 | 1.41 | 1.46 | 1.52 |

sustainable development of urban space and its economic and social benefits, balancing quality of life and ecological environment, has become a new and important topic to be explored. This study ranks the indicators of the evaluation system of sustainable development of urban space in less economically developed but ecologically resource-rich regions through systematic coupling analysis and quantitative analysis of synergistic evaluation information. The influence of urban spatial elements on sustainable urban development is revealed [24].

Due to the current population explosion, the existing spatial layout of gardens is no longer suitable for people. The increase in the number of people's activities within the gardens has had an impact on the layout of the gardens. In order to better extend the life of the public infrastructure, it is necessary to further optimise the spatial layout structure of the public infrastructure. At the same time, the ecological carrying capacity of the garden ecosystem is being further tested, so we should increase the ecological linkage between the public infrastructure of the garden and the ecology. Ecological pressure. For large-scale applications within gardens, it is necessary to design different amounts and scales of ecological public infrastructure depending on the different areas of the garden.

The field measurements were used to test the reasonableness of the computer simulation results and are necessary to identify the different ventilation in different infrastructure layouts. In order to make the measured nodes reflect the general characteristics of different types of minimum resistance paths as far as possible, four main categories of six nodes were selected: (1) Important traffic nodes C and *E*. (2) Large park nodes B. (3) River corridor nodes A and F. (4) Dense building nodes *D*.

The weather in the garden on the day of the site of measurement was cloudy, with no sustained winds at levels 1-2 and an average temperature of 19°C. The height of the measurement was 1.5 m. The measured height was 1.5 m. The maximum wind speed and maximum temperature within 5 minutes were measured. The difference in wind speed was most pronounced in area B due to the large green areas and less so in area C due to the density of construction in the garden centre.

By analyzing the influence of nine indicators on the ventilation within the garden at the six measured nodes and calculating the combined weights of each indicator, the wind speed and temperature data at the six nodes with different infrastructure layouts were compared to identify the best results, as shown in Table 9.

A pie chart comparing wind speed and temperature data in the six nodes are shown in Figure 8. As can be seen from the graph, nodes C and *E* are traffic-oriented nodes with wide areas, so the wind speed is maximum and the corresponding temperature is at the right level. Node *D*, on the other hand, is located in a dense building where ventilation is poor and the technical facilities are locally closer together, which affects the entry of the wind, and the wind speed at *D* is low and the temperature is highest a highly unreasonable layout. Nodes A and F are located in the river, where the wind speed is higher and the difference in wind speed is higher, and the temperature is lower, the layout here is the opposite of D. A balanced adjustment of the two areas should be made. Node B is located in a park, where the infrastructure is well distributed and well landscaped, so the wind and temperature are appropriate.

With the growing demand for small urban green infrastructure, understanding public perceptions of small urban green infrastructure is important for future urban planning and decision-making [25]. The article uses a federal learning approach to the scientific and rational spatial layout of public infrastructure in gardens so as to improve the ecological control of gardens.

This process not only promotes the beneficial development of the ecological environment of the garden but is also essential for achieving sustainable development of the garden. Firstly, when carrying out the spatial layout of the garden's public infrastructure, it is important not only to understand the different disturbing factors in each area of the garden but also to make a more detailed assessment of the green development of the garden, for example, the changes in the oxygen content of the water bodies in the garden and the construction area of the green areas in the garden. Secondly, some ecological public infrastructure can be appropriately arranged in the garden, such as green gardens and ecological green areas, which can make use of

Table 6: Weighting of indicators obtained by hierarchical analysis.

| Guideline level indicators | Weight | Indicator layer indicators | Weighting |
|---|---|---|---|
| Both G1 | 0.492 | W1 greenspace landscape index | 0.081 |
| | | W2 water body landscape index | 0.083 |
| | | W3 arable landscape index | 0.196 |
| | | W4 green space shape index | 0.050 |
| | | W5 water body shape index | 0.065 |
| | | W6 arable shape index | 0.017 |
| Potential G1 | 0.287 | W7 average road width | 0.187 |
| | | W8 density of road network | 0.100 |
| G1 chart bottom space | 0.211 | W9 weighted building windward area density | 0.221 |

Table 7: Entropy weighting of the indicators obtained by the entropy weighting method.

| Indicator layer | Information entropy value | Information utility value | Indicator weights |
|---|---|---|---|
| W1 greenspace landscape index | 0.711 | 0.289 | 0.195 |
| W2 water body landscape index | 0.688 | 0.312 | 0.211 |
| W3 arable landscape index | 0.805 | 0.195 | 0.132 |
| W4 green space shape index | 0.885 | 0.115 | 0.078 |
| W5 water body shape index | 0.954 | 0.046 | 0.031 |
| W6 arable shape index | 0.913 | 0.087 | 0.059 |
| W7 average road width | 0.916 | 0.084 | 0.057 |
| W8 density of road network | 0.876 | 0.124 | 0.084 |
| W9 weighted building windward area density | 0.774 | 0.226 | 0.153 |

Table 8: Final weights determined by the composite indicator method.

| Indicator layer | Weights obtained from AHP | Weights obtained by the entropy method | Combined weights |
|---|---|---|---|
| W1 greenspace landscape index | 0.081 | 0.195 | 0.138 |
| W2 water body landscape index | 0.093 | 0.211 | 0.147 |
| W3 arable landscape index | 0.196 | 0.132 | 0.164 |
| W4 green space shape index | 0.050 | 0.078 | 0.064 |
| W5 water body shape index | 0.065 | 0.031 | 0.048 |
| W6 arable shape index | 0.017 | 0.059 | 0.038 |
| W7 average road width | 0.187 | 0.057 | 0.122 |
| W8 density of road network | 0.100 | 0.084 | 0.092 |
| W9 weighted building windward area density | 0.221 | 0.153 | 0.187 |

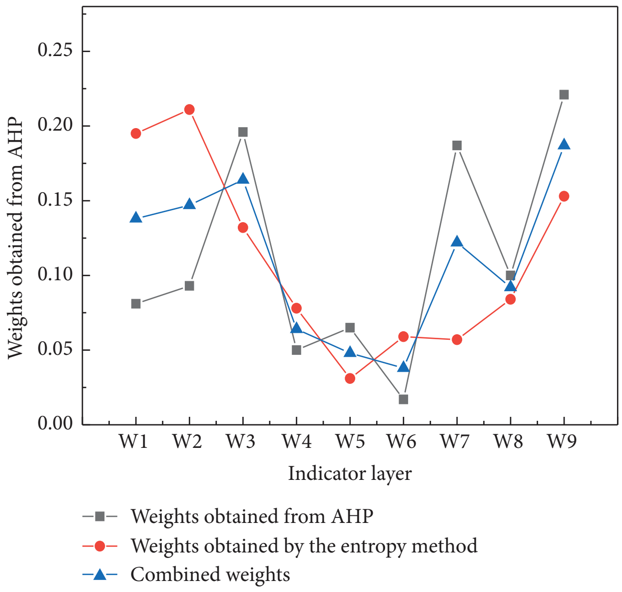
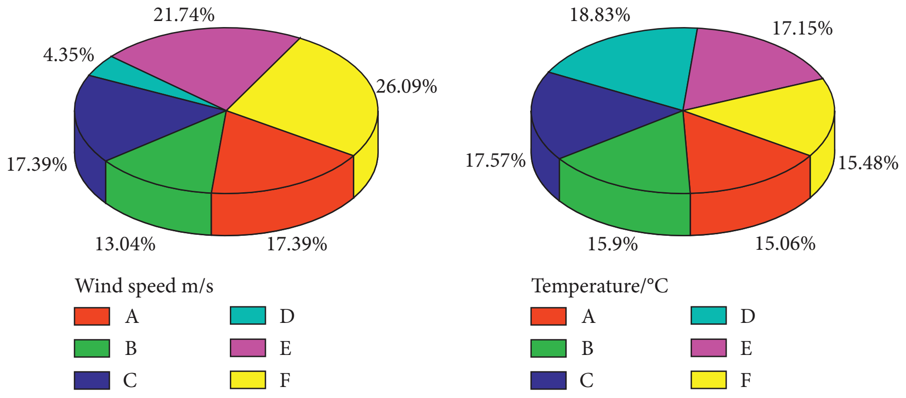


Figure 7: Comparison of the weight values of the three methods.

Table 9: Comparison of wind speed and temperature data for the 6 nodes.

| Nodes | Wind speed m/s | Temperature (°C) |
|---|---|---|
| A | 2 | 18 |
| B | 1.5 | 19 |
| C | 2 | 21 |
| D | 0.5 | 22.5 |
| E | 2.5 | 20.5 |
| F | 3 | 18.5 |

their own ecological restoration capacity to maintain the ecological environment of the garden. In terms of spatial layout, these public infrastructures should be set up in a certain proportion, and different amounts and scales of ecological public infrastructure should be designed according to different areas of the garden. Finally, the number of infrastructures in different areas should be coordinated, combining the number with the corresponding needs in a reasonable way to further optimise the infrastructure layout.



(a) (b)

Figure 8: Comparison of wind speed and temperature data in 6 nodes. (a) Wind speed, (b) temperature.

## 5. Conclusion

The planning of the layout of green infrastructure concerns the basic life of residents. It is not only a guiding strategy to solve a series of problems but also one of the most important ways to enhance people's happiness in life. In this paper, the shape index and landscape index of green infrastructure (green space, cultivated land, and water bodies), the average width and road network density of roads, and the weighted building windward area density of buildings are selected as the influencing indicators, and the comprehensive weights of each indicator are obtained by using hierarchical analysis and the entropy weighting method. The experimental results show that the differences in wind speed and temperature in the different zones are due to the differences in their structures and that these differences have a significant impact on the layout of the infrastructure. According to the results of the experiments, the infrastructure in different areas should be integrated and some of the facilities in the less populated areas should be placed in the densely populated built-up areas, this approach can also improve the ecological environment of different areas. It is hoped that the layout optimization method proposed in this paper will serve as a guide to the spatial optimization of garden infrastructure.

## 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 they have no conflicts of interest.

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